9 NOISE & VIBRATION

9.1 Introduction

9.1.1 Introduction

This Chapter reports on the predicted effect of the proposed junction and access road improvements on the A77 at Symington and Bogend Toll on noise and vibration. The Scheme would potentially affect traffic noise and vibration levels due to changes in traffic flows, as experienced by residents of properties along the Scheme, as well as residents in the vicinity of any affected side roads.

During the construction works temporary construction noise and vibration impacts may also occur.

All individual or groups of residential properties within 300m of the Scheme and surrounding affected roads have been identified and used to assess the potentially significant noise and vibration impacts of the Scheme.

The operational traffic noise and vibration assessment has been undertaken using the methodology as described in the Design Manual for Roads and Bridges (DMRB) Volume 11.

The significance of the operational impact of the Scheme is assessed based on the change in predicted traffic noise levels at residential properties due to the Scheme and the change in the overall number of occupants of residential properties likely to be bothered by traffic noise and vibration.

9.2 Methodology

9.2.1 Construction Noise Impact Assessment

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

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

Construction noise predictions have been carried out based on the methodology outlined in BS 5228: 1997 'Noise and vibration control on construction and open sites'. BS 5228 predicts noise as an equivalent continuous noise level averaged over a suitable assessment period, for example, 1 hour ($L_{Aeq,1h}$).

BS 5228 contains a database on the noise emission from individual items of equipment and activities, and routines to predict noise from construction activities

to identified receptors. The prediction method gives guidance on the effects of different types of ground, barrier attenuation and how to assess the impact of fixed and mobile plant.

In order to evaluate the noise from construction it is necessary to define the various activities that would be undertaken. At this stage a Contractor has not been appointed and a detailed construction programme of the required activities and phasing is not available. In addition, unless contractually obliged to use a particular method, different contractors will use different approaches to achieve the same ends. Therefore, an estimate of the likely construction activities and equipment has been made (see Table 9.1). The assessment considers the construction of the two grade-separated junctions and associated link roads. Stopping up of sections of the central reserve is not considered to be a potentially significant source of noise or vibration.

Table 9.1: Construction Activities

	Activity
1	Topsoil Strip
2	Embankments
3	Bridge Foundations
4	Bridge Substructure
5	Bridge Superstructure
6	Road Construction

Details of the equipment assumed to be operating during each activity are provided in Appendix 9.

The impact of bridge construction activities has been assessed for the two proposed new bridges at Symington and Bogend Toll.

It is assumed within the noise predictions that the Contractor will follow standard best practicable means to reduce the noise impact upon the local community:

- Proper use of plant with respect to minimising noise emissions and regular maintenance. All vehicles and mechanical plant used for the purpose of the works should be fitted with effective exhaust silencers and should be maintained in good efficient working order;
- Selection of inherently quiet plant where appropriate. All major compressors should be 'sound reduced' models fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use and all ancillary pneumatic percussive tools should be fitted with mufflers or silencers of the type recommended by the manufacturers;
- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum; and

- All ancillary plant such as generators, compressors and pumps should be positioned so as to cause minimum noise disturbance.

Construction noise levels have been predicted for each applicable activity at a selection of the closest identified residential receptors along the Scheme, see Figure 9.1 and Table 9.2:

Table 9.2: Construction Noise Receptors

Receptor	
C1	Jeanfield, Symington
C2	Kilmarnock Road, Symington
C3	Stockbridge Cottage, Symington
C4	Tarbolton Road, Bogend Toll
C5	Kilmarnock Road, Whitelees

It is assumed that construction activities will take place within standard construction hours, Monday to Friday, between 07:00 and 19:00 hours and on Saturdays between 08:00 and 13:00 hours. No works will be carried out on Sundays or Bank holidays. No evening or night time work is anticipated to be required.

No details of the likely volume or routes of construction traffic is currently available, therefore, an assessment of the impact on traffic noise levels of the additional traffic cannot be made. However, current traffic flows on the A77 are around 35,000 vehicles per day, of which 10% are heavy duty vehicles (HDV). It is unlikely that construction traffic would result in an increase in traffic flows of 25% or more. Therefore, it is unlikely that construction traffic accessing the site will result in a significant adverse impact on existing traffic noise levels.

9.2.2 Construction Noise Significance Criteria

Noise levels generated by construction activities are regulated by guidelines and subject to local authority control.

South Ayrshire Council has developed its own guidelines on acceptable construction noise levels, which vary with the existing ambient noise level, see Table 9.3.

Table 9.3: South Ayrshire Council Construction Noise Guidelines

Existing Ambient	Weekday Day 0700-1900		Weekday Evening 1900-2200		Saturday 0800-1600
$L_{Aeq,2h}$ dB, 0800-1000 or 1900-2100, or as appropriate	$L_{Aeq,12h}$ dB	L_{Amax} dB	$L_{Aeq,3h}$ dB	L_{Amax} dB	$L_{Aeq,8h}$ dB
35	65	86	55	65	65
40	65	86	55	65	65
45	65	86	60	70	65
50	70	91	60	70	70
55	75	96	65	75	75
60	75	96	65	75	75
65	75	96	65	75	75
70	80	101	80	90	80
75	80	101	80	90	80

Exceedance of the South Ayrshire guideline levels indicates an adverse impact due to the construction works would occur at affected receptors. The significance of the adverse impact depends on the combination of the amount by which the limit is exceeded and the duration of the works. For example, a predicted construction noise level of 75 dB, L_{Aeq} for works lasting a number of months in a location where the guideline is 65 dB would result in a more significant impact than if the works lasted a number of days.

At this stage of the project a detailed construction programme outlining the duration of construction activities at individual locations is not available. The whole of the works are expected to be completed in a total of 12 months.

9.2.3 Construction vibration – method of assessment

It is likely that the two new bridges will require piled foundations. Piling is a potential source of ground borne vibration. A conservative approach to the assessment of noise and vibration impacts has been taken by assuming driven piling.

There are no accepted formulae for the prediction of the passage of vibration through ground due to the non-uniform effects of different ground conditions, although some empirical formulae have been proposed for known ground conditions based on previously measured data.

The vibration peak particle velocity (ppv) due to piling of foundations has been calculated at sensitive receptors using example measured source data and the propagation relationship taken from the BS 5228: 1992 (part 4). The predicted ppv at sensitive receptors can then be used to calculate the estimated vibration dose value (eVDV) following the calculation procedure in BS 6472: 1992 'Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)'.

The ppv data for hammer impact driven piling has been assumed to be 13 mms-1 at 3m, based on measured data reported in BS 5228: 1992 (part 4).

Due to the large effect local ground conditions have on the transmission of vibration and the lack of detailed information on the method of piling at this outline stage, the predicted vibration ppv and eVDV values should be treated as estimates.

9.2.4 Construction vibration –significance criteria- nuisance

Ground vibrations may cause reactions ranging from 'just perceptible', through 'concern' to 'alarm' and 'discomfort'. The subjective response varies widely and is a function of situation, information, time of day and duration.

British Standard BS 6472: 1992 'Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)' gives vibration dose values (VDVs) at which complaints are probable. VDVs may be used to assess the severity of impulsive and intermittent vibration, such as experienced from driven piling or from rail traffic, and steady vibration such as from fixed plant.

The adoption of the VDV parameter is based on social studies undertaken in the 1980s and early 1990s into human response to vibration. BS 6472 requires that the VDV be determined separately for the 16-hour daytime (07.00-23.00) and 8 hour night time (23.00-07.00) periods. It is assumed no night time construction work is required, therefore only the daytime VDV is considered.

The VDV increases by the same factor if either the acceleration is doubled while the duration of exposure remains constant, or if the acceleration is kept constant and the duration of exposure increases 16 fold.

Table 7 in the Appendix of BS 6472, reproduced below in Table 9.4, indicates the likelihood of compliant from various levels of vibration.

The estimated VDV due to the piling activities required to construct the new buildings on site is compared to the criteria specified in BS 6472 to determine the significance of the vibration impact in terms of nuisance impacts.

Table 9.4: Vibration Dose Values above which various degrees of adverse comment may be expected in residential buildings (from BS 6472: 1992)

Building Classification	Vibration Dose Values ($ms^{-1.75}$)		
	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
Residential buildings, 16 hr day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings, 8 hr night	0.13	0.26	0.54

9.2.5 Construction vibration –significance criteria – building damage

Buildings are reasonably resilient to ground-borne vibration and vibration-induced damage is rare. Vibration-induced damage can arise in different ways, making it difficult to arrive at universal criteria that will adequately and simply indicate damage risk. Damage can occur directly due to high dynamic stresses, due to accelerated ageing or indirectly, when high quasi-static stresses are induced by, for example, soil compaction.

Guidance on acceptable vibration levels in structures is provided in BS 5228: Part 4: 1997 'Code of practice for noise and vibration control applicable to piling operations'. This Standard recommends that a conservative threshold for minor or cosmetic damage should be taken as a peak particle velocity of 10 mms^{-1} for intermittent sources of vibration such as driven piling, to determine whether there is any risk of building damage.

The criteria shown in Table 9.5 below (compiled from paragraph 8.4.2, page 24 of BS 5228: Part 4: 1997) can be applied in the case of intermittent vibration from piling works.

Table 9.5: Vibration Limits Relating to Minor or Cosmetic Damage to Buildings from Piling Operations (from BS 5228: Part 4: 1992)

Building Classification	Intermittent Vibration (ppv, mms-1)
Residential in generally good repair	10
Residential where preliminary survey reveals significant defects	5
Industrial/commercial - light and flexible structure	20
Industrial/commercial - heavy and stiff structure	30

The estimated ppv due to the piling activities required to construct the two new bridges is compared to the criteria specified in BS 5228 to determine the significance of the construction vibration impact in terms of building damage.

9.2.6 Road Traffic Noise Impact Assessment

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

Noise from a stream of traffic is not constant; therefore, to assess the noise impact a single figure estimate of the overall noise level is necessary. The index adopted to assess traffic noise in 'The Calculation of Road Traffic Noise' (CRTN) is the $L_{A10,18h}$, which it defines as the arithmetic mean of the noise levels exceeded for 10% of the time in each of the eighteen 1 hour periods between 06.00 and 24.00. A reasonably good correlation has been shown to exist between this index and residents' perception of traffic noise over a wide range of exposures. CRTN provides a standard methodology for predicting the $L_{A10,18h}$ road traffic noise level at 1m external to the worst-affected façade, the predictions include the +2.5 dB façade correction specified in CRTN.

DMRB requires that the Study Area for the traffic noise impact assessment includes properties within a 300m corridor each side from the centreline of the Scheme and surrounding affected roads.

The computer noise modelling software SoundPlan version 6.4, which incorporates the CRTN methodology, has been used to predict traffic noise levels at the worst affected façade of all identified properties in the Study Area. Traffic noise levels are predicted at a height of 4m, representative of the 1st floor of a residential property. In the baseline scenarios the surface of the A77 and all surrounding roads are assumed to be standard hot rolled asphalt (HRA). All the new sections of road constructed as part of the Scheme are assumed to be a low noise surface. Technical details of the noise modelling are provided in Appendix 11.

Traffic noise levels at the façade of each identified property have been predicted for five scenarios: the existing baseline situation in 2006 (06NP) the anticipated year of opening 2009 with and without the Scheme (09WP and 09NP), and 15 years after year of opening in 2024 with and without the Scheme (24WP and 24NP).

To illustrate the likely impact on traffic noise levels the actual noise levels at nine residential properties located along the A77 and surrounding affected roads have been reported to enable comparison of the magnitude of the traffic noise impact between the five different assessment scenarios. The chosen receptors are listed in Table 9.6 and shown in Figure 9.1.

Table 9.6: Traffic Noise Receptors

Receptor	
T1	Kilmarnock Road, Symington
T2	South Trynlow Cottage, Symington
T3	Stockbridge Cottage, Symington
T4	Symington Road, Symington
T5	Symington Road North, Symington
T6	Brewlands Road, Symington
T7	Kilmarnock Road, Whitelees
T8	Fairfield Manor, Bogend Toll
T9	Tarbolton Road, Bogend Toll

To assist in the assessment of the magnitude of the impact of the predicted traffic noise levels on residents, the nuisance caused by varying levels of traffic noise is quantified. Individuals vary widely in their response to the same level of traffic noise. However, the average or community response from a large number of people to the same level of traffic noise is fairly stable, therefore, a community average degree of bother caused by traffic noise can be related to the long-term steady state noise level. The relationship between the steady state traffic noise level and the estimated nuisance experienced, expressed as the percentage of people 'bothered very much or quite a lot' is illustrated in Figure 9.2 (taken from DMRB). This shows, for example, that approximately 13% of all residents would be 'bothered very much or quite a lot' at a façade road traffic noise level of 60 dB $L_{A10,18h}$.

In addition, research has shown that people are more sensitive to abrupt changes in traffic noise, for example following the opening of a new road, than would be predicted from the steady state relationship between traffic noise and nuisance (described above). These effects last for a number of years, however, in the longer term the perceived noise nuisance tends towards the steady state level due to familiarisation. The percentage change in the traffic noise nuisance due to an abrupt change in the traffic noise is illustrated in Figure 9.3 (taken from DMRB).

Figure 9.2: Estimation of Traffic Noise Nuisance - Steady State

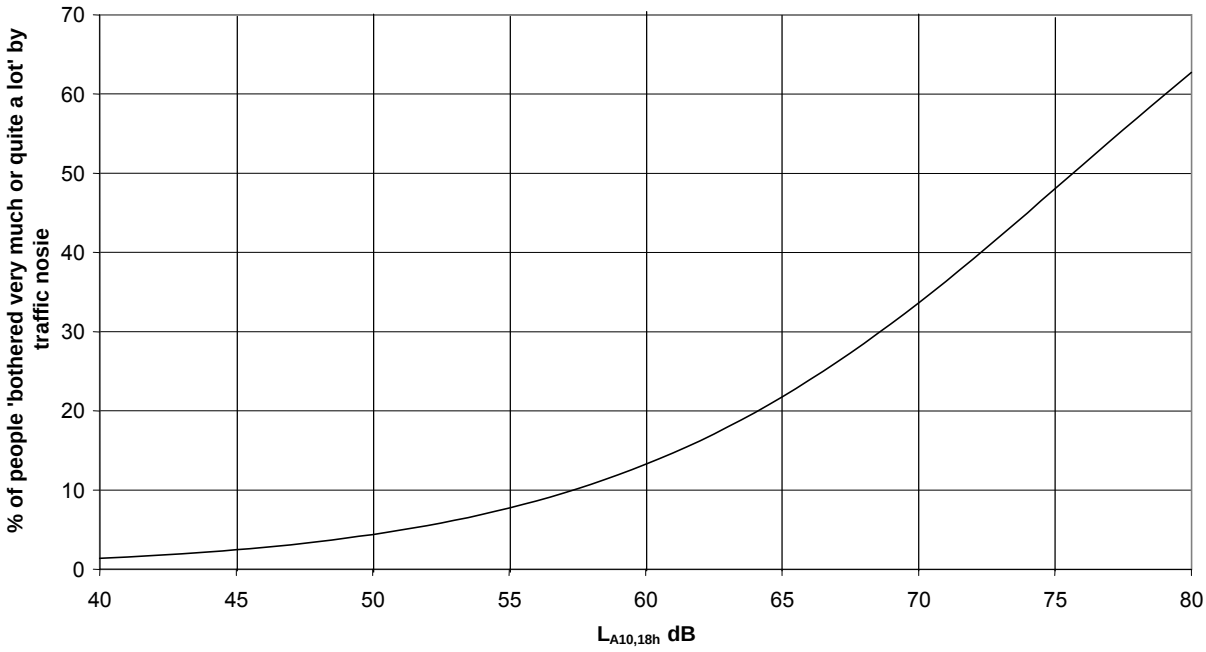

Figure 9.3:Estimation of Traffic Noise Nuisance - Immediate Change in '% people bothered very much or quite a lot' by traffic nosie

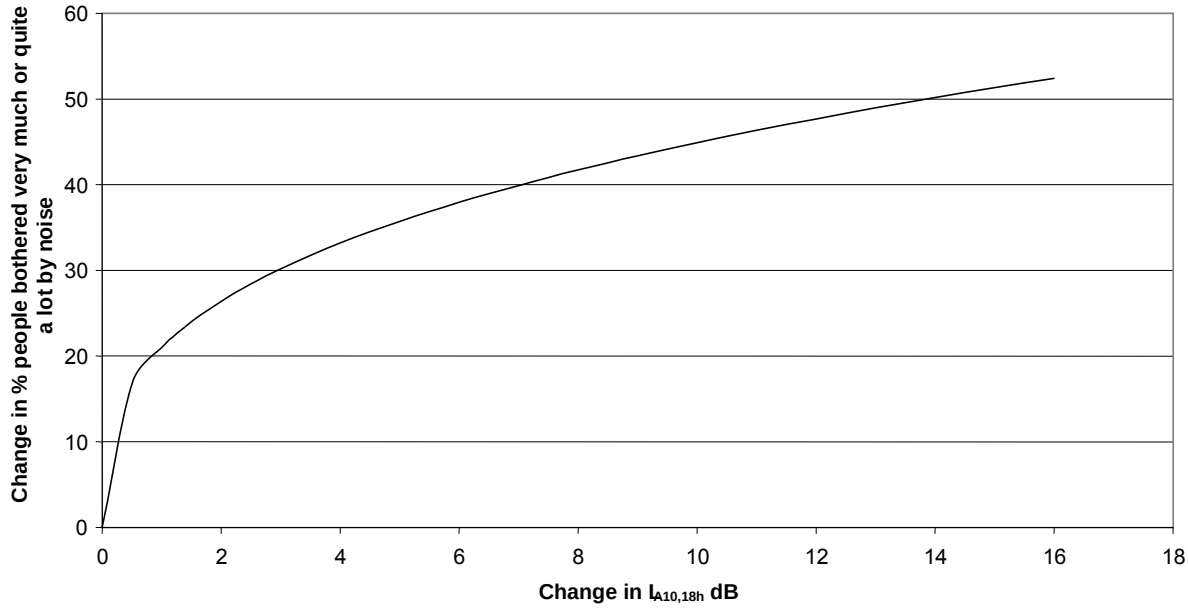

Figure 9.3 shows, for example, that with an abrupt (and permanent) increase of 10 dB(A) there would be a net change of 45% residents 'bothered very much or quite a lot' by road traffic noise. If the initial noise level was 60 dB $L_{A10,18h}$ (13% bothered) then there would be 58% bothered immediately after the increase to 70 dB $L_{A10,18h}$. This would eventually diminish in the long term due to familiarisation to become approximately 34% bothered (Figure 9.2).

These relationships between traffic noise and the level of nuisance experienced by occupants of residential properties have been used to calculate the nuisance level at each property in each scenario. In addition, this has been converted into the number of people likely to be bothered by road traffic noise for each scenario using the national average household size of 2.36 people.

9.2.7 Road Traffic Noise Significance Criteria

The Noise Insulation (Scotland) Regulations 1975 and the Memorandum on the Noise Insulation (Scotland) Regulations 1975 allow provision of noise attenuation measures in the form of secondary glazing, secondary doors, blinds and mechanical ventilation to habitable rooms of residential properties affected by road traffic noise from a 'new or altered highway' which meet the following criteria:

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the new or altered road together with other traffic in the vicinity must not be less than the specified noise level, 68 dB $L_{A10,18h}$;
- The relevant noise level is at least 1.0 dB(A) more than the prevailing noise level, i.e. the total traffic noise level existing before the works to construct or improve the road were begun;
- The property is within 300m of the nearest point of the carriageway of the new or altered road;
- A straight line can be drawn from the property to a point on the new or altered road without passing through another building; and
- The property is not outside the triangular area at the end of the new or altered road, the apexes of which are 50m along the centre of the existing carriageway from the end point of the new or altered road, and the bases of which extend 300m from the edge of the carriageway at right angles to the centre of the carriageway.

The predicted traffic noise levels at each property have been used to indicate if any properties are likely to meet the criteria. It should be noted that traffic noise levels have been predicted using the 1988 CRTN methodology, rather than repeating all the predictions using the more simple 1975 method specified in the Memorandum on the Regulations. In addition, the predicted baseline traffic noise levels in the year of opening (2009) have been used as an approximation of the prevailing noise level.

If the Scheme goes ahead a dedicated Noise Insulation Regulations assessment is recommended, as a full assessment is beyond the scope of the Environmental Statement.

The significance of the predicted traffic noise impact has been assessed firstly by consideration of the provisions of the Noise Insulation (Scotland) Regulations but primarily by the difference in traffic noise and nuisance levels at each noise sensitive receptor, with and without the Scheme in operation, as prescribed in DMRB.

It is generally accepted that changes in road traffic noise levels of up to 3 dB(A) are not widely perceptible. Consequently at the nine selected individual properties for which traffic noise levels are reported in detail, the significance of the predicted change in traffic noise levels has been considered using the scale of significance shown in Table 9.7. The criteria have been developed by Scott Wilson based on a range of current guidance including DMRB, WebTAG and Institute of Environmental Management & Assessment and Institute of Acoustics Guidelines.

Table 9.7: Significance of the Predicted Change in Traffic Noise Levels at Individual Receptors

Change in Traffic Noise $L_{A10,18h}$ dB	*Significance*
<1	Negligible
1 - <3	Minor
3 - <5	Moderate
≥5	Substantial

The significance of the effect of the Scheme on traffic noise levels at all the residential properties in the Study Area is assessed based on the change in traffic noise levels due to the Scheme. The change in traffic noise level due to the Scheme at each property in the study area is determined in both 2009 (09WP-09NP) and 2024 (24WP-24NP).

In addition, the DMRB methodology requires that the assessment of significance considers the highest noise levels experienced in the first 15 years after opening. As traffic flows are predicted to rise over time the highest traffic flows, and noise levels, occur 15 years after opening in 2024. Therefore, following DMRB baseline traffic noise levels in 2009 (09NP) are compared with the baseline and operational traffic noise levels in 2024 (24NP and 24WP).

In accordance with the requirements of DMRB, predicted baseline traffic noise levels in 2009 (09NP) at each residential property have been classified into one of four noise bands: <50, 50<60, 60<70, and ≥70 dB $L_{A10,18h}$. The change in traffic noise level in 2024 with (24WP) and without (24NP) the Scheme is reported by classifying the number of properties in each noise band which are subject to an increase or decrease in traffic noise level of <1, 1<3, 3<5, 5<10, 10<15 and >15 dB(A).

The greater the number of properties experiencing a large reduction in traffic noise levels the more significant the beneficial impact of the Scheme, conversely, the greater the number of properties experiencing a large increase in traffic noise levels the more significant the adverse impact of the Scheme.

The significance of the impact of the Scheme on traffic noise nuisance levels at all the residential properties in the Study Area is assessed based on the change in traffic noise nuisance levels due to the Scheme. The change in the number of people in the study area likely to be bothered by road traffic noise due to the Scheme is determined in both 2009 (09WP-09NP) and 2024 (24WP-24NP), based on the national average household size of 2.36. A decrease in the overall number of people bothered by traffic noise would indicate a net benefit to the community as a whole (even though some properties may experience an increase in traffic noise levels).

In addition, the DMRB methodology requires that the assessment of significance considers the highest nuisance levels experienced in the first 15 years after opening.

In the baseline situation, without the Scheme in operation, the nuisance caused by traffic noise rises over time as traffic volumes generally increase over time. Therefore, the difference between the long-term steady state nuisance levels for the existing baseline (09NP) and the steady state future baseline (24NP), as determined by the relationship in Figure 9.2, has been calculated.

At properties that would experience an immediate decrease in traffic noise upon opening of the Scheme the nuisance caused by traffic noise initially drops but then rises over time as traffic volumes increase due to natural growth. DMRB requires a worst-case assessment and therefore the difference between the long-term steady state nuisance levels for the existing baseline (09NP) and the operation of the Scheme 15 years after opening (24WP), as determined by the relationship in Figure 9.2, has been calculated. This approach does not highlight the immediate reduction in nuisance experienced by occupants of properties where traffic noise reduces immediately after the Scheme is opened.

At properties that would experience an immediate increase in traffic noise upon opening of the Scheme the greatest nuisance caused by an increase in traffic noise due to a scheme in operation will usually be immediately after the scheme opens (unless very high road traffic growth is predicted within the 15 year assessment period). Therefore, the abrupt increase in traffic noise between the existing baseline (09NP) and the operation of the Scheme in the year of opening (09WP) has been used to determine the change in nuisance, based on the relationship illustrated in Figure 9.3.

Properties are then classified into the following bands based on the change (increase or decrease) in the percentage of people bothered by traffic noise: <10 percentage points, 10<20 percentage points, 20<30 percentage points, 30<40 percentage points or ≥40 percentage points.

A large number of properties experiencing a large reduction in traffic noise nuisance levels would indicate a substantial beneficial impact of the Scheme; conversely a large number of properties experiencing a large increase in traffic noise nuisance levels would indicate a substantial adverse impact of the Scheme.

9.2.8 Road Traffic Vibration Impact Assessment

Vibration can be transmitted through the air or through the ground. The engines and exhausts of road vehicles produce air borne vibration, with dominant

frequencies typically in the range 50 – 100 Hz. Ground borne vibration is produced by the interaction of the vehicle tyres and the road surface with dominant frequencies typically in the range 8 – 20 Hz. The passage of vehicles over irregularities in the road surface is a source of ground borne vibration. Vibration is commonly measured in terms of peak particle velocity (ppv) in $mms^{-1.}$

Vibration can have an effect on buildings and cause disturbance to occupiers. Occupiers notice air borne vibration more often than ground borne vibration as it may result in detectable vibrations in building elements such as windows and doors.

Traffic vibration becomes perceptible to people at a ppv of around 0.5 mms^{-1} in the vertical direction. However vibration levels of above approximately 10 mms^{-1} are required to cause cosmetic damage to buildings. In the structure of buildings close to busy roads ppv's are typically well below 1 mms^{-1} and rarely exceed 2 mms^{-1}. Extensive research on a wide range of buildings has found no evidence of traffic induced ground borne vibration being a source of damage to buildings.

To assess the impact of traffic induced vibration on residents a parameter is needed which relates to peoples subjective rating of vibration disturbance, DMRB recommends the use of the $L_{A10,18h}$. The relationship between the $L_{A10,18h}$ and bother due to vibration is similar to that for bother due to steady state traffic noise, as described in Figure 9.2 above, except that the percentage of people bothered by vibration is lower. For a given level of noise exposure the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for annoyance due to traffic noise. Below 58 dB(A) the percentage of people bothered by vibration is assumed to be zero.

At each property in the Study Area where traffic noise levels are predicted to be 58 dB, $L_{A10,18h}$ or more the percentage of people likely to be bothered very much or quite a lot by vibration is calculated, based on the nuisance levels in Figure 9.2, reduced by 10%. The vibration nuisance level at each property is converted to the number of people likely to be bothered based on the national average household size of 2.36.

The vibration nuisance predictions are calculated for each of the five scenarios current baseline 2006 (06NP), with and without the Scheme in 2009 (09NP and 09WP) and with and without the Scheme in 2024 (24NP and 24WP).

9.2.9 Road Traffic Vibration Significance Criteria

The significance of the impact of the Scheme on vibration nuisance due to road traffic is based on the change in the number of people likely to be bothered due to the operation of the Scheme (09WP-09NP and 24WP-24NP). A large reduction in the number of people likely to be bothered would indicate a substantial beneficial impact; conversely a large increase in the number of people likely to be bothered would indicate a substantial adverse impact.

9.2.10 Ambient Noise Monitoring

Ambient noise levels were monitored at a total of four locations over the period Wednesday 15 November 2006 – Saturday 18 November 2006 (see Table 9.8 and

Figure 9.1). The monitoring was carried out continuously using unmanned automatically recording sound level meters.

Table 9.8: Ambient Noise Monitoring Locations

Location	
M1	Jeanfield, Symington
M2	Rear of South Trynlow Cottage, Symington
M3	Rear of Stockbridge Cottage, Symington
M4	Rear of Tarbolton Road, Bogend Toll

The monitoring procedures adopted conformed to BS 7445:1991 'Description and Measurement of Environmental Noise'. All measurements were made 'free-field' (no vertical reflective surfaces within 3 metres of the microphone) and at a height of 1.5m above the ground.

Noise monitoring was undertaken using the following equipment:

- Brüel and Kjær sound level meters, type 2238;
- Brüel and Kjær all weather microphone protection kit; and
- Brüel and Kjær acoustic calibrator, type 423115.39

Each instrument was calibrated immediately before and after the survey period. No changes in the calibration level were noted. Weather conditions during the ambient noise monitoring were mainly dry with moderate winds. The instrumentation was protected by an all-weather kit at all times. The sound level meters were set to log various noise parameters including the L_{Aeq}, L_{A90} and $L_{Amax,fast}$ values on a repeat 15 minute basis.

9.3 Consultations

A summary of the consultation undertaken as part of the noise and vibration assessment is provided in Table 9.9.

Table 9.9: Consultation Summary

Consultee	Comment	Response
South Ayrshire Council	Discussion on construction noise operating hours and guideline levels	Guidelines incorporated into methodology

9.4 Baseline

9.4.1 Monitored Ambient Noise Levels

A summary of the monitored free-field noise levels is provided in Table 9.10. Further details are provided in Appendix 10.

Table 9.10: Summary of Ambient Monitoring

Location		Day 0700-1900		Evening 1900-2200		Night 2200-0700		$L_{A10,18h}$ dB
		L_{Aeq} # dB	L_{A90} * dB	L_{Aeq} # dB	L_{A90} * dB	L_{Aeq} # dB	L_{A90} * dB	
M1	Jeanfield	65	61	61	56	57	46	64
M2	S. Trynlaw Cottage	54	50	52	46	48	37	55
M3	Stockbridge Cottage	58	54	58	54	53	46	59
M4	Tarbolton Rd	56	52	53	49	49	41	56

logarithmic average
* arithmetric average

The daytime noise levels at M2, M3 and M4 are fairly similar with L_{Aeq} levels around the mid fifties. Levels at M2 South Trynlow Cottage would be expected to be higher due to its close proximity to the A77, however, due to security issues the noise meter was located in the rear garden, and benefited from considerable shielding from the A77. At M3 and M4 other buildings provide some shielding of the A77. The highest monitored noise levels are at M1, Jeanfield, which is at a higher elevation than the A77 and has an unimpeded view of the road.

Based on the requirements of South Ayrshire Council the recommended daytime construction noise guideline for properties in the vicinity of the upgraded Symington and Bogend Toll junctions is 75 dB, L_{Aeq}.

9.4.2 Predicted Baseline Traffic Noise and Vibration Levels

Noise levels due to traffic on the existing A77 and surrounding roads are predicted for the three no Scheme scenarios, in 2006, 2009 and 2024. The results for the nine selected traffic noise receptors are provided in Table 9.11.

Table 9.11: Baseline Traffic Noise Levels – Traffic Noise Receptors

Receptor		Predicted Façade Traffic Noise Level $L_{A10,18h}$ dB		
		2006 (06NP)	2009 (09NP)	2024 (24NP)
T1	Kilmarnock Road, Symington	78.9	79.1	80.1
T2	South Trynlow Cottage, Symington	76.9	77.1	78.1
T3	Stockbridge Cottage, Symington	65.3	65.1	66.3
T4	Symington Road, Symington	63.8	63.2	64.6
T5	Symington Road North, Symington	60.6	60.3	61.4
T6	Brewlands Road, Symington	58.4	58.7	60.0
T7	Kilmarnock Road, Whitelees	79.8	80.0	81.0
T8	Fairfield Manor, Bogend Toll	64.0	64.3	65.3
T9	Tarbolton Road, Bogend Toll	67.2	67.6	68.9

As would be expected the highest baseline traffic noise levels are predicted at T1, T2 and T7, which all face directly onto the A77. The lowest baseline noise levels are predicted at T5 and T6, which are located on local roads in Symington with low traffic flows.

The predicted 2006 baseline noise levels at residential properties in the Study Area are illustrated in Figure 9.4, using free-field noise levels and a 5m grid calculation area. Corresponding figures for 2009 and 2024 are provided in Figure 9.5 and 9.6 respectively. The Figures are provided to illustrate the propagation of noise from the A77 and local roads, the free-field noise levels on the Figures are not directly comparable with the façade noise levels predicted for each property and used in the impact assessment. The nature of the CRTN façade noise correction of +2.5 dB means it cannot be incorporated into the noise map.

The number of residential properties, and therefore the number of people likely to be bothered by noise and vibration in the long term is provided in Tables 9.12 and 9.13, based on an average household size of 2.36 and the steady state relationship between traffic noise and bother in Figure 9.2.

Table 9.12 Predicted Traffic Noise Impact - Baseline

Noise Band $L_{A10,18h}$ dB	2006 (06NP)		2009 (09NP)		2024 (24NP)	
	No. residential properties	No. people bothered	No. residential properties	No. people bothered	No. residential properties	No. people bothered
<50	158	14	150	13	106	10
50<60	178	30	186	31	216	36
60<70	50	24	50	25	64	32
≥70	39	51	39	51	39	54
TOTAL	425	119	425	120	425	132

Table 9.13 Predicted Traffic Vibration Impact - Baseline

Noise Band $L_{A10,18h}$ dB	2006 (06NP)		2009 (09NP)		2024 (24NP)	
	No. residential properties	No. people bothered	No. residential properties	No. people bothered	No. residential properties	No. people bothered
<58	318	0	315	0	301	0
58<60	18	1	21	1	21	1
60<70	50	12	50	12	64	17
≥70	39	42	39	42	39	44
TOTAL	425	55	425	55	425	62

A total of approximately 425 residential properties are located within 300m of the length of existing A77 affected by the Scheme, the upgraded junctions and surrounding affected roads (Symington Road, Symington Road North and Brewlands Road). Assuming an average household size of 2.36, a maximum of 1003 people are considered in the noise and vibration impact assessment.

In the baseline scenarios the majority of properties (over 70%) are located in the lowest two noise bands and experience traffic noise levels of less than 60 dB, $L_{A10,18h}$.

12-13% of the total population in the study area are predicted to be annoyed by road traffic noise in the baseline scenarios. 6% of the population are estimated to be annoyed by vibration.

Baseline traffic noise levels, and therefore the number of people likely to be bothered by traffic noise and vibration, increase slightly from 2006 to 2024 due to the slight rise in traffic flows over time.

9.5 Environmental Effects

9.5.1 Effects of Construction Noise

The predicted free-field construction noise levels at the five selected construction noise receptors are provided in Table 9.14, see Figure 9.1 for receptor locations. Predicted noise levels above the South Ayrshire Council guideline of 75 dB, L_{Aeq} are highlighted in bold. The construction equipment assumed for each activity and the distance to each receptor are provided in Appendix 9; no attenuation provided by barriers or fencing has been assumed.

Table 9.14: Predicted Construction Noise Levels

Activity	*Predicted free-field Construction Noise Level $L_{Aeq,1h}$ dB*				
	C1 Jeanfield	*C2 Kilmarnock Rd, Symington*	*C3 Stockbridge Cottage*	*C4 Tarbolton Rd*	*C5 Kilmarknock Rd, Whitelees*
1:Topsoil Strip	55	72	71	71	**76**
2:Embankments	56	63	57	60	47
3.Bridge Foundations	57	64	56	61	48
4:Bridge Substructure	52	59	51	56	43
5:Bridge Superstructure	55	62	53	59	45
6:Road Construction	52	74	73	73	**78**

The highest noise levels are predicted at receptor C5, Kilmarnock Road, Whitelees. The new access road to the rear of the houses is a minimum of 15m from the property. Therefore, during the topsoil strip and construction of the new access road (activity 1 and 6) construction noise levels are estimated to be slightly over the 75 dB, L_{Aeq} guideline. It should be noted that the South Ayrshire guideline of 75 dB, L_{Aeq} is over a full 12-hour day. However, the estimated construction noise levels are based on a worst-case 1-hour period, with all the equipment at the closest approach to the property. It is unlikely that all the equipment would operate at the closest approach to the property over a full 12 hour day, therefore the construction noise level over 12 hours is likely to be lower than the worst case 1 hour.

Due to the distance of C5 from the upgraded junctions the estimated construction noise levels for activities 2-5 are very low, less than 50 dB, L_{Aeq}.

Estimated construction nose levels at C1, Jeanfield are also low as the property is located a minimum of 150m from the new embankment at the upgraded Symington junction and 180m from the new bridge.

Receptor C2, Kilmarnock Road, Symington is the closest property to the upgraded Symington junction, approximately 25m away. The estimated worst case construction noise levels do not exceed 75 dB, L_{Aeq}.

Symington Road in front of receptor C3, Stockbridge Cottage is realigned as part of the Scheme, therefore the estimated construction noise levels are fairly high for activities 1 and 6, topsoil strip and road construction. Construction noise levels for the embankment and bridge works are fairly low due to the distance of these activities from the property.

Receptor C4, Tarbolton Road is one of the closest properties to the upgraded Bogend Toll junction, located approximately 30m from the new road and 120m from the new bridge. Therefore, construction noise levels are fairly high for activities 1 and 6, topsoil strip and road construction.

The magnitude of the impact of construction noise at receptors C1 to C4 is ranked as slight as predicted worst case construction noise levels are below 75 dB, $L_{Aeq,1h}$ for all activities. At receptor C5, Kilmarnock Road, Whiteless the magnitude of the impact is ranked as moderate as the activities topsoil strip and road construction result in estimated worst-case construction noise levels slightly over 75 dB, $L_{Aeq,1h}$.

9.5.2 Effects of Construction Vibration

As a worst-case approach the foundations of the two new bridges are assumed to be constructed using precast driven concrete piles. The predicted ppv and eVDV are based on the following assumptions:

- ppv at 3m of 13 mms-1 (BS 5228:1997 Part 4, Table 11, ref C21);
- On time of 40 minutes per hour;
- 8 hour working day;
- 60 impacts per minute;
- 0.5 seconds per impact;

Based on the above assumptions, ppv levels and eVDV levels are given below in Table 9.15.

Table 9.15: Predicted Construction Vibration Levels

	Receptor				
	C1 Jeanfield	C2 Kilmarnock Rd, Symington	C3 Stockbridge Cottage	C4 Tarbolton Rd	C5 Kilmarknock Rd, Whitelees
eVDV $ms^{-1.75}$	0.11	0.21	0.10	0.16	0.04
ppv mms^{-1}	0.01	0.02	0.01	0.01	<0.01

Comparison of the calculated eVDV values in Table 9.15, with the VDV criteria values in Table 9.4, indicates that at all receptors the estimated levels are either within or below the daytime 'low probability of adverse comment' band, Therefore, the significance of the adverse impact of construction vibration in terms of nuisance to residents is ranked as negligible.

Comparison of the calculated ppv values in Table 9.15, with the ppv criteria values in Table 9.5, indicates that the calculated values are well below the criteria for the onset of minor or cosmetic damage in residential buildings, which already have significant defects. Therefore, the significance of the impact of construction vibration in terms of building damage is negligible throughout the works.

9.5.3 Effects of Operation

Noise levels due to traffic with the Scheme in operation are predicted for the two with Scheme scenarios in 2009 and 2024. The results for the nine selected traffic noise receptors are provided in Table 9.16.

Table 9.16: Operational Traffic Noise Levels – Traffic Noise Receptors (continued over)

Receptor		Predicted Façade Traffic Noise Level $L_{A10,18h}$ dB	
		2009 (09WP)	2024 (24WP)
T1	Kilmarnock Road, Symington	79.3	80.3
T2	South Trynlow Cottage, Symington	77.4	78.4
T3	Stockbridge Cottage, Symington	63.4	64.4
T4	Symington Road, Symington	64.9	65.9
T5	Symington Road North,	57.5	58.5

Receptor		Predicted Façade Traffic Noise Level $L_{A10,18h}$ dB	
		2009 (09WP)	2024 (24WP)
	Symington		
T6	Brewlands Road, Symington	61.4	62.6
T7	Kilmarnock Road, Whitelees	79.9	81
T8	Fairfield Manor, Bogend Toll	64.8	65.8
T9	Tarbolton Road, Bogend Toll	65.4	66.5

As for the baseline situation the highest ambient noise levels are estimated at T1, T2 and T7 located along the A77. The lowest traffic noise levels are estimated at receptor T5 and T6 located on surrounding affected road with low traffic flows.

The predicted operational noise levels in 2009 and 2024 at residential properties in the Study Area are illustrated in Figures 9.7 and 9.8 using free-field noise levels and a 5m grid calculation area. The Figures are provided to illustrate the propagation of noise from the road; the free-field noise levels on the Figures are not directly comparable with the façade noise levels predicted for each property and used in the impact assessment. The nature of the CRTN façade noise correction of +2.5 dB means it cannot be incorporated into the noise map.

The number of residential properties, and therefore the number of people likely to be bothered by noise or vibration is provided in Tables 9.17 and 9.18, based on an average household size of 2.36. In 2009 (09WP) the number of people bothered by traffic noise at properties that experience an abrupt increase in traffic noise is based on the immediate nuisance impact relationship (Figure 9.3). However, at properties that experience an abrupt reduction in road traffic noise, DMRB requires that the number of people bothered by noise is determined using the long-term nuisance relationship (Figure 9.2), ensuring a pessimistic overall assessment.

Table 9.17: Predicted Traffic Noise Impact – Operation (continued over)

Noise Band $L_{A10,18h}$ dB	2009 (09WP)		2024 (24WP)	
	No. residential properties	No. people bothered	No. residential properties	No. people bothered
<50	145	55	96	9
50<60	178	92	216	35
60<70	63	55	73	38

Noise Band $L_{A10,18h}$ dB	2009 (09WP)		2024 (24WP)	
	No. residential properties	No. people bothered	No. residential properties	No. people bothered
≥70	39	56	40	55
TOTAL	425	258	425	137

Table 9.18: Predicted Traffic Vibration Impact - Operation

Noise Band $L_{A10,18h}$ dB	2009 (09WP)		2024 (24WP)	
	No. residential properties	No. people bothered	No. residential properties	No. people bothered
<58	309	0	289	0
50<60	14	1	23	1
60<70	63	16	73	20
≥70	39	42	40	45
TOTAL	425	59	425	66

As in the baseline situation, with the Scheme in operation, the majority of properties, over 70%, experience traffic noise levels of less than 60 dB, $L_{A10,18h}$.

In the long term the operation of the Scheme results in a negligible increase in the number of people annoyed by road traffic noise of +5 people (<0.5 % of the population in the study area).

In the short term, the magnitude of the immediate impact is ranked as moderate, an additional 138 people (14%) are predicted to be annoyed following the abrupt change in traffic noise levels.

The Scheme results in an increase in the number of people likely to be bothered by traffic vibration of +3 or +4 people. The magnitude of the impact of the Scheme on traffic vibration is negligible.

9.5.4 Significance of Environmental Effect

Construction

A detailed construction programme has not been produced but it is assumed that the works will take approximately 12 months to complete. The assessment of the significance of the predicted construction noise impacts focuses on the magnitude

of the predicted levels with regard to the South Ayrshire Council daytime guideline levels, to identify the onset of potentially significant impacts.

The significance of the effect of construction noise at receptors C1, Jeanfield, C2, Kilmarnock Road, Symington, C3, Stockbridge Cottage and C4, Tarbolton Road is ranked as minor adverse, as predicted worst case construction noise levels are below 75 dB, $L_{Aeq,1h}$ for all activities. At receptor C5, Kilmarnock Road, Whiteless the significance of the impact is ranked as moderate adverse as the activities topsoil strip and road construction result in estimated worst case construction noise levels slightly over 75 dB, $L_{Aeq,1h}$.

Operation

Initial predictions indicate that, of the 425 residential properties considered, none are likely to meet the Noise Insulation (Scotland) Regulations criteria to qualify for additional noise insulation measures.

The change in traffic noise levels due to the Scheme in 2009 and 2024 at the nine representative traffic noise receptors are provided in Table 9.19.

Table 9.19: Operational Traffic Noise Levels – Traffic Noise Receptors

Receptor		***Change in Predicted Façade Traffic Noise Level $L_{A10,18h}$ dB***	
		2009 (09WP)	***2024 (24WP)***
T1	Kilmarnock Road, Symington	+0.2	+0.2
T2	South Trynlow Cottage, Symington	+0.3	+0.3
T3	Stockbridge Cottage, Symington	-1.7	-1.9
T4	Symington Road, Symington	+1.7	+1.3
T5	Symington Road North, Symington	-2.8	-2.9
T6	Brewlands Road, Symington	+2.7	+2.6
T7	Kilmarnock Road, Whitelees	-0.1	0
T8	Fairfield Manor, Bogend Toll	+0.5	+0.5
T9	Tarbolton Road, Bogend Toll	-2.2	-2.4

A negligible (<1 dB) increase in road traffic noise levels is predicted at T1, T2 and T8 due to the operation of the Scheme. At T1, 7 Kilmarnock Road, Symington Road is relocated from the west of the property to the east, at the same distance away. Traffic flows on the first section of Symington Road off the A77 decrease by around 20%, however, flows on the A77 increase by around 5% and traffic on the new bridge also contributes, resulting in an overall negligible increase. At T2, South Trynlow Cottage, the negligible increase is due to an increase in traffic on the A77 of around 5% and the contribution from traffic on the new junction. At T8, Fairfield Manor, traffic on the adjacent B730 increases by around 30% and traffic using the new bridge also contributes, resulting in a negligible increase in traffic noise.

At T4 and T6, located within Symington, traffic on the adjacent local road increases by around 50% and 80% respectively, resulting in a minor (1<3 dB) increase in traffic noise. However, the absolute traffic flows are still very low on these local roads, the 18hr flow is less than 3500 vehicles.

A negligible (<1 dB) decrease in traffic noise levels is predicted at T7, Kilmarnock Road, Whitelees, in 2009 and no change in 2024. 18hr flows on the A77 decrease by around 1% at this location. 18hr traffic flows on the new access road to the rear of the property are very low, less than 200 vehicles; therefore, the new access road does not make a significant contribution.

A minor (1<3 dB) reduction in traffic noise levels is predicted at T3 and T9. At T3, Stockbridge Cottage, Symington, 18hr traffic flows increase by around 50%, however, this is more than offset by the relocation of the road further away from the property. At T9, Tarbolton Road, Bogend Toll, the operation of the new junction reduces traffic flows on Tarbolton Road by almost 40%, which outweighs the impact of traffic on the new junction.

The significance of the change in overall traffic noise levels is initially assessed by consideration of the difference in traffic noise levels and nuisance levels between the 2009 and 2024 baselines and the corresponding 2009 and 2024 operational scenarios, a summary is provided in Table 9.20 and 9.21.

Table 9.20: Change in Predicted Traffic Noise Levels (Operation – Baseline)

Change $L_{A10,18h}$ dB	***No. Residential properties 2009***		***No. Residential properties 2024***	
	Increase	***Decrease***	***Increase***	***Decrease***
<1	324	30	321	35
1<3	46	13	46	11
3<5	9	0	12	0
≥5	3	0	0	0
TOTAL	**382**	**43**	**379**	**46**

In 2009 10% and in 2024 11% of properties experience a reduction in traffic noise levels due to the Scheme. A minor decrease is predicted at properties at Bogend Toll, Stockbridge and Symington Road North. A negligible decrease is predicted at a small number of individual properties along the A77, Symington Road North, Whitelees, Stockbridge and Bogend Toll. At Bogend Toll the reduction is due to the decrease in traffic flows on Tarbolton Road with the new junction in operation. The stopping up of the access on to the A77 from Symington Road North greatly reduces traffic flows on this road and small changes in traffic flows on the A77 due to the Scheme result in negligible decreases in noise levels at individual properties on the A77 and at Whitelees. At Stockbridge the relocation of Symington Road further away from the properties results in a decrease in traffic noise levels.

89-90% of properties experience an increase in traffic noise levels due to the Scheme; however, only 12 (3%) experience a moderate or substantial increase. The three properties which experience a substantial increase in 2009 (≥5 dB) are all located in Symington very close to Brewlands Road, the highest increase is +5.2 dB. The 9 properties which undergo a moderate (3<5 dB) increase in 2009, and all 12 properties in 2024, are all located along Brewlands Road. The 80% increase in 18hr traffic flows on Brewlands Road due to the operation of the Scheme is responsible for the increase. The magnitude and significance of the increase increases the closer a property is located to the road.

The 46 properties which experience a minor increase in traffic noise levels are mainly located along Brewlands Road.

Table 9.21: Change in Traffic Noise Nuisance Impacts (Operation – Baseline)

Noise Band $L_{A10,18h}$ dB	***Change in no. people bothered 2009 (2009WP-2009NP)***	***Change in no. people bothered 2025 (2024WP-2024NP)***
<50	+42	-41
50<60	+60	0
60<70	+31	6
≥70	+5	+1
TOTAL	+138	+5

The significance of the effect of the Scheme in terms of annoyance due to road traffic noise is ranked as moderate adverse in the short term and negligible in the long term.

In addition, the DMRB methodology requires a worst-case assessment of the significance of the change in traffic noise and nuisance levels by considering the greatest level of traffic noise and nuisance experienced in the first 15 years after Scheme opening. For properties where the noise level increases due to the operation of the Scheme, this is the immediate impact in 2009, based on Figure 9.3. For properties where the noise level decreases due to the operation of the Scheme, this is the long-term steady state nuisance level in 2024, based on Figure

9.2. Table 9.22 illustrates the results for the properties in each of the four noise bands for the baseline scenario in 2009 (09NP), as required in DMRB.

Table 9.22: Significance of the Predicted Traffic Noise Impact (table is to the requirements of DMRB)

		Baseline 2009 Traffic Noise Band $L_{A10,18h}$ dB									
		<50		50<60		60<70		≥70		TOTAL	
		Operation	Baseline	Operation	Baseline	Operation	Baseline	Operation	Baseline	Operation	Baseline
Increase in traffic noise level is based on worst-case, i.e. comparison between 09NP to 24WP for operation, 09NP to 24NP for baseline.											
Increase in Traffic Noise $L_{A10,18h}$, Properties	<1	0	0	6	0	6	6	16	3	28	9
	1<3	96	106	204	216	29	58	23	36	352	416
	3<5	0	0	2	0	20	0	1	0	23	0
	5<10	0	0	0	0	11	0	0	0	11	0
	10<15	0	0	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0	0	0
Increase in nuisance is based on worst-case i.e. comparison between 09NP to 09WP for operation, 09NP to 24NP for baseline.											
Increase in Nuisance Level % points, Properties	<10%	36	106	8	216	2	64	0	39	46	425
	10<20%	109	0	110	0	6	0	13	0	238	0
	20-<30%	0	0	35	0	4	0	2	0	41	0
	30-<40%	0	0	5	0	16	0	0	0	21	0
	≥40%	0	0	0	0	10	0	0	0	10	0
Decrease in traffic noise is based on worst-case (least benefit) i.e. 09NP to 24WP for operation, 09NP to 24NP baseline.											
Decrease in Traffic Noise $L_{A10,18h}$, Properties	<1	0	0	2	0	5	0	0	0	7	0
	1<3	0	0	2	0	2	0	0	0	4	0
	3<5	0	0	0	0	0	0	0	0	0	0
	5<10	0	0	0	0	0	0	0	0	0	0
	10<15	0	0	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0	0	0
Decrease in traffic nuisance is based on worst-case (least benefit) i.e. 10NP to 25WP for operation, 09NP to 24NP baseline.											
Decrease in Nuisance Level % points, Properties	<10%	0	0	4	0	7	0	0	0	11	0
	10<20%	0	0	0	0	0	0	0	0	0	0
	20-<30%	0	0	0	0	0	0	0	0	0	0
	30-<40%	0	0	0	0	0	0	0	0	0	0
	≥40%	0	0	0	0	0	0	0	0	0	0

Following the DMRB assessment based on the worst-case change in traffic noise in the first 15 years after opening, 11 properties experience a decrease in traffic noise, all of which experience a negligible or minor decrease. These properties are located at Bogend Toll, Stockbridge and Symington Road North. 414 properties experience an increase in noise levels in the long term, at 11 of which the increase is ranked as substantial, all of which are located in close proximity to Brewlands Road. In the immediate impact in 2009 356 properties experience an increase in nuisance. At 10 properties, all located along Brewlands Road, the increase is ranked as substantial (≥40%).

The significance of the change in traffic vibration impacts is assessed by consideration of the difference in the number of people likely to be bothered by traffic vibration between the 2009 and 2024 baselines and the corresponding 2009 and 2024 operational scenarios, a summary is provided in Table 9.23.

Table 9.23: Change in Traffic Vibration Impacts (Operation – Baseline)

Noise Band $L_{A10,18h}$ dB	***Change in no. people bothered 2009 (2009WP-2009NP)***	***Change in no. people bothered 2024 (2024WP-2024NP)***
<58	0	0
50<60	0	0
60<70	+4	+3
≥70	0	+1
TOTAL	+4	+4

The significance of the effect of the Scheme in terms of road traffic vibration is ranked as negligible in both the short and long term.

Summary

A summary of the significance of the effects is provided in Table 9.24.

Table 9.24: Significance of Effects Summary

Feature	Potential Impact/effect	Magnitude of Impact	Sensitivity/ Importance of Receptor	Significance of impact
Construction Noise	Temporary construction noise impacts	Minor–moderate adverse	High	Minor adverse
Traffic Noise	Permanent change in traffic noise levels due to the Scheme	Negligible	High	Negligible
Traffic Vibration	Permanent change in traffic vibration levels due to the Scheme	Negligible	High	Negligible

9.6 Mitigation

9.6.1 Construction

Construction noise mitigation measures are recommended in the vicinity of residential receptors along Kilmarnock Road, Whitelees, during the construction of the new access road to the rear of the properties.

Construction noise levels could be significantly reduced through the use of site boundary noise barriers. Close boarded solid wooden fencing with a minimum surface density of 15 kgm^{-2}, 2-3m high would provide 5-10 dB(A) noise attenuation. Such noise barriers would reduce worst case construction noise levels at all residential properties to below 75 dB, $L_{Aeq,1h}$.

Additional noise mitigation measures are not essential during the works to upgrade the junctions at Symington and Bogend Toll.

9.6.2 Operation

At the vast majority of properties the change in traffic noise levels due to the Scheme is ranked as negligible or minor. Only 12 properties undergo a moderate or substantial increase in traffic noise level due to the Scheme in 2009 and 2024. All of these properties are located along Brewlands Road, an existing side road, which undergoes an 80% increase in traffic flows due to the Scheme. Noise mitigation measures such as noise barriers are not practicable along an existing side road. In addition actual 18hr traffic flows are still very low, less than 3500 vehicles in 2024. Therefore, no traffic noise mitigation measures are recommended.

9.7 Residual Impacts

9.7.1 Construction

With site boundary noise barriers in place at Whitlees the significance of the residual construction noise impact is minor adverse at worst.

9.7.2 Operation

No additional operational noise mitigation measures are recommended. The significance of the overall impact of the Scheme is ranked as negligible.

9.8 Summary

This Chapter reports on the predicted effects of the proposed A77 works on noise and vibration during both construction and operation of the Scheme.

Precise details of the construction activities, equipment to be used and construction programme will not be available until a contractor has been appointed. Therefore, construction noise predictions have been carried out based on an estimate of the likely activities and equipment. Based on the ambient monitored noise levels, South Ayrshire Council's recommended guideline for construction noise at properties in the vicinity of the junction and access road works is 75 dB, $L_{Aeq,12h}$. The works at Symington and Bogend Toll junctions are not predicted to result in any exceedance of South Ayrshire Council's guideline limit. In the absence of additional mitigation measures a small number of properties on Kilmarnock Road at Whitelees are predicted to experience worst-case construction noise levels slightly above 75 dB, L_{Aeq}, during construction of the new access road to the rear of the properties. Site boundary noise barriers are recommended at this location during these works. With such measures in place the magnitude and significance of the impact of construction noise is ranked as minor adverse at worst.

As a worst case approach the foundations of the two new bridges have been assumed to require driven piled foundations. Driven piling is a potentially significant source of vibration. However, due to the distance of the bridge locations from the nearest properties, the magnitude and significance of vibration impacts have been estimated to be negligible in terms of both nuisance and building damage.

Road traffic noise levels have been predicted at a total of 425 properties located within 300m of the A77, the upgraded junctions and surrounding affected roads, in 2006, 2009, the year of opening with and without the Scheme, and 2024, 15 years after opening with and without the Scheme.

In both the baseline and operational scenarios, the majority (over 70%) of the 425 properties in the study area experience relatively low traffic noise levels, below 60 dB, $L_{A10,18h}$.

In 2024 the Scheme results in an increase in traffic noise levels at a total of 379 properties. A negligible (<1 dB) increase in traffic noise is predicted at 321 properties, a minor increase (1<3 dB) at 46 properties and a moderate increase (3-

<5 dB) at 12 properties. The properties which undergo a moderate increase are all located along Brewlands Road, which undergoes an 80% increase in 18hr traffic flows due to the Scheme, though absolute traffic flows are still very low, less than 3500. 46 properties experience a decrease in traffic noise levels due to the Scheme in 2024. At 35 of these properties the decrease is negligible, and at 11 minor. The properties which undergo a minor reduction in traffic noise levels are located at Bogend Toll and Symington Road North.

In 2009, the year of opening, the number of people predicted to be 'bothered very much or quite a lot' by traffic noise increases by 138 people, out of a total population in the study area of 1003, due to the abrupt change in road traffic noise levels. In the long term by 2024 the Scheme results in a negligible increase of 5 people predicted to be bothered by traffic noise, compared to the baseline situation without the Scheme in 2024.

No properties are estimated to be likely to meet the criteria for additional noise insulation works under the Noise Insulation (Scotland) Regulations.

The overall significance of the Scheme on road traffic noise levels is ranked as moderate adverse in the short term and negligible in the long term.

The operation of the Scheme results in a negligible change in the number of people predicted to be bothered by road traffic vibration.