15 Traffic Noise and Vibration

This chapter considers likely noise and vibration impacts due to road traffic for receptors in the vicinity of the Northern Leg. A total of 291 residential properties were identified within 300m and an additional 185 within 300-500m. Noise modelling was undertaken for all properties within 300m, and 42 were selected as sample receptors to illustrate the predicted noise in the Year of Opening and the Design Year, both with and without the proposed scheme.

Where possible, noise mitigation is proposed for potential impacts of Moderate or worse significance with a noise level of over 59.5dB $L_{A10(18hr)}$. Mitigation includes incorporated elements of the road design such as embankments and low noise road surfacing, plus acoustic screens to provide noise attenuation for specific receptors.

At ground floor, with mitigation, for the Year of Opening there are an estimated 126 properties within 300m that would experience an increase in noise level of at least 1dB, and 70 that would experience a decrease of at least 1dB. For the Design Year the corresponding number of properties is 130 and 86 respectively. At ground floor there are an estimated 186 properties where the change in the noise level would result in an increase in the percentage of people bothered by noise and 105 properties where the change would result in a decrease.

At ground floor, with mitigation it is predicted that 4 properties in the Year of Opening and 5 in the Design Year will experience residual impacts that exceed the desired mitigation threshold. The results also indicate that 1 property may also qualify for noise insulation.

At first floor for the Year of Opening, with proposed mitigation, it estimated that 118 properties within 300m would experience an increase in noise level of at least 1dB, and for the Design Year this increases to 126. There are 68 properties in the Year of Opening and 66 in the Design Year that would experience a decrease of at least 1dB.

The results also indicate that there 7 properties that may qualify for noise insulation at first floor (7 in the Design Year and 6 in the Year of Opening).

There are approximately 17 residential buildings within 40m that would exceed the DMRB 58 dB $L_{A10,18h}$ lower threshold for vibration assessment in the Design Year, however vibration annoyance is not considered to be a significant issue for the proposed scheme.

15.1 Introduction

15.1.1 This chapter provides an assessment of the noise and vibration impacts due to road traffic for receptors in the vicinity of the Northern Leg of the proposed scheme.

Noise

15.1.2 The World Health Organisation (WHO, 1999) defines noise as unwanted sound, and sound is measured in terms of decibels (dB). Whilst the audible range of hearing extends from 20 Hertz (Hz) to 20,000Hz, human hearing is not equally sensitive to all frequencies. Consequently, the A-weighting is used to simulate the response of the human ear and environmental noise is generally measured in terms of dB(A).

15.1.3 Generally, noise fluctuates over time and to compare different types of time-varying sound it is therefore necessary to obtain representative levels. For environmental noise this is commonly the equivalent continuous sound pressure level, the $L_{eq(T)}$. It is also possible to represent time-varying noise by means of statistical parameters such as analysis of the distribution of sound levels. For example, L_{90}, is the level exceeded for 90% of the measurement time and L_{10} is the level exceeded for 10% of the measurement time period. The index adopted by the Government to assess traffic noise is the $L_{A10(18hr)}$, which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the one hour periods between 06:00h and midnight.

15.1.4 For the purposes of assessment, noise impacts are considered as increases or decreases in road traffic or construction noise relative to the pre-existing noise levels within the area affected. When considering noise levels it may be of assistance to note that doubling or halving of the otherwise similar traffic flow is equivalent to a change of approximately 3 dB(A), and a subjective impression of a doubling of loudness generally corresponds to a 10 dB(A) sound level increase. As noise is assessed as a logarithmic ratio of pressure levels (i.e. decibels), it is sometimes helpful to consider the relationship between the subjective evaluation of noise and the actual objective levels, and examples are therefore provided in Table 15.1 below.

Table 15.1 – Typical Noise Levels and Subjective Evaluation

Noise Level dB(A)	Description
120	Threshold of pain
95	Pneumatic drill (unsilenced); 7m distance
83	Heavy diesel lorry (40 km/h at 7m distance)
81	Modern twin-engined jet (at take-off at 152m distance)
70	Passenger car (60 km/h at 7m distance)
60	Office environment
50	Ordinary conversation
40	Library
35	Quiet bedroom
0	Threshold of hearing

15.1.5 When considering noise from traffic, the main sources can be separated into two components. The first is generated by the engine, exhaust system and transmission, and is the dominant noise source when traffic is not freely flowing. This contributes a significant proportion of low frequency noise and is particularly apparent from heavy goods vehicles (HGVs) when accelerating, braking or changing gear. The second noise source component is generated from the interaction of tyres with the road surface; this is the dominant noise source under free flow traffic conditions at moderate to high road speeds, and contributes a significant proportion of higher frequency noise.

15.1.6 The noise from a stream of traffic at a receptor point is an aggregation of noise from each of a number of vehicles at various distances. There are several factors that influence the noise level experienced by the residents of a property, and these can be separated into two categories. Firstly there are factors that affect the noise emissions at source, such as volume and speed of traffic, the composition of the traffic (i.e. the percentage of HGVs), and the gradient and surface characteristics of the carriageway. Secondly there are those factors affecting the propagation characteristics, such as the distance of the receptor from the source, the topography and characteristics of the ground between the source and receptor, the presence of any screening or barrier effects, and the wind strength and direction.

Vibration

15.1.7 Traffic-induced vibration is a low frequency disturbance which can be transmitted through the air or ground. Vibration can be measured in terms of peak particle velocities, or PPVs (i.e. the maximum speed of movement of a point in the ground during the passage of a vibration). A traffic generated vibration PPV of 0.2mm/s measured on a floor in the vertical direction is generally imperceptible, at about 0.5 mm/s it is perceptible, and may become disturbing or annoying at higher levels. Air-borne vibration from traffic is produced by the engine and exhaust of the vehicle, whereas ground-borne vibration is produced by the interaction between rolling wheels and the road surface.

15.1.8 There are two effects of traffic vibration that need to be considered; the effects on buildings, and the disturbance caused to occupiers of properties. However, extensive research has been carried out on a range of buildings of various ages and types, and no evidence has been found to support the theory that traffic-induced, ground-borne vibration is a source of significant damage to buildings (Watts, 1990). As such, ground-borne vibration is not assessed in this chapter. Ground-borne

vibration is much less likely to be the cause of disturbance to occupiers than air-borne vibration (Baughan & Martin, 1981; Watts, 1984). Although there is no evidence that traffic-induced air-borne vibration can cause even minor damage to buildings, it can be a source of annoyance to local people, causing vibrations of flexible elements within properties close to the carriageway (e.g. doors, windows and occasionally floors). This chapter therefore addresses the issue of nuisance at properties caused by air-borne vibration.

15.2 Approach and Methods

15.2.1 This chapter describes the impacts that would be expected on properties in the vicinity of the Northern Leg during operation of the proposed scheme, including changes to noise and vibration levels, and perceived noise and vibration nuisance. Noise and vibration impacts due to construction are addressed separately in Chapter 18 (Disruption due to Construction).

15.2.2 The assessment of noise is made in terms of the difference between the level of noise that would be likely to be experienced with the proposed scheme (the Do-Something scenario) and without the proposed scheme (the Do-Minimum scenario) for both the Year of Opening and the Design Year (15 years later). The existing, or ambient, noise in the 'base' year of 2005 is also reported at sample properties. The use of 2005 as base year is consistent with the Air Quality assessment (Chapter 14) and available traffic data. Paragraphs 5.3.1-5.3.2 of Chapter 5 (Overview of Assessment Process) provide a description of the traffic predictions on which this assessment is based.

Legislation and Guidance

15.2.3 This assessment has been carried out with reference to the following documents:

- Design Manual for Roads and Bridges (DMRB) (The Highways Agency et al., 1993);
- Calculation of Road Traffic Noise (CRTN) (Department of Transport, 1988);
- The Noise Insulation (Scotland) Regulations 1975 (NISR);
- Memorandum on the Noise Insulation (Scotland) Regulations 1975 (Memorandum);
- Scot-TAG: Scottish Transport Appraisal Guidance (STAG); and
- World Health Organisation, (WHO), Guidelines for Community Noise, 1999.

15.2.4 The definitions of 'Core Study Area' and 'Wider Area' are provided in paragraph 15.2.5. In accordance with the requirements of DMRB Volume 11, Section 3, Part 7, this Stage 3 Assessment has been carried out by:

- identifying noise sensitive locations, and calculating the ambient and proposed noise levels to determine possible noise changes due to the scheme. Properties within the Core Study Area, (including side roads) were assessed using a three dimensional model;
- identifying properties predicted to experience an increase of 25%, or a decreases by 20% in traffic flow (equivalent to a 1dB change) were also assessed as part of the Wider Area assessment;
- identifying appropriate mitigation methods to reduce the impact of any adverse effects within 300m either side of the road centrelines. Given the predicted noise levels generated by road traffic using the proposed scheme there will not be properties beyond 300m where the mitigation criteria as detailed in paragraph 15.2.38, are met);
- undertaking a noise nuisance assessment for properties within the Core Study Area which experience a noise change of 1dB(A) or more;
- considering traffic-induced vibration; and
- estimating the number of properties likely to be eligible in terms of NISR.

Study Area

15.2.5 The operational noise has been considered within a 500m 'Core Study Area' extending to each side of the centreline of the proposed scheme. This has been extended from the more commonly accepted 300m because of the rural nature of parts of the proposed route. However, DMRB advises that beyond 300m the varying effects of wind and temperature render forecasting difficult in most circumstances and the 300m-500m study area is therefore included only to provide additional comparative information. The Core Study Area is indicated on Figure 15.1a-g.

15.2.6 The noise for the proposed scheme has been considered within three separate study areas as explained in Chapter 1 (Introduction). This chapter is therefore limited to consideration of noise and vibration impacts of the proposed scheme on properties located within the Northern Leg Core Study Area as indicated on Figure 15.1a-g. Any properties located to the south of the dividing line as shown on Figure 15.1a are considered in Chapter 30 (Southern Leg). However, impacts of traffic utilising the full proposed scheme (i.e. not the Northern Leg traffic in isolation) are considered for each receptor.

15.2.7 Within the Core Study Area, the traffic noise assessment has classified locations according to predicted ambient levels, in bands of below 50 dB(A), 50 to <60 dB(A), 60 to <70 dB(A) and ≥70 dB(A). For each band, the number of properties, and other receptors, subject to the following increases or decreases have been assessed: 1 to <3 dB(A), 3 to <5 dB(A), 5 to <10 dB(A), 10 to 15 dB(A) and over 15 dB(A). These noise bands are indicated on Figures 15.1 to 15.4.

15.2.8 A 'Wider Study Area' was also assessed and is reported separately in Chapter 54 (Cumulative Impact Assessment). The Wider Study Area assessment considers the indirect changes to noise levels as a result of altered traffic flows on the existing wider road network (caused by operation of the proposed scheme). This indirect impact on noise levels and the level of perceived noise nuisance experienced by local residents already exposed to road traffic noise may therefore occur beyond the Core Study Areas of the Northern Leg, Southern Leg and Fastlink.

Impact Assessment

15.2.9 The assessment of the significance of noise impacts was based on the sensitivity of noise receptors and the magnitude of impact in terms of predicted noise levels and extent of noise change.

15.2.10 The significance of impact was assessed by comparing future years scenarios, (i.e. Year of Opening and Design Year with and without the scheme). The difference in noise levels, together with the sensitivity of the receptors, determines the significance of impact as explained in this section.

Sensitivity

15.2.11 The criteria used to classify the sensitivity of receptors to noise as a result of the proposed scheme are defined in Table 15.2.

Table 15.2 - Criteria used to Define Noise Sensitive Receptors

Sensitivity	Description	Examples of Receptors
High	Receptors where people or operations are particularly susceptible to noise.	Residential. Quiet outdoor areas used for recreation. Conference facilities. Auditoria/studios. Schools in daytime. Hospitals/residential care homes.
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance.	Offices. Restaurants.
Low	Receptors where distraction or disturbance from noise is minimal.	Residences and other buildings not occupied during working hours. Factories and working environments with existing high noise levels.

Impact Magnitude

15.2.12 When considering two sounds with similar acoustic properties, i.e. similar spectral and temporal characteristics, a change of more than 3 dB(A) is regarded as being just perceptible to the human ear. The magnitude of impact can therefore be based on this acoustic 'rule of thumb', supplemented with the evidence contained within DMRB Vol. 11, Section 3, Part 7, Chapter 3, Paragraph 3.5. The latter highlights that 'people are more sensitive to abrupt changes in traffic noise associated with new road schemes than would be predicted from the steady state evidence. In the period following a change in traffic flow, people may find benefits or disbenefits when the noise changes are as small as 1 dB(A)'.

15.2.13 The magnitude of impact has been assessed by comparison between the increase or decrease in noise levels between the future year with and without the proposed scheme (i.e. Year of Opening and Design Year). The magnitude of impact was defined as shown in Table 15.3.

Table 15.3 - Magnitude of Impacts due to Changes in Road Traffic Noise

Change in Noise Level	Magnitude of Impact
5 dB(A) and greater	High adverse
3 to < 5 dB(A)	Medium adverse
1 to < 3 dB(A)	Low adverse
0 to < 1 dB(A)	Negligible adverse
0 dB(A)	No impact
0 to <-1 dB(A)	Negligible beneficial
-1 to < -3 dB(A)	Low beneficial
-3 to < -5 dB(A)	Medium beneficial
-5 dB(A) and greater	High beneficial

Impact Significance

15.2.14 The significance of noise impacts was determined according to the relationship between magnitude and sensitivity, as shown in Table 15.4.

Table 15.4 - Significance of Noise Impacts

Magnitude	Sensitivity		
	Low	Medium	High
High	Moderate	Moderate/Substantial	Substantial
Medium	Slight/Moderate	Moderate	Moderate/Substantial
Low	Negligible/Slight	Slight/Moderate	Moderate
Negligible	Negligible	Negligible/Slight	Slight

Assessment Methods

15.2.15 All properties within the study area were assessed in accordance with DMRB. However, for discussion purposes a number of properties and locations were selected as being representative of their locality on the basis of one or more of the following principles:

- where it has been anticipated that properties will experience significant changes in noise level;
- where properties are representative of surrounding buildings and the effects of noise will be similar; and
- where it has been considered that buildings may qualify for sound insulation.

Baseline (Ambient) Noise Monitoring

15.2.16 With regard to the determination of existing (ambient) noise levels DMRB advises that there are three basic types of ambient noise situations which can occur:

- where the ambient noise is dominated by traffic noise;
- where the ambient noise is comprised of a combination of several undefined sources, such as might be encountered in low noise sites in rural settings; or
- where the ambient noise is dominated by noise from non-road traffic sources, such as aircraft or trains.

15.2.17 For condition (i) the ambient noise should be measured using L_{A10}. For condition (ii) it is advised that the L_{A10} may be inappropriate and suggests that, while the L_{Aeq} parameter could be considered, the L_{A90} scale is a suitable alternative. For condition (iii) DMRB recommends the L_{A90}. Where the existing noise climate is determined by road traffic noise, the existing ambient levels can also be predicted using the methodology set out in the 1988 Department of Transport publication 'Calculation of Road Traffic Noise' (CRTN).

15.2.18 Long term ambient noise monitoring (i.e. over a period longer than one day) was undertaken during May and June 2005 at representative locations along the route of the proposed scheme, with additional short term measurements undertaken during June and July 2006. All instrumentation was calibrated before, and after, each measurement, and there was no significant shift in the calibration level recorded. The instrumentation used is listed in Appendix A15.1 and this includes notes on meteorological conditions prevailing during the short term measurement periods. The longer term measurements were undertaken by Jacobs and since weather conditions over an extended period of time will change no metrological data have been recorded for these measurements.

15.2.19 The long and short term monitoring locations are shown on Figure 15.1a-g. A summary of the ambient noise monitoring is included as Appendix A15.1. The monitoring locations were as follows:

- 1 Walton View Bucksburn, Aberdeen, AB21 9TL (Figure 15.1b).
- Straithbathie Cottages, Hareburn Terrace, Blackdog, Aberdeen, AB23 8BE (Figure 15.1g).
- 1 Sunnybank Cottages, Craibstone Estate, Bucksburn, Aberdeen, AB21 9ST (to be demolished, therefore not included in graphic).
- Tillybrig Cottage, Dyce, Aberdeen, AB21 0DP (Figure 15.1d).

15.2.20 The short term locations were as follows:

- Cranfield Lodge, Bridge of Don, Aberdeen, AB23 8NR (Figure 15.1g).
- 1 Lochgreens Cottages, Dyce, Aberdeen, AB21 7AS (Figure 15.1f).
- The Emmerick, Parkhill, Dyce, Aberdeen, AB21 7AT (Figure 15.1f).
- 1 Bogenjoss, Dyce, Aberdeen, AB21 0HE (Figure 15.1c).
- Parkhill Pumping Station, Dyce, Aberdeen, AB21 0HQ (Figure 15.1e).

15.2.21 All measured noise levels were taken in free field conditions (i.e. not at the façade of the property, and at least 3.5m away from any hard reflecting surface other than the ground). The measured noise readings therefore require to be adjusted to be comparable with the calculated noise levels, which are determined at the property façade (+ 2.5dB to the measured free field). A summary of the field results is contained within Appendix A15.1.

15.2.22 In all areas further than 300m from a georectified road (i.e. a road for which traffic data were collated and subsequently incorporated as an attribute of the road for use in the 3-dimensional model), the ambient descriptor was taken to be the $L_{A90(T)}$. An example of such properties is at Bogenjoss. It should be noted that for a one hour period, the L_{A90} is determined by the quietest six minutes, whereas the predicted level of traffic noise is described by the L_{A10}, which is determined by the noisiest six minutes. Therefore, it is possible that in evaluating the effects for areas with no existing traffic, the DMRB comparison of the L_{A10} and the L_{A90} can, in certain circumstances, lead to some distortion of impact, i.e. the difference between the ambient and the predicted noise levels will be over estimated. DMRB expects that once the scheme is in place, the L_{A90} will tend towards the L_{A10}. Any possible exaggeration of impact will be illustrated by considering the measured results for L_{A90} and L_{A10} from an area where the existing noise climate is dominated by road traffic.

Traffic Noise Prediction

15.2.23 The prediction of traffic noise levels were calculated using Cadna® software, which adopts the algorithms contained within CRTN. Ground contours were supplied by Jacobs, and the building locations were identified using OS Mastermap data under license from the Scottish Executive (in some instances these locations were amended by the Jacobs Survey Department). In addition to this, buildings were classified by type (e.g. residential, commercial) using Address Point Data.

15.2.24 Using the methodology set out in CRTN, noise levels were calculated at all properties within 500m of the current road network with the base year, as well as with and without the proposed scheme in the Year of Opening, and Design Year. Calculations were based on predicted levels at a point 1m in front of the most exposed façade (unless in open areas, such as Murcar Golf Club, where the levels are reported as free field levels). All calculations are based on the predicted traffic flows as described in Chapter 5. Noise calculations have been undertaken using Annual Average Weekday Traffic values (AAWT; 18hr, 5 day average) provided by MVA. All traffic data have been derived using the ASAM3B traffic model. The traffic modelling is fully explained in Chapter 5 (Overview of Assessment Process).

Noise Nuisance Assessment

15.2.25 DMRB states that a noise nuisance assessment should be carried out for properties with a 1dB change or more. This assessment has been undertaken for all relevant properties within the Core Study Area (i.e. those with a 1 dB change or more). Due to variability in individual responses, DMRB recommends that community annoyance ratings are used for each noise level, and it is therefore important to note that the results of the nuisance assessment should not be related to individual annoyance response.

15.2.26 The term 'nuisance' is assessed as the percentage of people bothered by traffic noise (i.e. those who say they are 'very much' or 'quite a lot' bothered on a four point worded scale).

15.2.27 DMRB details procedures for estimating changes in traffic noise nuisance when a new road scheme is planned. This method is based on the results of surveys which examined the relationship between objective measures of road traffic noise outside residential properties, and the percentage of people bothered by road traffic noise. The 1977 National Environmental Survey (England) (Harland and Abbot, 1997), has shown that once people become accustomed to a change in noise, their general dissatisfaction with traffic noise does not alter until changes in level on the $L_{A10,18h}$ scale exceed at least 3 dB(A). However, in the period immediately following the completion of a road scheme, people may find appreciable benefits or disbenefits when noise changes are less than 3 dB(A). Prior to the publication of DMRB available research (1977) indicated that an abrupt change in traffic noise as small as 1 dB(A) may result in a 21% change in the number of people bothered 'very much' or 'quite a lot' by road traffic noise. A noise disturbance assessment was therefore made for all properties with an expected noise change of 1 dB(A) or greater due to the proposed scheme. This change in noise level would be produced by a change in traffic flow of approximately +25% or -20%, assuming that other factors, such as the average speed and the percentage of HGVs remain unchanged.

15.2.28 Noise nuisance predictions for the proposed scheme are based on the highest nuisance levels expected during the first 15 years after opening. These assessments have been undertaken in accordance with the predictive technique presented in DMRB, although the method has limitations as discussed in the paragraphs 15.2.32 – 15.2.34.

15.2.29 DMRB also requires an indication of the number of properties which are likely to be eligible for statutory insulation. The 'Noise Insulation (Scotland) Regulations 1975' provide for acoustic insulation to be offered for residential properties. The qualifying criteria are detailed within the Regulations, and within the 'Memorandum on the Noise Insulation (Scotland) Regulations 1975' (NISR), regulations 3 and 6: The qualifying criteria are as follows:

- the properties are situated within 300m of the new or altered carriageway;
- the properties lie within the triangular area at the terminal point of the new road, the apexes of which are 50m along the centre-line of the existing road from the terminal points, and the bases of which extend from points 300m on either side of the road to the nearest point on the carriageway, at right angles to the centre line of the carriageway;
- a straight line can be drawn from any point of the property to a point on the carriageway without passing through another building;
- the use of the road causes, or is expected to cause, noise at a level not less than 68 dB(A); and
- the property will experience noise levels exceeding the 'prevailing noise level' by at least 1 dB(A).

Vibration

15.2.30 DMRB notes that investigations have determined a relationship between the number of people affected by the traffic noise, and those adversely impacted by air-borne vibration. It was found that the $L_{A10,18h}$ index was among the physical variables most closely associated with average vibration disturbance ratings. The relationships between the percentage of people affected by largely air-borne vibration, and this noise exposure index, are similar to that for noise nuisance except that the percentage of people bothered by vibration is lower at all levels. It is recommended in DMRB that for the purposes of assessment, the percentage of people bothered by vibration is 10% lower than the corresponding noise nuisance figure, and that at noise levels below 58dB $L_{A10,18h}$, it should be assumed that no people would be affected.

15.2.31 In accordance with DMRB Volume 11, the prediction of disturbance caused by air-borne vibration, is made for properties within 40m of the road centreline which are un-screened.

Limitations to Assessment

15.2.32 The surveys on which the DMRB methods for noise nuisance assessment are based were conducted at sites where road traffic was the dominant noise source, noise levels ranged from 65 to 78 dB$L_{A10,18h}$, the changes in traffic noise were up to 10 dB $L_{A10,18h}$, and properties were up to 18m from the kerb. Therefore, it is only at these noise levels and distance ranges that the method is strictly valid. The DMRB method is also valid only for noise changes caused by alterations in traffic flow and will not necessarily give a good prediction if traffic noise changes are brought about by other means, such as barriers or low noise road surfaces. The Northern Leg of the proposed scheme has areas where the ambient levels are dominated by road traffic noise, and also areas where the ambient noise climate is not dominated by road traffic noise. The ambient descriptor will therefore be the L_{A90} or L_{A10} as appropriate (refer to paragraph 15.2.17) but as the nuisance assessment is based on changes in road traffic noise level, the noise nuisance results are strictly not applicable where the L_{A90} is used. However, DMRB, Volume 11, Section 3, Part 7, Chapter 8, Paragraph 5.10 states that 'Strictly, the method should not be used outside the noise and distance ranges covered by the surveys, or when the ambient noise is not from traffic. However, it seems likely that the mechanisms underlying the survey results will operate outside these ranges. Until better information becomes available, it is recommended that the method is used to predict nuisance changes outside these noise and distance ranges, albeit with caution'.

15.2.33 As the method for assessing vibration is similar to noise nuisance it is subject to the same limitations as discussed above.

15.2.34 The prediction method detailed within the NISR Memorandum for considering requirements for statutory noise insulation has been improved since 1975. While DMRB does allow for the use of the method detailed within the NISR Memorandum, the prediction methodology employed in this assessment uses the more detailed and accurate predictive methods set out in CRTN. However, to ensure compliance with NISR the assessment uses as a proxy a CRTN predicted level of 65dB(A) as a preliminary indicator of the need to utilise the full NISR Memorandum methodology assessment of eligibility, where all the other qualifying criteria are met.

Threshold for Mitigation

15.2.35 As best practice, mitigation should be implemented, where practicable, where the significance of impact in the Design Year is found to be 'Moderate Adverse' or worse at ground floor. This is an onerous target as mitigation is therefore considered where there is an increase of greater than 1dB irrespective of the absolute noise level (in recognition of the sudden change effects as reported within DMRB), and must be applied with caution in rural areas where there are at present no traffic sources. For guidance on onset of effects, reference was made to the current WHO document entitled 'Community Noise' (WHO, 1999). This document does not contain recommendations, but provides guideline values based on the precautionary principle. The WHO document states that 'To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound

level from steady, continuous noise should not exceed 55dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development'.

15.2.36 The WHO refers to a daytime time base of 16 hours ($L_{Aeq(16hr}$), and CRTN predictions are in terms of $L_{A10(18hr)}$. To translate the WHO $L_{Aeq(16hr)}$ to $L_{A10(18hr)}$ a correction of approximately +2dB is therefore required, with a further +2.5dB necessary to translate into façade levels. This translation applied to 55dB $L_{Aeq,16hr}$ gives an equivalent threshold façade level of 59.5dB $L_{A10(18hr)}$.

15.2.37 In addition, it is necessary that in all cases where it is considered, mitigation should comply with acceptable standards in terms of traffic, safety, environmental and economic issues (DMRB Volume 11, Section 2, Part 3, Mitigation, paragraph 1.2(a)). Examples which could preclude the use of mitigation are disproportionate cost and unacceptable visual impact.

15.2.38 In summary, taking into account the above WHO and DMRB guidance, mitigation was considered where the significance of impact at a receptor was assessed as Moderate Adverse or worse, and where the predicted façade level exceeded 59.5dB $L_{A10(18hr)}$. As noted in paragraph 15.2.5, noise prediction beyond 300m may be inaccurate, and the mitigation threshold was therefore only applied to receptors within 300m in accordance with DMRB.

15.3 Baseline Conditions

15.3.1 A total of 584 potentially sensitive receptors were identified within 500m of the Northern Leg of the proposed scheme. Of these, 476 are categorised as residential and 113 as non-residential, including 5 which are considered within both receptor categories (i.e. residential properties that are also historic buildings).

15.3.2 Table 15.5 illustrates the number of potentially sensitive receptors within each category. As explained above, certain receptors are listed in more than one category, as indicated by the table footnote.

Table 15.5 - Number of Properties (Address Points) Within 500m of the Proposed Northern Leg

Distance from centreline	Residential	Non-Residential							
		Commercial/ Industrial	Amenity/ Recreational	Farms	Educational	Woodlands	Historic	Footpath	SSSI
0 – 50m	34	6	0	1	0	5	2	4	0
50 – 100m	36	6	0	0	0	5	6	0	0
100 – 200m	79	8	0	4	2	4	2	1	1
200 – 300m	142	6	0	2	5	1	3	1	0
300m – 500m	185	19	0	5	1	6	5	2	0
Total	476[+]	45	0	12	8	21	18[+]	8	1

[+] *includes 5 categorised as both residential and historic.*

15.3.3 DMRB requires that the assessment also includes 'all relevant locations' and relevant is further defined through the examples of 'sports fields, canals, footpaths'. References to Figures 15.1a-g are provided where appropriate below. These include the locations of all 42 sample receptors reported in this assessment, and a representative selection of additional receptors within 500m of the proposed scheme:

Educational

- 4 educational properties, North of Scotland College of Agriculture, Bucksburn, AB21 9TP (Figure 15.1b).
- Scottish Agricultural College, Craibstone Estate, Bucksburn, AB21 9YA (Figure 15.1b).
- Scottish Agricultural College, Bucksburn, AB21 9TT (Figure 15.1b).
- Rowett Research Institute, Greenburn Rd, AB21 9SB.
- Cordyce School, Riverview Drive, AB21 7NF.

Historical

- St Mary's Chapel and St Mary's Chapel Graveyard, Stoneywood (Figure 15.1b).
- Standingstones, Stone Circle 300m (Figure 15.1c).
- Newhills, Old Parish Church.
- Newhills, Old Parish Church, Burial-Ground (Figure 15.1a).
- Remains Of Aberdeenshire Canal (Figure 15.1d).
- Ashtown, Boundary Marker 38 (Figure 15.1b).
- Kirkhill Farm, Boundary Marker 40 (Figure 15.1b).
- Ashtown, Boundary Marker 39 (Figure 15.1b).
- Parkhill Pumping Station, Water Tanks
- Parkhill Pumping Station, Lade And Aqueduct
- Goval Bridge, A947
- Manse Cottage (Figure 15.1a). [note: also categorised as 'residential' in Table 15.5].
- Pitmedden House [note: also categorised as 'residential' in Table 15.5].
- Parkhill Pumping Station, Supervisor's House
- Parkhill Pumping Station [note: also categorised as 'residential' in Table 15.5].
- Parkhill House, West Lodge [note: also categorised as 'residential' in Table 15.5].
- Mains Of Dyce [note: also categorised as 'residential' in Table 15.5].
- Walton Farm

Footpaths

- Near Lower Waulkmill, Newmachar (Figure 15.1e).
- Kingswells To Howes Road Bucksburn (Figure 15.1a).
- Near, Glendale Hill Of Clinterty, Bucksburn (Figure 15.1b).
- Near, 1 Walton View, Bucksburn (Figure 15.1c).
- Kirkhill Industrial Estate, Dyce (Figure 15.1c).
- Near, Overton Grange, Dyce (Figure 15.1d).
- Near, Hill Crest, Bucksburn (Figure 15.1b).
- Near, 2 Walton Farm Cottages, Bucksburn.

Woodland

- East Dovecot Wood, Riverview Drive, Dyce.
- West Dovecot Wood, Riverview Drive, Dyce.
- North West Dovecot Wood, Riverview Drive.
- Pitmedden House, Dyce (Figure 15.1d).
- Pitmedden Road, Dyce.
- A96 Kinellar And Dyce (Figure 15.1c).
- Dyce Drive, Dyce (Figure 15.1d).
- West Woods, Bucksburn (Figure 15.1b).
- Parkhead Wood, Bucksburn.
- Near, Scottish Agricultural College, Bucksburn (Figure 15.1b).
- Near, Kirkhill Farm, Bucksburn (Figure 15.1b).
- Potterton (Figure 15.1g).
- Goval Wood/Goval Belt, Newmachar (Figure 15.1e).
- Littlejohn's Wood, Newmachar (Figure 15.1e).
- Goval Wood, Dyce (Figure 15.1e).
- Den Wood, Dyce (Figure 15.1f).
- Skate Wood, Dyce.
- Near A947, Dyce (Figure 15.1e).
- Corsehill Wood, Newmachar.
- Near, Grieves Cottage, Dyce.
- Near, The Kennels, Dyce.

SSSI

- Biological - Corby, Lily And Bishops Lochs, Whitecairns (Figure 15.1f).

Commercial/Industrial

- Kingswells Community Centre Webster Park, Derbeth Grange, Kingswells, AB15 8UD.
- Sand & Gravel Ltd, Dyce, AB21 0HA.
- Woodsons Of Aberdeen Goval House, Dyce, AB21 0HT.
- A R R Craib Transporthowe Moss Drive, Dyce, AB21 0GL.
- P G S Production House, Howe Moss Drive, Dyce, AB21 0GL (Figure 15.1c).
- Anson Ltd, 24 Howe Moss Drive, Dyce, AB21 0GL.
- Alan B Davie Pest Control Pitmedden Gardeners Cottage, Dyce, AB21 0HB.
- Overton Garage Ltd, Dyce, AB21 0EQ.
- Bowen Toolskirkton Avenue, Dyce, AB21 0BF.
- G C Carle & Sonmoss-Side, Parkhill, Dyce, AB21 7AS.
- Moss-Side, Parkhill, Dyce, AB21 7AS

- Station House, Parkhilldyce, AB21 7AJ.
- Parkhill Sawmill, Dyce, AB21 7AL.
- Fountain Executive Hill Of Goval, Newmachar, AB21 7NX.
- Parkhill Nurseries Parkhill, Dyce, AB21 7AT.
- A-Line Sound Services Ltd Parkhill, Dyce, AB21 7AT.
- Rovtech Ltd Rovtech House, Kirkton Avenue, Dyce, AB21 0BA.
- Containental Offshore Ltd Cothal House, Kirkton Avenue, Dyce, AB21 0BA.
- Kwik-Fit, Victoria Street, Dyce, AB21 7AB.
- Hayes Mccubbin Lochgreens Farm, Dyce, AB21 7AS.
- Redcraigsunit A2, Cordyce School, Riverview Drive, Dyce, AB21 7NF.
- Thistle Aberdeen Airport, Argyll Road, Dyce, AB21 0AF.
- Shell Uk Ltd Airport Service Station, Argyll Road, Dyce, AB21 0AF.
- Marshall Trailers Ltd Chapel Works, Bucksburn, AB21 9TL (Figure 15.1b).
- Fraser Ingham Shand (Chemical) Ltd Chapel Croft, Bucksburn, AB21 9TN (Figure 15.1b).
- Craibstone Estate, Bucksburn, AB21 9SJ.
- Grampian Service Brokerage Ltd Mill Of Craibstone, Bucksburn, AB21 9TB.
- S A C Centre For Rural Building, Bucksburn, AB21 9TR.
- Gorrod Davie Kemp & Walker Gourdieburn Farm, Potterton, AB23 8UY.
- Refer Scientific Hareburn House, Hareburn Terrace, Bridge Of Don, AB23 8BE.
- Easter Hatton Landfill Site, Balmedie, AB23 8YY.
- T J Mccaul Transport Blackdog Centre, Bridge Of Don, AB23 8BT.
- Almar Garage Blackdog Centre, Bridge Of Don, AB23 8BT.
- Sureclean Ltd Blackdog Centre, Bridge Of Don, AB23 8BT.
- Sandy Bruce Trucking Ltd, Unit C, Blackdog Centre, Bridge Of Don, AB23 8BT.
- John Gilbert Transport Training Blackdog Centre, Bridge Of Don, AB23 8BT.
- J L C Plastics Ltd, Yard D, Blackdog Centre, Bridge Of Don, AB23 8BT.
- Nu-Look Windows, Hareburn Terrace, Bridge Of Don, AB23 8BE.
- Stable Services Harehill Industrial Park, Bridge Of Don, AB23 8BQ.
- Abermove Removalsunit, 3-6 Harehill Industrial Estate, Bridge Of Don, AB23 8BQ.
- Thistle Tubes, Bridge Of Don, AB23 8BQ.
- Offshore Products International Ltd, Unit 4 Harehill Industrial Estate, Bridge Of Don, AB23 8BQ.
- Drain Devils Grampian Ltd Harehill, Bridge Of Don, AB23 8BQ.
- Stephenson & Kelly, Balmedie, AB23 8YY.
- Donside Safetyhareburn Terrace, Bridge Of Don, AB23 8BE.

Farm

- Derbeth Farm, Kingswells, AB15 8SD.

- Newton Farm, Bucksburn, AB21 9RP.
- Newton Farmdyce, AB21 0HJ.
- Pitmedden Home Farm, Dyce, AB21 0HB.
- Goval Farm, Dyce, AB21 0HS.
- Newtonhill Farm, Whitecairns, AB23 8UT.
- Lochgreens Farm, Dyce, AB21 7AS (Figure 15.1f).
- Agronomy Department, SAC Macrobert Farm, Bucksburn, AB21 9TT.
- Chapel Farm, Bucksburn, AB21 9TN.
- Kirkhill Farm, Bucksburn, AB21 9SQ.
- Millden Farm, Balmedie, AB23 8YY.
- Harehill Farm, Bridge Of Don, AB23 8BS (Figure 15.1f).

15.3.4 All Listed Historic Buildings within 500m of the proposed scheme were considered during identification of sensitive receptors (i.e. 18) , however, noise climate is not one of the listing criteria and as such noise would not have any cultural heritage implications. Impacts on four historic buildings/sites have been included in this assessment as potential noise receptors.

15.4 Potential Impacts

Noise Model Calibration

15.4.1 To calibrate the 3D noise model of the existing road network model, generated predicted noise levels were compared with the measured noise levels at a selection of sample receptors (see selection criteria in paragraph 15.2.15). For comparison, predicted noise levels were determined for ground floor level, and compared to the measured noise levels at these locations, as shown in Table 15.6. It must be noted that there will rarely be perfect agreement between predicted and measured levels as the modelled levels use flow data for an 18 hour period and the measured levels are based on the short term measurement period, and DMRB does not expect this. The CRTN shortened measurement procedure advises that where a measurement is made over three consecutive hours, a correction factor of -1dB should be applied to obtain an 18 hour value. In essence, the short term measured levels are likely to be slightly higher than the predicted levels.

15.4.2 The predicted levels for the DMRB '*relevant locations*' (refer to paragraph 15.3.2) listed above and the associated significance of impact are shown in Figures 15.1a-g.

Table 15.6 - Modelled Predicted Noise Levels versus Measured Noise Levels

Sample Receptor	Modelled Predicted (dB) $L_{A10(18hr)}$	Equivalent Measured (dB) $L_{A10(18hr)}$
1 Walton View	61.7	58.4
Straithbathie Cottages	70.2	68.2
Cranfield Lodge	50.8	50.5

15.4.3 The results in Table 15.6 do show reasonable agreement between the modelled predicted noise levels and the measured noise levels, and therefore effectively calibrate the 3D noise model created. It is stated in DMRB that with regard to the actual measured levels '*care is needed in the interpreting of the levels of the $L_{A10,18h}$ recorded. These will vary from day to day during the year, depending on the influence of varying traffic and weather conditions and seasonal effects*'. It is therefore recommended that where road traffic noise presently dominates the noise climate the predicted Do-Minimum levels of $L_{A10(18hr)}$ provide a more reliable measure for an average day than the measured level and therefore the predicted ambient levels are, where possible (see paragraph

15.2.22 for an explanation of where the predicted $L_{A10(18hr)}$ is not used), used in this future year comparison assessment.

Traffic Noise

15.4.4 The finalised road traffic model for the Northern Leg incorporates design elements which will mitigate traffic noise, such as sections of embankments/false cutting. These are summarised in Section 15.5 (Mitigation) and have been developed iteratively through discussion between the road engineers, Jacobs landscape team and Hamilton & McGregor noise specialists. The potential impacts described in this section are based on the finalised road model and therefore take these measures into account.

15.4.5 Section 15.6 (Residual Impacts) takes account of the incorporated measures plus further receptor-specific measures to further reduce impacts as described in Section 15.5 (Mitigation).

15.4.6 In total, there are 291 residential properties within 300m of the proposed Northern Leg. The results for the 42 selected sample receptors (comprising the 9 properties selected for ambient noise monitoring and 33 additional properties deemed to be representative of their locality) at ground and first floor, for both the Year of Opening and the Design Year with and without the proposed scheme are presented in Table 15.7(a) and Table 15.7(b) together with the associated significance of impact. It should be appreciated that, in order to determine the change in noise level between scenarios, the following process has been adopted: receptor points were located at a distance of 1m from each façade of each building, and the receptor location that had the highest noise level in the Do-Something scenario was then compared with the same receptor location in the Do-Minimum scenario. The results in Table 15.7(a) and Table 15.7(b) are reproduced graphically in Figures 15.1a-g and Figures 15.2a-g.

15.4.7 As explained in paragraph 15.2.22, where a property is outwith 300m of a georectified road the $L_{A90(T)}$ noise parameter has been used to characterise the noise at that property. Although it was not feasible to take noise measurements at every property beyond 300m, the arithmetic average of the $L_{A90(T)}$ noise level as measured at three sample properties beyond 300m has been used as a proxy for the $L_{A90(T)}$ for all properties. These were Denhead of Cloghill (41.0 dB $L_{A90(T)}$), 1 Bogenjoss (42.2 dB $L_{A90(T)}$) and 1 Lochgreens Cottage (37.9 dB $L_{A90(T)}$), giving an average of 40.4 dB $L_{A90(T)}$. Where appropriate, this is the $L_{A90(T)}$ noise level used in the noise assessment.

Table 15.7(a) - Ground Floor Predicted Noise Level (receiver height = 1.5m, $L_{A10(T)}$, or ** where = $L_{A90(T)}$)

Note: DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Dykeside Steading	Residential	66.0	66.9	64.4	67.5	64.7	Moderate Beneficial	Moderate Beneficial
Scottish Agricultural College, Craibstone Estate	To be demolished	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Brimmond Lodge	Residential	44.8	45.5	58.3	46.2	59.0	Substantial Adverse	Substantial Adverse
West Lodge, Craibstone	Residential	56.3	57.5	56.1	58.4	56.9	Moderate Beneficial	Moderate Beneficial
Kirkhill Cottage	Residential	52.7	54.0	54.3	54.8	55.0	Slight Adverse	Slight Adverse
Kepplestone Farmhouse	Residential	44.3	45.5	57.0	46.3	57.7	Substantial Adverse	Substantial Adverse
1 Walton View	Residential	58.3	54.6	60.6	55.0	61.9	Substantial Adverse	Substantial Adverse
1 Parkhead Farm Cottages	Residential	46.2	48.4	55.0	49.4	55.8	Substantial Adverse	Substantial Adverse
Marshall Trailers Ltd	Commercial/Industrial	64.9	63.5	63.5	64.0	64.2	No Benefit	Negligible/ Slight Adverse
Fraser Ingham Shand (Chemical) Ltd	Commercial/Industrial	57.5	57.2	57.4	57.7	58.4	Negligible/ Slight Adverse	Negligible/ Slight Adverse
8 Craibstone Farm Cottages	Residential	57.7	58.4	60.1	58.8	60.6	Moderate Adverse	Moderate Adverse
Scottish Agricultural College	Education	56.3	56.8	59.2	57.4	60.0	Moderate Adverse	Moderate Adverse
Heathercraig**	Residential	40.4	40.4	52.4	40.4	53.4	Substantial Adverse	Substantial Adverse
Lyndmoor Pitmedden Road	Residential	45.6	46.0	60.5	46.5	61.8	Substantial Adverse	Substantial Adverse
Tillybrig Pitmedden Road	Residential	59.0	48.3	59.7	48.8	61.0	Substantial Adverse	Substantial Adverse
Overton Lodge**	Residential	40.4	40.4	52.5	40.4	53.7	Substantial Adverse	Substantial Adverse
Naurcris	Residential	49.5	49.9	57.6	50.5	58.8	Substantial Adverse	Substantial Adverse
Pitmedden House**	Residential	40.4	40.4	48.1	40.4	49.3	Substantial Adverse	Substantial Adverse
East Woodlands House**	Residential	40.4	40.4	49.4	40.4	50.6	Substantial Adverse	Substantial Adverse
1 Bogenjoss**	Residential	40.4	40.4	46.1	40.4	47.3	Substantial Adverse	Substantial Adverse
2 Bogenjoss**	Residential	40.4	40.4	63.1	40.4	64.3	Substantial Adverse	Substantial Adverse
Howe Moss Farm**	Residential	40.4	40.4	51.7	40.4	52.8	Substantial Adverse	Substantial Adverse
Goval Villa	Residential	48.3	49.9	56.3	50.7	57.6	Substantial Adverse	Substantial Adverse

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
P G S, Howe Moss Drive	Commercial/Industrial	55.5	44.7	49.5	45.0	50.6	Moderate Adverse	Moderate/ Substantial Adverse
Parkhill Cottage, Parkhill Pumping Station	Residential	56.5	57.0	58.8	57.2	59.9	Moderate Adverse	Moderate Adverse
1 Little Goval Cottages, Parkhill	Residential	49.5	49.7	59.7	50.1	60.4	Substantial Adverse	Substantial Adverse
Meadowhead**	Residential	40.4	40.4	54.6	40.4	55.4	Substantial Adverse	Substantial Adverse
Waulkmill Croft**	Residential	40.4	40.4	58.2	40.4	59.1	Substantial Adverse	Substantial Adverse
Lochgreens Farm**	Farm	40.4	40.4	56.2	40.4	56.9	Moderate Adverse	Moderate Adverse
Capalaba, Moss Belt	Residential	49.8	50.0	53.1	50.2	53.8	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Birchville, Corsehill	Residential	44.9	45.2	58.2	45.5	58.9	Substantial Adverse	Substantial Adverse
Meadowbank	Residential	50.1	50.2	56.3	50.7	57.1	Substantial Adverse	Substantial Adverse
1 Lochgreens Cottages**	Residential	40.4	40.4	55.1	40.4	55.8	Substantial Adverse	Substantial Adverse
The Emmerick, Parkhill	Residential	53.5	63.0	60.1	63.2	60.6	Moderate Beneficial	Moderate Beneficial
2 Lochgreens Cottages**	Residential	40.4	40.4	61.6	40.4	62.3	Substantial Adverse	Substantial Adverse
Newton Of Shielhill**	Residential	40.4	40.4	47.1	40.4	47.8	Substantial Adverse	Substantial Adverse
Leuchlands Croft**	Residential	40.4	40.4	52.4	40.4	53.1	Substantial Adverse	Substantial Adverse
Cranfield Lodge	Residential	51.5	53.3	56.8	53.6	57.2	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Blackdog Heights	Residential	62.2	61.4	58.9	61.7	59.3	Moderate Beneficial	Moderate Beneficial
3 Strabathie Cottages Hareburn Terrace	Residential	59.0	72.4	71.4	72.7	71.5	Slight Beneficial	Moderate Beneficial
Harehill Farm**	Farm	40.4	40.4	54.2	40.4	54.5	Moderate Adverse	Moderate Adverse
Middleton Farm Steading East**	Residential	40.4	40.4	57.0	40.4	57.7	Substantial Adverse	Substantial Adverse
2 Hareburn Road	Residential	59.4	58.8	57.0	59.0	57.2	Moderate Beneficial	Moderate Beneficial

Table 15.7(b) - First Floor Predicted Noise Level (receiver height = 4.5m, $L_{A10(T)}$, or ** = $L_{A90(T)}$)

Note: DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Dykeside Steading	Residential	68.8	69.5	67.0	70.1	67.3	Moderate Beneficial	Moderate Beneficial
Scottish Agricultural College, Craibstone Estate	Not Used	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Brimmond Lodge	Residential	46.3	46.9	59.3	47.5	60.0	Substantial Adverse	Substantial Adverse
West Lodge, Craibstone	Residential	58.2	59.6	57.6	60.6	58.4	Moderate Beneficial	Moderate Beneficial
Kirkhill Cottage	Residential	54.9	56.3	56.1	57.1	56.8	Slight Beneficial	Slight Beneficial
Kepplestone Farmhouse	Residential	47.3	48.5	58.6	49.2	59.3	Substantial Adverse	Substantial Adverse
1 Walton View	Residential	67.5	56.7	63.3	57.1	64.5	Substantial Adverse	Substantial Adverse
1 Parkhead Farm Cottages	Residential	47.5	49.7	56.0	50.7	56.7	Substantial Adverse	Substantial Adverse
Marshall Trailers Ltd	Commercial/Industrial	66.1	65.3	65.4	65.8	66.0	Negligible/ Slight Adverse	Negligible/ Slight Adverse
Fraser Ingham Shand (Chemical) Ltd	Commercial/Industrial	58.9	58.5	58.9	59.1	59.9	Negligible/ Slight Adverse	Negligible/ Slight Adverse
8 Craibstone Farm Cottages	Residential	59.3	60.0	61.8	60.4	62.4	Moderate Adverse	Moderate Adverse
Scottish Agricultural College	Education	58.2	58.6	60.4	59.1	61.2	Moderate Adverse	Moderate Adverse
Heathercraig**	Residential	40.4	40.4	53.8	40.4	54.9	Substantial Adverse	Substantial Adverse
Lyndmoor Pitmedden Road	Residential	49.9	50.2	63.0	50.7	64.3	Substantial Adverse	Substantial Adverse
Tillybrig Pitmedden Road	Residential	49.3	49.6	60.2	50.1	61.5	Substantial Adverse	Substantial Adverse
Overton Lodge**	Residential	40.4	40.4	53.3	40.4	54.5	Substantial Adverse	Substantial Adverse
Naurcris	Residential	51.0	51.4	58.2	51.9	59.3	Substantial Adverse	Substantial Adverse
Pitmedden House**	Residential	40.4	40.4	49.5	40.4	50.7	Substantial Adverse	Substantial Adverse
East Woodlands House**	Residential	40.4	40.4	50.5	40.4	51.7	Substantial Adverse	Substantial Adverse
1 Bogenjoss**	Residential	40.4	40.4	46.8	40.4	48.0	Substantial Adverse	Substantial Adverse
2 Bogenjoss**	Residential	40.4	40.4	66.4	40.4	67.7	Substantial Adverse	Substantial Adverse
Howe Moss Farm**	Residential	40.4	40.4	52.4	40.4	53.5	Substantial Adverse	Substantial Adverse
Goval Villa	Residential	50.4	51.9	57.5	52.7	58.8	Substantial Adverse	Substantial Adverse
P G S, Howe Moss Drive	Commercial/Industrial	56.8	46.2	50.3	46.4	51.3	Moderate Adverse	Moderate Adverse

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels dB $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Parkhill Cottage, Parkhill Pumping Station	Residential	59.2	59.7	61.7	59.9	62.8	Moderate Adverse	Moderate Adverse
1 Little Goval Cottages, Parkhill	Residential	56.6	56.7	60.7	57.2	61.5	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Meadowhead**	Residential	40.4	40.4	55.7	40.4	56.5	Substantial Adverse	Substantial Adverse
Waulkmill Croft**	Residential	40.4	40.4	59.4	40.4	60.3	Substantial Adverse	Substantial Adverse
Lochgreens Farm**	Farm	40.4	40.4	57.3	40.4	58.0	Moderate Adverse	Moderate Adverse
Capalaba, Moss Belt	Residential	52.3	52.4	54.7	52.7	55.4	Moderate Adverse	Moderate Adverse
Birchville, Corsehill	Residential	47.5	47.7	60.6	48.1	61.4	Substantial Adverse	Substantial Adverse
Meadowbank	Residential	51.4	51.5	57.3	52.0	58.0	Substantial Adverse	Substantial Adverse
1 Lochgreens Cottages**	Residential	40.4	40.4	55.9	40.4	56.6	Substantial Adverse	Substantial Adverse
The Emmerick, Parkhill	Residential	65.2	65.5	62.3	65.7	62.8	Moderate/ Substantial Beneficial	Moderate Beneficial
2 Lochgreens Cottages**	Residential	40.4	40.4	65.6	40.4	66.3	Substantial Adverse	Substantial Adverse
Newton Of Shielhill**	Residential	40.4	40.4	48.1	40.4	48.9	Substantial Adverse	Substantial Adverse
Leuchlands Croft**	Residential	40.4	40.4	53.8	40.4	54.5	Substantial Adverse	Substantial Adverse
Cranfield Lodge	Residential	54.3	54.7	58.0	55.1	58.4	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Blackdog Heights	Residential	63.5	62.7	60.6	63.0	60.9	Moderate Beneficial	Moderate Beneficial
3 Strabathie Cottages Hareburn Terrace	Residential	75.4	74.5	73.5	74.8	73.6	Slight Beneficial	Moderate Beneficial
Harehill Farm**	Farm	40.4	40.4	55.3	40.4	55.6	Moderate Adverse	Moderate Adverse
Middleton Farm Steading East**	Residential	40.4	40.4	58.5	40.4	59.2	Substantial Adverse	Substantial Adverse
2 Hareburn Road	Residential	60.3	59.6	58.0	59.9	58.2	Moderate Beneficial	Moderate Beneficial

Ground Floor

15.4.8 Table 15.7(a) shows the potential noise levels for the 42 selected sample receptors at ground floor level. For the 291 residential properties within 300m of the proposed Northern Leg, in terms of no change or beneficial impacts there is 1 residential property which experiences 'No change' in the Year of Opening and none in the Design Year, and 70 properties in the Year of Opening and 86 in the Design Year that experience a significance of impact that is Moderate Beneficial or better.

15.4.9 Beneficial impacts occur because traffic moves from existing roads on to the AWPR. An example of this is to the network to the south of where the proposed scheme would join the A90 north of Aberdeen, both the percentage of HGVs and the number of vehicles using this stretch of road decreases: in the Design Year the percentage of HGVs reduces by approximately 4% and the traffic flow falls by 1,589 vehicles. Similar effects occur along the B999 and B977, and minor roads to the east and west of the AWPR south of the A93. In addition, some roads (e.g. B999 and B977), would be realigned as they cross the proposed scheme, thus providing benefits for such properties as Westacre (AB2 17AS), close to the B977 and Cranfield Farm, close to the B999.

15.4.10 Of the 291 residential properties within 300m of the proposed Northern Leg, there are 139 properties in the Year of Opening and 142 properties in the Design Year that will experience a potential significance of impact that is Moderate Adverse or worse, due to proximity of the proposed scheme, or increased traffic on feeder roads. There are 28 properties (including non-residential) in the Year of Opening and 38 in the Design Year that also exceed $L_{A10(18hr)}$ of 59.5dB. These properties are as follows (with applicable assessment years shown in brackets). Where the property is a selected sample receptor, reference to the appropriate Figure has been included.

- Lyndmoor, Pitmedden Road, Dyce (Year of Opening, Design Year) (Figure 15.1d).
- Tillybrig, Pitmedden Road, Dyce (Year of Opening, Design Year) (Figure 15.1d).
- 2 Bogenjoss, Dyce (Year of Opening, Design Year) (Figure 15.1d).
- Upper Kirkton, Dyce (Design Year).
- Parkhill Cottage, Parkhill Pumping Station, Dyce (Design Year) (Figure 15.1e).
- Nether Kirkton, Dyce (Design Year).
- Bungalow, Parkhill, Dyce (Year of Opening, Design Year).
- Kinnaird, Parkhill, Dyce (Year of Opening, Design Year).
- Corsehill House, New Machar (Design Year).
- 1 Little Goval Cottages, Parkhill, Dyce (Year of Opening, Design Year) (Figure 15.1e).
- 2 Lochgreens Cottages, Dyce (Year of Opening, Design Year) (Figure 15.1f).
- 1 Walton Farm Cottages, Bucksburn (Year of Opening, Design Year).
- 2 Walton Farm Cottages, Bucksburn (Year of Opening, Design Year).
- Greenacres, Bucksburn (Design Year).
- Hill Crest, Bucksburn (Year of Opening, Design Year).
- 1 Walton View, Bucksburn (Year of Opening, Design Year) (Figure 15.1b).
- 2 Walton View, Bucksburn (Year of Opening, Design Year).
- 3 Walton View, Bucksburn (Design Year).
- 4 Walton View, Bucksburn (Design Year).
- Tulloch, Bucksburn (Year of Opening, Design Year).
- Mill Of Craibstone Cottage, Bucksburn (Year of Opening, Design Year).

- Veterinary Services, SAC, Mill Of Craibstone, Bucksburn (Year of Opening, Design Year).
- Artificial Insemination Centre, SAC, Bucksburn (Year of Opening, Design Year).
- Grampian Service Brokerage Ltd, Mill Of Craibstone, Bucksburn (Year of Opening, Design Year).
- Millview, Bucksburn (Year of Opening, Design Year).
- 3 Craibstone Farm Cottages, Bucksburn (Year of Opening, Design Year).
- 4 Craibstone Farm Cottages, Bucksburn (Design Year).
- 5 Craibstone Farm Cottages, Bucksburn (Year of Opening, Design Year).
- 6 Craibstone Farm Cottages, Bucksburn (Year of Opening, Design Year).
- 7 Craibstone Farm Cottages, Bucksburn (Year of Opening, Design Year).
- 8 Craibstone Farm Cottages, Bucksburn (Year of Opening, Design Year) (Figure 15.1b).
- Mackie Hall House, Bucksburn (Design Year).
- Millden House West, Balmedie (Year of Opening, Design Year).
- Easter Hatton, Balmedie (Year of Opening, Design Year).
- Middleton Farm, Bridge Of Don (Design Year).
- 1 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).
- 2 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).
- Millden Steading West, Balmedie (Year of Opening, Design Year).

First Floor

15.4.11 Table 15.7(b) shows the potential noise levels for the selected sample receptors at first floor level for the Northern Leg. For the 291 residential properties within 300m, at first floor, there are 2 properties in the year of opening and 6 properties in the Design Year that experience 'No change'. For the core study area, there are 68 properties in the Year of Opening and 83 properties in the Design Year that experience a significance of impact that is Moderate Beneficial or better (see paragraph 15.4.9).

15.4.12 Of the 291 residential properties within 300m of the proposed Northern Leg, there are 132 properties in the Year of Opening and 133 in the Design Year that are predicted to experience a significance of impact that is Moderate Adverse or worse. Of these properties, there are 40 properties in the year of opening and 44 in the Design Year that also exceed $L_{A10(18hr)}$ of 59.5dB. These properties are as listed in Appendix A15.3 (with applicable assessment years shown in brackets).

15.5 Mitigation

15.5.1 Mitigation is considered in terms of incorporated mitigation (i.e. measures included as part of the assessed road model as explained in paragraph 15.4.4), and receptor specific mitigation for the properties identified above in Section 15.4 with potential impacts of Moderate Adverse or worse significance and a noise level exceeding 59.5dB $L_{A10(18hr)}$

15.5.2 Mitigation measures comprise substantial acoustic screens, and some revised earthworks. It should also be noted that properties situated further back from the road may experience further noise reduction from intervening buildings.

Incorporated Mitigation

Earthworks

15.5.3 Areas of false cutting have been incorporated, and provide noise and/or visual mitigation. Earthworks mitigation is fully described within the Chapter 11 (Landscape) but has been summarised here for clarification:

- Overhills (ch314800 - 316300) - false cutting to east to provide screening to the Chapel of Stoneywood to Fairley access road.
- Craibstone (ch316300-317500) Craibstone SAC Estate - false cutting to screen A96 roundabout junction from properties to the east of Craibstone, false cutting to screen properties at Chapel of Stoneywood
- Newton (ch317500-318900) - false cutting on west side of road to provide screening for Greenacres and Walton View, false cutting on east side of the road to provide screening for Walton Cottages.
- Tyrebagger Hill/Kirkhill (ch318900-322300) - false cuttings to provide screening for Balgosie and Howewood, false cutting on the eastern side of road from South Kirkhill junction to ch319600 to assist screening traffic movement and the road corridor from the wider landscape.
- Newton (ch322300-322800) – false cuttings on either side of the road to assist in screening views of the road from Tilybrig and Lyndmoor, Dyce Drive, the railway and the wider landscape.
- Lower Goval (ch322800-324000, includes bridge across River Don) - false cutting to assist screening views from Goval Villa.
- Goval (ch324000-325350) – false cuttings around Goval junction to assist screening of properties to the north and south of the junction and views from the Formartine and Buchan Way.
- Perwinnes (ch326000 - 328200) - false cutting to provide screening for properties east of Littlejohns Wood, false cutting to provide screening for Lochgreens Cottage.
- Potterton (ch328200 - A90 North Junction) - false cutting between A90 and Blackdog Road, false cutting between Blackdog Croft and Blackdog Road, false cutting between A90 and Wester Hatton cottages access road, false cutting between A90 and Wester Hatton Farm to screen views, false cutting to reduce impact of elevated roundabout on Blackdog Industrial Estate and properties.

Low Noise Surfacing

15.5.4 Low noise road surfacing is proposed throughout the scheme. Quieter road surfaces such as Stone Mastic Asphalt (SMA), or a pervious material, would be likely to reduce noise levels by approximately 2.5dB $L_{A10\ 18h}$ compared with conventional hot rolled asphalt surfacing. This benefit is related to the speed of the traffic on the road, and is likely to be significant at speeds above approximately 50kph.

Receptor Specific Mitigation

Acoustic Screens

15.5.5 Noise mitigation will be positioned as close to the carriageway as possible to ensure maximum attenuation, taking into account alignment requirements, land available, and landscaping and visual requirements. Noise barriers set close to a road generally provide protection to garden areas as well as the living space of properties.

15.5.6 The acoustic screens may be in the form of an earth bund, or a combination of an earth bund and a noise fence. It should be noted that any acoustic fencing will be of a minimum surface density of 15kg/m^2 with no holes or gaps. Timbers must be overlapped to allow for shrinkage and timber screens should be well bedded in gravel (or equivalent) to avoid soil erosion, which could create gaps underneath the screens, reducing their noise attenuation effectiveness.

15.5.7 The specific additional mitigation measures are summarised below in Table 15.8, and have been incorporated to minimise the impacts at properties meeting the threshold described in paragraphs 15.2.35 – 15.2.38 for consideration of mitigation where practicable (see paragraph 13.2.37). Figure 15.1 shows the locations of the proposed acoustic screens.

Table 15.8 - Acoustic Screen Noise Mitigation

Property	Height(s) (m)	Length(s) (m)	Approximate Chainage
Millview, Chapel of Stoneywood	1.0	145	A96 Junction
Greenacres, Chapel of Stoneywood	2.8, 1.2, 2.0	20, 140, 57	ch317685 - 317880
1 Walton View, Chapel of Stoneywood	2.8, 1.2, 2.0	20, 140, 57	ch317685 - 317880
2 Walton View, Chapel of Stoneywood	2.8, 1.2, 2.0	20, 140, 57	ch317685 - 317880
3 Walton View, Chapel of Stoneywood	2.8, 1.2, 2.0	20, 140, 57	ch317685 - 317880
4 Walton View, Chapel of Stoneywood	2.8, 1.2, 2.0	20, 140, 57	ch317685 - 317880
2 Bogenjoss, Dyce	2.5	116	ch320430 -320545
Upper Kirkton, Dyce	1.6, 1.0	222, 42	ch322200 - 322475
Lyndmoor,Pitmedden Road, Dyce	1.2 1.2, 1.2, 1.5	272 13, 29, 129	ch322210 - 322480 ch322510 - 322685
Tillybrig, Pitmedden Road, Dyce	1.2 1.2, 1.2, 1.5	272 13, 29, 129	ch322210 - 322480 ch322510 - 322685
Nether Kirkton, Dyce	1.0, 1.0	74, 75	ch322705 – 322855
Parkhill Cottage, Pumping Station	0.5	97	ch323955 - 324055
Bungalow, Parkhill, Dyce	1.8	190	Adjacent to A947
Kinnaird,Parkhill ,Dyce	0.5	117	Adjacent to A947
Corsehill House, Goval	1.0	286	ch325000 - 325375
2 Lochgreens Cottages, Dyce	1.6	169	ch326755 - 326925
Middleton Farm, Bridge Of Don	1.0	173	ch330420 - 330595
1 Wester Hatton Cottages, Balmedie	1.0	48	A90
2 Wester Hatton Cottages, Balmedie	1.0	48	A90

Noise Insulation

15.5.8 As noted in paragraph 15.2.29, Regulation 3 of the Noise Insulation (Scotland) Regulations 1975 (NISR), confers a duty on the roads authorities in certain instances to offer insulation to eligible residential properties affected by noise.

15.5.9 The results of this noise assessment indicate that with receptor specific mitigation measures in place the following properties may qualify in terms of the NISR due to noise level exceedence at ground floor level:

- Easter Hatton, Balmedie, Aberdeen (Design Year).

15.5.10 At the first floor level the following properties may qualify:

- Hatton Of Millden, Balmedie (Design Year).
- Millden House West, Balmedie (Year of Opening, Design Year).
- Millden House East, Balmedie (Year of Opening, Design Year).
- Lauren Grove Millden, Balmedie (Year of Opening, Design Year).
- Easter Hatton, Balmedie (Year of Opening, Design Year).
- 1 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).
- 2 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).

15.5.11 The list of properties that may be eligible will be confirmed in advance of the construction stage. Prevailing noise levels will be assessed pre-construction for these properties in accordance with NISR and within 12 months of the opening of the road, further assessments will be undertaken to determine eligibility. NISR also require that eligibility for noise insulation is reviewed at defined intervals (5, 10 and 15 years) after the road is opened. The statutory noise insulation assessments will be undertaken by Scottish Executive or its nominated representatives.

Summary of Mitigation

15.5.12 Proposed mitigation is summarised in Table 15.9.

Table 15.9 - Summary of General Measures Employed to Address Noise Potential Impacts

Type of Measure	Description
Prevent	Where practicable road aligned to avoid closely populated areas..
Reduce	Construction of noise barriers, earthworks bunds and the use of low noise surfacing will reduce the predicted traffic noise levels.
Offset	A list of properties that may be eligible for noise insulation due to increase in noise caused by the new road will be drawn up and assessed prior to construction.
Enhance	None.

15.6 Residual Impacts

15.6.1 Residual impacts are reported assuming the implementation of all mitigation measures described in the preceding section.

Traffic Noise

15.6.2 The residual predicted noise levels and associated derived residual significance of impact for the selected sample properties are presented in Tables 15.10(a) and 15.10(b).

Table 15.10(a) - Residual Impacts at Ground Floor (receiver height = 1.5m, $L_{A10(T)}$, or ** where = $L_{A90(T)}$)

Note: DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Dykeside Steading	Residential	66.0	66.9	64.4	67.5	64.6	Moderate Beneficial	Moderate Beneficial
Scottish Agricultural College, Craibstone Estate	Education	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Brimmond Lodge	Residential	44.8	45.5	58.3	46.2	59.0	Substantial Adverse	Substantial Adverse
West Lodge, Craibstone	Residential	56.3	57.5	56.1	58.4	56.9	Moderate Beneficial	Moderate Beneficial
Kirkhill Cottage	Residential	52.7	54.0	54.3	54.8	55.0	Slight Adverse	Slight Adverse
Kepplestone Farmhouse	Residential	44.3	45.5	57.0	46.3	57.7	Substantial Adverse	Substantial Adverse
1 Walton View	Residential	58.3	54.6	58.2	55.0	59.4	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
1 Parkhead Farm Cottages	Residential	46.2	48.4	55.0	49.4	55.8	Substantial Adverse	Substantial Adverse
Marshall Trailers Ltd	Commercial/Industrial	64.9	63.5	63.5	64.0	64.2	No Benefit	Negligible/ Slight Adverse
Fraser Ingham Shand (Chemical) Ltd	Commercial/Industrial	57.5	57.2	57.4	57.7	58.4	Negligible/ Slight Adverse	Negligible/ Slight Adverse
8 Craibstone Farm Cottages	Residential	57.7	58.4	59.1	58.8	59.6	Slight Adverse	Slight Adverse
Scottish Agricultural College	Education	56.3	56.8	58.2	57.4	59.1	Moderate Adverse	Moderate Adverse
Heathercraig**	Residential	40.4	40.4	52.3	40.4	53.4	Substantial Adverse	Substantial Adverse
Lyndmoor Pitmedden Road	Residential	45.6	46.0	58.0	46.5	59.3	Substantial Adverse	Substantial Adverse
Tillybrig Pitmedden Road	Residential	59.0	48.3	58.2	48.8	59.5	Substantial Adverse	Substantial Adverse
Overton Lodge**	Residential	40.4	40.4	52.3	40.4	53.5	Substantial Adverse	Substantial Adverse
Naurcris	Residential	49.5	49.9	57.5	50.5	58.6	Substantial Adverse	Substantial Adverse
Pitmedden House**	Residential	40.4	40.4	48.1	40.4	49.3	Substantial Adverse	Substantial Adverse
East Woodlands House**	Residential	40.4	40.4	49.3	40.4	50.5	Substantial Adverse	Substantial Adverse
1 Bogenjoss**	Residential	40.4	40.4	46.1	40.4	47.3	Substantial Adverse	Substantial Adverse
2 Bogenjoss**	Residential	40.4	40.4	58.0	40.4	59.2	Substantial Adverse	Substantial Adverse

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels $L_{A10(18hr)}$				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Howe Moss Farm**	Residential	40.4	40.4	51.7	40.4	52.8	Substantial Adverse	Substantial Adverse
Goval Villa	Residential	48.3	49.9	56.3	50.7	57.5	Substantial Adverse	Substantial Adverse
P G S, Howe Moss Drive	Commercial/Industrial	55.5	44.7	49.5	45.0	50.6	Moderate Adverse	Moderate/ Substantial Adverse
Parkhill Cottage, Parkhill Pumping Station	Residential	56.5	57.0	58.3	57.2	59.4	Moderate Adverse	Moderate Adverse
1 Little Goval Cottages, Parkhill	Residential	49.5	49.7	59.6	50.1	60.4	Substantial Adverse	Substantial Adverse
Meadowhead**	Residential	40.4	40.4	54.6	40.4	55.4	Substantial Adverse	Substantial Adverse
Waulkmill Croft**	Residential	40.4	40.4	58.2	40.4	59.1	Substantial Adverse	Substantial Adverse
Lochgreens Farm**	Farm	40.4	40.4	56.2	40.4	56.9	Moderate Adverse	Moderate Adverse
Capalaba, Moss Belt	Residential	49.8	50.0	53.1	50.2	53.8	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Birchville, Corsehill	Residential	44.9	45.2	58.2	45.5	58.9	Substantial Adverse	Substantial Adverse
Meadowbank	Residential	50.1	50.2	56.3	50.7	57.0	Substantial Adverse	Substantial Adverse
1 Lochgreens Cottages**	Residential	40.4	40.4	55.1	40.4	55.8	Substantial Adverse	Substantial Adverse
The Emmerick, Parkhill	Residential	53.5	63.0	60.1	63.2	60.6	Moderate Beneficial	Moderate Beneficial
2 Lochgreens Cottages**	Residential	40.4	40.4	58.8	40.4	59.5	Substantial Adverse	Substantial Adverse
Newton Of Shielhill**	Residential	40.4	40.4	47.1	40.4	47.8	Substantial Adverse	Substantial Adverse
Leuchlands Croft**	Residential	40.4	40.4	52.4	40.4	53.1	Substantial Adverse	Substantial Adverse
Cranfield Lodge	Residential	51.5	53.3	56.8	53.6	57.2	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Blackdog Heights	Residential	62.2	61.4	58.9	61.7	59.3	Moderate Beneficial	Moderate Beneficial
3 Strabathie Cottages Hareburn Terrace	Residential	59.0	72.4	71.4	72.7	71.5	Slight Beneficial	Moderate Beneficial
Harehill Farm**	Residential	40.4	40.4	54.2	40.4	54.5	Moderate Adverse	Moderate Adverse
Middleton Farm Steading East**	Residential	40.4	40.4	56.9	40.4	57.6	Substantial Adverse	Substantial Adverse
2 Hareburn Road	Residential	59.4	58.8	57.0	59.0	57.2	Moderate Beneficial	Moderate Beneficial

Table 15.10(b) - Residual Impacts at First Floor (receiver height = 4.5m, $L_{A10(T)}$, or ** where = $L_{A90(T)}$)

Note: DS = Do-Something (i.e. With Proposed scheme), DM = Do-minimum (i.e. without scheme)

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels LA10(18hr)				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
Dykeside Steading	Residential	68.8	69.5	67.0	70.1	67.3	Moderate Beneficial	Moderate Beneficial
Scottish Agricultural College, Craibstone Estate	Not Used						n/a	n/a
Brimmond Lodge	Residential	46.3	46.9	59.3	47.5	60.0	Substantial Adverse	Substantial Adverse
West Lodge, Craibstone	Residential	58.2	59.6	57.6	60.6	58.7	Moderate Beneficial	Moderate Beneficial
Kirkhill Cottage	Residential	54.9	56.3	56.1	57.1	56.8	Slight Beneficial	Slight Beneficial
Kepplestone Farmhouse	Residential	47.3	48.5	58.5	49.2	59.3	Substantial Adverse	Substantial Adverse
1 Walton View	Residential	67.5	56.7	61.3	57.1	62.6	Moderate/ Substantial Adverse	Substantial Adverse
1 Parkhead Farm Cottages	Residential	47.5	49.7	56.0	50.7	56.7	Substantial Adverse	Substantial Adverse
Marshall Trailers Ltd	Commercial/Industrial	66.1	65.3	65.4	65.8	66.5	Negligible/ Slight Adverse	Negligible/ Slight Adverse
Fraser Ingham Shand (Chemical) Ltd	Commercial/Industrial	58.9	58.5	58.9	59.1	60.1	Negligible/ Slight Adverse	Slight/ Moderate Adverse
8 Craibstone Farm Cottages	Residential	59.3	60.0	60.9	60.4	61.5	Slight Adverse	Moderate Adverse
Scottish Agricultural College	Education	58.2	58.6	59.2	59.1	60.0	Slight Adverse	Slight Adverse
Heathercraig**	Residential	40.4	40.4	53.8	40.4	54.9	Substantial Adverse	Substantial Adverse
Lyndmoor Pitmedden Road	Residential	49.9	50.2	60.1	50.7	61.3	Substantial Adverse	Substantial Adverse
Tillybrig Pitmedden Road	Residential	49.3	49.6	58.8	50.1	60.1	Substantial Adverse	Substantial Adverse
Overton Lodge**	Residential	40.4	40.4	53.1	40.4	54.3	Substantial Adverse	Substantial Adverse
Naurcris	Residential	51.0	51.4	58.1	51.9	59.2	Substantial Adverse	Substantial Adverse
Pitmedden House**	Residential	40.4	40.4	49.5	40.4	50.7	Substantial Adverse	Substantial Adverse
East Woodlands House**	Residential	40.4	40.4	50.4	40.4	51.6	Substantial Adverse	Substantial Adverse
1 Bogenjoss**	Residential	40.4	40.4	46.8	40.4	48.0	Substantial Adverse	Substantial Adverse
2 Bogenjoss**	Residential	40.4	40.4	61.2	40.4	62.4	Substantial Adverse	Substantial Adverse
Howe Moss Farm**	Residential	40.4	40.4	52.4	40.4	53.5	Substantial Adverse	Substantial Adverse
Goval Villa	Residential	50.4	51.9	57.5	52.7	58.8	Substantial Adverse	Substantial Adverse

Property	Building Type	Base 2005 $L_{A10(T)}$ **=$L_{A90(T)}$	Noise Levels LA10(18hr)				Significance of Impact	
			Year of Opening		Design Year		Year of Opening	Design Year
			DM	DS	DM	DS		
P G S, Howe Moss Drive	Commercial/Industrial	56.8	46.2	50.3	46.4	51.3	Moderate Adverse	Moderate Adverse
Parkhill Cottage, Parkhill Pumping Station	Residential	59.2	59.7	61.1	59.9	62.3	Moderate Adverse	Moderate Adverse
1 Little Goval Cottages, Parkhill	Residential	56.6	56.7	60.7	57.2	61.5	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Meadowhead**	Residential	40.4	40.4	55.7	40.4	56.5	Substantial Adverse	Substantial Adverse
Waulkmill Croft**	Residential	40.4	40.4	59.4	40.4	60.3	Substantial Adverse	Substantial Adverse
Lochgreens Farm**	Farm	40.4	40.4	57.3	40.4	58.0	Moderate Adverse	Moderate Adverse
Capalaba, Moss Belt	Residential	52.3	52.4	54.7	52.7	55.4	Moderate Adverse	Moderate Adverse
Birchville, Corsehill	Residential	47.5	47.7	60.6	48.1	61.4	Substantial Adverse	Substantial Adverse
Meadowbank	Residential	51.4	51.5	57.2	52.0	58.0	Substantial Adverse	Substantial Adverse
1 Lochgreens Cottages**	Residential	40.4	40.4	55.9	40.4	56.6	Substantial Adverse	Substantial Adverse
The Emmerick, Parkhill	Residential	65.2	65.5	62.3	65.7	62.8	Moderate/ Substantial Beneficial	Moderate Beneficial
2 Lochgreens Cottages**	Residential	40.4	40.4	61.7	40.4	62.4	Substantial Adverse	Substantial Adverse
Newton Of Shielhill**	Residential	40.4	40.4	48.1	40.4	48.8	Substantial Adverse	Substantial Adverse
Leuchlands Croft**	Residential	40.4	40.4	53.8	40.4	54.5	Substantial Adverse	Substantial Adverse
Cranfield Lodge	Residential	54.3	54.7	58.0	55.1	58.4	Moderate/ Substantial Adverse	Moderate/ Substantial Adverse
Blackdog Heights	Residential	63.5	62.7	60.6	63.0	61.0	Moderate Beneficial	Moderate Beneficial
3 Strabathie Cottages Hareburn Terrace	Residential	75.4	74.5	73.5	74.8	73.8	Slight Beneficial	Slight Beneficial
Harehill Farm**	Farm	40.4	40.4	55.3	40.4	55.7	Moderate Adverse	Moderate Adverse
Middleton Farm Steading East**	Residential	40.4	40.4	58.1	40.4	58.8	Substantial Adverse	Substantial Adverse
2 Hareburn Road	Residential	60.3	59.6	58.0	59.9	58.4	Moderate Beneficial	Moderate Beneficial

Ground Floor

15.6.3 Of the 291 residential properties within 300m, there is 1 property which will experience 'No change' in Year of Opening and there are none in the Design Year at ground floor level. At ground floor there are 70 properties in the Year of Opening and 86 properties in the Design Year that would experience a residual significance of impact that is Moderate Beneficial or better. These beneficial impacts are indicated on Figures 15.2a-g, and explained in paragraphs 15.4.8 and 15.4.9.

15.6.4 At ground floor level within 300m, 126 properties in the Year of Opening and 130 properties in the Design Year would experience a residual significance of impact of Moderate Adverse or worse.

15.6.5 As noted in paragraph 15.2.37, the use of mitigation may be precluded under certain circumstances. There are 4 properties in the Year of Opening that have a predicted residual significance of impact that is Moderate Adverse or worse, with an $L_{A10(18hr)}$ that exceeds 59.5dB but for which mitigation is not proposed. Of these, two are properties where non-local acoustic barriers are ineffectual (1 Little Goval Cottage and Hill Crest), and two are properties that only exceed the mitigation threshold by 0.2dB and 0.3dB (Easter Hatton and Millden Steading West respectively) and it was therefore deemed to be disproportionate to erect roadside acoustic barriers. For the Design Year, similar residual exceedence levels will be experienced at 7 properties (the aforementioned properties, plus Milldon House West, and 1 and 2 Walton Farm). Exceedence at Milldon House West is only 0.1dB and mitigation and cost was considered disproportionate. At 1 and 2 Walton Farm, roadside acoustic barriers alongside the A96(T) extending for approximately 243m, at a height of 3.5m would be necessary to achieve the target noise level. Due to landscaping and visual impact considerations it was deemed inappropriate to provide this form of mitigation. However, it should be appreciated that the exceedence, above the mitigation threshold, at these properties, is only 1dB at the most exposed property to road traffic noise.

15.6.6 It should be noted that Mackie Hall is excluded from the above Design Year total, as it is understood that this property is used as a College Halls of Residence, and the exceedence is for the gable end of this property and available information indicates that there are no apartment spaces within the gable end and, as such, further mitigation is deemed unnecessary.

15.6.7 It should be noted that the number of properties that fall into each of the significance of impact categories before and after mitigation are similar. This similarity arises because the aim of the additional specific mitigation was to reduce noise levels such that they do not exceed $L_{A10(18hr)}$ 59.5dB for those properties where the significance of impact is Moderate Adverse or worse. Although there is little change in the number of properties that are predicted to experience a significance of impact that is Moderate Adverse or worse, all but 7 residential properties (i.e. excluding Mackie Hall, as explained above) are predicted to experience noise levels that do not exceed $L_{A10(18hr)}$ 59.5dB, or experience a noise increase, above that of the Do-Minimum scenario, that is less than 1dB.

First Floor

15.6.8 At first floor, there are 2 properties in the Year of Opening and 7 in the Design Year that would experience 'No change'. There are 68 properties in the Year of Opening and 66 properties in the Design Year properties that would experience a residual significance of impact that is Moderate Beneficial or better. These beneficial impacts are indicated on Figures 15.4a-g, and explained in paragraphs 15.4.8 and 15.4.9).

15.6.9 At first floor level 118 properties in the Year of Opening and 126 properties in the Design Year would experience a residual significance of impact that is Moderate Adverse or worse. However, of these only 21 properties in the Year of Opening and 36 properties in the Design Year also exceed the mitigation threshold of $L_{A10(18hr)}$ 59.5dB. These residential properties are as follows (the year in which the mitigation threshold ($L_{A10(18hr)}$ 59.5dB) remains exceeded is shown as a bracketed term, and where the property is a selected sample receptor, reference to the appropriate Figure has been included):

- Brimmond Lodge, Bucksburn (Design Year) (Figure 15.1a).
- Lyndmoor, Pitmedden Road, Dyce (Year of Opening, Design Year) (Figure 15.1d).
- Tillybrig, Pitmedden Road, Dyce (Design Year) (Figure 15.1d).
- 2 Bogenjoss, Dyce (Year of Opening, Design Year) (Figure 15.1d).
- Upper Kirkton, Dyce (Design Year).
- Parkhill Cottage, Parkhill Pumping Station, Dyce (Year of Opening, Design Year) (Figure 15.1e).
- Nether Kirkton, Dyce (Year of Opening, Design Year).
- Parkview Dyce (Design Year).
- Bungalow, Parkhill Dyce (Year of Opening, Design Year).
- Kinnaird, Parkhill Dyce (Year of Opening, Design Year).
- Beech Cottage, Parkhill Dyce (Year of Opening, Design Year).
- Waulkmill Croft Newmachar (Design Year) (Figure 15.1e).
- Corsehill House Newmachar (Design Year).
- Birchville, Corsehill Newmachar (Year of Opening, Design Year) (Figure 15.1e).
- Roselea, Parkhill Newmachar (Year of Opening, Design Year).
- 1 Little Goval Cottages, Parkhill Dyce (Year of Opening, Design Year) (Figure 15.1e).
- 2 Lochgreens Cottages Dyce (Year of Opening, Design Year) (Figure 15.1f).
- Greenacres, Bucksburn (Year of Opening, Design Year).
- Hill Crest, Bucksburn (Year of Opening, Design Year).
- 1 Walton View, Bucksburn (Year of Opening, Design Year) (Figure 15.1b).
- 2 Walton View, Bucksburn (Year of Opening, Design Year).
- 3 Walton View, Bucksburn (Design Year).
- 8 Craibstone Farm Cottages, Bucksburn (Design Year) (Figure 15.1b).
- Mackie Hall House, Bucksburn (Year of Opening, Design Year).
- Hatton Of Millden, Balmedie (Design Year).
- Millden House West, Balmedie (Design Year).
- Millden House East, Balmedie (Design Year).
- Lauren Grove Millden, Balmedie (Design Year).
- Warrendale, Millden, Balmedie (Design Year).
- Millden Steading East, Balmedie (Design Year)
- Easter Hatton, Balmedie (Year of Opening, Design Year).
- Middleton Farm, Bridge Of Don (Year of Opening, Design Year).
- Middlefield Farmhouse, Bridge Of Don (Design Year).
- 1 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).
- 2 Wester Hatton Cottages, Balmedie (Year of Opening, Design Year).
- Millden Steading West, Balmedie (Year of Opening, Design Year).

15.6.10 Generally, the adverse impacts would be experienced due to the introduction of the proposed scheme where no road previously existed. As mentioned previously, the beneficial impacts would accrue from traffic reductions on the existing roads, as occur as detailed in paragraphs 15.4.8 to 15.4.9.

15.6.11 A summary of the residual impact significance is provided in Table 15.11.

Table 15.11 - Residual Impact Significance for Residential Properties within 300m

Significance of Impact	Ground Floor				First Floor			
	Unmitigated		Mitigated		Unmitigated		Mitigated	
	Year of Opening	Design Year	Year of Opening	Design Year	Year of Opening	Design Year	Year of Opening	Design Year
Substantial Adverse	86	86	83	83	85	86	81	86
Moderate/ Substantial Adverse	9	10	11	11	8	8	11	7
Moderate Adverse	44	46	32	36	39	39	26	33
Slight Adverse	33	31	45	42	34	33	46	40
No Change	1	0	1	0	2	6	2	7
Slight Beneficial	48	32	49	33	55	36	57	52
Moderate Beneficial	63	80	63	80	58	74	58	57
Moderate/ Substantial Beneficial	5	4	5	4	8	7	8	7
Substantial Beneficial	2	2	2	2	2	2	2	2

Noise Nuisance

15.6.12 An assessment of noise nuisance has been carried out for selected properties in accordance with the predictive technique presented in DMRB. Although the method has limitations as discussed in Section 15.2 it does provide for a useful comparison of effects.

15.6.13 All changes in terms of noise and nuisance levels are reported in Tables 1a-d and Tables 2a-d of Appendix A15.2 for each of the DMRB defined ambient noise bands at ground and first floor respectively. The changes at ground floor will be summarised here to bring the effects of the proposed Northern Leg into focus.

15.6.14 Within 300m approximately 158 properties at ground floor that will experience an increase in noise of at least 1dB, whilst 61 properties at ground floor will experience a decrease of at least 1dB. There is likely to be 186 properties at which the change in the noise level will result in an increase in the percentage of people bothered, and 105 properties where the change in noise levels will result in a decrease in the percentage of people likely to be bothered by noise.

15.6.15 The biggest change in the percentages of people likely to be bothered by noise is at those properties where the existing ambient noise level is low (below 50dB(A)), i.e. where there are no busy roads in close proximity to the properties at present. In this category, as can be seen by reference to Table 1a of Appendix 15.2, 108 properties will experience an increase in noise level, with the change at 33 of these properties being greater than 10dB, whereas in the Do-minimum scenario there are no properties that would experience an increase in noise of 1db or more. Overall, within the less than 50dB(A) ambient noise category, the scheme will result in a net increase in noise of at least 1dB at 108 properties. There is 1 property in the less than 50dB(A) ambient noise band that will experience a decrease in noise of between 1 and 3 dB for the Do-something scenario. This property is 11 Harburn Road, south of where the AWPR joins the A90 north of Aberdeen, which is due to decreases in both traffic flow and percentage of HGVs using the A90 south of the AWPR/A90 junction.

15.6.16 However, as the existing ambient noise levels increase, the proposed scheme results in noise benefits. These benefits occur where traffic on existing roads migrates to the scheme; thus

reducing the traffic flows on these roads. Where the existing ambient noise climate is between 50 and 60dB(A), 34 properties will experience an increase in the noise level of at least 1dB with 37 properties experiencing a decrease in noise level of at least 1dB. However, for the Do-Minimum scenario there are no properties where the noise level increase is predicted to increase, or decrease, by 1dB or more.. Therefore, in effect the scheme will result in a net increase at 34 properties with a net benefit at 37 properties in terms of noise reduction where the existing ambient noise level is between 50 and 60dB(A).

15.6.17 Within 300m of the scheme, where the existing ambient noise climate is between 60 and 70dB(A), i.e. at properties reasonably close to existing roads, 15 properties will experience an increase in noise of at least 1dB, with 21 properties experiencing a decrease in noise level of at least 1dB. This compares with a potential increase in the noise level of at least 1dB with the Do-minimum scenario of approximately 1 property and a decrease in the noise level of at least 1dB at no properties. Therefore, in effect the scheme will result in 14 additional properties experiencing an increase in the noise level of at least 1dB, and with a net benefit at 21 properties in terms of noise reduction.

15.6.18 Within 300m of the scheme, where the existing ambient noise climate is greater than 70dB(A), i.e., at properties adjacent to existing roads, there is one residential property for the Do-Something scenario that will experience an increase in noise level of 1dB or more and 2 where there is a decrease in the noise level of 1dB or more.

15.6.19 Overall, within the Core Study Area, more properties will be subject to an increase in noise level than to a decrease and this is very apparent in areas of existing low ambient noise. This is also evidenced in the nuisance assessment (Table 1a in Appendix A15.2), which shows that 186 properties will experience an increase in the percentage of people bothered by noise. However, as the existing ambient level increases, benefits of the scheme become apparent. This is evidenced by the number of properties that experience a decrease in noise with the scheme in place when compared with the Do-minimum scenario; 37 versus 0 in the 50-60dB(A) ambient noise band and 21 versus 0 in the 60-70dB(A) ambient noise band. It is also evidenced by the decrease in nuisance level for the with scheme option in the 50-60dB(A) and 60-70dB(A) ambient bands (Table 1b and 1c in Appendix A15.2).

Vibration

15.6.20 As explained in Section 15.2 (Approach and Methods), nuisance caused by vibration is considered in terms of noise nuisance categories, but reduced by 10%, and properties experiencing noise levels below 58 dB $L_{A10,18h}$ and/or outwith 40m of the road will not experience nuisance from vibration.

15.6.21 There are approximately 17 residential buildings within 40m of the proposed scheme that will exceed the 58 dB $L_{A10,18h}$ lower threshold for vibration assessment. The greatest increase in noise levels is at 2 Bogenjoss where the existing noise level has been established as 40.4dB(A), which is below the threshold for vibration. With the mitigated scheme in place in the Year of Opening this would rise to 58dB(A), which does not exceed the DRMB thresholds of vibration annoyance. By the Design Year the noise level will have gradually increased by a further 1.2dB(A) to 59.2dB(A), however due to people being accustomed to higher levels of ambient noise the percentage of people bothered as defined by DMRB would be approximately 2%. It is important that this comparison should not be taken as indicative of responses at individual properties, but it does serve to illustrate that vibration annoyance would not be a significant issue for this scheme.

15.7 References

Baughan and Martin (1981); cited in Design Manual for Roads and Bridges (DMRB) P6/1.

Berglund B, Lindvall T, & Schwela D (Eds) (1999) Guidelines for Community Noise. World Health Organisation.

Department of Transport Welsh Office. (1988) Calculation of Road Traffic Noise (CRTN).

Harland D.G. & Abbott P.G. (1997) Noise and Road Traffic Outside Homes in England. TRRL Report LR770 Department of Transport/Department of the Environment.

Highways Agency ([1992] 2006) Traffic Noise and Vibration. Design Manual for Roads and Bridges (DMRB). Volume 11, Section 3, Part 7.

http://www.defra.gov.uk/environment/noise/research/nis0001/index.htm

Scottish Executive (2006) Scottish Transport Appraisal Guidance (STAG). V1.0. http://www.scot-tag.org.uk/stag/exec.htm

Scottish Office Development Department (SDD). (1996) Controlling the Environmental Effects of Surface Mineral Workings. Planning Advice Note 50, Annex A.

Skinner, C.J. & Grimwood C.J. (2000/2001) The UK National Noise Incidence Study. Building Research Establishment (BRE).

Watts, G.R. (1984) Vibration Nuisance from Road Traffic – results of a 50 site survey. TRRL Report LR 1119. Department of Transport/Department of the Environment.

Watts, G.R. (1990) Traffic Induced Vibration in Buildings. TRRL Report 246 Department of Transport/Department of the Environment.