13 TRAFFIC NOISE AND VIBRATION

13.1 INTRODUCTION

This chapter considers the noise and vibration effects of the proposed scheme. The aspects of the scheme that could give rise to noise and vibration impacts are the changes to the existing noise and vibration climate due to the operation of the proposed scheme, and the noise and vibration impact associated with construction works including construction operations and construction traffic.

The assessment of road traffic noise and vibration changes has been completed in accordance with the Detailed Assessment methodology presented in The DMRB Volume 11, Section 3, Part 7: *Traffic Noise and Vibration: 2008*. This assessment addresses the change in road traffic noise levels likely to be experienced by local receptors for the Do-Minimum condition in the baseline year against the Do-Minimum condition in the future assessment year, and the Do-Minimum condition in the baseline year against the Do-Something condition in the future assessment year (see Section 13.4). The assessment includes an appraisal of change in permanent traffic noise impacts and permanent traffic nuisance[171] impacts (see Section 13.8.3) as a result of the proposed scheme. In addition, an assessment of significance of effects has been undertaken.

In accordance with the requirements for a DMRB Detailed Assessment of temporary noise and vibration impacts, consideration has been given to the potential for noise and vibration impacts to arise from construction works. The number of dwellings and other sensitive receptors located within 100m of any proposed new or altered carriageways have been confirmed and a series of construction noise level predictions has been undertaken for a sample of locations. The predicted noise levels have been compared with construction noise assessment criteria agreed with Stirling Council (see Section 13.3). Indicative groundborne vibration calculations have been undertaken for a sample of typical construction activities, the outcome of which has been assessed against criteria adopted from relevant British Standards.

This chapter is necessarily technical in nature and contains terminology relating to noise and vibration. The terminology used in this chapter is defined and explained in Appendix 13.1.

13.1.1 Interpreting Noise

Noise is defined as unwanted sound. The human ear is able to respond to sound in the frequency range 20 Hz (deep bass) to 20 kHz (high treble) and over the audible range of 0dB (the threshold of perception) to 120dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude, but is more responsive to some frequencies than others. To quantify noise in a manner that approximates the response of the human ear, a weighting (filtering) mechanism is used.

The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement and the levels are denoted as dB(A) or L_{Aeq}, L_{A10}, etc.

[171] 'Noise Nuisance' is defined by the World Health Organisation as '*a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them*'. This definition is referenced within the DMRB

The perception of noise may also be determined by a number of other factors, which may not necessarily be acoustic. In general, the impact of noise depends upon its level, the margin by which it exceeds the background level, its character and its variation over a given period of time.

Various noise indices have been derived to describe the fluctuation of noise levels that vary over time. Usually, these noise indices relate to specific types of noise, and as such different noise indices are used to describe road traffic noise, background noise, construction noise, etc.

The standard noise index used to describe road traffic noise in the UK is the $L_{A10\ 18hour}$, which is defined as the arithmetic average of 18 $L_{A10\ 1hour}$ levels between 06:00 and 24:00 hours. The $L_{A10\ 1hour}$ level, is the noise level that is exceeded for 10% of the time during the hour in question.

The DMRB states that where there is no clearly discernible road traffic, the ambient noise level can be determined using an alternative noise index such as the $L_{A90,T,}$ which is more commonly used to determine the 'background noise level'. The $L_{A90,T}$ is defined as the noise level that is exceeded for 90% of the time during the specified period T.

The standard noise index used to describe construction site noise is the $L_{Aeq,T}$, the equivalent continuous noise level. This can be defined as the level of a notional steady sound that, if continued over the time period (T), would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded during that same time period.

The decibel scale is logarithmic rather than linear. As a result of this, a 3dB increase in sound level represents a doubling of the sound energy present. Judgement of the loudness of sound is subjective, but as a general guide a 10dB(A) increase in the sound pressure level can be taken to represent a doubling of loudness, whilst an increase in the order of 3dB(A) is generally regarded as the minimum change in noise level that is perceptible under normal conditions, assuming a similar spectral and temporal nature (although the DMRB suggests that in the period following a change in traffic flow, people may find benefits or dis-benefits when noise changes are as small as 1dB(A), however this reaction may be partly attributed to an awareness of the changes in traffic rather than noise). Table 13.1 demonstrates a few examples of noise levels typically experienced during everyday activities.

Table 13.1: Typical Sound Levels found in the Environment

Sound Level	Location
0dB(A)	Threshold of hearing
10 to 30dB(A)	Broadcasting studio
30 to 40dB(A)	Quiet bedroom
50 to 60dB(A)	Busy office
60 to 70dB(A)	Typical high street
70 to 80dB(A)	Passenger car or light van at 60km/h and 7m
80 to 90dB(A)	Heavy diesel lorry at 40km/h and 7m or twin engine modern jet during take off at 152m
90 to 100dB(A)	Pneumatic drill (unsilenced) at 7m
120dB(A)	Threshold of pain

13.1.2 Interpreting Vibration

Vibration is defined as a repetitive oscillatory motion. Groundborne vibration can be transmitted to the human body through the supporting surfaces; in most situations this will be through the ground or through the floors of a building.

Vibration from road traffic can also be airborne. Such airborne vibration is transmitted as a low-frequency sound wave and is often perceived when the sound wave causes windows or other objects to rattle.

Vibration is often complex, containing many frequencies, occurring in many directions and changing over time. There are many factors that influence human response to vibration. Physical factors include vibration magnitude, vibration frequency, vibration axis, duration, point of entry into the human body and posture of the human body. Other factors include the exposed persons experience, expectation, arousal and activity.

Disturbance or annoyance from vibration in residential situations can arise when the magnitude of vibration is only slightly in excess of the threshold of perception.

The threshold of perception depends on the frequency of vibration. The human body is most sensitive to vibration in the frequency range 1 to 80Hz and especially sensitive to vibration in the range 4 to 8Hz. As with noise, a frequency weighting mechanism is used to quantify vibration in a way that best corresponds to the frequency response of the human body. For occupants within buildings, the frequency weighting curve is defined in British Standard (BS) 6472: Part 1: 2008 '*Guide to evaluation of human exposure to vibration in buildings*'. Volume 11, Section 3, Part 7, Chapter 6 of the *Design Manual for Roads and Bridges*, defines traffic vibration as 'a low frequency disturbance producing physical movement in buildings and their occupants', and goes on to state that vibration can be transmitted through both ground and the air and provides a summary of studies pertinent to the subject.

13.2 SOURCES OF INFORMATION

Environmental Assessment, Section 3, Environmental Assessment Techniques, Part 7: Traffic Noise and Vibration: 2008

This section of the DMRB documents a method of appraisal for the assessment of noise and vibration impacts from proposed new or altered roads. The presented methodology follows four discrete assessment phases, namely, Screening, Scoping, Simple, and Detailed, intended to apply to various phases of planning .

The DMRB states that '*these phases are generally followed in sequence, although progression may depend on the scale of the proposed project, the site and local circumstances. Where sensitive receptors are identified during the scoping phase at which significant noise and vibration impacts are clearly identifiable at such an early stage, it may be appropriate to move directly to a detailed assessment*.'.

An earlier assessment has been undertaken in accordance with the Stage II methodology of the previous revision of the DMRB[172]. This assessment identified potential adverse noise impacts at a number of sensitive receptors, as such it is considered appropriate to progress to the detailed assessment methodology. This assessment therefore follows the methodology presented within the detailed assessment phase of the DMRB and where considered appropriate/relevant, supplementary information and assessment has been provided.

[172] Grontmij, 2008. A82/A85 Crianlarich Bypass: Stage 2 Addendum Report, March 2008. Transport Scotland

An assessment in accordance with the Detailed Phase requires that:

- a noise assessment be undertaken for all new and existing routes where the change in noise level is >1dB (corresponding to an increase in existing traffic flow of 25% or a decrease of 20%) as a result of the project on opening;
- predicted noise level changes (taking into account mitigation) at all dwellings within the study area (as defined within Section 13.5.1) be identified and presented within a summary table showing the number of dwellings subject to specific noise level changes within specified façade noise level bands;
- a noise nuisance assessment is required for all dwellings within the study area. The DMRB states that '*All calculations should be based on the highest nuisance levels calculated during the first 15 years after opening*' and '*When the scheme will cause increases in noise, the highest level of nuisance experienced will usually be soon after opening*', it goes on to state that *'For decreases in noise level as a result of the project, the highest nuisance experienced during the first 15 years after opening will usually be that in the 15th year'*;
- the overall magnitude of the noise impact from the project should be reported, using the suggested classification presented within the DMRB;
- an assessment of night time noise be undertaken where necessary;
- an assessment of traffic induced vibration impact be undertaken '*where appropriate'*;
- the assessment from the simple stage for other sensitive receptors should be updated where considered necessary; and
- an assessment be undertaken of disruption at the works site.

The Calculation of Road Traffic Noise Memorandum (CRTN)
CRTN, published in 1988 by the then Department of Transport and the Welsh Office, sets out standard procedures for calculating noise levels from road traffic. The calculation methods use a number of input variables, including traffic flow, average vehicle speed, percentage of heavy goods vehicles (HGVs), type of road surface, site geometry and the presence of noise barriers or acoustically absorbent ground. CRTN provides methods for predicting the $L_{A10\ 18hour}$ or $L_{A10\ 1hour}$ noise level for any receptor point at a given distance from the road.

CRTN also documents procedures for the measurement of road traffic noise. Three methods of road traffic noise measurement are described, the first entitled 'The Measurement Method', for direct measurement of the $L_{A10\ 18hour}$ noise level, the second entitled the 'Shortened Measurement Procedure', for measurement of the $L_{A10\ 3hour}$ noise level (from which the $L_{A10\ 18hour}$ level can be derived) and the third entitled 'Comparative Measurements' which is a procedure to establish noise levels from a single road traffic route at various points, provided that the route remains the dominant source. CRTN states that if the Shortened Measurement Procedure is followed, a correction of -1dB can be applied to approximate the $L_{A10\ 18hour}$ noise level.

The Noise Insulation (Scotland) Regulations 1975 (NISR)
This document provides for noise insulation to be offered in respect of residential properties affected by noise from new or altered roads. 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 highway, the apexes of which are 50m along the centre-line of the existing highway from the terminal points and the bases of which extend from points 300m on either side of the highway 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 68dB(A); and
- the property would experience noise levels exceeding the 'prevailing noise level' by at least 1.0dB(A).

The road traffic noise prediction method detailed within the Memorandum has been improved over the years and the present methodology contained within CRTN is more accurate and detailed. While DMRB does allow the use of the method detailed within the Memorandum, the predictive tool employed in this assessment is CadnaA which uses the predictive methods set out in CRTN to calculate road traffic noise levels. While the CRTN methodology is more detailed and accurate than that contained within the Memorandum, the NISR strictly requires that eligibility be assessed in terms of the Memorandum methodology. Therefore, the assessment presented later in this chapter can only be taken as providing an indication of the properties which are likely to be eligible for statutory noise insulation.

BS5228: Noise and Vibration Control on Construction and Open Sites: Part 1: Noise: 2009

This standard sets out techniques to predict the likely noise and vibration effects from construction works, based on detailed information on the type and number of plant being used, their location and the length of time they are in operation.

The noise prediction method is used to establish likely noise levels in terms of the $L_{Aeq,T}$ over the core working day. For the purpose of this assessment, it is assumed that the core working day would be the 10-hours between 08:00 and 19:00, with a 1-hour break for lunch Monday to Friday and 09:00 to 13:00 hours on Saturdays.

This standard also documents a database of information, including previously measured sound power/sound pressure levels for a variety of different construction plant undertaking various common activities.

Example criteria are presented for the assessment of the significance of noise effects. Such criteria are concerned with fixed noise limits and ambient noise level changes. For fixed noise limits BS5228 presents those included within Advisory Leaflet 72: 1976: *Noise Control on Building Sites*. These fixed limits are presented according to the nature of the surrounding environment, for a 12-hour working day. The presented limits are:

- 70.0 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise; and
- 75.0 dB(A) in urban areas near main roads and heavy industrial areas.

Given that the site is located in a largely rural area, the construction works have been assessed against a core working daytime (10-hour) noise level criterion of 70dB $L_{Aeq,T}$. Applying this criteria to a shorter daytime period (10 hours rather than

12), ensures a more stringent assessment. This approach has been agreed during consultation with Stirling Council (see Section 13.3).

BS5228: Noise and Vibration Control on Construction and Open Sites: Part 2: Vibration: 2009

This standard provides recommendations for basic methods of vibration control relating to construction and open sites. The legislative background to vibration control is described and guidance is provided concerning methods of measuring vibration and assessing its effects on the environment.

Guidance criteria are suggested for the assessment of the significance of vibration effects, such criteria are provided in terms of Peak Particle Velocities (PPV) and are concerned with both human and structural responses to vibration.

Those applicable to human perception and disturbance are presented in Table 13.2.

Table 13.2: Guidance on Effects of Vibration Levels

Vibration Level	Effect
0.14 mm s^{-1}	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm s^{-1}	Vibration might be just perceptible in residential environments.
1.0 mm s^{-1}	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm s^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

The standard goes on to present guidance criteria applicable to the vibration response limits of buildings in terms of the component PPV, these are presented in Table 13.3.

Table 13.3: Transient Vibration Guide Values for Cosmetic Damage

Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and above
Reinforced or framed structures industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	50 mm/s at 4Hz and above
Unreinforced or light framed structures Residential or light commercial buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above
Note 1: Values referred to are at the base of the building Note 2: At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) is not to be exceeded		

As stated within BS5228: Part 2, the guide values presented within Table 13.3 relate predominantly to transient vibration which does not give rise to resonant responses in structures. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance,

especially at lower frequencies where lower guide values apply, then the guide values in Table 13.3 might need to be reduced by up to 50%. It is not expected that dynamic loading will result from typical construction activities, therefore for the purpose of this assessment, no alterations have been made to the guide values provided within Table 13.3.

It should be noted that the values presented within Table 13.3 are applicable to cosmetic damage only. It is stated within BS5228-2 that minor damage is possible at vibration magnitudes which are greater than twice those given in the table.

13.2.1 Significance Criteria – Construction

For on-site construction, following advice provided within BS5228-1:2009 and given the rural nature of the Site, it was considered appropriate that the construction noise assessment be undertaken against the fixed noise limit of 70dB $L_{Aeq,T}$ (façade). Construction noise levels are considered to result in a moderate adverse effect where the adopted criterion is likely to be exceeded. Where noise levels are likely to fall below this criterion minor adverse effects are registered.

The assessment of groundborne vibration associated with typical on-site construction activities has been undertaken drawing upon the guidance presented within BS5228-2:2009. The following criteria have been adopted for residential dwellings:

Table 13.4: Significance Criteria applicable to Construction Vibration

Vibration Level	Effect	Significance
<0.3 mm s^{-1}	Onset of perceptibility in the most sensitive situations	Negligible
0.3>1.0 mm s^{-1}	Onset of perceptibility in residential environments	Minor
1.0>10.0 mm s^{-1}	Complaints likely in residential environments	Moderate
>10.0 mm s^{-1}	Vibration is likely to be intolerable for any more than a very brief exposure to this level	Major

Table 13.4 has been generated based upon the guidance on effects of vibration levels presented within BS5228-2:2009, the corresponding vibration ranges and adopted significance ratings adopted for the purpose of this assessment have also been included within the table.

13.2.2 Significance Criteria – Operational

The DMRB states that the magnitude of noise impact from a project should be classified into levels of impact in order to assist with the interpretation of the project. An example classification of magnitude of impacts for traffic noise is provided within the guidance.

Whilst the DMRB does present guidance on assessing the significance of noise effects it is also considered useful to draw on other available guidance when determining the magnitude of impact. The *Guidelines for Environmental Noise Impact Assessment* produced by the joint working party of the Institute of Acoustics (IOA) and Institute of Environmental Management and Assessment

(IEMA) in 2002 is only draft at this stage but the content is considered to be useful when establishing the significance of noise impacts.

This guidance presents an example of how changes in noise level can be categorised by significance, based on key benchmarks that relate to human perception of sound. These benchmarks include a 3dB and a 10 dB change in sound pressure level (see Section 13.1.1).

When determining the significance of predicted noise impacts it is necessary to consider likely subjective response to the noise. Accordingly, it is necessary to consider the sensitivity of the receptor, the predicted noise levels and the magnitude of the predicted noise level change. Table 13.5 presents the criteria used to define the sensitivity of receptors.

Table 13.5: Criteria used to define Sensitivity of Receptors

Sensitivity	Description	Example Receptors
High	Receptors where people or operations are particularly sensitive to noise	Residential dwellings Quiet outdoor areas used for recreation Conference facilities Auditoria/studios Schools in the daytime Hospitals/residential care homes
Medium	Receptors moderately sensitive to noise where it may cause some distraction or disturbance	Offices Restaurants Scheduled Ancient Monuments/Listed Buildings
Low	Receptors where distraction or disturbance from noise is minimal	Factories Commercial installations Storage centres Industrial sites

The magnitude of noise impacts has been assessed by categorisation of the predicted noise level changes in accordance with Table 13.6 below. This table has been generated based on the suggested classification presented within the DMRB:

Table 13.6: Criteria used to define Magnitude of Noise level Changes

Magnitude of Impact	**Change in Noise Level**
No Change	0 dB
Negligible	0.1 to 0.9 dB
Minor	1 to 2.9 dB
Moderate	3 to 4.9 dB
Major	>5 dB

The significance of noise impacts has been determined according to the following impact matrix presented in Table 13.7.

Table 13.7: Noise Effect Significance Matrix

Magnitude (Table 13.6)	**Sensitivity (Table 13.5)**		
	Low	**Medium**	**High**
No Change	None	None	None
Negligible	None	None	Minor
Minor	None	Minor	Minor

Magnitude (Table 13.6)	Sensitivity (Table 13.5)		
	Low	**Medium**	**High**
Moderate	Minor	Minor	Moderate
Major	Minor	Moderate	Major

Effects have been categorised as adverse where noise level increases have been identified and beneficial where noise level decreases have been identified.

13.3 CONSULTATIONS

At the Scoping Assessment phase of the noise and vibration assessment, the DMRB states that the '*local Environmental Health Officer should be consulted about the existing noise climate. This consultation should include any known sources of complaint, either from traffic or other sources. Any noise constraints arising from Local or National Plans should also be identified at this stage*.' Within the guidance provided for the Detailed Assessment phase, there are no specific consultation requirements, therefore the Scoping Assessment consultation has been completed as part of the Detailed Assessment.

The Stirling Council Environmental Health Department officer covering the Crianlarich region was consulted and requested to provide any relevant information on existing noise nuisance and noise constraints arising from Local Plans (see Annex A).

The consultation response identified that there are no current noise complaints/issues in Crianlarich and that the dominant noise source throughout the village is road traffic, although there will be an input from rail traffic, both passenger and freight.

It was also advised that whilst there are no industrial operations *per-se* in the area, there is some intermodal transfer of timber from road to rail at the railway siding at Crianlarich Station which has raised noise issues previously, particularly from idling freight locomotives late at night. This problem was addressed by EWS Rail and there has been no recurrence of complaints.

It was confirmed that although the current Local Plan was drawn up by Stirling Council its implementation is now the responsibility of the National Park Authority and any comments should be sought from this body.

The Loch Lomond and the Trossachs National Park publication *National Park Plan 2007 to 2012* presents policies and initiatives aimed at securing positive change over five years to 2012, while working towards a longer term vision for this region of Scotland. Whilst there is little mention of noise, 'tranquillity' is identified as a special quality of some areas of the national park, especially the enjoyment of tranquillity. Tranquillity is referenced in relation to remote areas such as, Balquhidder Glen and Loch Lubnaig in Breadalbane, Loch Eck in Argyll Forest and Strathard in The Trossachs.

Tranquillity is addressed in policy LS3 (*Landscape Experience*) of the Plan. The policy requires that '*The landscape experience of the Park will be conserved and enhanced through*' several measures, including '*safeguarding the unspoiled, wild and tranquil qualities of the Park's landscape by resisting development or land use activities that have adverse effects on these qualities.*'

The perception of tranquillity depends upon a number of other factors as well as noise. The Cambridge dictionary defines Tranquil as '*calm and peaceful and without noise, violence, anxiety, etc.'* and in 1991, the Campaign for the Protection of Rural England, who undertook a mapping exercise on behalf of the Department of Transport, to determine tranquil areas in England, defined tranquillity as '*places which are sufficiently far away from the visual or noise intrusion of development or traffic to be considered unspoilt by urban influences'*

It was agreed during consultation with Loch Lomond and the Trossachs National Park that the proposed development is not located in an area considered to have a tranquil quality (see Annex A) because the proposed scheme would be located in close vicinity to Crianlarich town and the existing local road and rail network

The 70dB core working daytime criterion adopted for the construction noise assessment was agreed during consultation with Stirling Council.

13.4 ASSESSMENT METHODOLOGY

The assessment of road traffic noise and vibration impacts has been undertaken in accordance with the Detailed Assessment phase methodology outlined in the DMRB Volume 11, Section 3, Part 7. This methodology requires that an assessment of permanent traffic noise impacts be undertaken for all dwellings where existing traffic is likely to increase by 25% or decrease by 20% (equivalent to a change in noise level of 1dB) as a result of the development proposals. In addition, an assessment of noise nuisance is required for all dwellings included within the assessment of traffic noise impacts. Accordingly, the following methodology has been followed:

- a 48 hour noise survey has been undertaken within the study area to determine the existing noise climate at two locations, considered representative of the residential properties anticipated to be subject to the greatest noise level changes, and to aid in the identification of key local noise sources (results summarised in Section 13.5.3));
- the DMRB references research which suggests that the impact of construction nuisance in one form or another, diminishes rapidly with distance. The DMRB suggests that an assessment be carried out for dwellings located within 100m from the project. On this basis, the number of dwellings or other sensitive receptors within 100m of the project boundary has been estimated;
- for a sample of key areas potentially affected by construction noise, a series of construction noise level predictions has been undertaken in accordance with BS5228: Code of practice for *noise and vibration control on construction and open sites*: Part 1: 2009: *Noise*, based on assumed construction plant. The resulting noise levels have been compared with the guidance contained within BS5228: 2009: Part 1, as agreed with the Local Authority;
- the assessment of potential earthwork / construction generated groundborne vibration levels has drawn upon the guidance and criteria presented within BS5228: 2009: *Code of practice for noise and vibration control on construction and open sites*: Part 2: 2009: *Vibration*. Predictions have been undertaken using the empirical prediction procedures presented within the Transport and Road Research Laboratory Research Report 246: *Traffic induced vibrations in buildings* (TRL RR 246): 1990 (applicable to HGV induced vibration), and TRL Report 429: *Groundborne vibration caused by mechanised construction works*: 2000 (applicable to vibratory rollers);

- qualitative consideration has been given to the likely magnitude/significance of noise impacts associated with construction traffic that would arise during the construction of the scheme;
- all proposed roads subject to a change in alignment, and existing local roads subject to road traffic flow changes of greater than +25% or -20% have been identified. This assessment has been undertaken comparing the proposed year of opening (2011DM), with the design year with scheme scenario (2026DS);
- for the purpose of the assessment of potential noise impacts, the scheme study area has been defined as the region within 600m of any of the above identified routes;
- for the purpose of the assessment of potential vibration impacts, the study area has been defined as the region within 40m of any new or altered routes;
- local noise-sensitive receptors within the study area have been identified by means of a site walkover and a review of ordnance survey mapping;
- detailed noise models have been prepared for the Do-Minimum condition without the scheme in place in the baseline and future assessment years (2011DM and 2026DM respectively), and the Do-Something condition with the scheme in place (including proposed mitigation measures) in the baseline and future assessment years (2011DS and 2026DS respectively). The baseline assessment year is defined within the DMRB as being the '*opening year of the project*' and the future assessment year is described as being '*typically the 15th year after the opening of the project*';
- based on detailed noise level predictions, all dwellings and other receptors within the study area have been classified according to their façade noise levels, in 3dB bands between 47.5 dB(A) and 83.5 dB(A), with additional categories for those with noise levels below 47.5 dB(A) or above 83.5 dB(A),
- for each ambient noise band, the number of dwellings and other sensitive receptors subject to noise increases / decreases of 0.1 to 0.9, 1.0 to 2.9, 3.0 to 4.9 and 5+ has been identified for both the 2011DM versus 2026DM scenario and the 2011DM versus 2026DS scenario with proposed noise mitigation measures in place. The significance of identified noise level changes has been identified, including that at a sample of key and typical receptors;
- in accordance with the DMRB methodology, where a dwelling is predicted to experience an increase in noise level on one façade and a decrease on another, the 'worst case' in terms of change in noise level has been adopted for each receptor. Where beneficial and adverse changes are experienced at different facades of the same property, although not strictly defined within the DMRB, a 'worst case' change has been taken to be the worst case adverse change. Therefore to represent a worst case situation, for receptors located between the existing A82 and proposed A82 re-alignment, the prediction point has been located on the façade facing the proposed route. Where it is expected that noise level decreases will be experienced at opposite facades facing towards the existing A82, Basic Noise Level calculations have been undertaken to determine the magnitude of these changes. These calculations have been undertaken in accordance with the methodology presented within CRTN as summarised within Section 3.2 of the CRTN. Calculations have been undertaken for the 2011DM versus 2026DS comparison based on road traffic data provided for the existing A82;
- a noise nuisance assessment has been undertaken in accordance with the DMRB, for all dwellings located within the study area. This assessment considers both noise level increases and decreases that could arise as a result of the scheme, and those that would result in absence of the scheme. When determining the change in nuisance for the Do Something scenario, the DMRB

states that this assessment "*should be based on the highest nuisance levels calculated during the first 15 years after opening*". The highest nuisance may be immediately following the opening of the scheme (2011), e.g. where an abrupt noise level increase occurs, or in the design year (2026), e.g. where there is a noise level decrease due to the scheme opening, with a subsequent gradual increase thereafter. The change in noise nuisance has therefore been determined using the appropriate chart from the DMRB (for either an abrupt or gradual change in noise), depending upon the specific conditions for each individual receptor;

- the percentage change in noise nuisance level has been categorised into bands of <10%, 10 to <20%, 20 to <30%, 30 to <40 % and ≥ 40%, in accordance with the DMRB;
- the results of the above nuisance assessments have been summarised in tables for each individual Ambient Noise Band;
- for vibration, properties within 40m of the proposed new route and existing routes subject to adjustment have been identified. Drawing on a review of the scheme traffic data and the proposed route design, general consideration has been given to anticipated airborne vibration impacts, and whether a detailed vibration assessment is required (as allowed by the DMRB). It has been determined that a detailed assessment of airborne vibration is not required;
- summary statements have been provided addressing both ambient and predicted noise levels;
- the number of properties that are likely to be eligible for statutory insulation in accordance with the Noise Insulation (Scotland) Regulations has been identified. The Noise Insulation (Scotland) Regulations require noise level predictions to be undertaken in accordance with the Memorandum on the Noise Insulation (Scotland) Regulations 1975 Regulations 3 and 6, but for the purpose of this assessment, the CRTN calculation method has been adopted.
- Where ground-borne vibration on existing routes is considered to be a potential problem, the DMRB requires that calculations or measurements of vibration at the foundations of typical buildings considered to be at high risk may be taken. Where appropriate, such measurements may be used to establish the likelihood of the threshold of perception being exceeded as a result of development generated road traffic changes. The DMRB only requires that a vibration assessment be undertaken '*where appropriate'*. Where an assessment of vibration nuisance is to be undertaken the DMRB states that Figure A3.1 (of the DMRB) [Estimate of Traffic Noise Nuisance – Steady State or Before Noise Change],should be employed by making a suitable adjustment (minus 10%) to the percentage bothered very much or quite a lot by traffic noise. It is stated; '*On average traffic induced vibration is expected to affect a very small percentage of people at exposure levels below 58 L_{A10} dB and, therefore zero per cent should be assumed in these cases'*. The DMRB goes on to state; '*the survey of vibration nuisance was restricted to dwellings within 40 ms of the carriageway where there were no barriers to traffic noise.*' It is therefore considered appropriate to apply this assessment / relationship to receptors located within distances of no greater than 40m from the proposed new carriageway.

13.5 BASELINE

13.5.1 Study Area

It is anticipated that effects from the proposed development would result from the introduction of new noise sources (e.g. the new road and associated junctions/ roundabouts), the realignment of existing noise sources (e.g. short sections of existing roads realigned to join the proposed junctions/roundabouts), and any

significant changes in flows along existing local road traffic routes resulting from the proposed scheme.

The start point of the scheme has been defined as the southern end of the proposed route design, i.e. the point on the A82 close to Stronua House in the south, at which point the proposed route starts to deviate from the existing route. The finish point of the scheme has been defined as the northern end of the proposed route, i.e. the point on the A82, west of Crianlarich at which the proposed route re-aligns with the existing route (see Figures 3.1a and b).

Based on guidance contained within the DMRB, the study area has been defined as all existing and proposed new routes that are predicted to be subject to a change in noise level of more than 1 dB(A) (equivalent to an increase in road traffic movements of at least 25% or decrease of at least 20%) as a result of the project on opening. The study area for which noise calculations are performed has been defined at 600m from those affected routes that are within two kilometres of these routes.

In defining the study area, the scheme traffic data (see Chapter 4) were assessed with comparisons drawn between the flow data for the year of opening (2011) Do Minimum scenario and the Do Something scenarios for the year of opening and year of opening +15 (2026). It was identified that the following routes were subject to traffic flow changes of greater than -20% or +25%:

- the proposed bypass including southern and northern roundabouts;
- short sections of existing routes that have to be realigned to allow access onto the proposed roundabouts; and
- the current route through Crianlarich town between the scheme start and finishing point.

The study area is shown on Figures 13.1a and b.

13.5.2 Sensitive Receptors

As discussed within Section 13.2, this assessment follows the detailed phase methodology presented within the DMRB. The DMRB Detailed Assessment phase is primarily concerned with the impact at dwellings, with the assessment from the simple stage for other sensitive receptors being updated if necessary. If the project has moved directly to the detailed phase, the DMRB requires an assessment of the noise impact at other sensitive receptors be undertaken to the level of detail required for a simple assessment. As an assessment has previously been undertaken in accordance with the Stage II methodology of the previous revision (August 1994) of the DMRB it is not considered necessary that a simple assessment be undertaken for 'other receptors'. Sensitive receptors other than dwellings have therefore been separately considered as part of the detailed assessment phase.

The DMRB provides examples of the receptor types, other than dwellings, that should be considered. The DMRB paragraph 3.24 states; '*other sensitive receptors (e.g. community facilities, public rights of ways) or designated areas (e.g. AONB, National Park, SAC, SPA, SSSI) within the study area need to be identified.*'

In the case of this development, the majority of receptors are dwellings within, or on the outer edges of Crianlarich, or local facilities such as the church, public

houses and post office etc, with relatively few industrial/commercial facilities. Accordingly, the receptors have been categorised as being either residential or 'other' (i.e. commercial/industrial, community facilities, public rights of way etc). Local holiday homes have been classified as 'other' whilst Bed and Breakfasts have been classified as 'residential' as it is assumed that these have permanent residents.

The whole of the study area falls within the Loch Lomond and the Trossachs National Park. The River Fillan (see Figure 6.1) is designated as being a Special Area of Conservation (SAC) (see Section 9.5.3). It is considered that the Loch Lomond and Trossachs National Park is appropriately represented by the numerous receptor locations covered within the assessment. The River Fillan has been represented at a point along the adjacent footpath.

A summary of the receptors within the study area is presented in Table 13.8.

During consultation, Historic Scotland raised concerns regarding noise level changes affecting the recreational enjoyment of Scheduled Ancient Monuments (SAM) and Listed Buildings (LBs) (see Annex A).

Accordingly, consideration has been given to the impact of noise level changes at the following sites:

- Crianlarich War Memorial (LB);
- Crianlarich Parish Church (LB);
- Crianlarich Station Works Building (Engine Shed) (LB); and
- Loch Dochart Castle (SAM).

The first three of these sites are within the study area, and have therefore been included within the assessment as 'other receptors'. Consideration has been given to the predicted noise level changes at Loch Dochart Castle, but as this is more than 600m from the scheme, this has not been included as a receptor *per-se*.

There are two main footpaths in the vicinity of the proposed route, a spur to the West Highland Way located west of Glenfalloch Road, and a series of footpaths though the community woodland park between the A82 and the A85 (see Section 6.4.4). These footpaths have been included as 'other' receptors, with noise level predictions undertaken at nominal points along their length.

Table 13.8: Summary of Receptors located within the Noise Study Area

Category	Sensitivity	Receptors
Residential	**High**	1, 2, 3, 4, 5 and 6 Railway Cottages 1, 2, 3, 4, 5 and 6 Strathfillan Terrace 1, 2, 3, 4, 5 Strathmore Terrace 1, 3, 5, 7, 9 and 11 Tyndrum Terrace 1, 2 and 3 Willow Brae 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 Willow Square Ardlea Bungalow Branch Cottage 5 Bungalows east of and fronting A82 Bungalow West of Stronua House Carna Cottage B&B Dunfraoich Dunvegan Block Glendale

Category	Sensitivity	Receptors
		Laurelbank 1 and 2 Meadow Grove Glenn Fiadh Lodge Northumbria B&B Station House Strathview Stronua Cottage Stronua House The Shieling Tigh Na Struith Craigbank B&B Glenarden B&B Cairnmore The Lodge Guest House **Total = 64**
Other	**High**	Children's nursery Crianlarich primary school
	Medium	Crianlarich Station works Laurelbank Garage Northumbria Chalet 3 holiday log cabins at Rod and Reel Public House Station Café Benmore Lodge – Cabins 3 & 4 Children's play area Crianlarich Parish Church Crianlarich Hotel Crianlarich Station Fire Station Police Station Post Office and Shop Rod and Reel Public House Village Hall War Memorial West Highland Way spur Community Woodland footpaths Old Military Road Footpath River Fillan Footpath & SAC Youth Hostel
	Low	Forestry Shed **Total = 27**

Many of the above receptors are located between the existing A82, and the proposed new route alignment, examples being dwellings on Tyndrum Terrace, Willow Brae and Willow Square (see Photograph 11, Annex E). At these receptors, noise level increases are anticipated on façades facing the new route with noise level decreases anticipated on façades facing the existing route. Guidance in the DMRB Detailed Assessment Stage states: '*Where a dwelling is predicted to experience an increase in noise level on one façade and a decrease on another façade, the worst case in terms of change in noise level should be reported in the assessment table*'. It is therefore deemed appropriate that a façade experiencing a 'worst case' change will be that where the highest development generated noise level increase is experienced. The following assessment therefore considers the receptor façades which would experience the 'worst case' increase in noise levels, with comment made to identify where decreases are expected on other façades.

The only exceptions are receptors which front the A85 east of the A82/A85 junction. For these receptors the northern façades have been selected as these receptors are well removed from the proposed route. Furthermore, the Glenfalloch Road, which is located to their rear and closer than the proposed route, is predicted to be subject to large traffic flow decreases following the opening of the scheme. This approach is therefore again considered worst case.

13.5.3 Baseline Noise Survey

A baseline noise survey was undertaken in December 2007, over the course of an approximate 48 hour period, to establish the existing noise climate in the vicinity of the study area. The aim of the survey was to establish the existing noise climate at a sample of locations considered representative of local receptors, particularly those which could be subject to significant noise level changes (increases and decreases) as a result of the proposed development.

The noise survey commenced at approximately 17:00 hours on Tuesday the 11th December 2007, concluding at approximately 12:00 hours on Thursday the 13th December 2007.

The following type 1 specification noise measurement equipment was used during the noise survey.

Table 13.9: Noise Measurement Equipment

Equipment	Serial Number
01-dB Stell SIP 95 Data Logging Integrating Sound Level Meter	60845
01-dB Stell PRE 12 N Preamplifier	13399
Microtech Gefell GmbH (Mk 250) condenser Microphone	85088
01dB Type CAL 21 acoustic calibrator	511031263

The sound level meter had been calibrated to traceable standards within the preceding two years and the calibrator within the preceding 12 months.

Measurement locations were selected as representative of identified receptors anticipated to be subject to the greatest noise level changes resulting from the scheme, e.g. the rear of residential dwellings located between Tyndrum Road and the proposed new route alignment.

The survey comprised two continuous long term measurements, one of 24 hours in length, and the second of 18 hours in length, each subject to periodic attendance such that the prevailing noise environment could be observed and noted.

Over the course of the noise survey, the weather remained cool with still to light winds, observed as no greater than Beaufort Scale 2 (0.5 to 1.3m/s - Light Breeze: wind felt on face and leaves rustle). On the morning of the 14th of December 2007, there was a fine drizzle and the ground was noted to be damp. By the close of the survey, there had been a marked increase in precipitation, the result being light rain.

Noise measurement locations were selected at positions where noise level increases were anticipated at nearby receptors following opening of the proposed bypass, e.g. where receptors were located between the proposed new route and the existing A82. The measurement locations adopted during the survey, were as follows:

- **Measurement Location 1**, located 1.5m above local ground in the field south of Willow Square, considered representative of dwellings in Willow Square and Gleann Fiadh Lodge. This location was subject to free-field conditions; and
- **Measurement Location 2,** located 1.5m above local ground in the rear garden of Number 7 Tyndrum Terrace, considered representative of the rear of dwellings in Tyndrum Terrace. This location was subject to free-field conditions.

The measurement locations are shown on Figure 13.1a.

At both locations, road traffic noise from existing routes through Crianlarich was subjectively judged to be clearly discernible and the dominant source during the daytime.

The full tabulated noise measurement data can be seen in Appendix 13.2 and are summarised in Table 13.10.

Table 13.10: Summary of Daytime Noise Level Data for Measurement Locations 1 and 2, Free-field, dBA

Measurement Location	Noise Level Data		
	$L_{A10\ (18hour)}$	$L_{Aeq\ 16hour}$	$L_{A90\ 16hour}$
1	46.2	46.7	31.0
2[1]	50.1[2]	46.9	34.2

[1] Measurements do not include the period from 12:00 to 16:00 hours, but are considered representative of full period measurements
[2.] $L_{A10\ (18hour\ )}$calculated from $L_{A10(3\ hour)}$) -1dB, in accordance with CRTN

From the noise measurement data presented within Appendix 13.2 it is evident that at both Locations 1 and 2, the $L_{A10,T}$ noise level is approximately 3dB higher than the $L_{Aeq,T}$ noise level. This is consistent with a situation where the noise environment is dominated by the pass-by of individual road traffic vehicles.

13.5.4 Baseline Noise Modelling

The baseline noise survey described above identified that the principal local noise source across the study area is existing road traffic, albeit that this is at a low level in some cases. As road traffic has been identified as dominant, it is appropriate to undertake baseline noise modelling to determine the prevailing noise environment across the site, in accordance with the DMRB. The noise modelling approach accounts for seasonal variability in the local noise environment, e.g. as a result of changing local traffic flows.

Accordingly, a detailed noise model was prepared using the CadnaA PC based noise modelling suite which implements the calculation methodology presented within CRTN. The recommendations provided within Annex 4 of the DMRB '*Additional Advice to CRTN Procedures*' has also been considered when undertaking noise calculations. This noise model was prepared to establish a baseline noise climate for the full study area. The following data was used to generate the noise model using CadnaA:

- the results of a detailed topographic survey undertaken for Crianlarich town and the area through which the new route is proposed;
- 1m, 2m, 5m and 10m ground contours for the region outside the detailed topographic study, calculated from the NextMap Database, which provides

height above sea level data on a 5m by 5m grid for the UK (calculated based on aeroplane fly-by radar measurements);
- Ordnance Survey Master Map data for the study area and beyond, in particular the buildings layer;
- the results of the traffic study (see Chapter 4), in particular the traffic data, including traffic flows, percentage HGVs and route speeds; and
- an inspection of the local roads including road widths and carriageway formats.

Traffic data for the seven day 2005 monthly profile have also been provided and are presented within Figure 13.7, Section 13.8.3.7. These data have been used for the purpose of the assessment of eligibility under the Noise Insulation (Scotland) regulations only and have not been used within the baseline noise model.

For this assessment, the baseline has been taken as the year of opening Do Minimum Scenario (2011DM), such that where necessary, the effects of the scheme can be established without the effect of general traffic growth anticipated to occur between the existing year and the year of opening.

The DMRB Detailed Assessment phase requires that predicted noise level changes be identified at all dwellings after taking into account mitigation (see Section 13.2). The 2011DM noise model was used to predict the baseline ground and first floor noise levels at all the receptors within the study area. Predicted noise levels are presented in Table 13.11 for a sample of representative residential receptors. The ground floor data are also presented in map format in Figures 13.2a and b.

Table 13.11: Modelled 2011DM Noise Levels at a Representative Sample of Residential Receptors, Façade, dB(A)

Location Number	Receptor	2011DM Noise Level, $L_{A10\ 18hour}$	
		Ground Floor	First Floor
1	The Shieling (Front)	61.8	63.8
2	Ardlea Bungalow (Front)	67.7	-
3	11 Tyndrum Terrace (Rear)	43.6	48.8
4	5 Tyndrum Terrace (Rear)	45.0	47.2
5	Tigh Na Struith (Front)	54.0	54.9
6	Carna Cottage (Rear)	49.7	58.2
7	2 Willow Brae (Rear)	40.5	44.8
8	1 Willow Square (Front)	40.3	42.6
9	5 Willow Square (Front)	47.5	52.6
10	Laurelbank Garage (Front)	69.4	69.8
11	Gleann Fiadh Lodge (Front)	39.8	43.1
12	War Memorial	63.2	64.9
13	3 Strathmore Terrace (Rear)	43.3	48.3
14	4 Strathfillan Terrace (Rear)	49.8	52.2
15	Village Hall (Front)	64.2	66.3
16	Station House (Front)	56.2	57.7
17	Bungalow east of A82 and North of Northumbria B&B (Front)	65.9	-
18	Bungalow east of A82 and South of Northumbria B&B (Front)	62.2	-
19	Stronua House (Front)	69.9	70.7

Location Number	Receptor	2011DM Noise Level, $L_{A10\ 18hour}$	
		Ground Floor	First Floor
20	Youth Hostel (Front)	47.4	48.4
21	Crianlarich Primary School (Front)	61.5	63.5
22	1 Meadow Grove (Front)	56.5	59.3
23	4 Railway Cottages (Rear)	65.3	66.5
All noise levels presented as façade levels with the exception of War Memorial which is free-field			

The individual receptor noise levels were all calculated to include the effect of first order reflections from reflective surfaces[173]. As required by the DMRB, receptor locations adjacent to façades therefore include a façade correction to account for reflected noise. A façade correction was not applied to free-field receptors such as footpaths or the children's play area.

The baseline noise model was run twice, firstly to identify the noise levels at all specific receptor locations, and secondly on a 4m grid square for the entire study area, with a receptor height of 1.5m above ground. The second model run was used to generate baseline noise maps which can be seen in Figures 13.3a and b. Unlike the noise level calculations at individual receptors, the noise maps do not include for the effect of reflections. The noise maps therefore represent free-field noise levels.

To check the accuracy of the noise model, predictions have been carried out at the noise survey measurement locations. Table 13.12 compares the measured noise levels with those predicted for the baseline 2011 scenario.

Table 13.12: Comparison of Measured and Predicted Baseline Noise Levels, Free-field, dB(A)

Measurement Location	$L_{A10\ 18hour}$ Noise Level		
	Measured	Predicted	Difference
1	46.5	45.5	-1.0
2	50.2	53.9	+3.7

It can be seen from Table 13.12 that the predicted noise level at Measurement Location 1 falls within 3dB of the measured level. At measurement Location 2, the measured noise level was marginally more than 3dB below the predicted noise level. It is anticipated that this would be due to seasonal variations in traffic flows (the noise model considers the annually averaged traffic data whereas the measurement data are representative of a single December daytime period). In addition, the noise model accounts for anticipated traffic growth between the time of the survey, and 2011. Local screening, such as garden fences and other such features could also have had a minor influence over the measured levels.

Overall, it is considered that the noise model is suitably accurate for determining road traffic noise levels in accordance with CRTN, as required for this assessment.

[173]Reflective surfaces include building facades and road surfaces

13.5.5 Baseline Ambient Noise Band Classification and Noise Nuisance Assessment for the Study Area

The Detailed Assessment Phase of the DMRB requires that dwellings be categorised into 3 dB ambient noise bands between 47.5 dB(A) and 83.5 dB(A), with additional categories for those with noise levels below 47.5 dB(A) and those with noise levels above 83.5 dB(A). A summary of the results of this categorisation is presented in Table 13.13 for the baseline (2011DM) scenario. In accordance with the DMRB, noise levels have been calculated at a default height of 1.5m above ground level. For receptors with a first floor, the noise level has been calculated at 4m. A façade correction has been applied to receptor positions 1m from buildings prior to categorisation.

Table 13.13: Classification of Dwellings in the Study Area According to Ambient Noise Bands for the Baseline (2011DM) Scenario

Ambient Noise Level Bands, dB(A), Façade												
<47.5	47.5-50.5	50.5-53.5	53.5-56.5	56.5-59.5	59.5-62.5	62.5-65.5	65.5-68.5	68.5-71.5	71.5-74.5	74.5-77.5	77.5-80.5	80.5-83.5
11	11	11	4	5	4	5	11	2	0	0	0	0

Table 13.14 presents the 2011DM ambient noise band categorisation for 'other receptors'.

Table 13.14: Classification of Other Receptors in the Study Area According to Ambient Noise Bands for the Baseline (2011DM) Scenario

Ambient Noise Level Bands, dB(A), Façade												
<47.5	47.5-50.5	50.5-53.5	53.5-56.5	56.5-59.5	59.5-62.5	62.5-65.5	65.5-68.5	68.5-71.5	71.5-74.5	74.5-77.5	77.5-80.5	80.5-83.5
9	3	1	1	2	3	6	1	1	0	0	0	0

The DMRB also requires a noise nuisance assessment to be undertaken for all dwellings at which noise calculations have been carried out and provides guidance on noise nuisance in terms of the percentage of people that would be bothered '*very much, or quite a lot*' by noise. Two different methods of calculating noise nuisance / change in noise nuisance are presented. The first method addresses a 'steady state' situation where only gradual noise level changes are anticipated or have occurred, i.e. where traffic flows have increased gradually over time. For this situation, nuisance is identified from the steady state curve presented in the DMRB, by the assessment of the measured or predicted ambient noise levels before and after the change has taken place. The associated change in noise nuisance is the difference between the two identified nuisance levels.

The second method addresses the situation where a sudden noise level 'change' is anticipated or has occurred e.g. as a result of the opening of a new road scheme. For this situation, the predicted noise level change is compared against the abrupt curve to identify the associated change in noise nuisance. The final noise nuisance level is identified by applying this immediate change to the nuisance level determined using the steady state method immediately prior to the opening of the road.

To establish the baseline noise nuisance for all dwellings in the study area, the steady state method has been adopted using the results of the baseline (2011DM) noise model. The resulting baseline noise nuisance is presented in Table 13.15. In accordance with the DMRB, the nuisance has been categorised into bands of 0 to <10%, 10 to <20%, 20 to<30%, 30 to 40% and ≥40 %.

Table 13.15: Classification of Dwellings in the Study Area According to Noise Nuisance for the Baseline (2011DM) Scenario

Estimation of People bothered very much or quite a lot by Traffic Noise				
0<10	**10 to <20**	**20 to <30**	**30 to <40**	**≥40**
37	10	15	2	0

13.5.6 Baseline Vibration Assessment

The DMRB only requires that an assessment of traffic induced vibration be undertaken '*where appropriate*'. The guidance relating to the assessment of airborne vibration states; '*For the purpose of predicting vibration nuisance, the curve in Figure A3.1* (Estimation of Traffic Noise Nuisance – Steady State or Before Noise Change) *should be employed by making a suitable adjustment to the percentage bothered*'. 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 noise nuisance. The DMRB also states that "*On average traffic induced vibration is expected to affect a very small percentage of people at exposure levels below 58 L_{A10} dB and therefore zero percent should be assumed in these cases*". The survey of vibration nuisance upon which this relationship is based was restricted to dwellings within 40m of the carriageway where there were no barriers to traffic noise. It is therefore appropriate that any assessment of traffic induced airborne vibration should also be restricted to those dwellings located within 40m of and with direct line of sight to the proposed new route alignment.

In the case of this development, no receptors are located within 40m of the proposed new route alignment and no properties are predicted to be subject to noise levels of greater than 58dB as a result of the scheme. The only properties within 40m of any existing routes subject to adjustment are two bungalows at the southern end of Crianlarich, east of the Glenfalloch Road, 5, 7, 9 and 11 Tyndrum Terrace and Ardlea Bungalow, all of which are at the western end of Crianlarich. These properties are only within 40m of existing routes subject to minor realignments. These realignments are associated with the tie-in of the proposed roundabouts with the existing route network, rather than being off-line changes. Furthermore, all of these receptors front the existing A82, along which decreases in road traffic flows are predicted as a result of the scheme.

Therefore, a detailed airborne vibration assessment is not considered warranted, although many local properties may be subject to a decrease in airborne vibration due to the decreased traffic flows on the existing A82, and the proposed route being located at greater distance from existing properties than the existing route.

It has been considered that a detailed assessment of airborne vibration has not been undertaken because of the reasons stated above.

13.6 POTENTIAL IMPACTS

13.6.1 Permanent

The potential permanent noise and vibration impacts associated with the scheme proposals have been considered within the 'operational impacts' section below.

13.6.2 Construction

- Noise impacts on local sensitive receptors from construction operations including those utilising heavy machinery, e.g. earth moving, aggregate spreading and road laying;

- groundborne vibration impacts on local sensitive receptors as a result of construction involving heavy machinery; and
- noise impacts on local sensitive receptors as a result of construction traffic accessing the site.

13.6.3 Operational

- Changes in road traffic noise levels at sensitive receptors, as a result of proposed new roads or realigned / modified existing roads;
- changes in road traffic noise levels at sensitive receptors as a result of changes in road traffic flows on existing, otherwise unchanged local roads;
- changes in airborne vibration levels at sensitive receptors as a result of road traffic on proposed new highways or realigned / modified existing roads; and
- changes in airborne vibration levels at sensitive receptors as a result of road traffic flow changes on existing, otherwise unchanged local roads.

There are no predicted increases in road traffic movements on existing routes as a result of the scheme. Furthermore for the existing A82, decreases in road traffic flows are predicted as a result of the scheme, thus resulting in potential reductions in road traffic induced groundborne vibration. Consequently, it is not expected that the development proposals would result in increasing ground-borne vibration levels on existing routes. The assessment of traffic induced ground-borne vibration on existing routes has therefore not been included within the assessment of operational impacts.

13.7 MITIGATION MEASURES

13.7.1 Mitigation Design Principles

When undertaking mitigation design for a proposed scheme it is necessary to give consideration to all issues affected by and influencing the proposed measures, and not solely the specific issue which the mitigation is designed to address. The DMRB requires that mitigation measures '*perform to an acceptable standard in traffic, safety, environmental, and economic terms*', the DMRB also states that '*reducing the noise and vibration impact from a road is just one of the factors to be considered in design, and conflicts may exist e.g. an acoustic barrier may introduce unacceptable visual intrusion or safety implications*'.

Accordingly the scheme design has followed an iterative process, such that identified impacts could be addressed as the scheme evolved. Where the potential for an adverse noise impact of minor significance or greater was identified (see Table 13.7), detailed noise mitigation design work was undertaken and feedback provided to the design team.

The design team then gave due consideration to the 'trade-off' between noise mitigation and landscape and visual intrusion resulting from environmental barriers and landscape design (see Chapter 10), with a view to ensuring that the final design gives equal and diligent consideration to all affected sensitive receptors. Consideration was given to all properties meeting all of the three criteria presented below.

13.7.2 Noise Mitigation Design Criteria

To establish which residential receptors warranted further consideration with respect to noise mitigation, consideration was initially given to the absolute Do Something noise levels, predicted noise level changes, and distance from the proposed new road/ road changes.

Consideration was given to both the noise level changes that would arise following the opening of the scheme and the absolute noise levels at noise-sensitive receptors.

A noise level change criterion of 1dB(A) was adopted, based on the guidance contained within the DMRB which states that '*surveys of residents before and after changes in noise exposure had occurred as a result of road projects indicated that people are more sensitive to abrupt changes in traffic noise than would have been predicted from the steady state evidence*' it goes on to state; '*in the period following a change in traffic flow, people may report positive or negative benefits when the actual noise changes are as small as 1 dB(A)*. From the DMRB it is possible to determine that 21% of people would be bothered '*very much*' or '*quite a lot*' by an abrupt change of 1dB(A).

Based on the guidance contained within the World Health Organisation (WHO) document: 1999: *Guidelines for Community Noise*, an absolute qualifying criterion of 59.5dB $L_{A10\ 18\ hours}$ (façade) was adopted. This document provides guideline values based on the precautionary principle and states that '*To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level should not exceed 55dB* L_{Aeq}' this statement is made with reference to steady state noise on balconies, terraces and in outdoor living areas. Planning Policy Guidance Note (PPG) 24: 1994: *Planning and Noise* states that an $L_{Aeq\ 16hour}$ noise level can be approximated by subtracting 2dB from an $L_{A10\ 18hour}$ noise level and CRTN states that the contribution from façade reflections should be assumed to be +2.5dB. These corrections were applied to the 55dB noise level to derive the qualifying criterion.

A distance threshold of within 600m was selected based on the guidance contained within the DMRB.

Initially, the following three assessment criteria were therefore adopted to determine those properties which qualified for consideration of noise mitigation:

- an absolute daytime 2011DS or 2026DS noise level of greater than 59.5dB $L_{A10\ 18hour}$ (façade) at ground or first floor level;
- a daytime noise level increase of 1dB $L_{A10\ 18hour}$ or more at ground or first floor (2011DM versus 2011DS and 2011DM versus 2026DS); and
- properties to be located within 600m of proposed new roads / road changes (in accordance with the DMRB assessment methodology).

However, it was identified that no properties subject to noise level changes of greater than +1dB were also subject to with scheme noise levels of greater than 59.5 dB $L_{A10\ 18hour}$. In fact, no properties were subject to noise level changes of greater than 1dB and absolute noise levels of 54.5dB $L_{A10\ 18hour}$ (which corresponds to a 50dB $L_{Aeq,T}$ as referenced by the WHO with respect to protecting *the majority of people from being moderately annoyed*).

Notwithstanding this, the DMRB states that reducing the noise and vibration impact of a road scheme is one of the factors to be considered in the route choice and design.

In Chapter 5, the DMRB states the following as examples of possible noise mitigation techniques:

- horizontal alignment: Moving a route away from residential areas or other sensitive receptors;
- vertical alignment: Keeping the route low within the natural topography to exploit any natural screening and enhancing this by use of cuttings and, in exceptional circumstances, sub-surface and surface tunnels;
- environmental barriers: Providing environmental barriers such as earth mounding or acoustic fencing or a combination of the two;
- the use of low-noise road surfaces; and
- traffic speed and volume restrictions.

Therefore, in accordance with the principles of the DMRB, noise and vibration was afforded due consideration in the development and optimisation of the final scheme design.

13.7.3 Noise Mitigation Design Process

In accordance with the noise mitigation measures outlined in the DMRB, the benefit of road side noise barriers, increased road side earth bund heights, and increased cutting depths was considered (a low noise road surface was already proposed as part of the scheme design).

In developing an appropriate scheme of noise mitigation, it was necessary to balance the noise reduction benefits afforded by the considered measures, against any disbenefits afforded in terms of visual intrusion and economy etc.

Following the mitigation design process, the proposed noise measures were finalised and are presented in Section 13.7.6.

13.7.4 Construction Noise

The nature of construction noise is inherently temporary. Human receptors will generally tolerate higher impacts where is it known that they will only be present for a limited time period.

Several safeguards exist to minimise the effects of construction noise and it is anticipated that these would be implemented, where necessary, during the construction of the proposed development. These safeguards include:

- the various EC Directives and UK Statutory Instruments that limit noise emissions of a variety of construction plant;
- guidance set out in BS 5228: Part 2: 2009, which covers noise control on construction sites; and
- the powers that exist for local authorities under Sections 60 and 61 of the Control of Pollution Act 1974 to control environmental noise on construction sites.

As part of the construction contract, the contractor would be required to implement all committed mitigation measures including compliance with construction noise limit (70dB $L_{Aeq,T}$) which has been agreed with Stirling Council. With a view to ensuring compliance with the agreed noise limits, the adoption of Best Practicable Means, as defined in the Control of Pollution Act 1974 is usually the most effective means of controlling noise from construction sites. Other additional measures to be adopted for the control of noise are as follows:

NV1. All site staff would receive appropriate environmental training at the beginning of the contract and throughout the construction period as required. The contractor's compliance with environmental procedures would be audited on site at regular intervals during the construction works by Transport Scotland's environmental representative.

NV2. Silenced or sound reduced compressors would be used.

NV3. Silencers or mufflers would be fitted to pneumatic tools.

NV4. Deliveries would be programmed to arrive during daytime hours only and care would be taken to minimise noise when unloading vehicles.

NV5. Delivery vehicles would be prohibited from waiting within the site with their engines running.

NV6. Plant items would be properly maintained and operated according to manufacturers' recommendations, in such a manner as to avoid causing excessive noise. All plant would be sited so that the noise impact at nearby noise-sensitive properties is minimised.

NV7. Local hoarding, screens or barriers would be erected as necessary to shield activities causing particular disturbance.

NV8. Access to the site would primarily be via the existing A82, which would limit the potential for construction traffic noise impacts.

NV9. Appropriate noise limits and working hours would be specified in the contract documents, and in the construction Environmental Management System. Construction activities would be undertaken during daytime periods only, between the hours of 08:00 to 19:00 hours Monday to Friday and 09:00 to 13:00 hours on Saturday. Should occasional night-time and Sunday working be required, e.g. to minimise traffic disruption on the local road network, the contractor would be required to receive permission from Stirling Council Planning and Environmental Services Department, in advance.

NV10. The contractor would be required to establish and maintain effective liaison with the local community throughout the construction period. This would include provision of information on the on-going activities and provision of contact telephone numbers to contact the site for information during operational hours. A person would be identified with appropriate authority to resolve any problems. A log of complaints and actions taken to remedy these would be available for inspection.

13.7.5 Construction Vibration

As for construction noise, construction vibration is inherently temporary in nature, which acts to limit the duration of any impacts. In addition, the following mitigation measures would be implemented in appropriate locations:

NV11. During backfilling, sub-base compaction and black topping works, it is anticipated that the use of vibratory rollers may be required. Where this is the case, groundborne vibration predictions would be undertaken in accordance with the prediction methodology presented in the Transport Research Laboratory (TRL) 429 document entitled: *Groundborne vibration from mechanical construction works* and where the results of these predictions dictate that it is appropriate, vibration monitoring would be undertaken. Such survey work would be undertaken in accordance with the recommendations outlined in BS 5228 Part 2: 2009 and BS 7385 Part 1:1990: *Evaluation and measurement for vibration in buildings*, Part 1: *Guide for measurement of vibrations and evaluation of their effects on buildings*. The results of such monitoring would be

compared against the guidance criteria presented within BS5228: Part 2 and BS 7385 Part 2 (which considers the potential for building damage).

NV12. Where vibration levels exceed 10 mm/s at vibration sensitive dwellings, works within such areas would cease and alternative methods / working practices would be considered.

13.7.6 Operational Phase

The following measures are included in the route design and would reduce noise from the scheme:

NV13. The use of a lower noise road surface for the proposed new route alignment. Lower noise road surfaces assist in the control of noise from the road/tyre interface (rather than the other key component which is engine, exhaust and transmission noise).

NV14. Between Chainages 200 and 400, an earth bund ranging in height between 2 to 2.5m along its length has been located on the east side of the proposed route to provide noise attenuation to properties on the east side of Glenfalloch Road.

NV15. Between Chainages 600 and 760, the proposed route has been designed in a cutting with average depth of approximately 2.5m (east side). Between Chainages 680 and 760, the effective cutting depth (which dictates the noise reduction performance) has been increased to approximately 5m with use of surplus cut material installed at the top of the cutting embankment.

NV16. Between Chainages 760 and 850, increased cutting height has been continued in the form of a road side earth bund ranging from 3 to 4m in height.

NV17. Between Chainages 850 and 1030, the proposed route has been designed in cutting ranging in height from 1.5 to 4m along its length on the east side, depending on the lie of the local ground. The effective cutting depth has been increased to range from 3m to 7.5m with use of surplus cut material installed at the top of the cutting embankment.

NV18. A 1.8m high timber noise barrier located adjacent to, and to the west of, the western garden boundary of Number 11 Tyndrum Terrace.

NV19. For noise reduction purposes, the proposed noise barriers would have a superficial density of at least 12.5kgm^{-2} (based on the superficial density calculation procedure presented in CRTN), be continuous, imperforate and sealed at the base.

Further detail on the benefit provided by the proposed barriers, and the receptors for which this benefit is afforded is presented in Section 13.8.3.1.

13.8 ASSESSMENT OF RESIDUAL EFFECTS

13.8.1 Permanent

The potential permanent noise and vibration effects associated with the scheme proposals have been considered within the ‘operational effects’ section below.

13.8.2 Construction

The total duration of the construction phase for the development is expected to be approximately 12 months. Accordingly, it is appropriate to consider the temporary noise and vibration impacts that could arise during this period. It is anticipated that impacts could arise as a result of:

- construction plant; and
- construction traffic.

Typical activities associated with the construction of the scheme would be earthworks (excavation[174] and embankment works), backfilling, sub-base compaction, black topping, drainage works, and structure fabrication. It is anticipated that the earthworks would be the most extensive of these activities as they would be required along the length of the proposed new route.

Structure fabrication works have the potential to generate high noise levels, but for this scheme such works would be short in duration with the only significant structure being an underpass required to facilitate access to the West Highland Way via the WHW spur.

With respect to construction noise impacts, the DMRB references research which suggests that the impact of construction nuisance in one form or another, diminishes rapidly with distance. It goes on to suggest that an assessment be carried out for dwellings located within 100m from the project. This assessment is therefore concentrated on receptors within 100m of the anticipated construction works.

13.8.2.1 Construction Plant Noise

Table 13.16 summarises the receptors identified within 100m of the proposed new road, proposed new link roads and existing routes subject to realignment in accordance with the methodology presented within Section 13.4. In accordance with the methodology presented in Section 13.4 the following assessment considers residential receptors only as these are considered to be the most sensitive and also to be representative of other locations near the scheme.

Also presented are details of the existing noise climate, the distance from the proposed works and a brief description of works proposed within 100m.

Table 13.16: Local Residential Receptors within 100m of Proposed Construction Works.

Receptor Number	Description	Existing Noise Climate	Proposed Works	Approximate Distance from Proposed Works
1	Bungalow west of Stronua House	Dominated by road traffic noise from the A82	Tie in works associated with new route southern roundabout	100m
2	2 Bungalows and Northumbria B&B, east of existing A82	Dominated by road traffic noise from the A82	Works associated with tie in to the southern roundabout, and proposed new route	Between 15 and 65m
3	3 Bungalows east of existing A82 and Station House	Dominated by road traffic noise from the A82	Works associated with proposed new route	40 to 90m
4	Gleann Fiadh	Dominated by	Works associated	70m

[174] It is anticipated that pecking of rock could be required in some areas. It has been assumed for this assessment that blasting would not be required. If blasting were required the contractor would be required to consider the noise and vibration impacts of this in advance and to identify appropriate mitigation

Receptor Number	Description	Existing Noise Climate	Proposed Works	Approximate Distance from Proposed Works
	Lodge	road traffic noise from the A82	with proposed new route	
5	1 to 3 Willow Brae, 1 to 11 Willow Square and Branch Cottage	Dominated by road traffic noise from the A82	Works associated with proposed new route	25 to 85m
6	Dunfraoich, Strath View and Carna Cottage	Dominated by road traffic noise from the A82	Works associated with proposed new route	35 to 45m
7	1, 3, 5, 7, 9 Tyndrum Terrace and Ardlea Bungalow	Dominated by road traffic noise from the A82	Works associated with proposed new route, and northern roundabout tie-in	10 to 30m
8	The Shieling	Dominated by road traffic noise from the A82	Works associated with proposed new route, and northern roundabout tie-in	30m

Table 13.16 shows that Receptors 1 and 2 would be subject to noise from similar operations with Receptor 2 being closer to the required works. As such, Receptor 2 is considered to represent a worst case. Similarly, Receptor 5 is considered to represent a worst case for 3, 4, 5 and 6, and Receptor 7 is considered to represent a worst case for 7 and 8.

A series of sample construction noise calculations have therefore been undertaken for Receptors 2, 5 and 7, which are considered to represent a worst case.

Although there are techniques available to predict the likely effect of noise from construction works, such as those contained within BS 5228, they are necessarily based on detailed information of the type and number of plant being used, their location and the length of time they are in operation.

Such specific details are not available at this stage and would depend on the appointed construction contractor (see Section 3.3.2). However, it is considered appropriate at this stage to undertake indicative construction noise predictions such that potential areas of key noise impact can be identified. Predictions have been undertaken at the identified receptors for a sample of construction operations considered likely to be replicated during the works. The predictions are based on the methodology contained within BS 5228: 1: 2009 (detailed within Section 13.2) and are in terms of the $L_{Aeq,T}$ over the core working day, which is assumed to be 08:00 to 18:00 hours. It is assumed that the committed mitigation measures would result in a minimum noise reduction of 5dBA.

Predictions have been undertaken for sample operations anticipated to be undertaken during the following works:

- earthworks including embankment and cutting works – Assumed to comprise the use of tracked excavators, dozers and lorries;
- black topping works – Assumed to comprise asphalt spreader, chip spreader, road roller and lorries; and

- fabrication works (e.g. installation of road side barriers, lighting, signage etc) – Assumed to comprise the use of a concrete mixer, club hammer, forklift truck and lorries.

Table 13.17 below sets out the typical plant type, number and utilisation (the percentage of time plant is likely to be operating during the working day – the 'on time') used in the prediction of noise levels during each phase.

For the purpose of these predictions, it is assumed that the intervening ground between the construction noise sources and the receivers would be acoustically hard such that there would be no additional attenuation of noise due to ground absorption, and that no acoustic barriers would be present.

Table13.17: Assumed Construction Plant Details (taken from BS5228 Part 1)

Phase	Plant Type	Sound Power Levels L_{WA} dB	Number of Plant	Assumed Percentage 'on' time
Earthworks	Tracked Exactor	104	1	40
	Lorry pulling up	98	2	10
	Lorry unloading	112	2	10
	Dozer	109	1	40
Black Topping Works	Asphalt Spreader and chip spreader	108	1	50
	Road Roller	101	1	50
	Lorry pulling up	98	2	10
Fabrication Works	Club Hammer	107	1	25
	Forklift Truck	104	1	30
	Concrete mixer	92	1	20
	Lorry pulling up	98	2	10
	Lorry unloading	112	2	10

Worst case and average case construction operations have been considered. The worst case considers works at the closest point in the relevant site areas to the receptor under consideration. The average case considers works at the approximate mid-point of the relevant site areas. Where the distance between the relevant site area and receptor is small, it is considered unreasonable to assume all plant would be located at this location, therefore the noise level generated by the single loudest plant item is considered.

Table 13.18 sets out the range of predicted construction noise levels. The range extends from the average to the worst case situation as described above.

Table 13.18: Predicted 'Average' and 'Worst' case Construction Noise Levels – Façade $L_{Aeq\ 11hours}$ dB

Receptor	Average and Worst Case Construction Noise Levels, $L_{Aeq\ 11hours}$ dB		
	Earth Works	Black Topping Works	Fabrication Works
2	61 – **71**	58 – **71**	59 – 68
5	60 – 67	57 – 67	58 – 64
7	64 - **75**	62 – **75**	63 – **72**

It can be seen from Table 13.18 that for each receptor and each considered construction phase, the average construction noise levels are well below 70dB

$L_{Aeq,T}$, a criterion appropriate for receptors in rural areas[175]. For the worst case, the predicted noise levels also meet the 70dB criterion at Receptor 5 with exceedences identified at Receptors 2 and 7. Where the adopted 70dB criterion is exceeded, it is assumed that temporary moderate adverse effects could arise. Where the criterion is not exceeded, it is anticipated that temporary increases in the noise environment could arise resulting in temporary minor adverse effects.

However, it should be noted that the predicted worst case noise levels are only likely to occur for short periods, and would be similar to, for example, the temporary noise that would occur when undertaking repairs to services such as water or electricity mains. As such, for the purpose of this assessment it is considered more appropriate to consider the average case which is anticipated to be more representative of typical conditions during the construction phase. In addition, noise levels would be controlled by means of agreed limits. It would therefore be necessary for the construction contractor to control the works, for example by means of limiting the periods during which works are undertaken in close vicinity of nearby receptors, to ensure compliance with these limits.

13.8.2.2 Construction Vibration

Groundborne vibration calculations have been performed for typical construction activities / machinery based on the empirical prediction procedures presented within the Transport and Road Research Laboratory Research Report 246: *Traffic induced vibrations in buildings* (TRL RR 246): 1990 (applicable to HGV induced vibration), and TRL Report 429: *Groundborne vibration caused by mechanised construction works: 2000* (applicable to vibratory rollers). Predictions have been made to determine the possible distances at which the adopted significance criteria may be registered. Groundborne vibration levels and associated distances have been identified for activities involving vibratory rollers and HGVs and are presented within Table 13.19. It is noted that there may be a variety of different potential vibration generating activities employed during the construction phase of the Proposed Development other than those presented below. The predicted levels given within Table 13.19 have been provided for indicative purposes such that the possibility of groundborne vibration impacts arising and their magnitude of effect can be considered.

The data presented within Table 13.19 are general in nature and not specific to any one site, however the vibration levels and associated distances can be used to determine the typical distances at which specific impacts may be registered.

Table 13.19: Predicted Groundborne Vibration Levels Applicable to Typical Vibration Generating Construction Activities

Operation	Confidence limit	Distance (m)	PPV (mm/s)
Vibratory Rollers – start & end	95	60	0.3
	95	23	1.0
Vibratory Rollers – steady state[1]	95	3.3	10
HGV's[2]	N/A	50	≤0.3[3]
	N/A	17	≤1.0[3]
	N/A	2.5	≤10[3]

[175] Advisory Leaflet 72: Construction and Noise and BS5228: Part 1 :2009

Operation	Confidence limit	Distance (m)	PPV (mm/s)
1. Assumes 2 rollers, 0.4mm amplitude, drum width of 1.3m, e.g. heavy duty ride on roller 2. Assumes max height / depth of surface defect of 50 mm, max speed of 30 kph, and that surface defect occurs at both wheels 3. Where alluvium soils are present, higher vibration levels can be expected			

It is evident from Table 13.16 that there is potential for construction activities to take place at distances of approximately 10 to 15m from a number of receptors (e.g. 2 and 7). In this regard, Table 13.20 presents the predicted significance of effects at such properties. It should be noted that the significance ratings presented within the table, in the case of vibratory rollers, have been generated based on a 95 percent confidence limit, in reality it is likely that lower vibration levels would prevail for the majority of the time.

Table 13.20: Predicted Significance of Effects at 10m from Activities - Groundborne Vibration

Activity	Significance of effect
Vibratory Rollers	Moderate Adverse
HGV's	Moderate Adverse

It is anticipated that vibratory rollers may be used during the backfilling, sub-base compaction and black topping works. Such works would be undertaken in close proximity to some sensitive receptors such as local dwellings. In such locations it is proposed that further groundborne vibration predictions would be undertaken in accordance with the prediction methodology presented in the Transport Research Laboratory (TRL) 429 document entitled: *Groundborne vibration from mechanical construction works* based on the precise location, plant and operational conditions to be employed. In the event that the results of these predictions indicate that impacts of major adverse significance are likely, it is recommended that vibration monitoring should be undertaken. No piling works are anticipated to be required during construction.

Vibration monitoring would be undertaken in accordance with the recommendations outlined in BS 5228 Part 1 and BS 7385 Part 1:1990: *Evaluation and measurement for vibration in buildings*, Part 1: *Guide for measurement of vibrations and evaluation of their effects on buildings*. Where vibration levels exceed 10 mm/s at vibration sensitive dwellings, works within such areas would cease and alternative methods / working practices would need to be considered.

13.8.2.3 Construction Traffic

Access to the works would primarily be via the existing A82 trunk road. Local roads where construction traffic would be restricted would be agreed with Stirling Council and listed in the construction contract. The majority of the works would be undertaken off-line, and independent of the existing road network, and it is likely that a haul route would be created along the construction corridor to allow movement of plant and materials etc.

The existing A82 is already subject to traffic between Glasgow and Fort William (amongst other destinations). In general terms, an increase in flow of 100% would be required to result in a 3dB noise level increase (assuming the percentage HGVs and speeds remain the same) and it is anticipated that the construction

traffic flows would be significantly below the existing traffic flows (see Section 4.3). Based on the guidance presented in Table 13.4, the effect of the additional construction traffic on this route would at worst result in temporary minor effect (not significant).

13.8.3 Operational

13.8.3.1 Mitigation Benefit

A detailed noise mitigation design process was followed, resulting in the specification of an acoustic barrier and the effective cutting depths to protect properties located between the existing and proposed route corridors (see Section 13.7.2).

Table 13.21 presents the benefit afforded at a sample of local properties as a result of the proposed measures. 'Without' mitigation measures have been taken from an earlier noise model, prepared prior to the mitigation design optimisation process. This model included the route corridor topography, but before the benefit was optimised. To provide an indication of the total mitigation benefit, the 'Without' mitigation noise model was run without lower noise road surfaces.

Table 13.21: Modelled 2011DS Noise Levels, with and without Proposed Noise Mitigation at Sample Receptors, Ground Floor, Façade, dB(A)

Mitigation Measure	Sample Receptor	2011DS Noise Level, $L_{A10\ 18hour}$		Mitigation Benefit (dBA)
		With Mitigation	Without Mitigation	
NV12 to NV 18	11 Tyndrum Terrace	46.7	53.9	7.2
	5 Tyndrum Terrace	47.1	53.2	6.1
	2 Willow Brae	43.1	49.5	6.4
	1 Willow Square	41.8	48.8	7.0
	Gleann Fiadh Lodge	43.8	50.1	6.3

It can be seen from the table above that the combined effect of the proposed mitigation measures provides an approximate 6 to 7dB noise level decrease at sample properties.

13.8.3.2 Noise

To facilitate the traffic noise and nuisance assessments, it is necessary to predict the noise levels at all receptors within the study area for the following scenarios (described within Section 13.4):

- Year of Opening Do Minimum (2011DM), taken as the baseline situation in the assessment;
- Year of Opening Do Something (2011DS);
- Design Year Do Minimum (2026DM); and
- Design Year Do Something (2026DS).

In accordance with the DMRB Do Something noise models include for the agreed noise mitigation measures.

To allow parallel calculations, three additional noise models were prepared in the CadnaA noise modelling suite, based on the completed baseline 2011DM noise model. The 2026DM model is identical to the 2011DM model with the exception of the traffic data which was updated accordingly.

The 2011DS and 2026DS models incorporate the final three dimensional (3D) cut and fill route design for the proposed scheme including the proposed new bypass route design and minor local roads subject to updates, including changes in elevation. For each scenario, the traffic flow data were then updated accordingly. The 2011DS and 2026DS models also include proposed mitigation measures, e.g. garden boundary acoustic fences, and low noise road surfaces where proposed.

The noise maps for each scenario are included as Figures 13.3 to 13.6 (a and b in each case) with each pair encompassing the study area. In addition, consideration has been given to the predicted noise levels at a sample of key and typical receptors for the 2011DS and 2026DS scenarios as shown in Table 13.22 below. These data are also presented in mapped form in Figure 13.2a and b. In accordance with the requirements of the DMRB, the Do Something noise levels have been predicted with the proposed noise mitigation measures in place.

Table 13.22: Modelled 2011DS and 2026DS Noise Levels at Representative Sample Receptors, Façade dB(A)

Location Number	Receptor	2011DS Noise Level, $L_{A10\ 18hour}$		2026DS Noise Level, $L_{A10\ 18hour}$	
		Grnd. Floor	First Floor	Grnd. Floor	First Floor
1	The Shieling (Front)	55.1	56.8	55.9	57.6
2	Ardlea Bungalow (Front)	64.0	-	64.9	-
3	11 Tyndrum Terrace (Rear)	46.7	51.7	47.5	52.4
4	5 Tyndrum Terrace (Rear)	47.1	49.9	47.9	50.6
5	Tigh Na Struith (Front)	53.1	54.0	53.9	54.8
6	Carna Cottage (Rear)	47.7	55.5	48.6	56.4
7	2 Willow Brae (Rear)	43.1	45.8	43.9	46.5
8	1 Willow Square (Front)	41.8	43.4	42.6	44.1
9	5 Willow Square (Front)	46.5	50.9	47.3	51.7
10	Laurelbank Garage (Front)	66.2	66.6	67.1	67.5
11	Gleann Fiadh Lodge (Front)	43.8	45.2	44.5	46.0
12	War Memorial	61.7	63.3	62.5	64.1
13	3 Strathmore Terrace (Rear)	41.4	47.3	42.2	48.1
14	4 Strathfillan Terrace (Rear)	44.4	46.7	45.5	47.8
15	Village Hall (Front)	64.2	66.3	65.0	67.1
16	Station House (Front)	50.1	51.2	51.3	52.4
17	Bungalow east of A82 and North of Northumbria B&B (Front)	59.1	-	60.3	-
18	Bungalow east of A82 and South of Northumbria B&B (Front)	55.7	-	56.8	-
19	Stronua House (Front)	70.0	70.8	70.8	71.6
20	Youth Hostel (Front)	44.2	45.3	45.1	46.2
21	Crianlarich Primary School (Front)	61.6	63.6	62.3	64.3
22	1 Meadow Grove (Front)	56.5	59.3	57.3	60.1
23	4 Railway Cottages (Front)	65.3	66.5	66.0	67.2
All noise levels presented as façade levels with the exception of War Memorial which is free-field					

13.8.3.3 Noise Level Change Classification

As detailed within Section 13.4 the following comparisons have been made for the purpose of the DMRB Detailed Assessment phase when assessing noise level changes:

- 2011DM versus 2026DM; and
- 2011DM versus 2026DS.

For completeness, although not strictly required for the purpose of the DMRB Detailed Assessment, a comparison of the 2011DM versus 2011DS has also been made:

Comparison of these scenarios, in conjunction with the absolute noise level predictions allows the noise nuisance assessment to be completed in full.

In accordance with the requirements of the DMRB, where receptors have a first floor, calculated levels at 4m above ground level have been adopted when calculating noise level changes. For receptors of only one storey in height, calculated levels at 1.5m above ground level have been adopted.

Table 13.23 presents the noise level changes associated with each of the three scenarios described above, for a sample of representative key and typical noise sensitive locations. In accordance with the requirements of the DMRB, Do Something noise levels have been predicted with the proposed noise mitigation measures in place.

Table 13.23: Predicted Noise Level Changes at Representative Sample Receptors, Façade, Ground Floor, dB(A)

Location Number	Receptor	Noise Level Change		
		2026DM-2011DM	2026DS-2011DM	2011 DS - 2011DM
1	The Shieling (Front)	0.8	-6.2	-7.0
2	Ardlea Bungalow (Front)	0.9	-2.8	-3.7
3	11 Tyndrum Terrace (Rear)	0.8	3.6	2.9
4	5 Tyndrum Terrace (Rear)	0.7	3.4	2.7
5	Tigh Na Struith (Front)	0.8	-0.1	-0.9
6	Carna Cottage (Rear)	0.8	-1.8	-2.7
7	2 Willow Brae (Rear)	0.8	1.7	1.0
8	1 Willow Square (Front)	0.6	1.5	0.8
9	5 Willow Square (Front)	0.8	-0.9	-1.7
10	Laurelbank Garage (Front)	0.4	-2.3	-3.2
11	Gleann Fiadh Lodge (Front)	0.7	2.9	2.1
12	War Memorial	0.7	-0.7	-1.5
13	3 Strathmore Terrace (Rear)	0.7	-0.2	-1.0
14	4 Strathfillan Terrace (Rear)	0.8	-4.4	-5.5
15	Village hall (Front)	0.7	0.8	0.0
16	Station House (Front)	0.8	-5.3	-6.5
17	Bungalow east of A82 and South of Northumbria B&B (Front)	0.8	-5.6	-6.8
18	Bungalow east of A82 and South of Northumbria B&B (Front)	0.8	-5.4	-6.5
19	Stronua House (Front)	0.8	0.9	0.1
20	Youth Hostel (Front)	0.7	-2.3	-3.2
21	Crianlarich Primary School (Front)	0.8	0.8	0.1
22	1 Meadow Grove (Front)	0.7	0.8	0.0
23	4 Railway Cottages (Front)	0.8	0.7	0.0
All noise levels presented as façade levels with the exception of the War Memorial which is free-field				

The noise level changes for all dwellings and other receptors in the study area, split into ambient noise level bands, are presented in Appendix 13.3, for the

2011DM versus 2026DM and 2011DM versus 2026DS scenarios. An overall summary encompassing all ambient noise bands is presented in Tables 13.24 and 13.25.

Table13.24: Number of Receptors in Study Area Subject to Different Noise Level Changes, 2011DM versus 2026DM

	Receptor Category		
Increase / Decrease	**Noise Level Change Bands, dB(A)**	**Dwellings**	**'Other'**
Decrease	≤ -5	0	0
	-3 to -4.9	0	0
	-1 to -2.9	0	0
	-0.1 to -0.9	0	0
	0	0	0
Increase	0.1 to 0.9	64	27
	1 to 2.9	0	0
	3 to 4.9	0	0
	≥ 5	0	0

Table 13.25: Numbers of Receptors in Study Area Subject to Different Noise Level Changes, 2011DM versus 2026DS

	Receptor Category		
Increase / Decrease	**Noise Level Change Bands, dB(A)**	Dwellings	'Other'
Decrease	≤ -5	9	0
	-3 to -4.9	6	5
	-1 to -2.9	6	4
	-0.1 to -0.9	12	3
	0	1	0
Increase	0.1 to 0.9	19	14[2]
	1 to 2.9	7[1]	0
	3 to 4.9	4[1]	1
	≥ 5	0	0

[1] Several receptors subject to noise level decreases on opposite facades, which are otherwise unaccounted for in the assessment
[2] Includes Children's Nursery and Crianlarich Primary School assumed to be of high sensitivity, and forestry shed considered to be of low sensitivity

Comparing Table 13.24 with the impact matrix presented in Table 13.7, it can be seen that for the 2011DM v 2026DM scenario, noise effects resulting from noise level changes associated with general traffic growth in the Do Minimum scenario is predicted to be minor adverse at all dwellings (not significant).

With respect to 'other' receptors, assuming medium sensitivity for all receptors with the exception of the Children's Nursery and Crianlarich Primary School, which are considered to be of high sensitivity, and the Forestry Shed which is considered to be of low sensitivity, noise impacts at twenty-five receptors are predicted to be none, and at two receptors (Children's Nursery and Crianlarich Primary School) are predicted to be minor adverse.

The information in Table 13.25 (which includes the effect of general traffic growth and the scheme) indicates that for residential receptors, one dwelling is predicted

to be subject to no effect, twenty-six are subject to an adverse minor effect , , and four are subject to an adverse effect of moderate significance. Eighteen dwellings are predicted to be subject to a minor beneficial effect , six subject to a beneficial effect of moderate significance, , and nine subject to a beneficial effect of major significance.

With respect to 'other' receptors, assuming medium sensitivity for all receptors with the exception of the Children's Nursery and Crianlarich Primary School which are considered to be of high sensitivity, and the Forestry Shed (industrial building) which is considered to be of low sensitivity, noise effects at fifteen receptors are predicted to be none, and at three receptors (including the Children's Nursery and Crianlarich Primary School) minor adverse. Nine receptors are subject to minor beneficial effects .

A summary of the dwellings predicted to be subject to moderate and major effect (beneficial and adverse) for the 2011DM versus 2026DS comparison is presented in Table 13.26.

Table 13.26: Summary of Study Area Residential Receptors Predicted to be Subject to Noise Effects of Major and Moderate Significance.

Effect Significance	Adverse / Beneficial	Summary of Residential Receptors
Major	Adverse	None
Moderate	Adverse	7 Tyndrum Terrace (Rear) 5 Tyndrum Terrace (Rear) 11 Tyndrum Terrace (Rear) 10 Willow Square (Front)
Moderate	Beneficial	6 Strathfillan Terrace (Rear) 5 Strathfillan Terrace (Rear) 4 Strathfillan Terrace (Rear) 3 Strathfillan Terrace (Rear) 2 Strathfillan Terrace (Rear) 1 Strathfillan Terrace (Rear)
Major	Beneficial	The Shielding Station House Northumbria B&B (Front) Dunvegan Block 5 Bungalows East of A82 (Front)

In accordance with the DMRB methodology detailed within Sections 3.2 and 3.4 of this report, where a dwelling is predicted to experience an increase in noise level on one façade and a decrease on another, the 'worst case' in terms of change in noise level has been adopted for each receptor. Where beneficial and adverse changes are experienced at different facades of the same property, although not strictly defined within the DMRB, a 'worst case' change has been taken to be the worst case adverse change. Therefore to represent a worst case situation, for receptors located between the existing A82 and proposed A82 re-alignment, the prediction point has been located on the façade facing the proposed route.

These properties are predicted to be subject to noise level decreases at opposite façades for this scheme. Each of the receptors that are predicted to be subject to moderate adverse effects, as presented in Table 13.26 above, are located between the existing A82 and the proposed route re-alignment, and are predicted

to benefit from minor beneficial noise level decreases (less than 3 dB) on opposite façades.

It can be seen from Table 13.26 that greater numbers of properties are predicted to be subject to moderate beneficial effects than there are subject to moderate adverse effects (six and four respectively), whilst nine are predicted to be subject to beneficial effects of major significance and none subject to adverse effects of major significance.

13.8.3.4 Noise Level Changes at Historic Sites

In recognition of Historic Scotland's (HS) concerns about noise level changes at Scheduled Ancient Monuments (SAM) and Listed Buildings (LB) (see Annex A), consideration has been given to those sites identified in Section 13.5.2. The sites which are located within the study area have been included in the DMRB assessment as individual receptors. For these receptors, the predicted 2011DM and 2011DS noise levels and associated noise level changes are presented in Table 13.27 below.

This table also presents the corresponding significance of effect, assuming that these receptors have a medium sensitivity (see Table 13.5).

Table 13.27: Noise Level Changes as a Result of Scheme Opening for Scheduled Ancient Monuments and Listed Buildings (2011DM v 2011DS)

Historic Site	Noise Level, dB $L_{A10\ 18hour}$		Noise Level Change (dB)	Effect Significance
	2011DM	2011DS		
Crianlarich War Memorial	63.2	61.7	-1.5	Minor Beneficial
Crianlarich Parish Church	45.6	42.4	-3.2	Minor Beneficial
Crianlarich Station Works	49.7	45.4	-4.3	Minor Beneficial

It can be seen from the data presented in Table 13.27 that each of the historic sites are predicted to be subject to minor beneficial effects as a result of the proposals.

Loch Dochart Castle is located more than 2km away from the proposed route realignment, and outside the area covered by the scheme noise models. However, it is anticipated that the noise levels at this receptor will be dominated by local noise sources, (e.g. closer road traffic routes and natural sources such as wind rustling tree and bird song etc), and that as such, the significance of noise impact resulting from the proposed scheme would be 'none'.

13.8.3.5 Change in Noise Nuisance for Do Minimum Scenario

For the Do Minimum Scenario, the change in noise nuisance has been considered between the year of opening (2011DM) and the design year (2026DM).

It is assumed that changes in road traffic for the Do Minimum Scenario would be gradual over time, and as such, this assessment uses the 'steady state' nuisance assessment method presented in the DMRB. The percentage of people bothered 'very much or quite a lot' by road traffic noise has been identified for each receptor within the study area for both the 2011DM and 2026DM scenarios. The difference

between the two figures has been identified as the change in percentage of people bothered.

The DMRB requires that noise nuisance changes be determined at all dwellings within the study area. The change in noise nuisance for all dwellings has been classified into specific percentage change bands for each different ambient band presented in Tables 13.13 and 13.14. The identified nuisance changes are presented in Appendix 13.3 for each ambient noise level band, with an overall summary encompassing all ambient noise bands presented in Table 13.28.

Table 13.28: Numbers of Properties Subject to Change in Noise Nuisance for 2026DM v 2011DM, (% of People bothered by Noise)

Change in Noise Nuisance (%)[1]	Number of Dwellings
≤ -40%	0
-30% to < -40%	0
-20% to < -30%	0
-10% to < -20%	0
0% to < -10%	0
0% to < 10%	64
10% to < 20%	0
20% to < 30%	0
30% to < 40%	0
≥ 40%	0

It can be seen from Table 13.28, that for the Do Minimum situation, all dwellings, at worst, are predicted to be subject to a small increase in noise nuisance as a result of general traffic growth, with some predicted to be subject to no change. All receptors are predicted to fall within the 0 to 10% category.

13.8.3.6 Change in Noise Nuisance for Do Something

The identified nuisance changes are presented in Appendix 13.3 for each ambient noise level band, with an overall summary encompassing all ambient noise bands presented in Table 13.29.

Table 13.29: Numbers of Properties Subject to Change in Noise Nuisance for 2026DS v 2011DM, (% of People bothered by Noise)

Change in Noise Nuisance (%)	Number of Dwellings
≤ -40%	0
-30% to < -40%	0
-20% to < -30%	0
-10% to < -20%	1
0% to < -10%	22
0% to < 10%	23
10% to < 20%	8
20% to < 30%	8
30% to < 40%	2
≥ 40%	0

By comparing Tables 13.28 and 13.29, it can be seen that greater changes in noise nuisance are expected for the Do Something Scenario, than the Do Minimum Scenario. This is because the scheme opening would cause an abrupt noise level change. The nuisance change arising from an abrupt change is evaluated following a different method within the DMRB. An abrupt change of 1dB

results in a change in noise nuisance of 21% but a change of the same magnitude which is gradual over time results in a nuisance change of only 1 to 3%, depending on the starting and finishing levels.

As such, it is unsurprising that several of the adversely affected receptors fall within the 20 to 30% and 30 to 40% bands. This is seen to be the case in Table 13.29, although a significant number of receptors are predicted to be subject to decreases in noise nuisance, albeit of lesser significance.

Eighteen residential receptors are predicted to be subject to an increase in noise nuisance of greater than 10% for the Do Something scenario compared with zero for the Do Minimum scenario, but 22 are predicted to be subject to decreases of between 0 and 10% for the Do Something scenario compared with zero for the Do Minimum scenario.

13.8.3.7 Noise Insulation (Scotland) Regulations

As highlighted within Section 13.4, the Noise Insulation (Scotland) Regulations require noise level predictions to be undertaken in accordance with the Memorandum on the Noise Insulation (Scotland) Regulations 1975 Regulations 3 and 6, but for the purpose of this assessment, the CRTN calculation method has been adopted.

The Scottish Memorandum method requires noise level predictions to be undertaken based on the maximum expected average (7 day) traffic flow in May or August, whereas the CRTN methodology is based on the maximum expected annual average weekday (5 day) traffic flow. Accordingly, it is necessary to determine an approximate (proxy) correction to apply to the CRTN predicted noise levels when determining likely eligibility under the Noise Insulation (Scotland) Regulations.

Figure 13.7 below presents the seven day 2005 monthly profile from the traffic count on the A82, south west of Crianlarich:

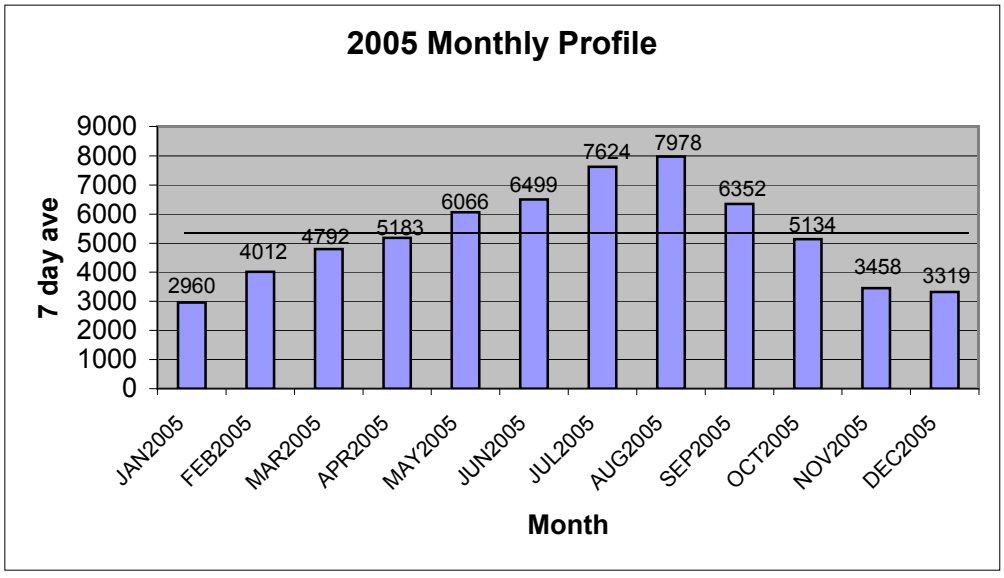

Figure 13.7 2005 Monthly Profile from Automatic Traffic Count on the A82, southwest of Crianlarich

From Figure 13.7 the Annually Averaged Daily Traffic (AADT) flow at this point on the road is calculated to be 5281, whilst the highest average AADT for August / May is predicted to be 7978. Based on standard acoustic principles, the corresponding noise level difference is predicted to be +1.8 dB. It is acknowledged that this is a proxy correction and assumes that a similar percentage change in flows would arise when comparing both week-day (5-day) and daily (7-day) traffic figures.

This correction has been applied to the predicted receptor noise levels, as a proxy correction to determine equivalent noise levels for the Memorandum on the Noise Insulation (Scotland) Regulations 1975 Regulations 3 and 6 prediction methodology.

Including for this correction, the only residential properties predicted subject to a 2026DS noise level of greater than 68dB $L_{A10\ 18hour}$ are Stronua House, the Rod and Reel Public House, Stronua Cottage, and Laurelbank. All these locations are predicted to be subject to either noise levels decreases, or increases of less than 1dB.

This assessment has therefore identified that no properties are predicted to qualify for eligibility through the Noise Insulation (Scotland) Regulations as a result of future road traffic noise levels. It may however be considered necessary that a full assessment of eligibility under the NISR be undertaken following the consenting of the scheme and the final details of the scheme are known.

13.8.3.8 Vibration

In the case of this development, no receptors are located within 40m of the proposed new route alignment. The only properties within 40m of any existing routes subject to adjustment are two bungalows at the southern end of Crianlarich, east of the Glenfalloch Road, and 5, 7, 9 and 11 Tyndrum Terrace and Ardlea Bungalow, all of which are at the western end of Crianlarich. These properties are only within 40m of existing routes subject to minor realignments. These realignments are associated with the tie-in of the proposed roundabouts with the existing route network, rather than being off-line changes. Furthermore, all of these receptors front the existing A82, along which decreases in road traffic flows are predicted as a result of the scheme.

As such, no significant adverse airborne vibration effects are expected to arise as a result of the proposed development, whilst some local properties may be subject to a decrease in airborne vibration due to the decreased traffic flows on the existing A82, and the proposed route being located at greater distance from existing properties than the existing route.

13.9 SUMMARY

The following section summarises the key findings of the assessment.

- A detailed baseline noise survey of the study area identified that the key noise source is local road traffic with additional contributions from natural sources such as rustling vegetation and bird song.

- Noise mitigation design was undertaken as part of the iterative design process for the scheme, resulting in a number of noise mitigation measures being incorporated in the proposals.
- The significance of noise effects resulting from noise level changes associated with general traffic growth in the Do Minimum scenario are predicted to be minor adverse at all dwellings.
- During the construction phase, temporary noise effects are predicted ranging in significance from minor to moderate adverse. Minor adverse effects are predicted to arise as a result of average case construction operations. Adverse effects of moderate significance are expected for short duration worst case construction activities where work is to be undertaken at the closest point of the relevant site areas to Northumbria B&B, Sharneil Bungalow, 3 Glenfalloch Road, 1 – 11 Tyndrum Terrace and Ardlea Bungalow. (Receptor Locations 2 and 7).
- During the construction works, temporary groundborne vibration impacts of moderate adverse significance are predicted to arise where heavy construction activities including the use of vibratory rollers are undertaken within distances of less than approximately 23m from vibration sensitive receptors. Where there is potential for moderate adverse effects to arise, vibration monitoring would be undertaken to allow impacts to be appropriately determined and controlled to within acceptable levels.
- The effect of general traffic growth up to the design year (2026DM versus 2011DM) across the study area is predicted to give rise to noise level changes of less than 1dB barely perceptible).
- More receptors are predicted to be subject to noise level decreases than increases. Furthermore,, the magnitude of noise level decreases is predicted to be greater than the magnitude of increases.
- Within the study area (defined within Figures 13.1 A and B), including for the effect of general traffic growth and the effect of the scheme, noise effects at dwellings are predicted to range from major beneficial decreases of greater than 5dB to moderate adverse increases of 3 to 5dB, with the majority of receptors subject to minor noise level changes or less.
- Within the study area, including for the effect of general traffic growth and the effect of the scheme, noise effects at 'other receptors' are predicted to range from moderate beneficial decreases of 3 to 5dB to moderate adverse increases of 3 to 5dB.
- Within the study area, including for general traffic growth and the effect of the scheme, no dwellings are predicted to be subject to adverse effects of major significance, and four are subject to adverse effects of moderate significance, (7, 5 and 11 Tyndrum Terrace and 10 Willow Square). There are six dwellings (1-6 Strathfillan Terrace) subject to beneficial effects of moderate significance and nine (The Shieling, Station House, Northumbria B&B, Dunvegan Block and 5 bungalows east of A82) would be subject to beneficial effects of major significance.
- Effects at Scheduled Ancient Monuments and Listed Buildings are predicted to range from none to minor beneficial.
- For the study area and Do Something scenario, a large proportion of dwellings are predicted to be subject to a change in noise nuisance of between 0% and +40%. Ten receptors are predicted to be subject to an increase in noise nuisance of greater than 20%, eight are predicted to be subject to an increase of between 10 and 20%, with twenty three predicted to be subject to increases of between 0 and 10% and twenty three predicted to be subject to decreases of between 0 and 20%.

- For the Do Minimum scenario, it was identified that all 64 residential receptors were predicted to be subject to an increase in noise nuisance of between 0 and 10%.
- For the study area, no significant adverse airborne vibration effects are expected to arise as a result of the proposed development, whilst some local properties may be subject to a decrease in airborne vibration due to traffic flow decreases on the existing A82, and the proposed route being located at greater distance from properties than the existing route.
- It is not expected that the proposals would result in increasing ground-borne vibration levels on existing routes, furthermore for the existing A82, decreases in road traffic flows are predicted as a result of the scheme, thus resulting in potential reductions in road traffic induced groundborne vibration.

Key

Study Area

Study Area Centre Line

DRAWN BY: NMB

CHECKED BY: JP

DATE: 3 August 2009

A82 Crianlarich Bypass

Figure 13.1A: Study Area (South)

Scale: 1:5000 @ A3

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Key

1 Measurement Location

Study Area

Study Area Centre Line

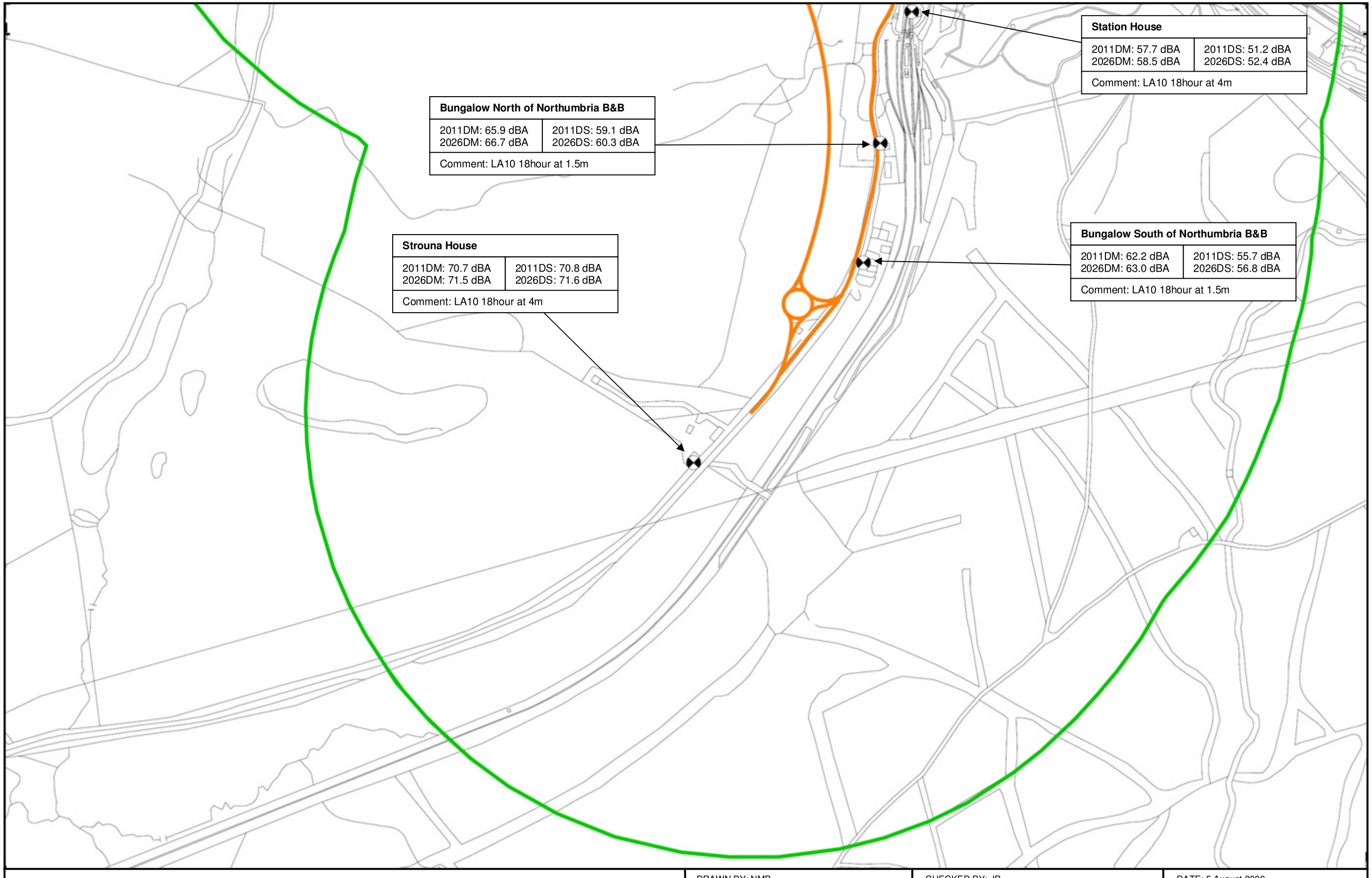
DRAWN BY: NMB	CHECKED BY: JP	DATE: 3 August 2009

A82 Crianlarich Bypass

Figure 13.1B: Study Area (North) and Measurement Locations

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

Sample Receptor Location

Study Area

Study Area Centre Line

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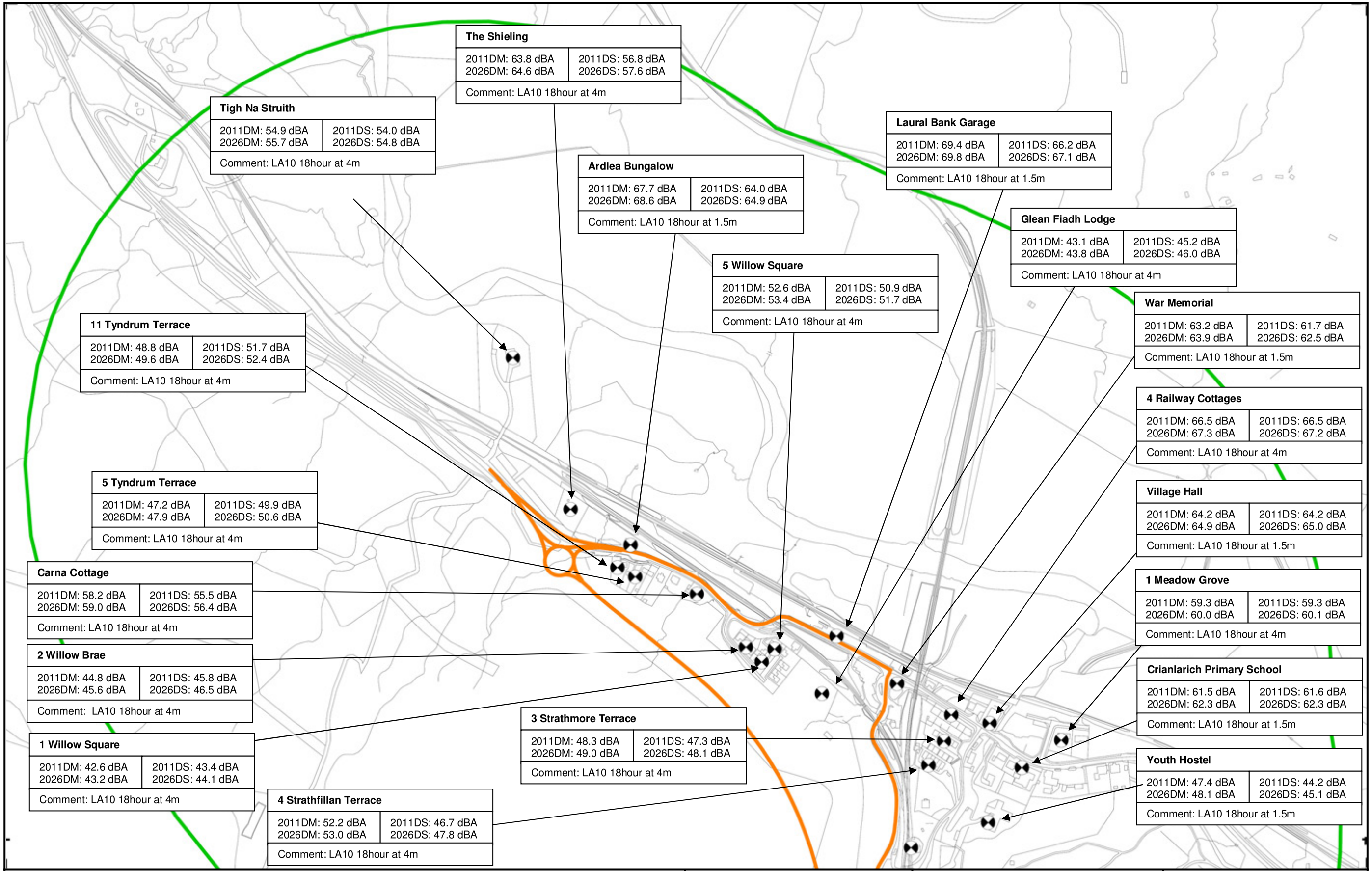
A82 Crianlarich Bypass

Figure 13.2A: Predicted sample receptor Noise Levels (South)

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

- Sample Receptor Location
- Study Area
- Study Area Centre Line

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Figure 13.2B: Predicted sample receptor Noise Levels (North)

Scale: 1:5000 @ A3

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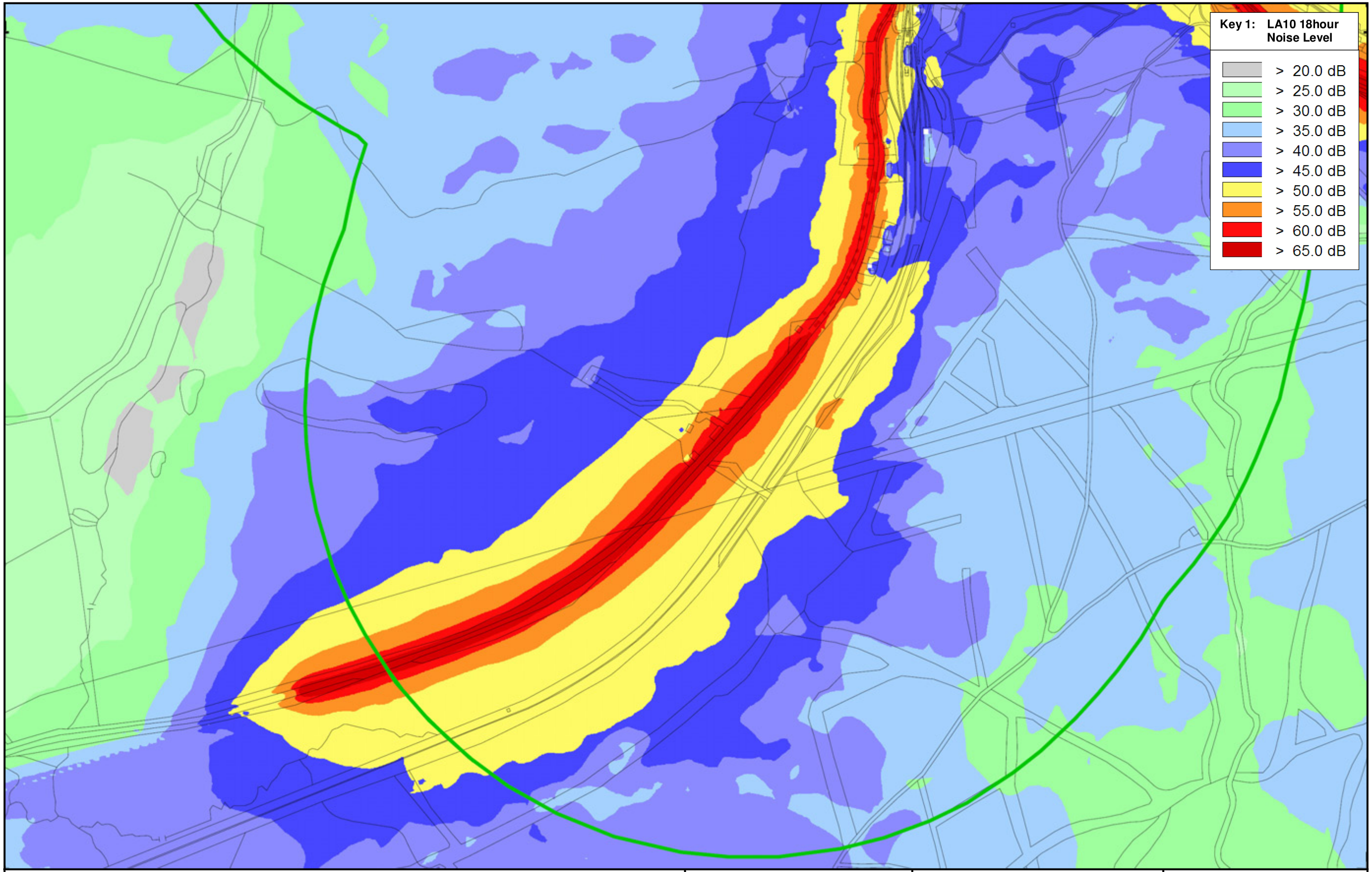

Key

Study Area

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DATE: 3 August 2009

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Figure 13.3A: 2011DM Ground Floor Free-field Noise levels (South)

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND

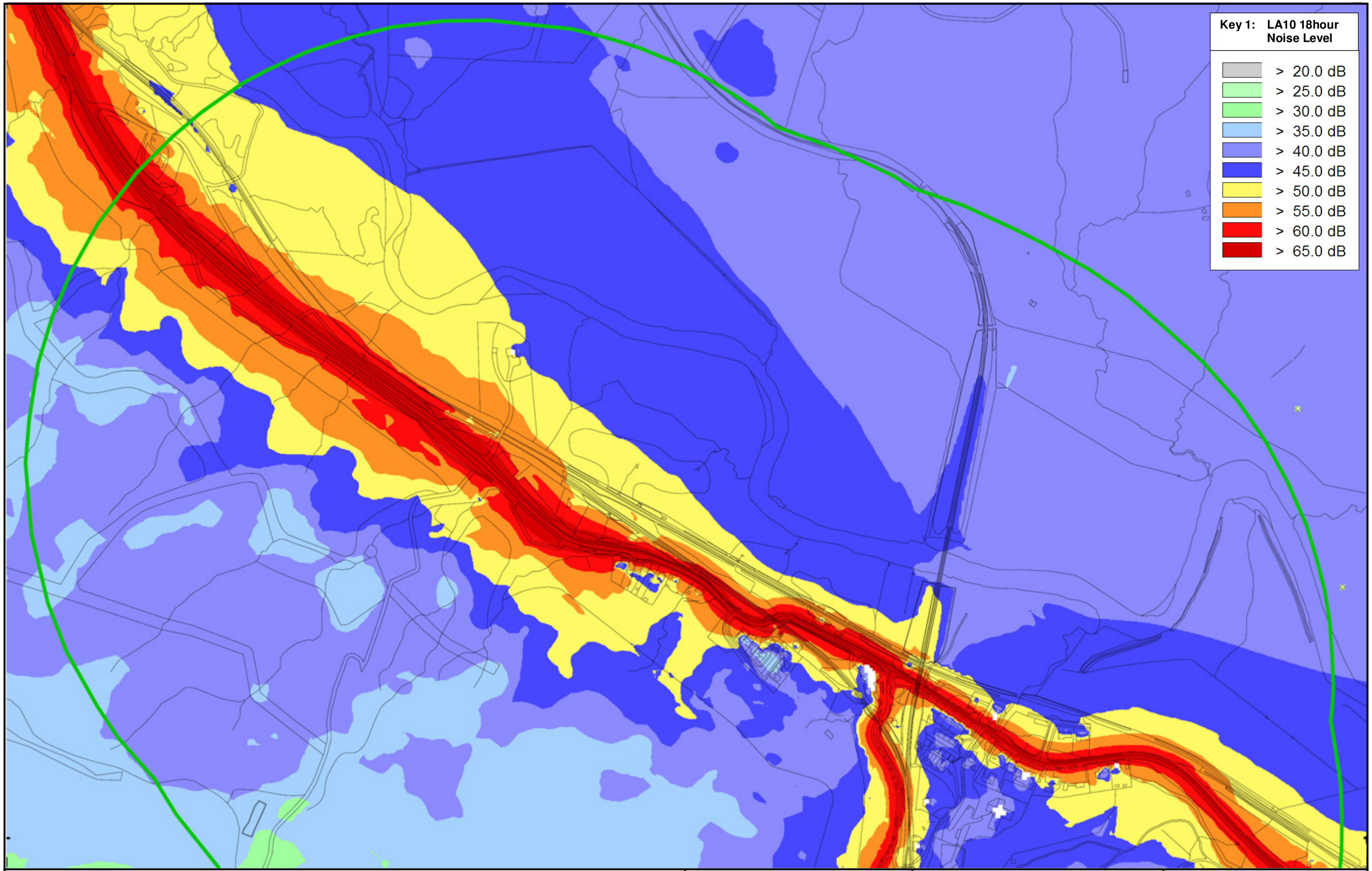

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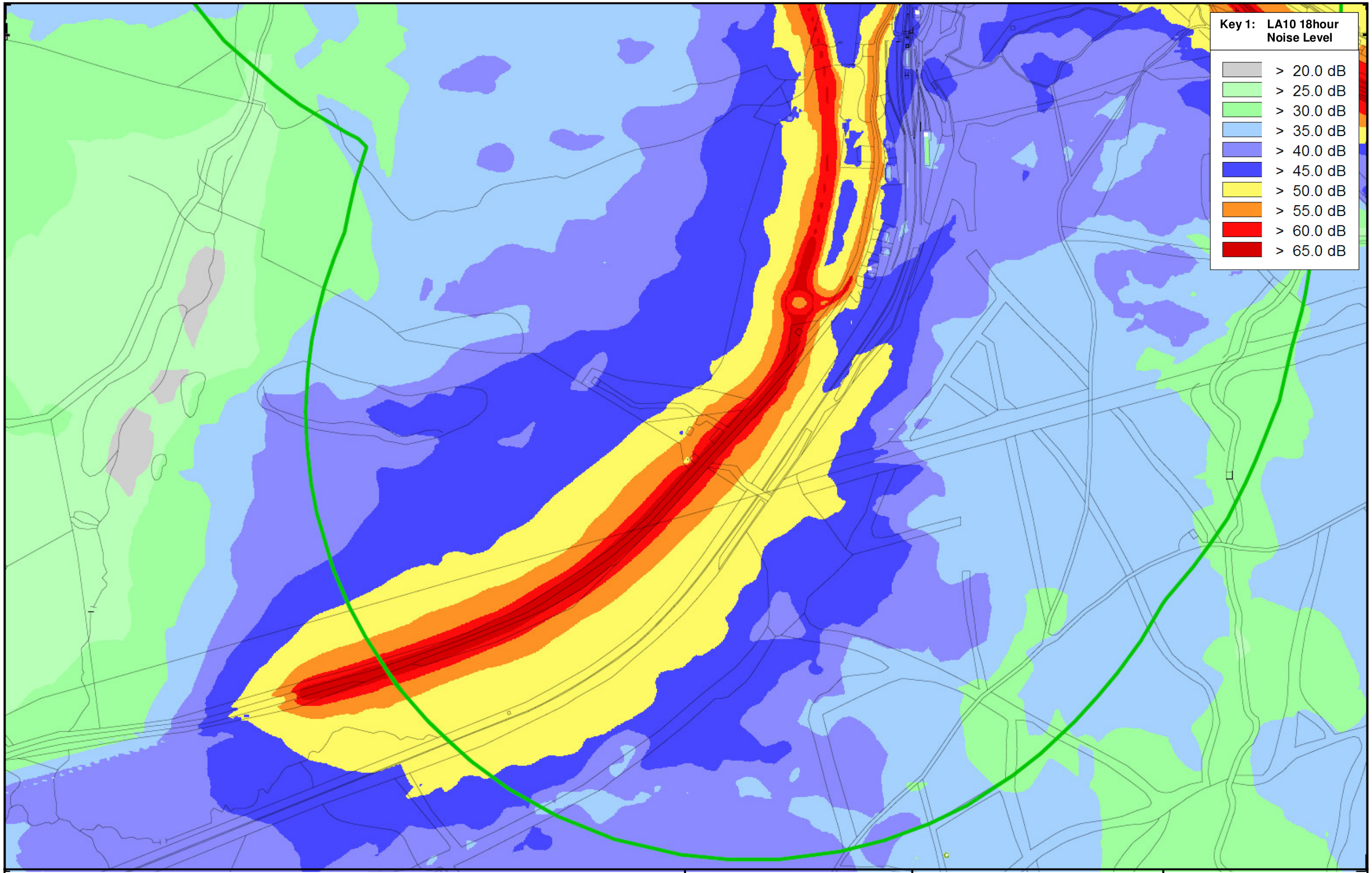
Figure 13.3B: 2011DM Ground Floor Free-field Noise levels (North)

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

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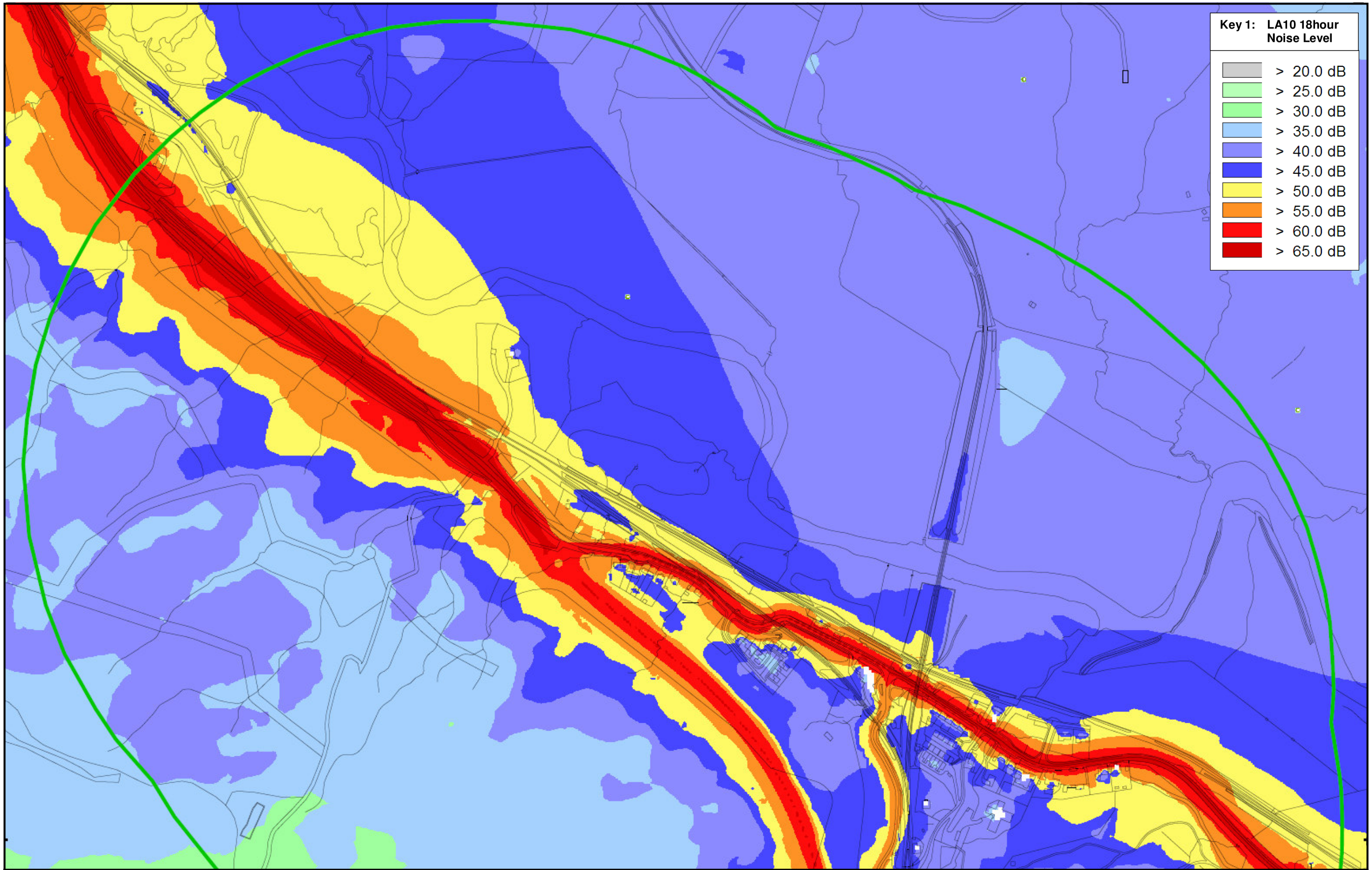
Figure 13.4A: 2011DS Ground Floor Free-Field Noise levels (with mitigation) - South

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

Study Area

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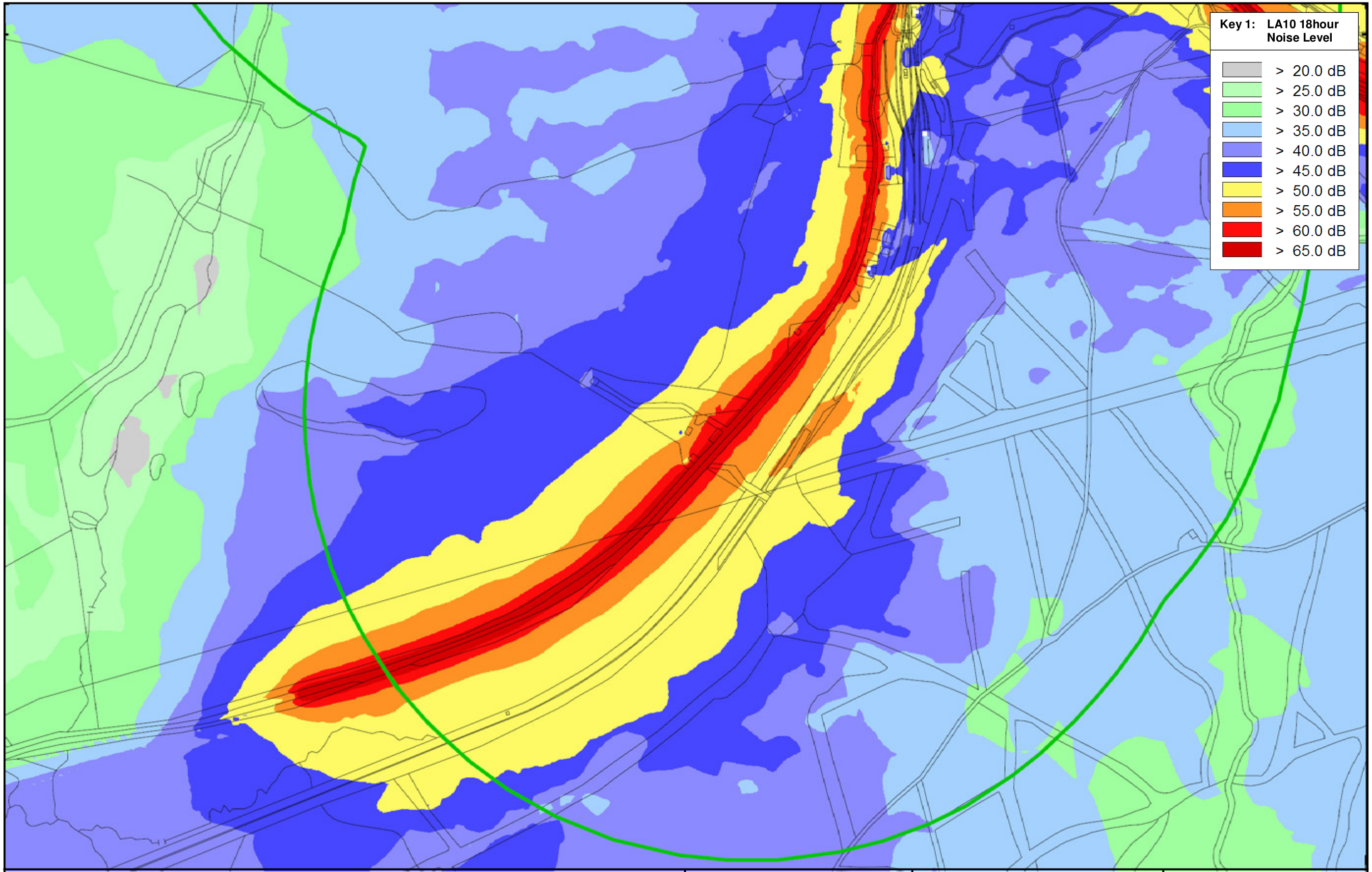
A82 Crianlarich Bypass

Figure 13.4B: 2011DS Ground Floor Free-field Noise levels (with mitigation) - North

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

Study Area

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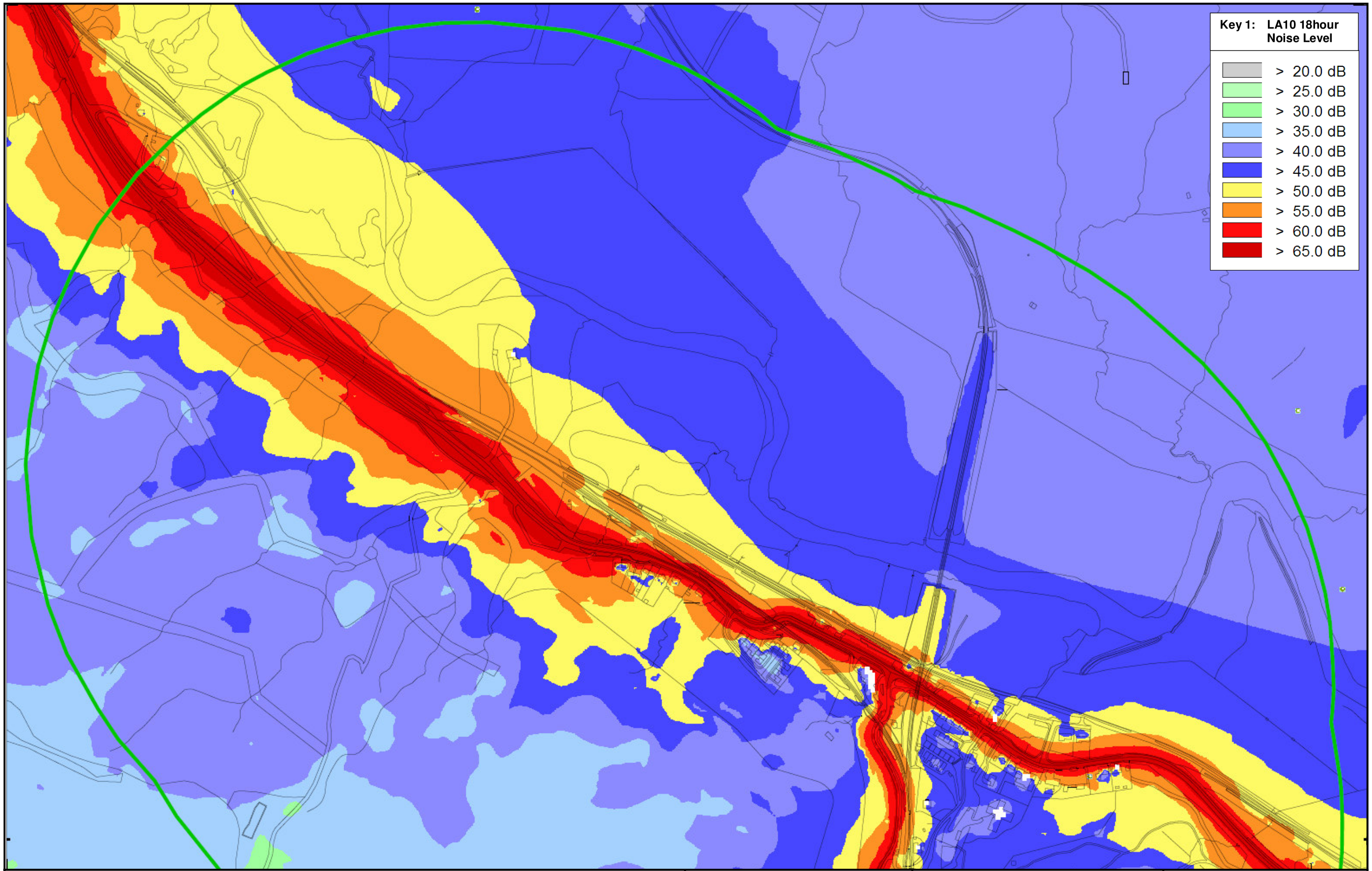
DATE: 3 August 2009

A82 Crianlarich Bypass

Figure 13.5A: 2026DM Ground Floor Free-field Noise levels (South)

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND



Key

Study Area

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A82 Crianlarich Bypass

Figure 13.5B: 2026DM Ground Floor Free-field Noise levels (North)

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND

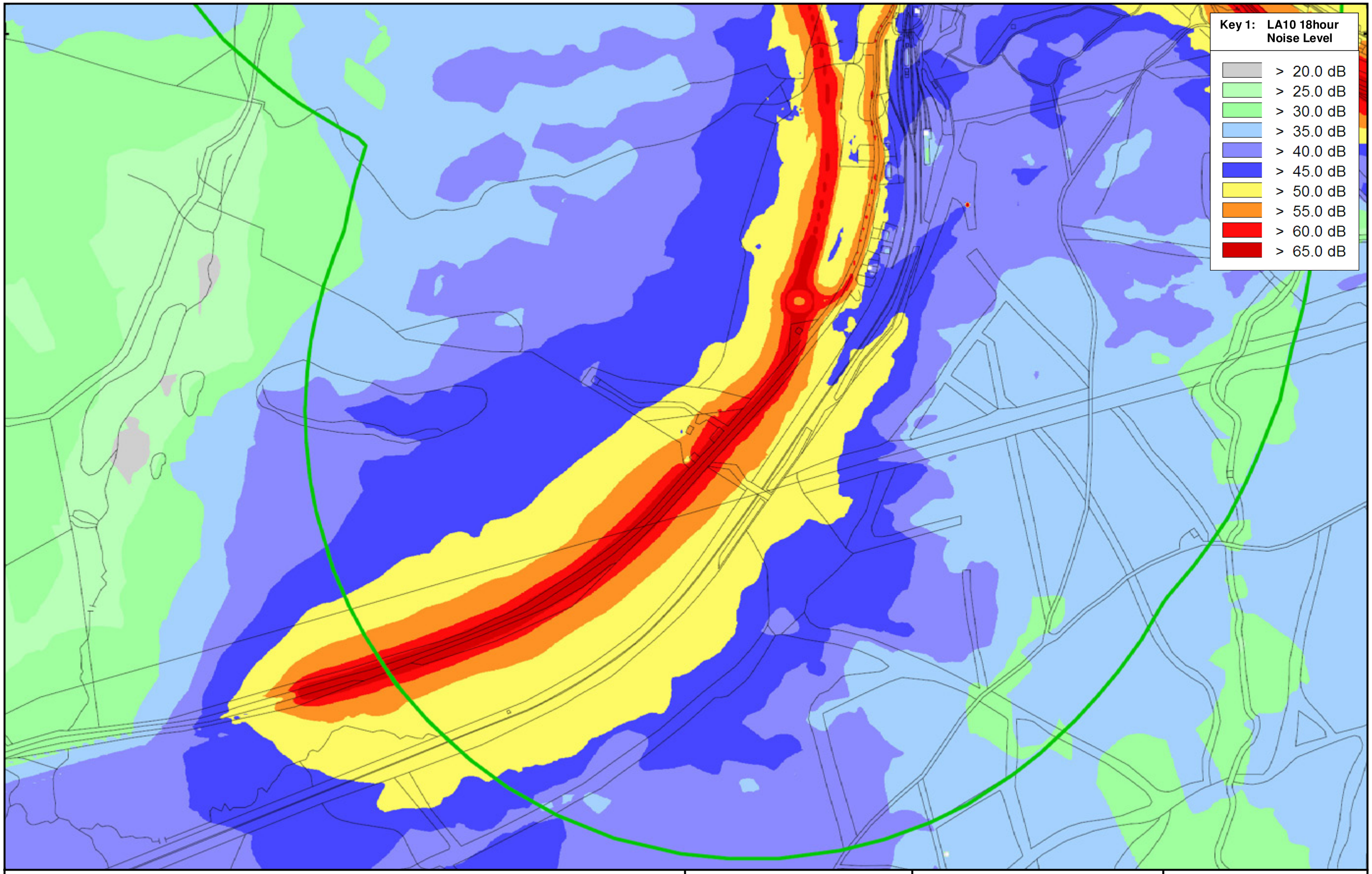

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Figure 13.6A: 2026DS Ground Floor Free-field Noise levels (with mitigation) - South

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND

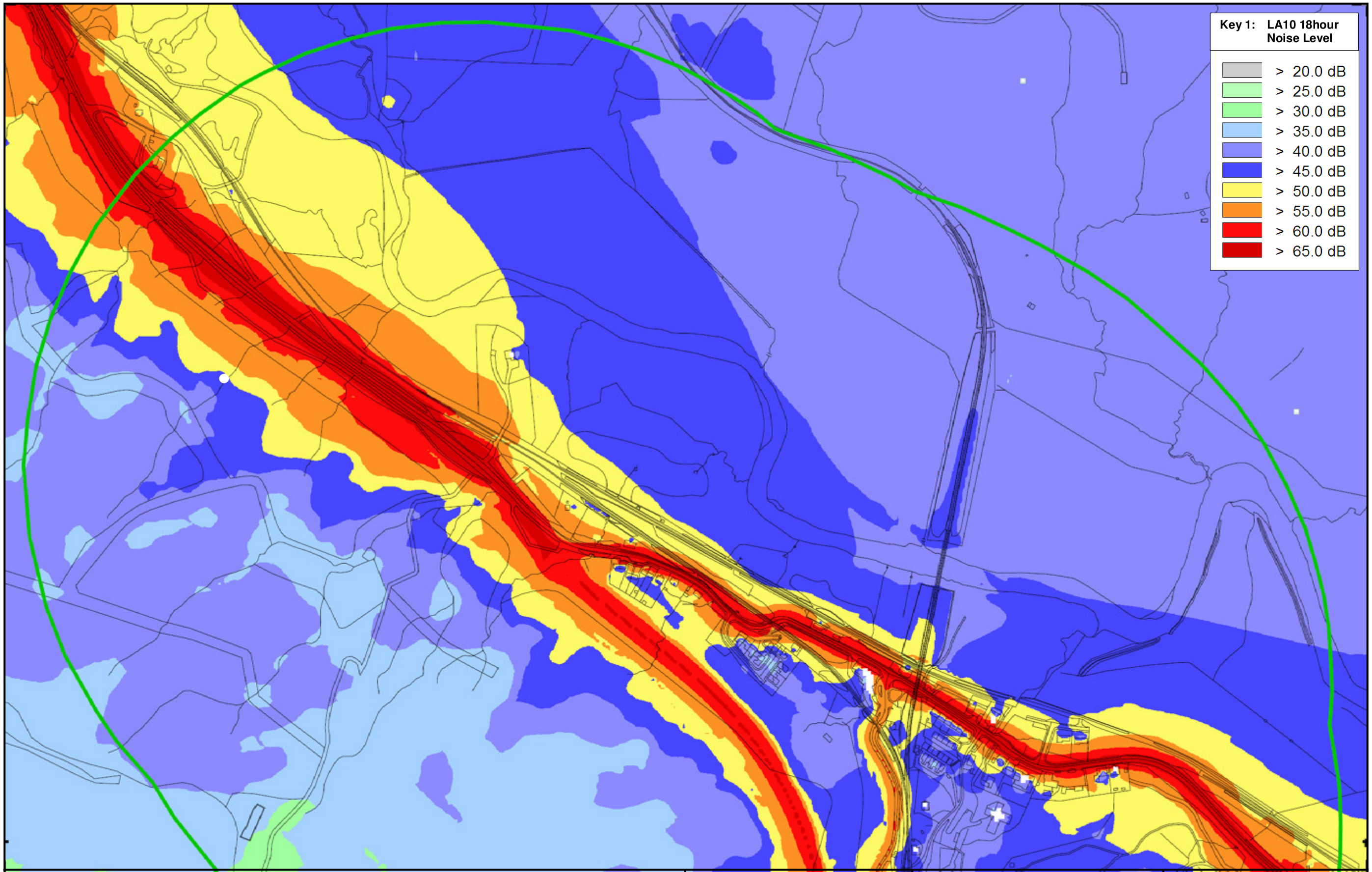

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Figure 13.6B: 2026DS Ground Floor Free-field Noise levels (with mitigation) - North

Scale: 1:5000 @ A3

TRANSPORT SCOTLAND