16. NOISE

EXECUTIVE SUMMARY

- The proposed development is being undertaken within an existing wellsite where multiple drilling operations, natural gas production and injection of produced liquids have been undertaken over the last 20 years
- This chapter of the Environmental Statement is concerned with the potential impacts associated with noise, as a result of the existing KMA wellsite and associated activities undertaken therein, including the existing boreholes and proposed KM8 hydraulic fracturing operations
- Background noise measurements were recorded continuously during the two week period 16th February to 2nd March 2015 at the agreed NSRs to establish baseline noise. Background noise measurements have been used to determine the change in noise level
- Traffic and source noise data for the various equipment to be used during the proposed development was acquired and used to predict noise impacts
- The assessment methodology is consistent with NPSE, NPPF and PPG
- Different assessment thresholds have been established for each phase of the development, based upon significant effect (SOAEL) and these have been compared with predicted levels
- The potential noise impacting activities within each phase of the proposed development have been assessed and noise levels predicted
- Each noise impacting activity has been assessed to determine the significance of impact
- Noise mitigation strategy has been developed to not just ensure SOAELs are not breached but also to ensure that the NPSE 2^{nd} Aim, which is to minimise all adverse noise effects and target LOAELs where reasonably practical, is carried through.
- For each phase of the proposed development, with mitigation in place, the impact on nearest sensitive receptors is not significant
- The residual effects from noise, with the mitigation in place, are considered by the Assessment Team to be **Neutral** with the potential for a temporary **Negligible** change in the baseline conditions

16.1 INTRODUCTION

This chapter of the Environmental Statement outlines the potential impact of the proposed development with respect to noise. The potential noise generated is assessed in terms of its impact upon the surrounding community, with consideration being given to whether such an impact is 'significant'. In general terms this requires consideration of changes to, or increases in, environmental noise levels resulting from the proposed development.

Where an impact is potentially significant (above the Significant Overall Adverse Effect Level (SOAEL)), mitigation measures are proposed to reduce noise levels to below the SOAEL. Where levels are below the SOAEL but above the Lowest Observable Adverse Effect Level (LOAEL), further mitigation measures are considered where practical.

This assessment has considered the following potential impacts:

- Noise impact arising from traffic on public local roads, associated with the pre-stimulation workover phase, hydraulic fracture stimulation/well test phase, production test phase and production phase;
- Noise impact arising from activity on site during the pre-stimulation workover phase, hydraulic fracture stimulation/well test phase and production test phase, activity associated with preparing the KM8 well for normal production of gas; and
- Noise impact arising during the production phase.

In each case, provided that the impact is considered to be potentially significant, a predicted numerical level of noise, expressed using the appropriate metric, is assessed in accordance with the appropriate guidance or procedures, and the results reported and expressed in accordance with their significance. In some cases, there is clear guidance as to what might constitute a significant impact, in other cases, interpretation and further evaluation is required before being able to draw conclusions on the significance of the predicted impact.

This chapter excludes an assessment of noise impacts on terrestrial ecology, the details of which are addressed separately within Chapter 11 Ecology. This chapter also excludes any assessment of vibration. The distance between the KMA wellsite and sensitive receptors is large and vibration assessment is not considered by the Assessment Team to be required for most of the activities. Vibration associated with potential microseismic events during hydraulic fracturing, however, is addressed within Chapter 18 Seismicity.

16.2 PLANNING POLICY CONTEXT

16.2.1 National Policy

16.2.1.1 Noise Policy Statement for England

Noise Policy Statement for England (NPSE) [Ref.1] was issued by Department for Environment, Food and Rural Affairs (DEFRA) [Ref.2] in March 2010. The stated policy aims, through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development, are given as being:

- To avoid significant adverse impacts on health and quality of life;
- To mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, to contribute to the improvement of health and quality of life.

NPSE then introduces concepts and terms that are relevant to consideration of 'significant adverse' and 'adverse' effects. It advises that there are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

NPSE says that these concepts can be extended to a concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur.

NPSE indicates that it is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations and that the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It acknowledges that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. Further, it says that not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

Having defined the terms, NPSE then expands on the two main aims. The first is to avoid significant adverse impacts or effects on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development. This means ensuring impact is less than the SOAEL.

The second main aim of the NPSE is to mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development. The aim is to reduce the impact even further to within the LOAEL if this is possible. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development whilst acknowledging that this does not mean that such adverse effects cannot occur.

The NPSE develops the idea of LOAEL and SOAEL. In the case of this development, especially of short term activity consistent with preparation of a mineral extraction operational development, the duration of the noise is critical in determining the values for LOAEL and SOAEL. Guidance on what values might be associated with these short term levels is not included within the NPSE.

16.2.1.2 National Planning Policy Framework

The National Planning Policy Framework (NPPF) [Ref.3] was enacted in March 2012 and has replaced a number of Planning Policy Statements and Planning Policy Guidance. It sets out the Government's planning policies for England and how these are expected to be applied.

The relevant generic policies of the NPPF are set out in Chapter 6 of this Environmental Statement.

The NPPF highlights that in preparing Local Plans, local planning authorities should set out environmental criteria, in line with the policies in the Framework, against which planning applications will be assessed. This will ensure that development does not have unacceptable adverse impacts on the natural and historic environment or human health, including from noise, dust, visual intrusion, traffic, tip-and quarry-slope stability, differential settlement of quarry backfill, mining subsidence, increased flood risk, impacts on the flow and quantity of surface and groundwater and migration of contamination from the site. It will also ensure that development takes into account the cumulative effects of multiple impacts from individual sites and/or a number of sites in a locality.

In the second relevant paragraph, the NPPF states that when developing noise limits, it should be recognised that some noisy short-term activities, which may otherwise be regarded as unacceptable, are unavoidable to facilitate minerals extraction.

The NPPF is directed here primarily to those authorities responsible for developing specific plans. The relevant authority in this case has no current 'saved' noise policy within the North Yorkshire Minerals Plan and therefore any noise and vibration matters raised within the NPPF have only limited relevance.

16.2.1.2 Planning Practice Guidance

The Planning Practice Guidance (PPG) [Ref.4] was published in March 2014. The document provides additional guidance in support of the NPPF. The chapter of particular relevance to noise is entitled 'Minerals' the relevant section being noise emissions.

Within the minerals guidance section of PPG there is specific guidance for assessing environmental impacts from minerals extraction operations. Paragraphs 19-22 cover the control of noise emissions. Paragraph 19 considers methodology for controlling noise emissions and Paragraph 20 looks at how to assess its impact. Paragraph 21 considers suitable noise limits that might be set for normal operations and Paragraph 22 considers limits that might apply for particularly noisy short term activities. This guidance is detailed fully below.

Paragraph 19 sets out the methodology for controlling noise emissions. It advises that a noise impact assessment should be completed to identify all sources of noise, taking account of source noise emission, its characteristics, proposed operating locations, procedures, schedules and duration of work for the life of the operation and its likely impact on the surrounding neighbourhood.

Paragraph 19 continues setting out that proposals for control or mitigation of noise emissions should:

- *Consider the main characteristics of the production process and its environs, including the location of noise-sensitive properties and sensitive environmental sites;*
- *Assess the existing acoustic environment around the site of the proposed operations, including background noise levels at nearby noise-sensitive properties;*
- *Estimate the likely future noise from the development and its impact on the neighbourhood of the proposed operations;*
- *Identify proposals to minimise, mitigate or remove noise emissions at source; and*
- *Monitor the resulting noise to check compliance with any proposed or imposed conditions.*

Paragraph 20 provides guidance as to how Mineral Planning Authorities (MPA) shall determine and assess the impact of noise. Account should be taken of the prevailing acoustic (background) environment in order to consider whether or not noise from the proposed operations would:

- *give rise to a significant adverse effect;*
- *give rise to an adverse effect; and*
- *enable a good standard of amenity to be achieved.*

In line with the NPSE, the MPA needs to identify whether the overall effect of noise exposures would be above or below the SOAEL and above or below the LOAEL, for each given situation. It further advises that as noise is a complex technical issue, the MPA may need to seek advice of a noise specialist when applying this policy.

Paragraph 21 sets out how numerical noise limits should be set for normal operations. It states that:

'Mineral planning authorities should aim to establish a noise limit, through a planning condition, at the noise-sensitive property that does not exceed the background noise level (La90,1 hour) by more than 10dB(A) during normal working hours (0700-1900). Where it will be difficult not to exceed the background level by more than 10dB(A) without imposing unreasonable burdens on the mineral operator, the limit set should be as near that level as practicable. In any event, the total noise from the operations should not exceed 55dB(A) Laeq,1 hour (free field). For operations during the evening (1900-2200) the noise limits should not exceed the background noise level (La90,1 hour) by more than 10dB(A) and should not exceed 55dB(A) Laeq,1 hour (free field). For any operations during the period 22.00-07.00 noise limits should be set to reduce to a minimum any adverse impacts, without imposing unreasonable burdens on the mineral operator. In any event the noise limit should not exceed 42dB(A) Laeq,1 hour (free field) at a noise sensitive property. Where the site noise has a significant tonal element, it may be appropriate to set specific limits to control this aspect. Peak or impulsive noise, which may include some reversing bleepers, may also require separate limits that are independent of background noise (e.g. Lmax in specific octave or third-octave frequency bands – and that should not be allowed to occur regularly at night.) Care should be taken, however, to avoid

any of these suggested values being implemented as fixed thresholds as specific circumstances may justify some small variation being allowed'.

The noise limits set here are detailed and include absolute values and values dependent upon pre-existing background levels. Where background noise levels are low, the absolute limits are in all cases essentially 'fall-back' positions to be used only in the event that more onerous lower limits cannot reasonably be achieved by the applicant. If absolute limits are to be used then the applicant would need to give necessary explanations as to why lower limits could not be achieved.

The noise limits within Paragraph 21 only apply for normal mineral operations. This term is not defined, however would reasonably mean the period when the mineral asset is actually being extracted. It implies a relatively long period especially as the limits for noise are relatively low. It would not be expected to apply to short term periods associated with site preparation and construction of facilities, both of which would be shorter term.

Paragraph 22 is concerned with noise limits applicable for particularly noisy short term activities. It advises examples of activities that fall into this category and indicates possible noise limits that might apply.

Paragraph 22 states:

'Activities such as soil-stripping, the construction and removal of baffle mounds, soil storage mounds and spoil heaps, construction of new permanent landforms and aspects of site road construction and maintenance.

Increased temporary daytime noise limits of up to 70dB(A) Laeq,1 hour (free field) for periods of up to eight weeks in a year at specified noise-sensitive properties should be considered to facilitate essential site preparation and restoration work and construction of baffle mounds where it is clear that this will bring longer-term environmental benefits to the site or its environs.

Where work is likely to take longer than eight weeks, a lower limit over a longer period should be considered. In some wholly exceptional cases, where there is no viable alternative, a higher limit for a very limited period may be appropriate in order to attain the environmental benefits. Within this framework, the 70dB(A) Laeq,1 hour (free field) limit referred to above should be regarded as the normal maximum'.

This paragraph lists activities that typically fall into this category including soil stripping, permanent landforms, and site road construction. It fails however to mention the construction of any permanent facilities that might be associated with normal long term mineral extraction operation which, in the case of gas production, does include a small amount of equipment. The construction of such facilities are a necessary short term activity which might fall into this category. Consideration of noise impact during such construction might then be evaluated using well established guidance commonly used outside the minerals extraction industry, in BS 5228-1.

Paragraphs 22 of PPG lists examples of activity within this category, including works that might be essential to the development, e.g. soil stripping and site road construction. It indicates that increased temporary noise limits up to 70 $L_{Aeq,1\ hr}$ can be used for activities in this category if they last no longer than eight (8) weeks in one year and are limited to daytime. Considering the text carefully here, the use of the word 'this' rather than 'these' in the text means that the condition of 'bringing longer term environmental benefit' applies only to the construction of 'baffle mounds' and not the other site preparation activities.

The relevance of Paragraph 22 has to be considered specifically in relation to the activities involved with this particular application. There is short period 24 hour/day pre-stimulation workover activity and also very short period daytime hydraulic fracturing, both of which are limited in time and are not normal long term mineral extraction activities. Paragraph 22 is relevant to both these activities, as is BS 5228-1.

16.2.2 Local Policy

The development plan for this area comprises the saved policies of the North Yorkshire Minerals Local Plan (1997). Also of relevance, although of limited weight due to the early stage in the plan making process, is the emerging Minerals and Waste Joint Plan, prepared jointly by the City of York Council, the North York Moors National Park Authority and North Yorkshire County Council.

16.2.2.1 North Yorkshire Minerals Plan

Saved Policy 4/1 of the North Yorkshire Minerals Plan [Ref. 5] states:

'*In considering an application for mining operations, the Mineral Planning Authority will need to be satisfied that, where appropriate:-*

- *a) the mineral deposit on the application site has been fully investigated;*
- *b) the siting and scale of the proposal is acceptable*
- *c) the proposed method and programme of working would minimise the impact of the proposal;*
- *d) landscaping and screening has been designed to effectively mitigate the impact of the proposal;*
- *e) other environmental and amenity safeguards would effectively mitigate the impact of the proposal;*
- *f) the proposals and programme for restoration are acceptable and would allow a high standard of restoration to be achieved;*
- *g) a high standard of aftercare and management of the land could be achieved;*
- *h) the proposed transport links to move the mineral to market are acceptable; and*

i) any cumulative impact on the local area resulting from the proposal is acceptable'

It is considered that c), d), e) and i) have relevance in consideration of noise, and in particular focus on the need to ensure that the development is programmed, in terms of hours of operation, to minimise impact, and that screening and other environmental and amenity safeguards are put in place to effectively mitigate the impact.

Saved policy 4/14 is also considered relevant:

'Proposals for mining operations and the associated depositing of mineral waste will be permitted only where there would not be an unacceptable impact on the local environment or residential amenity'.

16.2.2.2 North Yorkshire Minerals and Waste Joint Plan, Issues and Options (February 2014)

The Minerals and Waste Joint Plan, Issues and Options consultation [Ref.6], sets out in the section on reclamation and afteruse of minerals and waste sites, the likely content of the emerging policy. Policy is likely to seek to achieve appropriate reclamation and afteruse to a high standard in accordance with national policy.

16.2.3 Applicable Noise Standards and Guidance

16.2.3.1 British Standard 5228-1:2009

The British Standard 5228-1:2009 [Ref.7] is a code of practice for noise and vibration control on construction and open sites. Part 1 of the Standard covers noise.

This assessment has also followed guidance on construction and demolition noise in BS 5228-1:2009 and lists typical levels from construction plant and equipment. In Annex E of the Standard, it advises what levels constitute a significant impact through a series of worked examples.

16.2.3.1 CRTN and DMRB

Procedures for calculating and assessing road traffic noise impacts are described in Calculation of Road Traffic Noise (CRTN) - Department of Transport, Welsh Office [Ref.8], and also in the Highways Agency advice note Design Manual for Roads and Bridges (DMRB), Vol 11 Section 3, Part 7, HD 213/11 Revision 1 [Ref.9].

The latter document provides a procedure for measuring and predicting traffic noise levels, based on CRTN, and estimating response of people to changes in traffic noise levels outside dwellings, expressed in terms of $L_{A10,18hr}$ The procedure covers situations where existing traffic increases with a 25% increase threshold corresponding to a change in calculated noise level of +1dB; the smallest increment in noise increase that is generally regarded as being discernible. The revision in HD 213/11 includes guidance on the effects of magnitude of changes in road traffic noise.

16.3 CONSULTATION

Consultation has been undertaken with North Yorkshire County Council and the Environmental Health Officer at Ryedale District Council. A public consultation exercise has been undertaken and the views of the wider public sought. The feedback from these consultations is summarised in Table 16.1.

Consultee	Comments	Paragraph Reference as to where addressed within the Environmental Statement
North Yorkshire County Council Scoping Opinion	This impact has been proposed to be 'scoped' into the prospective Environmental Statement citing reference to the need to assess the potential impact upon sensitive receptors of the noise generated by operations on the proposed application site. Regard should, therefore, be had to the responses to consultation relating to matters of the possible adverse noise generated by the proposed development. In particular, regard should be had to the comments of the Ryedale District Council dated 26th February 2015. Any assessment of the environmental effects should include public health impacts arising from the activities proposed on-site (as well as off-site impacts generated for example by associated vehicular traffic) and any fugitive emissions (such as noise, dust, odour and/or vibration) which may be generated from those activities taking into account the proximity, location and nature of the sensitive receptors as well as information relating to the measures to be employed to control such emissions which should also be provided	Section 16.7 of this Environmental Statement (Noise).
Ryedale District Council	It is noted that the choice of rig has not yet been determined. It is important that this is stated in the Environmental Statement/planning application as any noise predictions based on actual readings should be validated against the same rig.	Chapter 4 of this Environmental Statement and Section 16.4.2 of this Environmental Statement (Noise).
	The planning application and Environmental Statement will be accompanied by a noise	Chapter 16 of this Environmental

	impact assessment. It is proposed to undertake background noise measurements at positions representative of the nearest noise sensitive properties to the wellsite. The background noise levels measured at the properties will be used to develop noise limits in line with Planning Policy Guidance (PPG).	Statement presents the results of a Noise Impact Assessment. Appendix 11 of the Technical Appendices provides the supporting information, including baseline monitoring and noise predictions.
	It is stated that "During the pre-stimulation workover, operations may run for 24 hours. Based on measurements previously completed on these operations, at the KM8 wellsite, night time noise levels during this phase of the development, are not anticipated to exceed a noise limit of LAeq,1 hour 42dB(A), which is advised in PPG, as the absolute noise limit for this period." The evidence of the previous readings should be included in the noise impact assessment.	The noise impact assessment provides predicted night time noise levels based on equipment proposed for use during the proposed development. Previous reading taken during the KM8 drilling operation in 2013 is not applicable.
	Noise impacts due to the hydraulic fracture operations, noise model predictions are proposed to be based on the sound power levels of the equipment associated with this operation. If actual noise readings exist for the operation of the same rig and auxiliary operations, they should also be included in the predictions of noise levels.	The basis for the noise modelling predications are provided in Appendix 11 of the Technical Appendices.
	The noise standard in PPG of a daytime, normal working hours level of 55dB(A) LAeq,1 hour (free field, should be taken as a maximum level and the applicant should aim to establish a noise limit at the noise-sensitive property that does not exceed the background level by more than 10dB(A). The modelling predictions should also take account of peak or tonal elements of total site noise. Peak or impulsive noise, which may include brake squeal, metal banging, reverse bleepers etc, should be addressed and mitigation measures included in the noise impact assessment.	Section 16.5 of this Environmental Statement (Noise) details the assessment methodology and the aims to establish noise limits at noise sensitive receptors.
	Noise monitoring is planned for three of the five phases of development, to include pre-stimulation workover, the hydraulic fracture	Paragraph 16.8.2 of this Environmental Statement (Noise).

	stimulation and the production test. Noise levels are not anticipated to be significant during the production or site restoration phases. The noise impact will be temporary with two potential noise generating phases, workover and hydraulic fracture lasting for a period of 2 weeks and 6 weeks respectively. The noise impact assessment should address proposals to be adopted should noise monitoring indicate that agreed noise levels are exceeded, including times for reporting and actions to address any exceedance.	
	It is recommended that the scoping addresses the timing of the operations to ideally take place over the autumn/winter period to reduce disturbance to residents.	Section 18.8.1 of this Environmental Statement.
Public Consultation Event Responses	The following concerns applicable to noise were raised at the public consultation events:	
	Level of noise;	Section 16.7 of this Environmental Statement.
	Potential of noise 24 hours a day;	Section 16.7 of this Environmental Statement.
	Will there be baseline monitoring.	Section 16.8 of this Environmental Statement.

Table 16.1: Summary of Consultations

16.4 ASSESSMENT METHODOLOGY

16.4.1 Study Area

The study area for noise impact to the human community extends beyond the site boundary up to the nearest Noise Sensitive Receptors (NSRs) representative of residential communities. These are rural farmhouses to the northwest and south of the site and the village of Kirby Misperton at a further distance northeast of the site. Further details of noise sensitive receptors are included within the Baseline Methodology section.

16.4.2 Data Sources

Background noise measurements were recorded continuously during the two week period 16th February to 2nd March 2015 at the agreed NSRs to establish baseline noise. Background noise measurements have been used to determine the change in noise level. A plan showing the locations where background noise measurements were obtained is provided as Appendix 11 within the Technical Appendices.

Source noise data for the short period pre-stimulation workover activity was taken from noise test data for a mechanical workover rig of the type that is expected to be used during the proposed development. Noise test results for this rig (Enerflow Mobile Service Rig) are provided in Appendix 11 within the Technical Appendices.

Source noise data for hydraulic fracturing equipment to be used during the proposed development is taken from noise test data provided for equipment of the type to be used during the proposed development. This is also provided in Appendix 11 within the Technical Appendices.

Source noise during the normal the production phase will be very low. Data is taken from Spectrum Acoustic's database for noise from similar equipment and this is also included as Appendix 11 within the Technical Appendices.

Source noise data for determining the noise during the restoration period is obtained from BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.

Measurement of baseline noise levels were made at three locations agreed with the Environmental Health Officer at Ryedale District Council. These locations have been used previously by the Applicant to obtain background noise levels in relation to earlier noise studies for development at wellsite. A duration of two weeks was chosen to acquire measurements of baseline noise as it was considered necessary to obtain a robust dataset of noise levels under a variety of wind conditions.

Recent changes to guidance on acquiring baseline noise data [4,5] require noise datasets to be formally post processed and single resulting values determined using statistical analysis. Guidance states that measurements made when wind velocities are above 5 m/s cannot be relied upon and so a local weather station can be set up to identify periods when high wind velocities occurred so that noise data at this time can be removed from the dataset. Guidance then requires full post processing to determine values of mean, modes and mean minus one standard deviation, to establish baseline values at each NSR.

The agreed noise monitoring locations are detailed below with further details, including a location plan, provided as Appendix 11 within the Technical Appendices:

- Alma House (Alma Farm) 300m WNW of KMA wellsite. The measurement positon was within the rear garden of this farmhouse;
- Kirby O Carr 210m south of KMA wellsite. The measurement position was in the front garden of the bungalow; and
- 5 Shire Grove 750m NE of KMA wellsite. This is representative of a number of properties within Kirby Misperton village and is the furthest of the NSRs from the wellsite.

[1] BS 4142:2014 *Methods for rating and assessing industrial and commercial sound*
[2] Guidelines for Environmental Noise Impact Assessment, IEMA, 2014

The selection of these NSRs is considered by the Assessment Team to be representative of other properties in the area and that the assessments of impact made at these NSRs will be generally equal to other locations. One such other location is the caravan park located northeast of the KMA wellsite, which provides static and touring caravan accommodation. The boundary of the caravan park is 420m from the KMA wellsite and extends a further 380m distance from the wellsite, as indicated on the location plan, provided as Appendix 11 within the Technical Appendices. The caravan park is significantly further from the two nearest NSRs, Alma Farm and Kirby O Carr. The noise impact at the caravan park will consequently be substantially lower than at the two nearest receptors and broadly similar to that at other receptors in the village, 5 Shire Grove in particular. Noise impact at the caravan park and any other receptor in the village of Kirby Misperton can be viewed on the noise contour maps provided later within this chapter and can be compared with predicted levels at the key receptors agreed with the Environmental Health Officer at Ryedale District Council.

Noise mitigation measures, which forms part of the proposed development takes account of the need to equally protect the amenity of both permanent and transient residents within the locality of the KMA wellsite.

16.4.3 General Assessment Methodology

The assessment methodology is consistent with NPSE, NPPF and PPG described earlier within this chapter. Different assessment thresholds have been established for each phase of the development, based upon significant effect (SOAEL) and these have been compared with predicted levels. The objective of the assessment is to ensure these thresholds are not breached and, where necessary, design mitigation developed and revised predictions made to demonstrate no breach.

LOAEL values are lower than SOAEL values and there is a general obligation for the Applicant to seek to achieve lower levels or levels close to the LOAEL without imposing unreasonable burdens on the mineral operator (the Applicant). What might constitute an unreasonable burden is difficult to define, however, a balance must be achieved between cost, increased engineering and site time on the one hand and reduced noise impact on the other. Design mitigation therefore should be considered during all phases in order to seek to move towards the LOAEL. However, LOAEL is a relatively new concept within noise impact assessments and for some of the activities, particularly those of short duration, there is very little in the way of published research or guidance on what might constitute a precise LOAEL. Under these circumstances implementing design mitigation to generate lower levels than SOAEL should be a desired objective.

16.4.4 Assessment Methodology for Off-Site Road Traffic Activity

Traffic movement on local roads is activity that will also potentially generate noise impact. Procedures for calculating and assessing road traffic noise impacts are described in Calculation of Road Traffic Noise (CRTN) - Department of Transport, Welsh Office, and also in the Highways Agency advice note Design Manual for Roads and Bridges (DMRB), Vol 11 Section 3, Part 7, HD 213/11 Revision 1.

The latter document provides a procedure for measuring and predicting traffic noise levels based on CRTN and estimating response of people to changes in traffic noise levels outside dwellings, expressed in terms of LA10 (18 hour). The procedure covers situations where existing traffic increases with a 25% increase threshold corresponding to a change in calculated noise level of +1dB; the smallest increment in noise increase that is generally regarded as being discernible. The revision in HD 213/11 includes guidance on the effects of magnitude of changes in road traffic noise.

Chapter 3 of DMRB HD 213/11 advises that a change in road traffic noise of 1dB in the $L_{A10,18hr}$ in the short term is the smallest that is considered perceptible and might therefore be considered a potential LOAEL. The magnitude of noise impact for short term changes in traffic noise and is reproduced as Table 16.2.

Noise Change $L_{A10,18hr}$	Magnitude of Impact
0	No change
0.1 - 0.9	Negligible
1 - 2.9	Minor
3 – 4.9	Moderate
5 +	Major

Table 16.2: Classification of Magnitude of Traffic Noise Impacts in the Short Term

In considering what values might represent SOAEL and LOAEL, reference could be made to absolute levels, however, it is considered more appropriate for the effect to be evaluated mainly from changes in noise level, but to subject this to judgement where the traffic flows are very low. At a noise increase of 1dB, the magnitude of impact changes from Negligible to Minor, which appears consistent with 1dB being a LOAEL. Similarly at 3dB, as the magnitude of impact changes from Minor to Moderate, the effect is likely to be at the threshold of significance which is the SOAEL.

16.4.5 Assessment Methodology for Short Term Activity not Normal Production

The following four (4) short term activities have the potential to be considered under this category

16.4.5.1 Pre-Stimulation Workover

This is activity that will extend over 2 weeks only and will be continuous within this period day and night.

16.4.5.2 Hydraulic Fracture Stimulations/Well Test

This phase will extend over 6 weeks, during which the main potentially significant noise generating activity will be the hydraulic fracture stimulation, which will be undertaken for a period of up to five (5) hours on five (5) separate occasions during the first five (5) weeks of this phase of work. The levels of noise are higher than those during workover rig activity, however, this activity will be carried out during the daytime, to minimise the impact to the community. Based upon a typical normal working day of 12 hours (0700-1900) the total duration of hydraulic fracture stimulation during this phase of work is just 2 days (25 hours).

Minor work and analysis will be undertaken throughout this period including at night with some equipment operational. Levels of noise during this time will be lower.

16.4.5.3 Production Test

This phase will extend over 13 weeks and will continue over a 24 hour/day basis. The production test equipment comprises a temporary high pressure flowline which will connect the KM8 well with the existing gas production equipment on site, from which gas will flow to the Knapton Generating Station via an existing underground pipeline. The levels of noise will be very low, consistent with historic insignificant gas production noise from this wellsite. Although the noise will continue for an extended period, including at night, the levels will be very low and no formal assessment is considered necessary. Noise in this phase will be similar to that during normal gas production.

Whilst noise from the hydraulic fracturing activity also can be considered under Paragraph 22 because it is restricted to daytime, other short term phases not associated with normal production, cannot. Pre-stimulation workover and production test have to continue overnight, however they are not 'normal production activities' and therefore should not be considered under Paragraph 21. Instead they should be considered only under the earlier paragraphs 19 and 20. These however do not advise numerical limits. They do require the noise to be compared with SOAEL values and potentially also LOAEL values, without stating what precisely the numerical targets for noise should be. However, the higher level guidance of NPSE is clear on this, which is that SOAEL values must be achieved (1st aim) and also it is necessary to mitigate and minimise adverse impacts on health and quality of life (2nd aim). Depending upon what is practical and reasonable, noise levels lower than SOAEL should be targeted if possible.

16.4.5.4 Site Restoration

Site restoration activity will generate similar levels of noise as that during the initial construction of the KMA wellsite.

Under the PPG paragraph 22 guidance for mineral planning, any short term daytime activity associated with site preparation for mineral extraction or finally restoration totalling less than 8 weeks/year can generate up to 70 $L_{Aeq,1hr}$ provided it is restricted to daytime hours. The total duration of the hydraulic fracturing activity, with its noise generating equipment operating, is just 2 days, although this comprises 5 periods of up to 5 hours spread across 5 weeks. Being very short periods, it is considered that the limit of 70 $L_{Aeq,1hr}$ applies under PPG. It may be implied that this limit is equivalent to the SOAEL. The precise wording of Paragraph 22 talks about levels of up to $L_{Aeq,1hr}$ being considered and this value being a maximum (limit) which suggests that the objective would be to agree a lower limit if reasonable. No quantified lower limit is specified therefore the emphasis is for the Applicant to consider what mitigation might reasonably be applied to further reduce noise and advise expected levels of noise accordingly.

Site restoration daytime activity is covered under Paragraph 22, however, if it takes longer than 8 weeks to complete, then a lower limit would apply, however, there is no indication of how that limit should be developed. Guidance for appropriate noise limits during site restoration, outside the minerals extraction industry, is provided within BS5228-1. This is a Standard which is widely used within the construction and engineering industries and can be referenced here for more detailed guidance on restoration but also on other short term activities such as pre-stimulation workover.

BS 5228-1 states that construction and restoration site noise is assessed differently to noise from permanent installations, as it is recognised that some degree of noise is an inevitable by-product of required works and that the construction works are a transient activity. The Standard is very broad in its scope, providing information on construction noise levels from various plant and construction operations and it also provides recommendations on procedures and mitigation that can be adopted to reduce its impact.

Annex E of BS 5228-1:2009 defines SOAEL values for temporary noise using the ABC method. It considers the impact of construction or restoration noise to be significant if there is a 5 dB(A) increase in ambient noise (LAeq) and alone it generates more than 65 dB(A) during the daytime, 55 dB(A) during the evening and 45 dB(A) at night. Assuming that existing ambient noise levels would rise at least 5 dB(A), which it would if baseline levels were low, then the SOAEL may be taken to be $L_{\mathrm{Aeq},T}$ 65 dB(A) during the day, 55 dB(A) during the evening and 45 dB(A) at night.

For site restoration work during the daytime during the working week, the SOAEL would be $L_{\mathrm{Aeq},T}$ 65 dB(A).

It is reasonable to consider the application of BS5228-1 to pre-stimulation workover also. This will be carried out 24hrs/day and would therefore be subject to the SOAEL advised for night-time periods of $L_{\mathrm{Aeq},T}$ 45 dB(A). As with other noise impacts, the NPSE requires levels to be achieved which are lower than the SOAEL depending upon what is practical and reasonable.

16.4.6 Assessment Methodology for Normal Production Activity on Site

Once production testing is completed, the KM8 well will move into normal production phase, which is a longer term activity and involves the commercial extraction of the mineral resource. Under the PPG Guidance, paragraph 21 applies as this seeks to advise how numerical noise limits should be set for normal operations.

Paragraph 21 of the PPG considers potential noise limits during the daytime, evening and night periods. These are summarised in table 16.3.

Time period, hrs	Limit expressed relative to $L_{A90,T}$ background level, $L_{Aeq,1hr}$	Maximum absolute limit, $L_{Aeq,1hr}$	Comment
Normal working hours 0700-1900	$L_{A90,1hr}$ + 10	55	Must achieve maximum limit and aim to achieve close to relative limit where reasonably practical
Evening 1900-2200	$L_{A90,1hr}$ + 10	55	Must achieve absolute limit and also achieve relative limit even if NOT reasonably practical.
Night 2200-0700	-	42	Aim to achieve as close to LOAEL as reasonably practical

Table 16.3: Noise limits advised in PPG paragraph 21 for normal production activity

It should be noted that in many rural locations, it is not uncommon for background noise levels, not just at night, but also during the evening to be very low, at around 25 dB(A). The PPG guidance as currently written has a mandatory requirement of $L_{A90,1hr}$ + 10 to be achieved in the evening which means an evening limit of 35dB(A). Yet at night when noise sensitivities are greater, the limit can rise to 42 dB(A). This does not appear to be consistent. It is proposed here in this rural environment, to treat the evening period as the same as night and apply the maximum noise criterion of 42 dBA.

BS 4142:2014 *Methods for rating and assessing industrial and commercial sound* [Ref.10] is relevant to longer term normal operating industrial noise.

The standard indicates that certain features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, a character correction should be added to the specific sound level to obtain the rating level. The subjective character corrections are summarized in Table 16.4.

Tonality	Impulsivity	Other sound characteristics	Intermittency
+2 dB just perceptible	+3 dB just perceptible	Where specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual environment, a penalty of 3 dB can be applied.	Where specific sound has identifiable on off conditions which are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied
+4 dB clearly perceptible	+6 dB clearly perceptible		
+6 dB highly perceptible	+9 dB highly perceptible		
The standard indicates that where tonal and impulsive characteristics are present within same reference period these two corrections can both be taken into account. If one feature is dominant then it might be appropriate to apply a single correction. Where both features are likely to affect perception and response, the corrections out normally be added in a linear fashion.			

Table 16.4: Summary of subjective corrections to be applied to specific sound levels in BS 4142

It should be noted that noise during gas production will likely to be continuous, at a low level and is unlikely to contain any impulsivity or tonality, therefore none of the corrections in Table 16.4 will apply.

Once the specific sound level is corrected to the rating level, the representative background sound level is subtracted from the rating level to provide an initial estimate of the impact. The greater the difference the greater the magnitude of the impact. The standard states that:

- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- A difference of around +5 dB is likely to be an indication of an adverse impact, depending on the context;
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context; and
- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact.

BS 4142 considers the situation when background sound levels and rating levels are low by advising that absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. It states that this is especially true at night. However it doesn't quantify what levels it considers to be low.

World Health Organisation (WHO) Night Noise Guidelines for Europe:2009 [Ref.11], consider absolute noise limits rather than limits relative to background noise. An extract from the section recommending limits outside NSRs is shown in Table 16.5.

Average night noise level over a year, $L_{Aeq,T}$	Health effects observed in the population
30-40 dB	A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. $L_{night,outside}$ ($L_{Aeq,T}$ at night) of 40 dB is equivalent to the LOAEL for night noise.

Table 16.5: Extract from WHO Night Noise Guidelines for Europe:2009

The WHO, in this document, identifies the LOAEL as being $L_{Aeq,T}$ 40dB at night. There would appear little value in setting limits below this, as it is not required by the NPSE. WHO do not, however, identify what might be the SOAEL within this document. However, in an earlier publication, Guidelines for Community Noise: 1999 [Ref.12], WHO recommend guideline values, which they define as LOAELs, in terms of façade limits at night immediately outside, and close to, bedroom windows of 45 dB, equivalent to $L_{Aeq,T}$ 42 dB under free-field conditions at 3.5m or more away from windows. This is broadly consistent with the 2009 recommendations for Europe. In neither document, however, is there any reference to SOAEL in the context of night noise.

16.4.7 Summary of Assessment Thresholds

A summary of various assessment thresholds that are considered relevant for each category of noise impact is included within Table 16.6.

Noise Impact	SOAEL	LOAEL	Critical time
Off-site road traffic	3dB increase in the $L_{A10,18hr}$	1dB increase in the $L_{A10,18hr}$	Daytime
Pre-stimulation workover	$L_{Aeq,1hr}$ 45 dB	$L_{Aeq,1hr}$ 40 dB	Night
HF and well testing	$L_{Aeq,1hr}$ 70 dB (HF) $L_{Aeq,1hr}$ 45 dB (other)	- $L_{Aeq,1hr}$ 40 dB	HF during day Other activities at night.
Normal production	$L_{Aeq,T}$ 42 dB (night)	$L_{Aeq,1hr}$ 40 dB (night)	Night
Restoration	$L_{Aeq,1hr}$ 65 dB	-	Daytime

Table 16.6: Summary of Noise Assessment Thresholds at Critical Times

The SOAEL thresholds included within Table 16.6 for pre-stimulation workover and normal production assume levels are constant day and night and therefore critical thresholds are given for the more sensitive night periods only. During the daytime, different SOAEL thresholds apply which would be $L_{Aeq,T}$ 70 dB during pre-stimulation workover and 55 dB during normal production.

No LOAEL thresholds are shown for short term daytime hydraulic fracturing and well testing activity, nor for restoration activity, as there is considered to be insufficient published research evidence to establish these values with any confidence.

The objective of the noise mitigation strategy is to achieve levels better (lower) than SOAEL values and approach LOAEL values wherever it is reasonably practical to do this, in line with NPSE and PPG guidance.

16.5 LIMITATIONS

The assessment of effects of noise as a result of the proposed development is based on the development description provided in Section 4 of this Environmental Statement.

16.6 BASELINE CONDITIONS

Baseline noise measurements were made over the two week period from 16th February to 2nd March 2015. Measurements were made using unmanned noise monitoring equipment at each of three (3) locations described within Section 16.4 Assessment Methodology. A weather station was also installed at one location to monitor wind conditions. A plan showing measurement positions and photos showing the equipment in place are all included in Appendix 11 within the Technical Appendices, together with the baseline noise dataset.

Figure 16.1. Baseline Noise and Weather Monitoring at Alma House

Recent changes in guidance on processing baseline noise data recommend a proper statistical analysis to be used in relation to processing data. The guidance indicates that a simple mean value is not necessarily appropriate suggesting that either/both modal values or mean minus 1 standard deviation would be a more scientific basis. In general, this method of processing results in significantly lower baseline values than simple mean values as can be seen in the dataset in Appendix 11 within the Technical Appendices (typically -6dB lower). Any assessment carried out using the latest 2014 guidance on statistical processing is highly likely to show an increased change in noise level and increased impact because of the lower baseline.

Part of the noise data post processing has been to identify, and exclude, noise measurements made when peak wind velocities exceeded 5m/s, as noise data under these conditions cannot be relied upon. This has removed some of the higher noise level data recorded when wind noise in vegetation became significant. Wind speed measurements made, included both mean and peak values. Peak values were typically 50-100% above mean values. To avoid including data which may have included significant periods where wind velocities exceeded 5m/s, the mean values over each 1 hour period were analysed and any noise data measured, when mean values exceeded 3.5m/s (shown in brown text within Appendix 11 of the Technical Appendices), were excluded on the grounds of being likely to have been influenced by occasional excessive peak winds velocities.

The results of the post processed baseline monitoring are summarised in Table 16.7. Results are rounded to the nearest integer value for assessment purposes. All values quoted are mean values less 1 standard deviation and are therefore representative of the lowest values occurring during the two week monitoring period.

Receptor	Daytime (07:00-19:00)		Evening (19:00-23:00)		Night (23:00-07:00)	
	$L_{Aeq,1hr}$	$L_{A90,1hr}$	$L_{Aeq,1hr}$	$L_{A90,1hr}$	$L_{Aeq,1hr}$	$L_{A90,1hr}$
Alma House	40	31	31	23	27	21
Kirby O Carr	52	32	43	28	31	18
5 Shire Grove	47	37	36	26	30	24

Table 16.7: Baseline residual ($L_{Aeq,1hr}$) and background ($L_{A90,1hr}$) levels during the day, evening and night periods (Mean – 1 SD)

The measured baseline levels are generally very low at all three (3) locations. $L_{Aeq,T}$ values at Kirby O Carr are influenced by both occasionally passing road traffic but also noise from milking equipment associated with the farm, located some 40m from the monitoring position. The resident and farmer at Kirby O Carr advised the milking times as being 05:00-07:30, 08:30-09:00 and 14:30-16:30. Inspection of the $L_{Aeq,1hr}$ curve on the graph in Appendix 11 confirms levels typically rise at 05:00 from around 35-40 up to 58 each day for 2 hours as a result of operation of the milking equipment. The background $L_{A90,1hr}$ values are, however, not influenced by the milking equipment.

Noise levels at 5 Shire Grove, especially the background $L_{A90,1hr}$ values, are typically higher than the levels at the other two locations likely due to the presence of more frequent local road traffic within the village of Kirby Misperton and also the potential of being closer to the A169 lying to the east. Nevertheless, noise levels are still low at both of these positions, especially during the evening and at night.

Post-processed residual $L_{Aeq,1hr}$ noise levels across the three (3) NSRs range between 40-52 dB during the day 36-43 dB during the evening and 27-31 dB at night. The background $L_{A90,1hr}$ noise levels range between 31-37 dB during the day, 23-28 dB during the evening and 18-21 dB at night. Background noise levels of 30 dB are generally considered to be very low and so levels are particularly low during both the evening and the night.

16.7 IMPACT ASSESSMENT

16.7.1 Potential Impacts

The effect of temporary increases in noise from local road traffic during pre-production phases of the proposed development and during restoration are considered in each of the following sections. Calculations are provided for properties located on the two roads on which ATC baseline traffic data was recorded. As it is the changes in noise that are primarily being considered, the set-back distance of properties is not critical. The calculation is for a nominal location 10m from the edge of the carriageway. It should be noted that at Position 1 (Habton Road) the existing baseline flows are significantly below the lowest limit allowed in the CRTN calculation (29 movements/hr, compared with a minimum required in the calculation of 50). This means that the results may be considered indicative at this position only. At Position 2 (Kirby Misperton Road), the existing baseline flows were much higher at typically 102 movements/hr.

Noise generated from activities associated with the proposed development are also predicted and assessed for each phase in the sub-sections which follow.

16.7.1.1 Pre-Stimulation Workover

Calculated changes in noise from offsite road traffic are shown in Appendix 11 within the Technical Appendices and for the busiest pre-stimulation workover period summarised in Table 16.8.

Location	Road traffic noise $L_{A10,18hr}$		
	Without development	With workover activity	Change
Pos 1. Habton Road	51.4	56.1	+4.7 (Indicative)
Pos 2. Kirby Misperton Road	62.5	63.7	+1.2

Table 16.8: Changes in road traffic noise during typical busiest period of Pre-Stimulation and Workover Phase

The low baseline flows on Habton Road are below the 50 movements/hr considered the minimum that allows for a calculation using CRTN. The results here are therefore indicative only. Whilst the potential magnitude of change is major, because the calculation starts from a low baseline, consideration should be given to absolute noise levels. It should be noted that the level during this period is 56.1 dBA, which is low and significantly less than the existing calculated 62.5dBA levels in the other road into the village, Kirby Misperton Road. The period concerned here is associated with mobilisation and demobilisation of workover equipment which is a very short duration. The effect on Habton Road properties is therefore considered not to be significant.

The baseline traffic flows on Kirby Misperton Road are above the minimum 50 movements/hr for which the CRTN calculation is considered reliable. The change in magnitude of impact is just +1.2dBA, which is less than the SOAEL increase of +3dBA and close to the LOAEL increase of +1.0dBA. The duration of this phase of the proposed development is short and the effect on the properties on Kirby Misperton Road is considered not to be significant.

Predictions have been made of noise generated on site during pre-stimulation workover activities using source data on an Enerflow mobile service rig listed in Appendix 11 within the Technical Appendices. A noise measurements test report for this rig is also included within the appendix. The activities within this phase of the proposed development are planned to be carried out during the day and night. The full results of the predictions of noise, including large scale noise contour map and table of results at NSRs, is included within Appendix 11 within the Technical Appendices, however a summary is shown in Table 16.9.

NSR	Predicted $L_{Aeq,1hr}$ without/with noise barrier	SOAEL Assessment Threshold, $L_{Aeq,1hr}$		
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00
1 – Alma House	42/34	70	55	45
2 – Kirby O Carr	46/46	70	55	45
3 – 5 Shire Grove	32/31	70	55	45

Table 16.9: Predicted noise level during pre-stimulation workover phase with noise barrier (and without barrier) and SOAEL assessment thresholds for different times. Based on BS 5228-1 ABC method for evening and night periods. Predictions to 1st floor level (4.5m) as 24 hour activity

The predicted levels with the noise barrier in place range between $L_{Aeq,1hr}$ 31-46. The barrier is effective in limiting noise to very low levels (below even the LOAEL of $L_{Aeq,1hr}$ of 40dB), except in the southerly direction to Kirby O Carr, where there is only a partial barrier as access has to be provided here to the site. It should be noted, however, that this prediction is made assuming that the rig engine will be operating continuously during the 1 hour assessment period. In practice it will generally be working for no longer than 50% of the time and therefore levels 3dB lower than the quoted levels will be more likely.

Small scale noise contour maps are included as Figures 16.2. Full size maps are provided in Appendix 11 within the Technical Appendices. This shows the benefit to the community from the temporary noise barrier that will be in place, which has been developed primarily for the hydraulic fracturing phase of the proposed development, when noise levels are higher. Nevertheless, the noise barrier can be seen to be effective particularly in the direction of the village of Kirby Misperton where there are the largest numbers of NSRs and consequently particularly high sensitivity. It may be observed on the contour map that the edge of the higher noise beam radiating south of the site lies very close to the Kirby O Carr and it may be possible at the detailed design stage to extend the partial south section of the noise barrier further west to reduce the impact to this property.

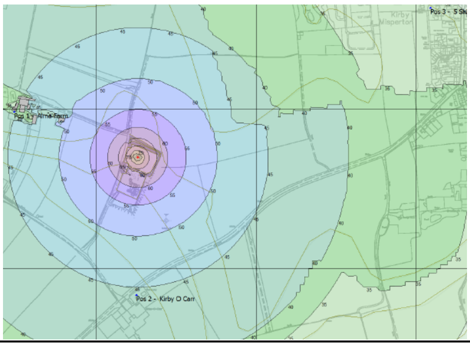
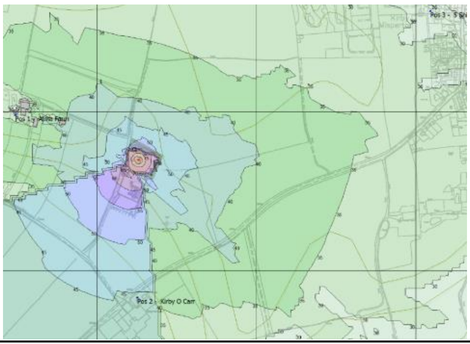
Without Noise Barrier	With Noise Barrier in Place
	

Figure 16.2: Noise contour maps during pre-stimulation workover, without and with noise barrier, $L_{Aeq,1hr}$

It is recognised that the introduction of the noise barrier will benefit a large section of the community and, whilst proposed SOAEL thresholds during the day and evening periods, for this short term activity are $L_{Aeq,1hr}$ 70 dB and 55 dB respectively, the expected levels are well below this. The level of noise at Kirby O Carr is likely to be in the range $L_{Aeq,1hr}$ 43-46 dB depending upon on-times of the workover rig. In practice the levels are highly unlikely to exceed the nightime SOAEL of $L_{Aeq,1hr}$ 45 dB. In view of the short duration of this phase of work, the effect at all NSRs is considered to be insignificant.

16.7.1.2 Hydraulic Fracture Stimulation/Well Test

Calculated changes in noise from offsite road traffic are shown in Appendix 11 within the Technical Appendices and for the hydraulic fracture stimulation/well test phases summarised in Table 16.10.

Location	Road traffic noise $L_{A10,18hr}$		
	Without development	With HF and well testing activity	Change
Pos 1. Habton Road	51.4	56.9	+5.5 (Indicative)
Pos 2. Kirby Misperton Road	62.5	63.9	+1.4

Table 16.10: Changes in road traffic noise during HF and Well Testing Phase

The low baseline flows in Habton Road are below the 50 movements/hr considered the minimum that allows for a calculation using CRTN. The results here are therefore indicative only. Whilst the potential magnitude of change is major, because the calculation starts from a low baseline, consideration should be given to absolute noise levels. It should be noted that the level during this period is expected to rise to only 56.9 dBA which is low and significantly less that the existing calculated 62.5 dBA levels in the other road into the village, Kirby Misperton Road. The period concerned here is associated with hydraulic fracturing stimulation/well test and is short. The effect on Habton Road properties is therefore considered not to be significant.

The baseline traffic flows in Kirby Misperton Road are above the minimum 50 movements/hr for which the CRTN calculation is considered reliable. The change in magnitude of impact is just +1.4dBA which is less than the SOAEL increase of +3dBA and close to the LOAEL increase of

+1.0dBA. The duration of this phase of the proposed development is short and the effect on the properties on Kirby Misperton Road is considered not to be significant.

Predictions have been made of noise generated on site during hydraulic fracture stimulation/well test phase using source data provided by the Applicant listed in Appendix 11 within the Technical Appendices. Noise data for all major items of noise generating equipment has been established through noise measurement. Noise data for the main hydraulic fracturing equipment (hydraulic fracture pumps and blenders) has been provided by the Applicant both in overall dBA terms and also in octave bands, which allows more accurate predictions to NSRs and more accurate evaluation of the potential benefit of the temporary noise barrier. The main hydraulic fracturing operation, when the hydraulic fracturing of the formation will occur, is planned to be undertaken during the day only. There will, however, be preparation and low level activities taking place overnight. Two noise models have therefore been constructed to cover this phase of the proposed development.

Hydraulic Fracturing Activities Generally during the Day

The main hydraulic fracturing activities, incorporating the hydraulic fracture pumps and blenders, will take place during the day. The full results of the predictions of noise, including large scale noise contour map and table of results at NSRs, is included within Appendix 11 within the Technical Appendices, however a summary is shown in Table 16.11.

NSR	Predicted $L_{Aeq,1hr}$ without/with noise barrier	SOAEL Assessment Threshold, $L_{Aeq,1hr}$		
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00
1 – Alma House	59/54	70	55	45
2 – Kirby O Carr	65/59	70	55	45
3 – 5 Shire Grove	52/48	70	55	45

Table 16.11: Predicted noise level during main HF daytime activity with and without noise barrier and SOAEL assessment thresholds for different times. Based on PPG for daytime and BS 5228-1 Annex jj ABC method for evening and night periods. Predictions to ground floor level (1.5m) as generally daytime activity

Small scale noise contour maps are included as Figures 16.3. Full size maps are provided in Appendix 11 within the Technical Appendices. This shows the benefit to the community from the temporary noise barrier that will be in place which has been developed for daytime activity in the hydraulic fracture stimulation/well test phase of the proposed development.

Without Noise Barrier	With Noise Barrier in Place

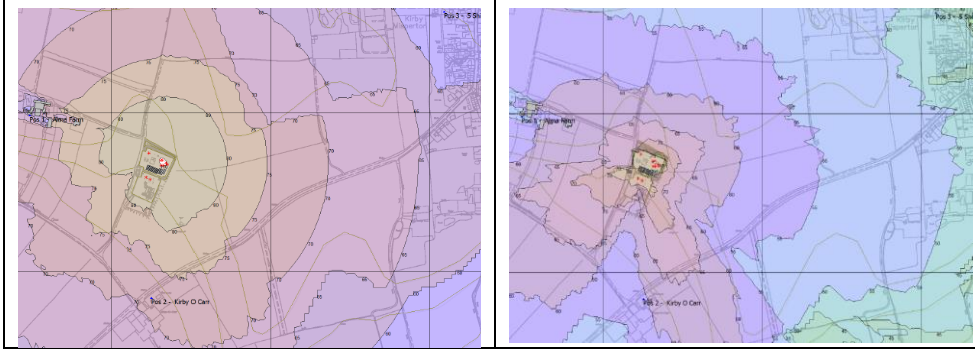


Figure 16.3: Noise contour maps during main HF daytime activity, without and with noise barrier, $L_{Aeq,1hr}$

The predicted levels with the noise barrier in place range between $L_{Aeq,1hr}$ 48-59. This compares with $L_{Aeq,1hr}$ 52-65 without the barrier. The barrier is effective in reducing noise levels to all NSRs, including Kirby O Carr to the south, through locating the hydraulic fracture pumps and blenders at the east side of the wellsite so that it is well screened by the partial southern section of the noise barrier. Without the noise barrier the predicted levels are less than the SOAEL threshold of $L_{Aeq,1hr}$ of 70. With the noise barrier, the levels are lower still being no greater than $L_{Aeq,1hr}$ 52 in Kirby Misperton village and $L_{Aeq,1hr}$ 54 at Alma House, which brings it within the evening SOAEL threshold of $L_{Aeq,1hr}$ 55 dB. Only at the single property of Kirby O Carr to the south does the level at $L_{Aeq,1hr}$ 59 slightly exceed the evening SOAEL.

Whilst without the noise barrier, predicted levels are within the SOAEL values, the objective of the noise control design is to mitigate the noise to achieve levels between the SOAEL and the LOAEL wherever this is practical, in line with principles laid out in the NPSE. This mitigation is considered particularly effective over the wide range of properties within the village of Kirby Misperton.

In view of the very short duration of this phase of the proposed development, the effect of daytime noise during the hydraulic fracture stimulation/well test phase is considered to be insignificant at all NSRs.

Hydraulic Fracturing Activities Overnight

Over the night period, main hydraulic fracturing activities will have ceased, however, there will be continuing lower level activities being carried out. The equipment sources modelled here are identified in Appendix 11 within the Technical Appendices.

The full results of the predictions of noise, including large scale noise contour map and table of results at NSRs, is included within Appendix 11 within the Technical Appendices, however a summary is shown in Table 16.12.

NSR	Predicted $L_{Aeq,1hr}$ without/with noise barrier	SOAEL Assessment Threshold, $L_{Aeq,1hr}$		
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00
1 – Alma House	40/35	70	55	45
2 – Kirby O Carr	42/42	70	55	45
3 – 5 Shire Grove	30/28	70	55	45

Table 16.12: Predicted noise level during overnight activity during HF and well testing phase, with and without noise barrier and SOAEL assessment thresholds for different times. Based on BS 5228-1 ABC method for evening and night periods. Predictions to 1st floor level (4.5m) as generally nightime activity

Small scale noise contour maps are included as Figures 16.4. Full size maps are provided in Appendix 11 within the Technical Appendices. This shows the benefit to the community from the temporary noise barrier that will be in place which has been developed specifically for daytime activity in the hydraulic fracture stimulation/well test phase of the proposed development.

Without Noise Barrier	With Noise Barrier in Place

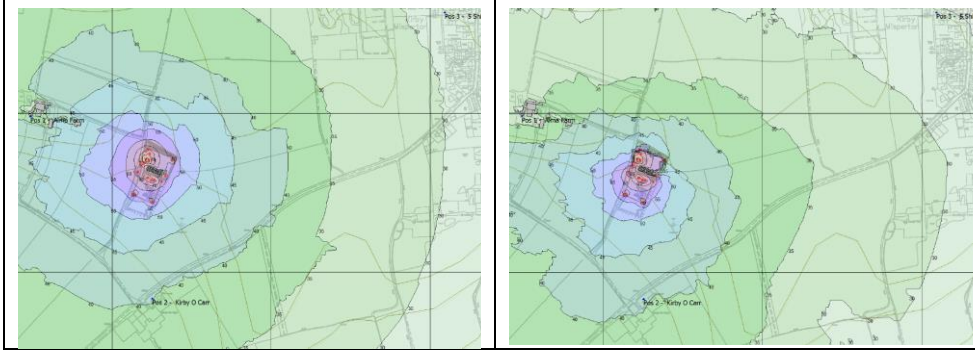


Figure 16.4: Noise contour maps during overnight activity during HF and well testing phase, without and with noise barrier, $L_{Aeq,1hr}$

The predicted levels with the noise barrier in place range between $L_{Aeq,1hr}$ 28-42. This compares with $L_{Aeq,1hr}$ 30-42 without the barrier. The barrier is effective in reducing noise levels to Alma House in particular and to some extent also to Kirby Misperton, however, the levels to the south, to Kirby O Carr, remain unchanged at $L_{Aeq,1hr}$ 42 dB, due partly to the equipment located at the south of the wellsite which is not within the noise barrier zone.

Without the noise barrier the predicted levels are less than the SOAEL thresholds during the day, evening and night of $L_{Aeq,1hr}$ 70/55/45 dB respectively. With the noise barrier, the levels are generally lower still.

Whilst without the noise barrier, predicted levels are within the SOAEL values, the objective of the noise control design is to mitigate the noise to achieve levels between the SOAEL and close to the LOAEL wherever this is practical, in line with principles laid out in the NPSE. With the LOAEL being $L_{Aeq,1hr}$ 40 dB, the noise levels with the noise barrier are at most locations below this lower threshold.

In view of the low predicted levels and the very short duration of this phase of the proposed development, the effect of overnight activity during the hydraulic fracture stimulation/well test phase is considered to be insignificant at all NSRs.

16.7.1.3 Production

The level of road traffic associated with normal operation of the site is very low and noise predictions are not considered to be necessary.

The full results of the predictions of noise, including large scale noise contour map and table of results at NSRs, is included within Appendix 11 within the Technical Appendices, however a summary is shown in Table 16.13.

NSR	Predicted $L_{Aeq,1hr}$	SOAEL Assessment Threshold, $L_{Aeq,1hr}$		
		Day 07:00-19:00	Evening 19:00-23:00	Night 23:00-07:00
1 – Alma House	22	55	42	42
2 – Kirby O Carr	25	55	42	42
3 – 5 Shire Grove	9	55	42	42

Table 16.13: Predicted noise level during overnight activity during normal production phase with SOAEL assessment thresholds advised in PPG for different times. Predictions to 1st floor level (4.5m) as includes nightime activity

Small scale noise contour maps are included as Figures 16.5. Full size maps are in provided within Appendix 11 within the Technical Appendices.

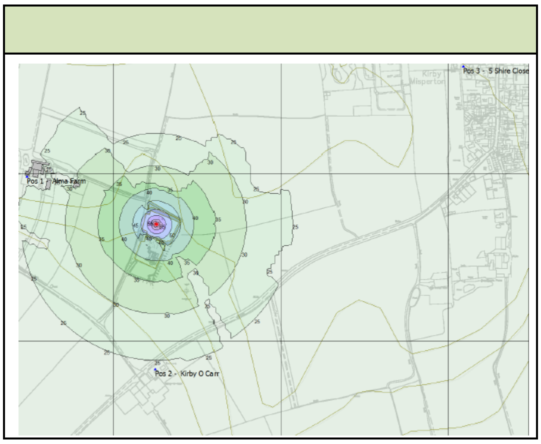


Figure 16.5: Noise contour map during normal operation phase (noise barrier removed) $L_{Aeq,1hr}$

The background noise levels measured during the baseline survey were established statistically as being in the range $L_{A90,1hr}$ 18-24 dB during the night. These results are very low and BS4142 states that in such situations consideration of absolute levels can be as, or more, relevant than consideration of relative levels. An assessment using BS 4142 is not therefore carried out.

The predicted levels at NSRs range between $L_{Aeq,1hr}$ 9-25 dB, This can be compared with the SOAEL advised within PPG of $L_{Aeq,1hr}$ 55 during the day and effectively 42 dB during the evening and night periods. With the LOAEL being $L_{Aeq,1hr}$ 40 dB, the predicted levels of noise are so far below this threshold that there will be no adverse effect.

In considering the potential change in noise level over the longer term operational phase of the proposed development, reference can be made to baseline monitoring results at each location. The change in noise level is expressed using the parameter $L_{Aeq,1hr}$ for day, evening and night times, the predicted changes in levels are shown in Tables 16.14 – 16.16.

Receptor	$L_{Aeq,1hr}$ (dB)			
	Current baseline	Predicted noise from normal operations	New level	Change
Alma House	40	22	40.1	0.1
Kirby O Carr	52	25	52.0	0.0
5 Shire Grove	47	9	47.0	0.0

Table 16.14: Predicted change in noise level during normal operations LAeq,1hr – Daytime 07:00-19:00

Receptor	$L_{Aeq,1hr}$ (dB)			
	Current baseline	Predicted noise from normal operations	New level	Change
Alma House	31	22	31.5	0.5
Kirby O Carr	43	25	43.1	0.1
5 Shire Grove	36	9	36.0	0.0

Table 16.15: Predicted change in noise level during normal operations $L_{Aeq,1hr}$ – Evening, 19:00-23:00

Receptor	$L_{Aeq,1hr}$ (dB)			
	Current baseline	Predicted noise from normal operations	New level	Change
Alma House	27	22	28.2	1.2
Kirby O Carr	31	25	32.0	1.0
5 Shire Grove	30	9	30.0	0.0

Table 16.16: Predicted change in noise level during normal operations $L_{Aeq,1hr}$ – Night 23:00-07:00

In spite of the baseline level at night being very low, the greatest change in level at any time is no more than 1.2dB at Alma House and Kirby O Carr and 0.0dB at 5 Shire Grove in Kirby Misperton village. These changes are insignificant in relative terms as well as resulting in absolute levels below both the SOAEL and LOAEL for normal operating noise.

16.7.1.4 Restoration

Calculated changes in noise from offsite road traffic are shown in Appendix 11 within the Technical Appendices and for the restoration period at the end of the proposed development, summarised in Table 16.17.

Location	Road traffic noise $L_{A10,18hr}$		
	Without development	With restoration activity	Increase
Pos 1. Habton Road	51.4	55.6	+4.2 (Indicative)
Pos 2. Kirby Misperton Road	62.5	63.6	+1.1

Table 16.16: Changes in road traffic noise during Restoration Phase

The low baseline flows in Habton Road are below the 50 movements/hr considered the minimum that allows for a calculation using CRTN. The results here are therefore indicative only. Whilst the potential magnitude of change is major, because the calculation starts from a low baseline, consideration should be given to absolute noise levels. It should be noted that the level during this period is 55.6 dBA which is low and significantly less that the existing calculated 62.5 dBA levels in the other road into the village, Kirby Misperton Road. The period concerned here is associated with restoration and is short. The effect on Habton Road properties is therefore considered not to be significant.

The baseline traffic flows in Kirby Misperton Road are above the minimum 50 movements/hr for which the CRTN calculation is considered reliable. The change in magnitude of impact is just +1.1dBA which is less that the SOAEL increase of +3dBA and very close to the LOAEL increase of +1.0dBA. The duration of this phase of the proposed development is short and the effect on the properties on Kirby Misperton Road is considered not to be significant.

Activity on site during restoration will be restricted to daytime. Typical equipment and noise levels would be similar to those used during construction. Table 16.17 shows construction equipment that might be working at a typical busy period.

Predictions have been made in accordance with guidelines and procedures contained in BS5228-1. The procedure involves identifying the main items of plant and equipment and then assigning a sound power level, based on equipment noise data included in Annex C and D. Where a number of sound power levels are given for similar plant, or activities, an average of the data is used.

Predictions of community noise levels are made by applying corrections to the sound power of each equipment source, to account for the following operational and environmental factors:

- Typical periods of operation of plant;
- Separating distances from source to receiver; and
- Presence of natural land topography screening or artificial barriers.

Overall LAeq(1 hour) and LAeq(16 hour) dB(A) noise levels have been predicted at the closest residential location to wellsite at Alma House. The results are summarised in Table 16.18.

Plant Type	Sound Power Level, L_{WA}	Distance correction	Screening correction	Sound Pressure Level L_{pA}	On time %	Activity $L_{Aeq(1hr)}$	Operating Period (hrs)	$L_{Aeq,16hr}$
Excavator	112	-58	-	54	30	49	10	47
Bulldozer	114	-58	-	56	30	51	10	49
Rollers	108	-58	-	50	30	45	10	43
Total Plant						54		52

Table 16.18: Predicted noise levels from construction works at Alma House.

The predictions indicate that the noisiest construction activities will generate $L_{Aeq,16hr}$ 52 dB at the nearest NSR Alma House. This is significantly less than the SOAEL of $L_{Aeq,1hr}$ 65, and therefore the effect is considered by the Assessment Team not to be significant.

16.7.2 Likely Significant Effects

Likely significant effects are effects (impacts) which have the potential to occur prior to mitigation being incorporated into the design and construction of the proposed development, including the existing KMA wellsite, the existing KM8 well and/or the KM8 hydraulic fracturing programme.

Following an assessment of all stages of the proposed development , the conclusions drawn from the assessment of the likely significant effects prior to mitigation with regard to noise include:

- Increased noise at the nearest sensitive receptors from traffic associated with the development; and
- Increased noise at the nearest sensitive receptors from activities on site.

For all five phases of the development, the impact assessment has identified that the impact from noise on the nearest sensitive receptors **will not be significant.**

16.7.3 Cumulative Effects

Generic cumulative effects applicable to all chapters are as set out in Chapter 7 of this Environmental Statement.

With the exception of the existing KMB wellsite, located 700m to the west of the KMA wellsite, the nearest existing wellsite is in excess of 2km from the KMA wellsite. The Applicant is the operator of the adjacent wellsites and therefore has overall control of the activities being undertaken therein.

No similar operations are to be undertaken at the KMB wellsites simultaneously during the KM8 hydraulic fracturing operation and, therefore, there is no cumulative impact with the KMB wellsite.

The change in noise levels from increased road traffic on local public roads may arise at the same time as increased levels of noise from the site., however, each is not significant, nor is the noise impact additive as noise from the site, will be generally steady in level, whilst passing road traffic generates much higher levels but only for a very short time.

The cumulative effect is therefore considered by the Assessment Team not to be significant.

16.7.4 Interactive Effects

Interactive effects are effects that result in changes to one environmental consideration (topic) giving rise to changes in another. Chapter 8 of the environmental statement sets out the interactive impacts of the development.

With specific regard to noise, increase in levels as a result of the proposed development could have interactive effects on ecology, public health and socio-economics. However, through both embedded and additional mitigation, the likely significance of any noise effects from all phases of the development is considered by the Assessment Team using the criteria set out in Section 6.4.4.3 as **Neutral/Slight**, therefore the potential for interactive effects from noise are low.

16.8 MITIGATION

There are two types of mitigation, embedded and additional. Embedded mitigation is incorporated into the development proposals, or has already been incorporated into the existing KMA wellsite design and/or the existing KM8 well. Embedded mitigation is also incorporated into the design and selection of a noise barrier.

A schedule of mitigation is provided as Appendix 19 within the Technical Appendices Schedule of Environmental Commitment, which sets out the Applicant's proposals for mitigation and in doing so, commits the Applicant to provide such mitigation.

16.8.1 Embedded Mitigation

It is a normal requirement for equipment used in a construction environment, to comply with BS 5228-1, in particular to the requirements for mitigation good practice. These measures include:

- Use of broad band reversing sounders rather than older style tonal devices, on all site based vehicles and if possible all visiting vehicles;
- Avoid unnecessary revving of engines and ensure equipment not in use is switched off;
- Start -machinery sequentially rather than all together;
- Use rubber linings in, for example, chutes and dumpers to reduce impact noises;
- Minimise drop heights of materials;
- Use of the quietest equipment available for the required purpose;
- Use of enclosures as far as reasonably practical and subject to the nature of the machine and its ventilation requirements;
- Siting of equipment to minimise noise; and
- Good maintenance to reduce noise.

Care needs to be taken in considering appropriate mitigation and what is reasonable and practical. It should also be noted that the process of bringing noise mitigation measures onto site (e.g. noise barrier system) can itself have an adverse impact (increased vehicle moments to/from site). It is necessary to make a balanced subjective judgement on net benefits.

With none of the phases within the proposed development expected to generate significant effects, the decision to introduce additional noise mitigation has been considered carefully. Studies and computer noise modelling ways of containing the spread of noise through the use of a temporary noise barrier system have been undertaken before proposing a suitable additional noise mitigation scheme.

The noise barrier system to be brought onto site will arrive prior to the pre-stimulation workover phase and will be removed on completion of the hydraulic fracture stimulation/well test phase. It will comprise a number of 6m (20ft) and 12m (40ft) ISO shipping containers, stacked three units high, on the west, north, east and part of the Kirby Misperton 1 wellsite extension. The overall height will be 8.7m. On the inside surface of the containers, facing inwards to the equipment, will be loosely draped a tarpaulin material set around 100mm clear of the container face, to provide some sound absorption characteristic and reduce reflections. Alternative noise barriers are still being explored with the aim of reducing vehicle movements associated with the mobilisation and demobilisation of the noise barrier. In any event, the noise barrier used will be equal to or more effective in providing noise reduction at the KMA wellsite during the pre-stimulation workover and hydraulic fracture stimulation/well test phases.

Where possible the Applicant will seek to undertake the pre-stimulation workover and hydraulic fracture stimulation during the autumn and winter season, however the timing of the operation is dependent upon receipt of planning consent, the issuing of Environmental Permits and availability of equipment.

16.8.2 Additional Mitigation

A scheme of noise monitoring will be implemented during the pre-stimulation workover and hydraulic fracture stimulation/well test phases of the proposed development. Noise monitoring provides a means to measure the effectiveness of embedded mitigation and gives reassurance to both the Applicant, Regulators and local communities that noise levels, as a result of the proposed development, will not present a significant environmental impact.

The scheme of noise monitoring is presented in Appendix 11 within the Technical Appendices.

16.9 RESIDUAL EFFECTS

The residual effects are those effects that remain following the implementation of mitigation.

Both offsite road traffic noise and on site generated noise is assessed as being not significant for all the phases of the development even before mitigation.

The residual effects after the construction of the temporary noise barrier mitigation for the pre-stimulation workover and hydraulic fracture stimulation/well test phases will be to further reduce the adverse effect of noise during these periods, especially to residents in the village of Kirby Misperton.

The residual effects from noise with the mitigation in place are considered by the Assessment Team to be **Neutral** with the potential for a temporary **Negligible** change in the baseline conditions

16.10 SUMMARY

This chapter of the Environmental Statement is concerned with the potential impacts associated with noise, as a result of the existing KMA wellsite and associated activities undertaken therein, including the existing boreholes and proposed KM8 hydraulic fracturing operations.

Background noise measurements were recorded continuously during the two week period 16th February to 2nd March 2015 at the agreed NSRs to establish baseline noise. Background noise measurements been used to determine the change in noise level.

Traffic and source noise data for the various equipment to be used during the proposed development was acquired and used to predict noise impacts.

The assessment methodology is consistent with NPSE, NPPF and PPG. Different assessment thresholds have been established for each phase of the development, based upon significant effect (SOAEL) and these have been compared with predicted levels. The objective of the assessment is to ensure these thresholds are not breached and, where necessary design mitigation developed and revised predictions made to demonstrate no breach.

Table 16.18 gives a list of the potential noise impacting activities within each phase of the proposed development. Against each potential impact is a statement as to whether the resulting effect is significant (exceeds the SOAEL). An indication of what key mitigation is offered and what the residual effect is with this mitigation installed.

Activity	Significance	Mitigation	Residual Effect
Pre-stimulation workover			
Off-site road traffic noise	Not significant	None	Not significant
On site activity	Not significant	Noise barrier	Not significant
HF and well testing			
Off-site road traffic noise	Not significant	None	Not significant
On site activity	Not significant	Noise barrier	Not significant
Normal production			
On site activity	Not significant	None	Not significant
Site restoration			
Off-site road traffic noise	Not significant	None	Not significant
On site activity	Not significant	None	Not significant

Table 16.19: Assessment summary

A key element in the development of the noise mitigation strategy has been to not just ensure SOAELs are not breached, but also to ensure that that the NPSE 2nd Aim, which is to minimise all adverse noise effects and target LOAELs where reasonably practical, is carried through.

Although no SOAEL is breached in the unmitigated scheme, the key mitigation element to further reduce adverse impact, is the introduction of the temporary noise barrier. A large amount of analysis and iterative noise modelling of different noise barrier constructions, heights and line/extents has been carried out, to produce an optimum design mitigation scheme to further protect residents, and in particular reduce noise impacts to the large number of properties within the village of Kirby Misperton.

The residual effects from noise with the mitigation in place are considered by the Assessment Team to be **Neutral** with the potential for a temporary **Negligible** change in the baseline conditions.

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16.10.1 Table of Significance of Impact

For the purposes of the noise impact assessment, Table 16.20 has been developed using criteria set out in section 6.4.4.3 of this Environmental Statement to assess the significance of the impact prior to mitigation. The residual impact uses the same significance criteria, to aid the reader and assesses the impact again once mitigation has been applied.

Receptor	Potential Impacts	Magnitude of Impact Major Moderate Minor Negligible No Change	Receptor Value Very High High Medium Low Negligible	Significance of Impact Very Large Large Moderate Slight Neutral	Mitigation		Residual Impact Very Large Large Moderate Slight Neutral
					Embedded	Additional	
Pre-Stimulation Workover							
Nearest Sensitive Receptors	Increased noise from traffic associated with the development. Increased noise from activities on site.	Minor	Low	Neutral/Slight	Distance from nearest village 700m. Temporary duration. 8.7m high noise barrier	Implementation of a Traffic Management Plan	Neutral
Hydraulic Fracturing and Well Test							
Nearest Sensitive Receptors	Increased noise from traffic associated with the development. Increased noise from activities on site.	Minor	Low	Neutral/Slight	Distance from nearest village 700m. Temporary duration. 8.7m high noise barrier	Implementation of a Traffic Management Plan	Neutral
Production Test							
Nearest Sensitive Receptors	Increased noise from traffic associated with	Minor	Low	Neutral/Slight	Distance from nearest village 700m. Temporary duration.	Implementation of a Traffic Management Plan	Neutral

	the development.						
Production							
Nearest Sensitive Receptors	Increased noise from activities on site.	Minor	Low	Neutral		N/A	Neutral
Restoration							
Nearest Sensitive Receptors	Increased noise from traffic associated with the development. Increased noise from activities on site.	Minor	Low	Neutral/Slight	Distance from nearest village 700m. Temporary duration.	Implementation of a Traffic Management Plan	Neutral

Table 16.20: Table of Significance of Impact

16.11 REFERENCES

Ref.1: Department for Environment Food and Rural Affairs, 2010. *Noise Policy Statement for England*

Ref.2: Department for Environment Food and Rural Affairs

Ref.3: DCLG, 2012. *National Planning Policy Framework*

Ref.4: DCLG 2014. *Planning Practice Guidance*

Ref.5 North Yorkshire County Council saved policy *Minerals Local Plan, 1997*

Ref.6: *The Minerals and Waste Joint Plan, Issues and Options, 2014*

Ref.7: British Standards Institution. *BS 5228-1: Code of practice for noise and vibration control on construction and open sites.*

Ref.8: Department of Transport and Welsh Office, 1988. *Calculation of Road Traffic Noise*

Ref.9: Department of Transport, 2011. Design manual for Roads and Bridges, Volume 11

Ref.10: British Standards Institution. *BS4142:2014 Methods for rating and assessing industrial and commercial sound*

Ref.11: World Health Organisation, 2009. *Night Noise Guidelines for Europe*

Ref.12: World Health Organisation, 1999. *Guidelines for Community Noise*

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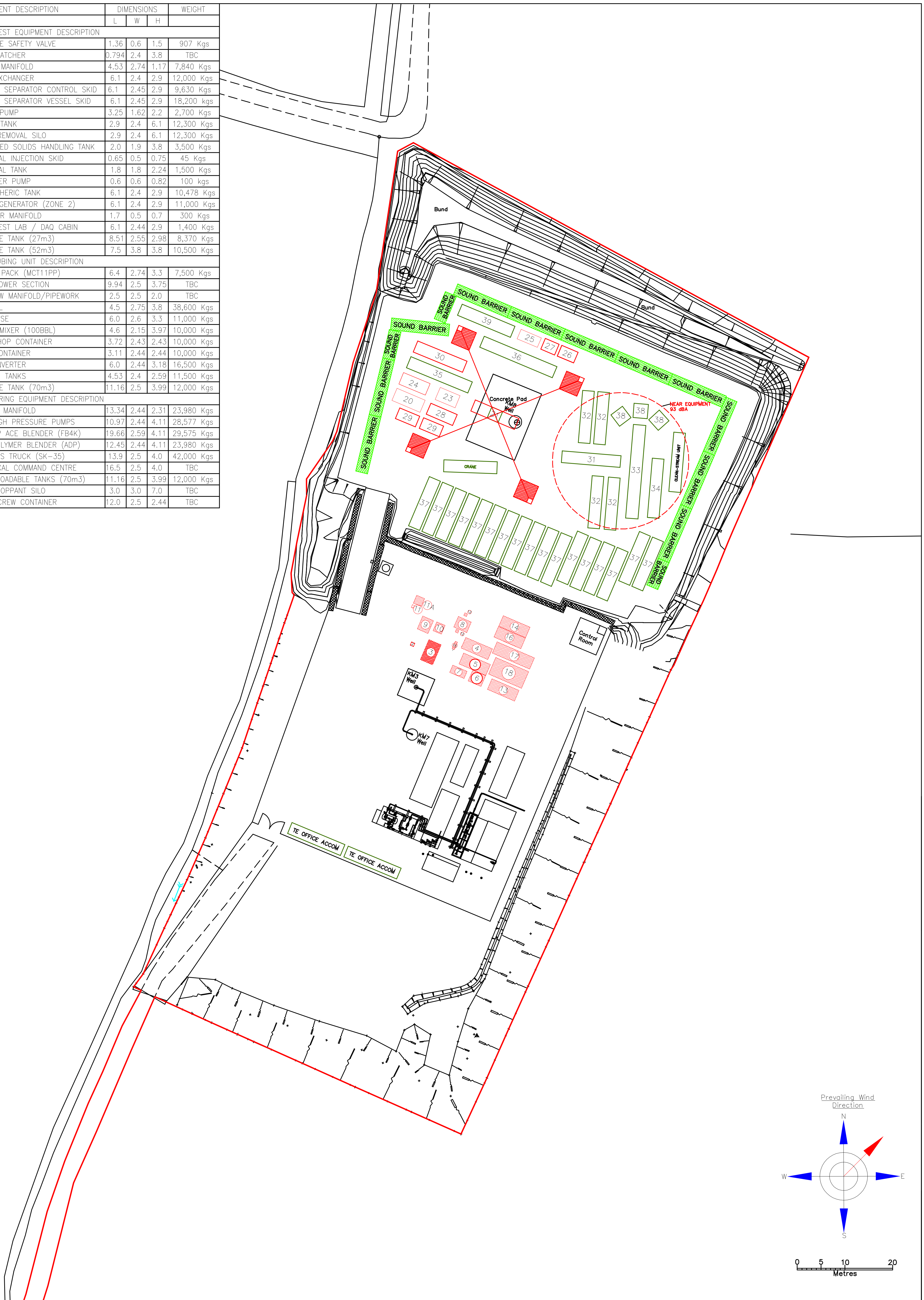
APPENDIX 11.1

Source Noise Data

- Site Layout
- Enerflow Mobile Service Rig noise test report
- Source noise data for HF equipment and normal gas production equipment

EQUIPMENT#	EQUIPMENT DESCRIPTION	DIMENSIONS L	W	H	WEIGHT
	WELL TEST EQUIPMENT DESCRIPTION				
1	SURFACE SAFETY VALVE	1.36	0.6	1.5	907 Kgs
2	SAND CATCHER	0.794	2.4	3.8	TBC
3	CHOKE MANIFOLD	4.53	2.74	1.17	7,840 Kgs
4	HEAT EXCHANGER	6.1	2.4	2.9	12,000 Kgs
5	4PHASE SEPARATOR CONTROL SKID	6.1	2.45	2.9	9,630 Kgs
6	4PHASE SEPARATOR VESSEL SKID	6.1	2.45	2.9	18,200 kgs
7	FLUSH PUMP	3.25	1.62	2.2	2,700 Kgs
8	SURGE TANK	2.9	2.4	6.1	12,300 Kgs
9	SOLID REMOVAL SILO	2.9	2.4	6.1	12,300 Kgs
10	ENCLOSED SOLIDS HANDLING TANK	2.0	1.9	3.8	3,500 Kgs
11	CHEMICAL INJECTION SKID	0.65	0.5	0.75	45 Kgs
12	CHEMICAL TANK	1.8	1.8	2.24	1,500 Kgs
13	TRANSFER PUMP	0.6	0.6	0.82	100 kgs
14	ATMOSPHERIC TANK	6.1	2.4	2.9	10,478 Kgs
15	STEAM GENERATOR (ZONE 2)	6.1	2.4	2.9	11,000 Kgs
16	DIVERTER MANIFOLD	1.7	0.5	0.7	300 Kgs
17	WELL TEST LAB / DAQ CABIN	6.1	2.44	2.9	1,400 Kgs
18	STORAGE TANK (27m3)	8.51	2.55	2.98	8,370 Kgs
19	STORAGE TANK (52m3)	7.5	3.8	3.8	10,500 Kgs
	COIL TUBING UNIT DESCRIPTION				
20	POWER PACK (MCT11PP)	6.4	2.74	3.3	7,500 Kgs
21	BASE TOWER SECTION	9.94	2.5	3.75	TBC
22	CT FLOW MANIFOLD/PIPEWORK	2.5	2.5	2.0	TBC
23	CT REEL	4.5	2.75	3.8	38,600 Kgs
24	CT HOUSE	6.0	2.6	3.3	11,000 Kgs
25	BATCH MIXER (100BBL)	4.6	2.15	3.97	10,000 Kgs
26	WORKSHOP CONTAINER	3.72	2.43	2.43	10,000 Kgs
27	IRON CONTAINER	3.11	2.44	2.44	10,000 Kgs
28	N2 CONVERTER	6.0	2.44	3.18	16,500 Kgs
29	4 X N2 TANKS	4.53	2.4	2.59	11,500 Kgs
30	STORAGE TANK (70m3)	11.16	2.5	3.99	12,000 Kgs
	FRACTURING EQUIPMENT DESCRIPTION				
31	MISSILE MANIFOLD	13.34	2.44	2.31	23,980 Kgs
32	4 X HIGH PRESSURE PUMPS	10.97	2.44	4.11	28,577 Kgs
33	50 BMP ACE BLENDER (FB4K)	19.66	2.59	4.11	29,575 Kgs
34	DRY POLYMER BLENDER (ADP)	12.45	2.44	4.11	23,980 Kgs
35	ANNULUS TRUCK (SK-35)	13.9	2.5	4.0	42,000 Kgs
36	TECHNICAL COMMAND CENTRE	16.5	2.5	4.0	TBC
37	19 X ROADABLE TANKS (70m3)	11.16	2.5	3.99	12,000 Kgs
38	3 X PROPPANT SILO	3.0	3.0	7.0	TBC
39	WORK/CREW CONTAINER	12.0	2.5	2.44	TBC



Key:

Planning Application Red Line Boundary

PSSL
Petroleum Safety Services Limited

Petroleum Safety Services Limited
23a Milton Street
Saltburn by the Sea
TS12 1DJ

Client: Third Energy UK Gas Ltd	**Drawn By:** Jonathan Foster
	Date Drawn: 05/01/2015
Project: KM8 Hydraulic Fracturing and Well Test Operation	**Approved By:** Jonathan Foster
	Date Approved: 05/01/2015
Drawing Title: Equipment Layout for Noise Models	**Drawing No:** PSSL/TE/KM8/HFS/N001
Scale: 1:750 (Print A3)	**Rev:** 0

May 17, 2010

Enerflow Industries Inc.
c/o Noise Solutions Inc.
301, 206 – 7th Avenue SW
Calgary, Alberta
T2P 0W7

Attention: [redacted]

Re: Mobile Service Rig Sound Level Measurements
File: 110-005-630-03

As requested by yourself on behalf of [redacted] of Enerflow Industries Inc. (Enerflow), FFA Consultants in Acoustics and Noise Control Ltd. undertook sound level measurements of a Mobile Service Rig at Enerflow's shop on May 3, 2010.

The sound pressure level measurements were conducted with a Brüel & Kjær Hand-held Analyzer Type 2250. The meter meets IEC/EN 60651 (1979) plus Amendment 1 (1993) and Amendment 2 (2000) Type 1, IEC 60804 (2000) Type 1, and IEC 61672 (2002) Class 1 standards. A windscreen was mounted on the microphone. The sound level meter was calibrated with a Brüel & Kjær Model 4231 Acoustic Calibrator before and after the measurements. The calibrator meets IEC 942 (1988) standard. The measurements were taken as a 20 second energy average (Leq) sound pressure level reading. Overall A-weighted levels were stored in the meter. In addition the peak sound pressure levels were stored in the meter.

The Mobile Service Rig was located in an industrial equipment yard with gravel and hard packed dirt. The environmental conditions during the measurements consisted of a temperature of 7.1°C, a relative humidity ranging from of 37-58% and a wind ranging from 30-50 km/h with the wind increasing as the measurement period progressed.

In order to develop an overall average sound power level of the unit measurements were taken in general accordance with International Standard ISO 3744, and British Standard BS 4142 (1997). All measurements were taken along a theoretical rectangular parallelepipedal surface overlain on the unit. Enerflow requested the measurement distance from the unit to be 1 metre. Therefore the theoretical surface is 2 metres greater in both the length and width, and 1 metre greater in height than the unit dimensions. The height of the measurements above the ground taken alongside the unit is 2.5 metres. The sound pressure level measurements for the unit are shown in Figure 1 enclosed with this letter.

All the 1 metre surface sound pressure level measurements for the unit were logarithmically averaged and a sound power level was calculated. The results of both are presented in Table 1.

Table 1
Mobile Service Rig
Average Sound Levels (dBA)

Surface Sound Pressure Level (L_{pA})	Sound Power Level (L_{wA})
85.6	109.8

FFA File 110-005-630-03

The average sound power level was entered in an acoustical model software program called ENM Windows to predict the sound pressure level at 250 metres. The environmental conditions of the model were set to 15°C, 70% relative humidity and a calm wind. The predicted sound pressure level at 250 metres is 50.7 dBA.

Enerflow also requested that measurements of emission sound pressure levels at workstations be completed at four locations on the Mobile Service Rig in accordance with ISO 11201 standard. See Figure 2 for the locations of the workstations. Due to the high wind speeds at the end of the measurement period it was unsafe to obtain the sound level readings at three of the four locations. At the three locations that sound level measurements were not taken predicted sound levels were calculated based on an average sound power level of the engine end of the unit. Both the measured and predicted sound levels are presented in Table 2.

Table 2
Mobile Service Rig
Measured and Predicted Emission Sound Pressure Levels (dB)

Work Station	Measured Sound Pressure Level (L_{pA})	Predicted Sound Pressure Level (L_{pA})	Measured Peak Sound Pressure Level ($L_{pC,peak}$)	Predicted Peak Sound Pressure Level ($L_{pC,peak}$)
1	74.1	N/A	99.9	N/A
2	N/A	77.0	N/A	99.5
3	N/A	75.4	N/A	97.9
4	N/A	73.0	N/A	95.4

FFA File 110-005-630-03

N/A Not Available

We trust this provides you with the information you require. If you have any questions or require additional information please contact the undersigned.

Sincerely

FFA Consultants in Acoustics and Noise Control Ltd.

[redacted]

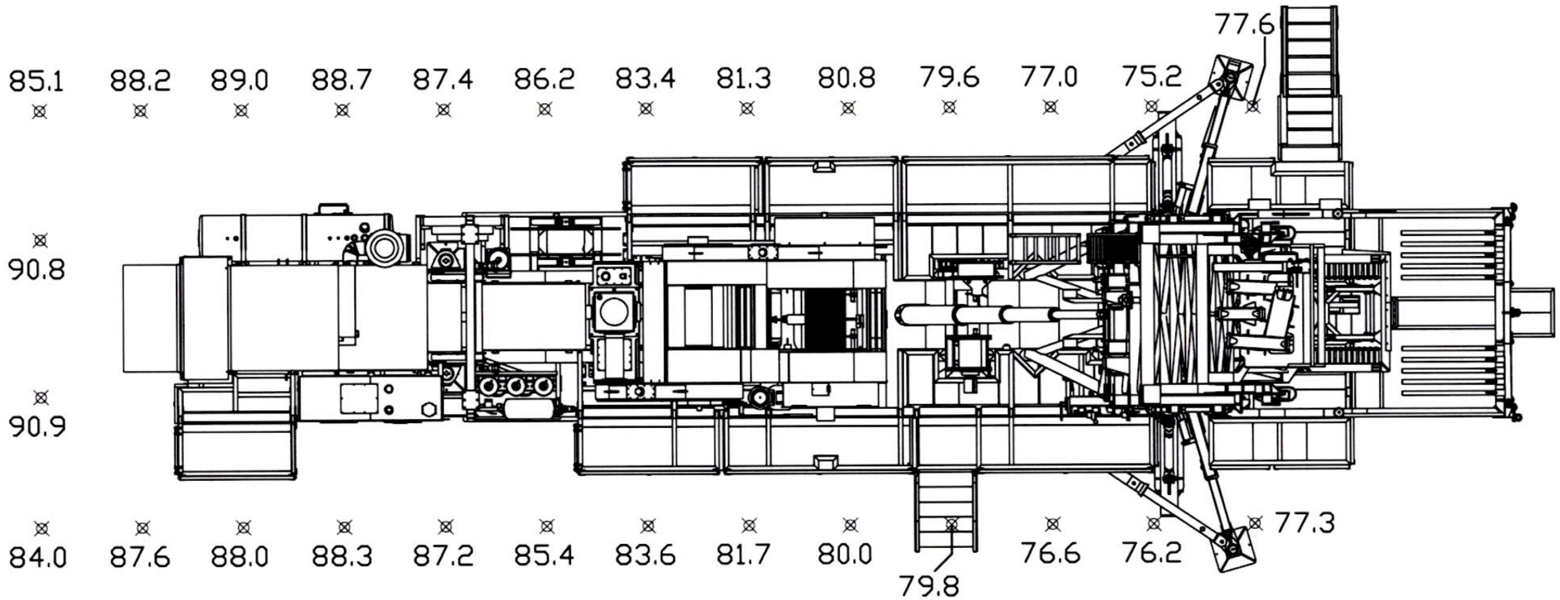
Clifford C. Faszer, P. Eng.

encl.

Figure 1

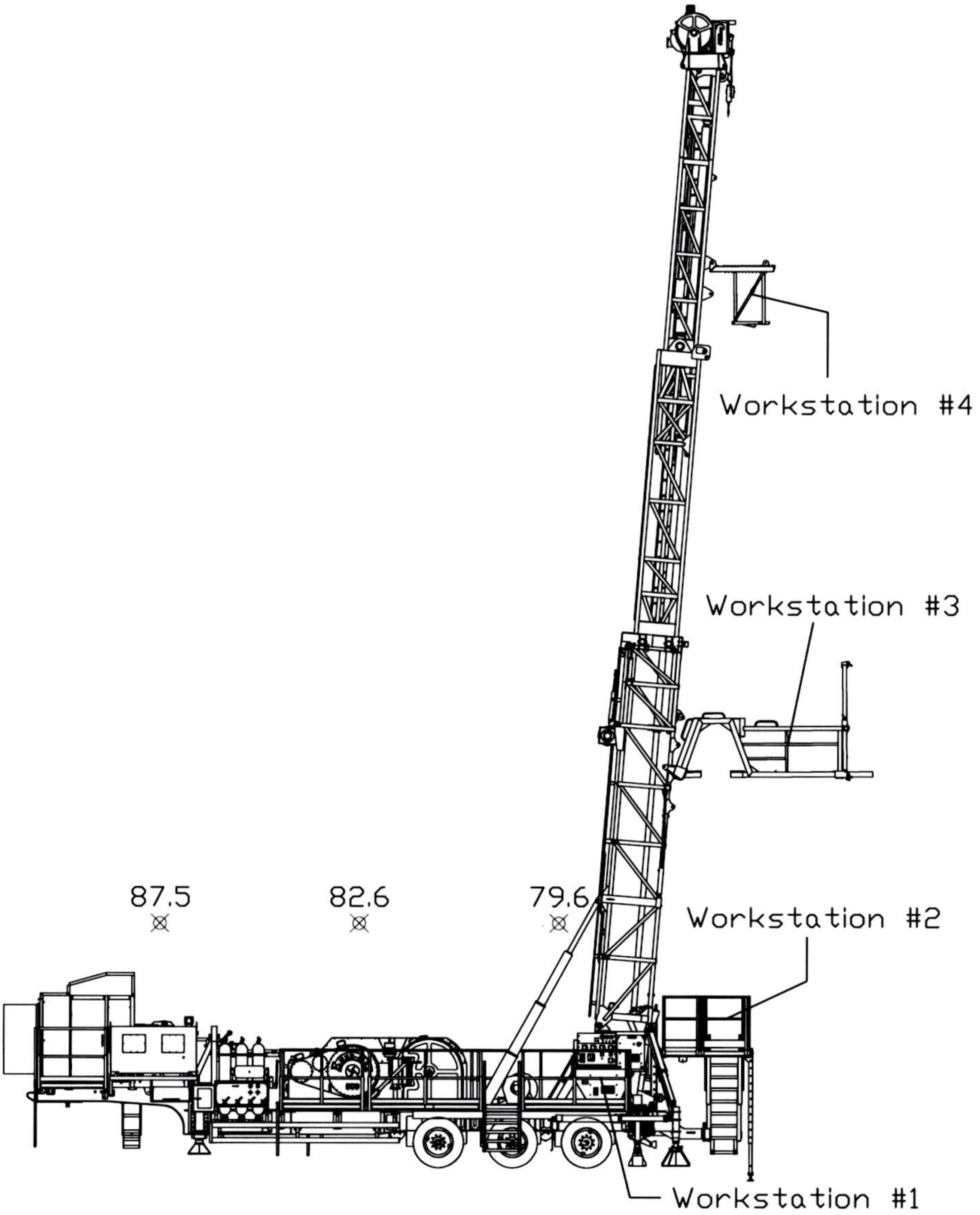
Mobile Service Rig

Sound Pressure Level Measurements (dBA)



FFA

Figure 2
Mobile Service Rig
Sound Pressure Level Measurements (dBA)
Workstation Positions



Third Energy – KM8 – Equipment List Sound Power Levels

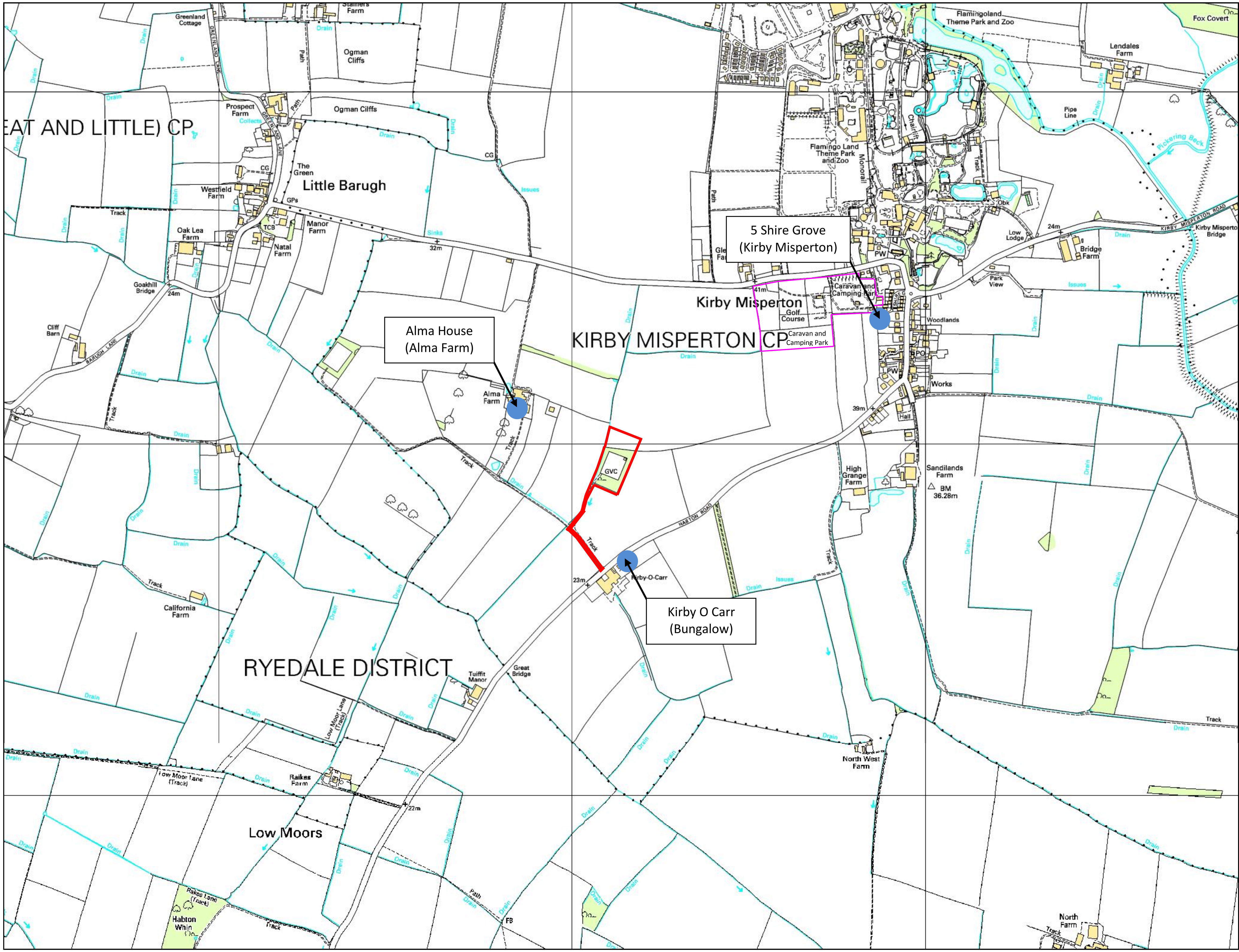
Revision	Date	Comment
0	20/4/15	Data generally from potential suppliers
1	30/4/15	Includes operating times
2	1/5/15	Updated data from Halliburton and Third Energy

Equipment or Source	Sound Power Level dB(A)	Octave Band Sound Power Level (dB), **(Linear)**									No. off of these on the project	Source: Line (L) Point (P) Area (A)	Operating times	Comments
		31Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 KHz	2 KHz	4 KHz	8 KHz				
HF and well testing														
Dry Gel Blender	120	113	124	124	117	115	115	114	110	103	1	P	07:00-19:00	Sound pressure and sound power data for Gelpro blender from Halliburton. Day running only
FB4K Main Blender	118	111	122	122	115	113	113	112	108	101	1	P	07:00-19:00	Sound pressure and sound power data for FB4K main slurry blender from Halliburton. Day running only
HF Pump driven by Cummins QSK50	125	118	129	131	122	120	120	119	115	108	4	P	07:00-19:00	Sound pressure and sound power data for HQ2000 HF trailer with Cummins engine from Halliburton. Day running only.
Centrifugal pump	95	103	103	103	98	93	88	85	81	78	2	P	07:00-07:00	Small 92 kW unit. Diesel driven in noise enclosure. Typical Sykes unit sound power level 95 dBA. .Frequency spectrum estimated by Spectrum Acoustics.
Electrical generator	87	95	95	95	90	85	80	77	73	70	1	P	07:00-07:00	73kW for lighting and small plant. In high performance noise enclosure. 70 dBA sound pressure level. 87 dBA sound power level. Frequency spectrum estimated by Spectrum Acoustics.
ICH truck	87	80	80	85	85	82	82	80	77	75	1	P	07:00-07:00	Wireline unit run on truck engine in idle.. Overall on time 1%only. Max 5 minutes/hour On-time correction -11dB over 1 hour. Sound pressure level advised as 80 dBA at 1m. On time sound power calculated by Spectrum Acoustics as 98-11 = 87dBA. Frequency spectrum estimated by Spectrum Acoustics. 24 hour running
Zone 2 air compressor	98	106	106	106	101	96	91	88	84	81	1	P	07:00-07:00	ATR Zone II compressor in high performance acoustic enclosure. Sound pressure level 76 dBA at 1m. Calculated sound power level 98 dBA. Frequency spectrum estimated by Spectrum Acoustics.
Zone 2 steam generator	96	104	104	104	99	94	89	86	82	79	1	p	07:00-07:00	Fired boiler 6mBTU/hr (Cochrane). Assumed fan enclosed and inlet silencer. Sound pressure level advised as 76dBA. Sound power level calculated as 96 dBA. Frequency spectrum estimated by Spectrum Acoustics.
CT Hydraulic Power Pack	104	112	112	112	107	102	97	94	90	87	1	P	07:00-07:00	Sound pressure level advised of 83dBA. Calculated sound power level 104dBA. Frequency spectrum estimated by Spectrum Acoustics.
Nitrogen unit	102	110	110	110	105	100	95	92	88	85	1	P	07:00-07:00	Diesel driven unit in 20' ISO container. 80 dBA sound pressure level advised. Calculated sound power level 102 dBA. 24 hour operation. Frequency spectrum estimated by Spectrum Acoustics.
Site located Lighting Generators	85	93	93	93	88	83	78	75	71	68	8	P	19:00-07:00	SMC TL-90 mobile lighting tower data sheet quotes 7m sound pressure level of 60 dBA and sound power level of 85dBA.Frequency spectrum estimated by Spectrum Acoustics. Night running only.
Pre stimulation Workover														
Workover rig	110	112	120	115	110	105	105	102	102	93	1	P	07:00-07:00	Day and night. Test report on Enerflow Mobile Service Rig advises Sound power level of 110 dBA. Octave band values estimated by Spectrum Acoustics.
Production														
Glycol pump	85	78	78	83	83	80	80	78	75	73	1	P	07:00-07:00	Spectrum Acoustics estimate is 72- 75 dBA at 1m.
Pipework above ground	90	73	73	73	73	78	81	85	85	83	1	P	07:00-07:00	Typical flow noise estimate from Spectrum Acoustics is 70- 72 dBA at 1m.10m length of piping.
Wellhead valve	88	71	71	71	71	76	79	83	83	81	1	P	07:00-07:00	When open fully. Spectrum Acoustics estimate is 75- 78 dBA at 1m

A P P E N D I X 11.2

Baseline Noise Monitoring

- Plan of NSRs
- Photos of measuring equipment
- Noise dataset and post processed results
- Model settings
- Wind rose



Key:

Site Location

Baseline Noise Monitoring Position

Caravan Park

PSSL
Petroleum Safety Services Limited

Petroleum Safety Services
23a Milton Street
Saltburn by the Sea
TS12 1DJ

Client:
Third Energy UK Gas Limited

Project:
KM8 Hydraulic Fracturing Operation

Drawing Title:
Baseline Noise Monitoring Plan

Scale:
1: 10,000 (Printed A3)

Drawn By:
Jonathan Foster

Date Drawn:
10/06/2015

Approved By:
Jonathan Foster

Date Approved:
10/06/2015

Drawing No:
PSSL/TE/KM8/HFS/PA/N/01

Rev: 1

Location 1: Alma House – weather station

Location 1 Alma House: Noise monitor

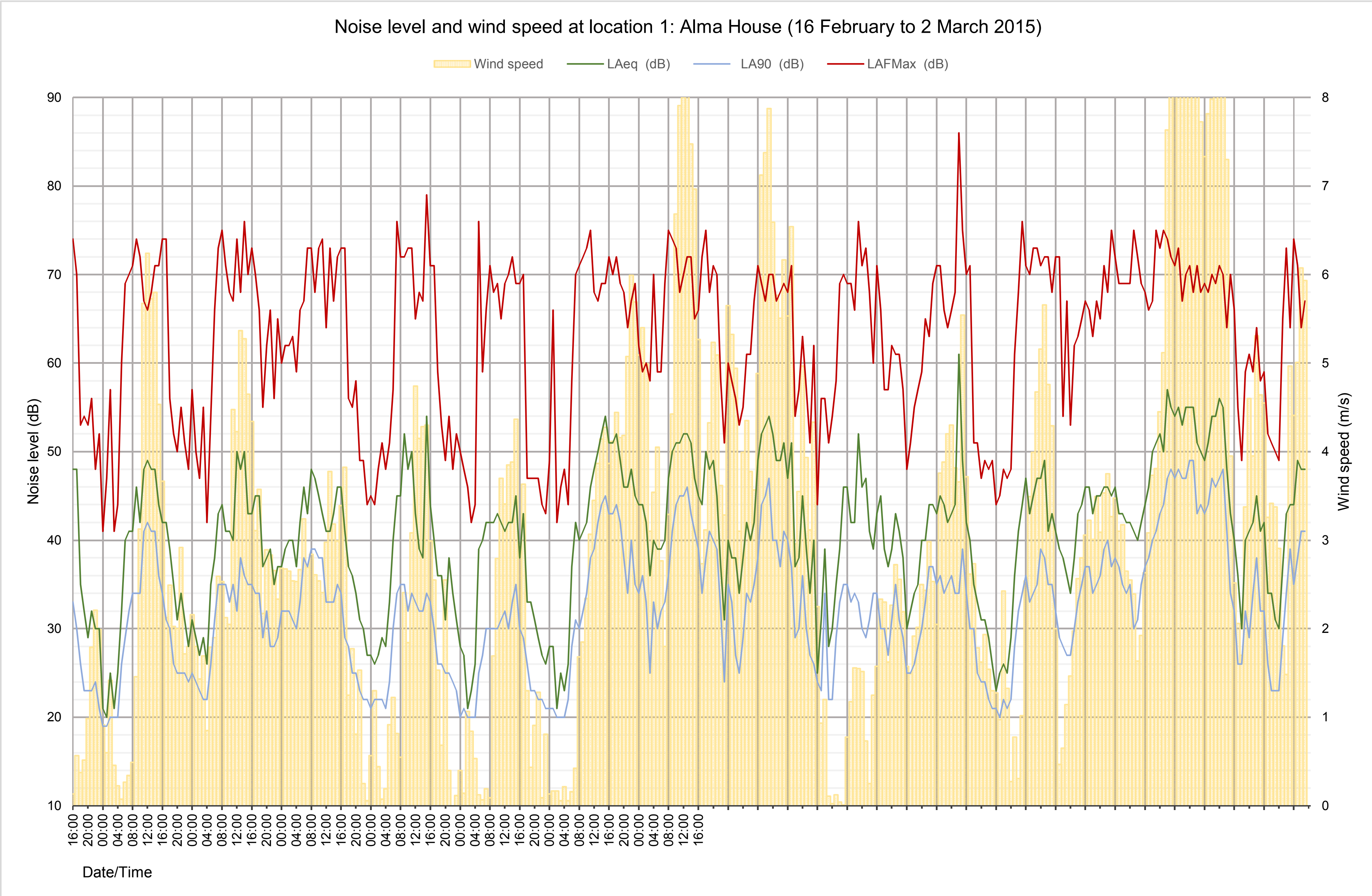
Location 2: Kirby O Carr

Location 2 : Kirby O Carr

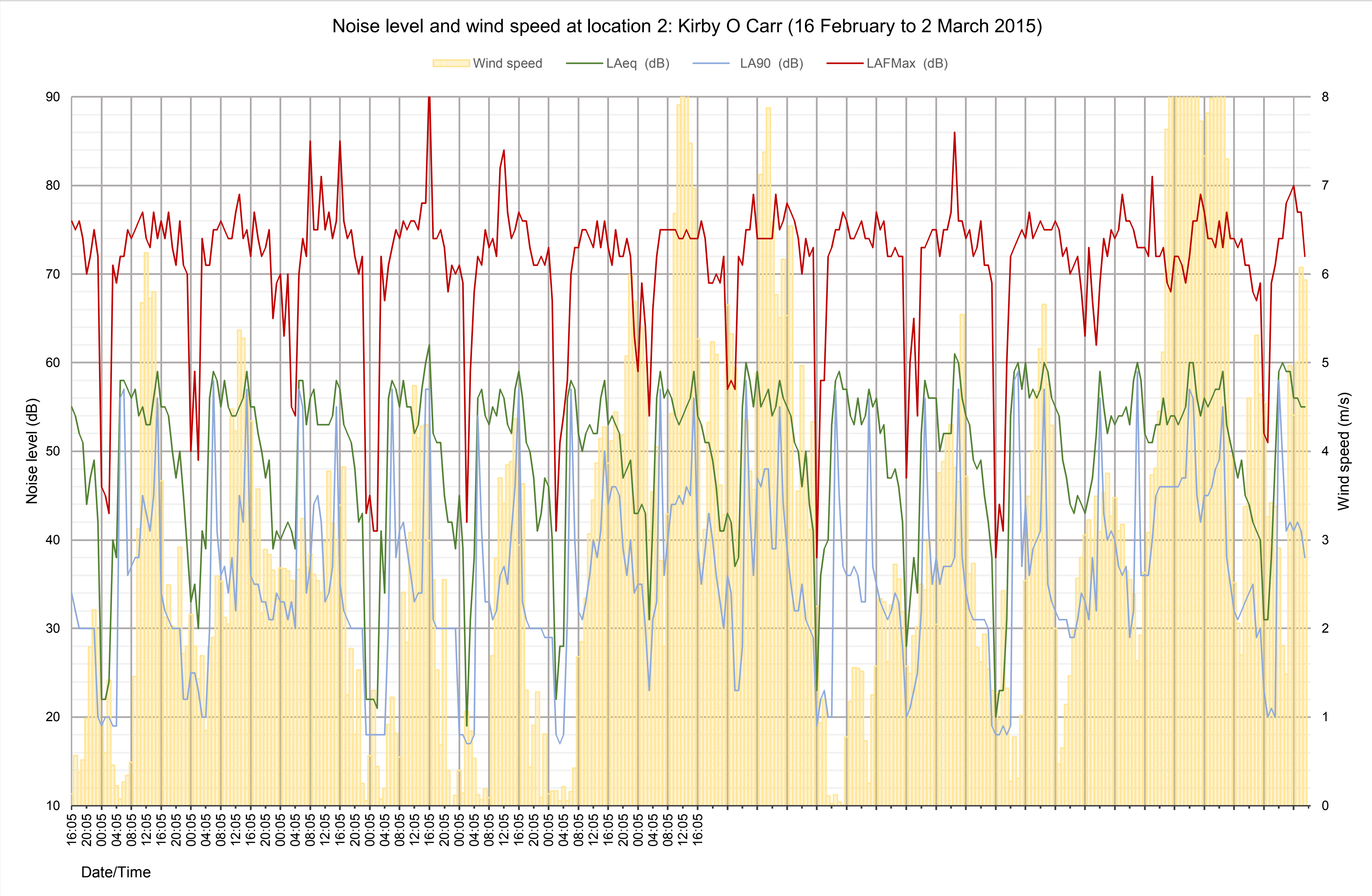
Location 3: 5 Shire Grove

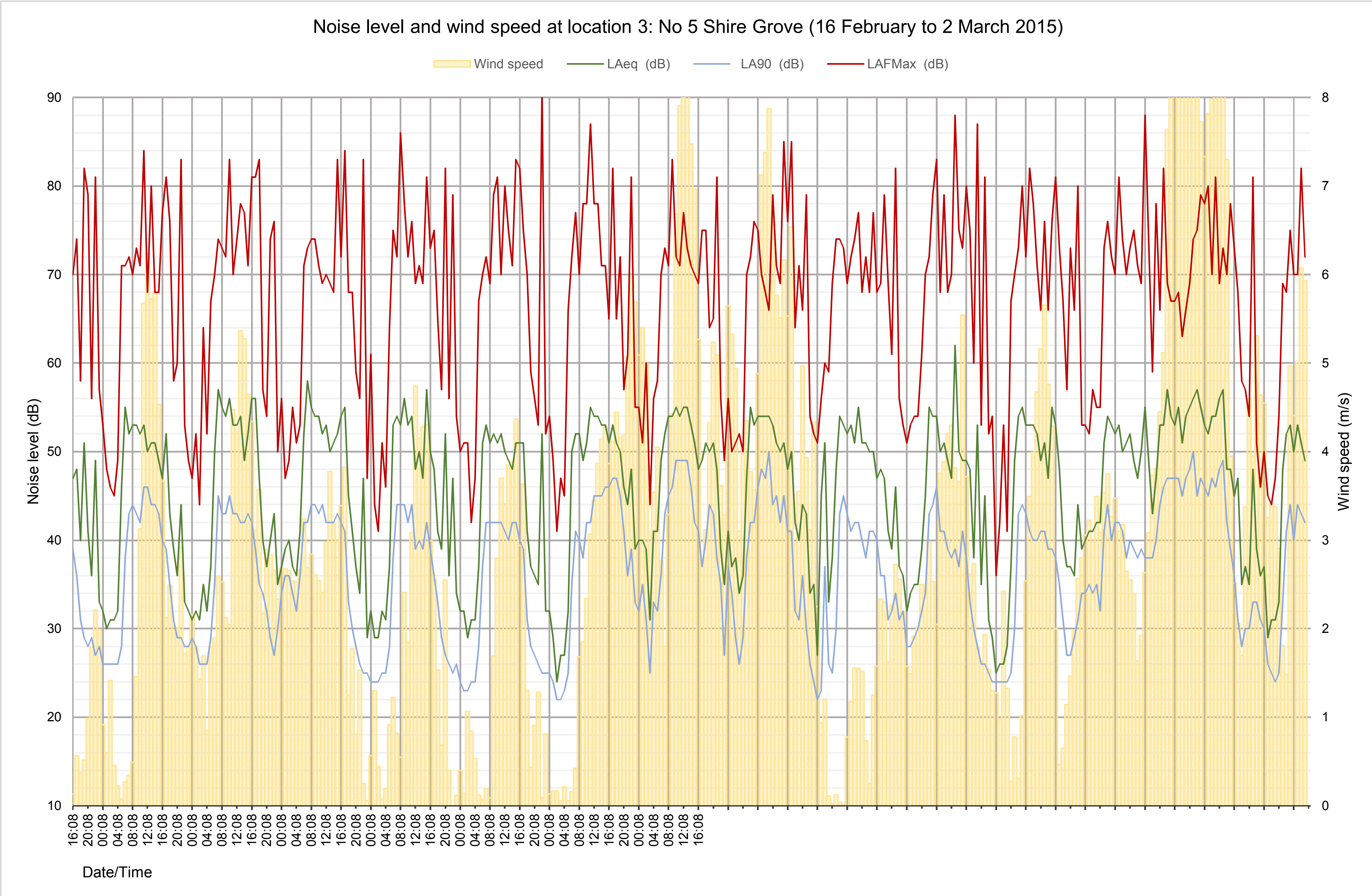
Location 5 Shire Grove

Photos of noise and weather monitoring equipment



Noise level and wind speed at location 1: Alma House (16 February to 2 March 2015)
Wind speed
LAeq (dB)
LA90 (dB)
LAFMax (dB)
Noise level (dB)
Wind speed (m/s)
Date/Time


Noise level and wind speed at location 2: Kirby O Carr (16 February to 2 March 2015)
Wind speed
LAeq (dB)
LA90 (dB)
LAFMax (dB)
Noise level (dB)
Wind speed (m/s)
90
80
70
60
50
40
30
20
10
8
7
6
5
4
3
2
1
0
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
20:05
00:05
04:05
08:05
12:05
16:05
Date/Time


Noise level and wind speed at location 3: No 5 Shire Grove (16 February to 2 March 2015)
Wind speed
LAeq (dB)
LA90 (dB)
LAFMax (dB)
Noise level (dB)
Wind speed (m/s)
Date/Time

Raw data and central tendencies for Alma House

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	42	30	69	-
Mean	45	36	69	-
Mean - 1 s.d.	40	31	-	-
Log Average	48	-	-	-

Table 2: Daytime period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	16:00	48	33	74		0.133333333
16/02/2015	17:00	48	30	70		0.566666667
16/02/2015	18:00	35	26	53		0.375
17/02/2015	07:00	41	32	70		0.341666667
17/02/2015	08:00	41	34	71		0.491666667
17/02/2015	09:00	46	34	74		1.458333333
17/02/2015	10:00	42	34	72		3.125
17/02/2015	**11:00**	**48**	**41**	**67**		**5.675**
17/02/2015	**12:00**	**49**	**42**	**66**		**6.241666667**
17/02/2015	**13:00**	**48**	**41**	**68**		**5.725**
17/02/2015	**14:00**	**48**	**41**	**71**		**5.8**
17/02/2015	**15:00**	**44**	**36**	**71**		**4.533333333**
17/02/2015	**16:00**	**42**	**34**	**74**		**3.666666667**
17/02/2015	17:00	42	31	74		2.125
17/02/2015	18:00	39	30	56		2.491666667
18/02/2015	07:00	43	35	73		2.591666667
18/02/2015	08:00	44	35	75		2.533333333
18/02/2015	09:00	41	35	71		2.125
18/02/2015	10:00	41	33	68		2.05
18/02/2015	**11:00**	**40**	**35**	**67**		**4.475**
18/02/2015	**12:00**	**50**	**32**	**74**		**4.225**
18/02/2015	**13:00**	**48**	**38**	**68**		**5.366666667**
18/02/2015	**14:00**	**50**	**36**	**76**		**5.275**
18/02/2015	**15:00**	**43**	**35**	**70**		**4.65**
18/02/2015	**16:00**	**43**	**35**	**73**		**4.341666667**
18/02/2015	17:00	45	34	70		3.108333333
18/02/2015	**18:00**	**45**	**34**	**66**		**3.575**
19/02/2015	07:00	43	37	73		2.691666667
19/02/2015	08:00	48	39	73		2.841666667
19/02/2015	09:00	47	39	68		2.608333333
19/02/2015	10:00	45	38	73		2.541666667
19/02/2015	11:00	43	38	74		2.408333333
19/02/2015	12:00	41	33	64		2.975
19/02/2015	**13:00**	**41**	**33**	**73**		**3.775**
19/02/2015	14:00	43	33	67		3.183333333
19/02/2015	15:00	46	35	72		2.991666667
19/02/2015	16:00	46	34	73		3.391666667
19/02/2015	**17:00**	**41**	**29**	**73**		**3.825**
19/02/2015	18:00	37	28	56		1.25
20/02/2015	07:00	45	34	76		0.816666667

20/02/2015	08:00	45	35	72		0.55
20/02/2015	09:00	52	35	72		2.408333333
20/02/2015	10:00	48	32	73		1.841666667
20/02/2015	11:00	50	34	73		3.083333333
20/02/2015	**12:00**	**43**	**33**	**65**		**4.741666667**
20/02/2015	**13:00**	**39**	**32**	**68**		**4.15**
20/02/2015	**14:00**	**38**	**32**	**67**		**4.283333333**
20/02/2015	**15:00**	**54**	**34**	**79**		**4.3**
20/02/2015	16:00	44	33	71		2.991666667
20/02/2015	17:00	40	30	71		2.55
20/02/2015	18:00	36	26	59		1.533333333
21/02/2015	07:00	42	30	66		0.191666667
21/02/2015	08:00	42	30	71		0.091666667
21/02/2015	09:00	42	30	68		1.691666667
21/02/2015	10:00	43	30	69		2.791666667
21/02/2015	**11:00**	**42**	**31**	**65**		**3.7**
21/02/2015	12:00	41	32	69		3.408333333
21/02/2015	**13:00**	**42**	**30**	**70**		**3.85**
21/02/2015	**14:00**	**42**	**33**	**72**		**3.883333333**
21/02/2015	**15:00**	**45**	**35**	**69**		**4.366666667**
21/02/2015	16:00	38	30	69		2.941666667
21/02/2015	**17:00**	**43**	**29**	**70**		**3.633333333**
21/02/2015	18:00	33	26	47		1.3
22/02/2015	07:00	42	31	70		0.425
22/02/2015	08:00	40	30	71		1.683333333
22/02/2015	09:00	41	32	72		1.85
22/02/2015	10:00	42	34	73		2.341666667
22/02/2015	11:00	46	38	75		3.066666667
22/02/2015	12:00	48	39	68		3.45
22/02/2015	**13:00**	**50**	**42**	**67**		**3.866666667**
22/02/2015	**14:00**	**52**	**44**	**69**		**4.141666667**
22/02/2015	**15:00**	**54**	**45**	**69**		**4.275**
22/02/2015	**16:00**	**51**	**43**	**72**		**3.866666667**
22/02/2015	**17:00**	**51**	**43**	**70**		**4.116666667**
22/02/2015	**18:00**	**52**	**44**	**72**		**4.441666667**
23/02/2015	07:00	40	33	69		1.8
23/02/2015	08:00	47	36	75		3.291666667
23/02/2015	**09:00**	**50**	**41**	**74**		**4.425**
23/02/2015	**10:00**	**51**	**44**	**73**		**6.683333333**
23/02/2015	**11:00**	**51**	**45**	**68**		**7.908333333**
23/02/2015	**12:00**	**52**	**45**	**70**		**8**
23/02/2015	**13:00**	**52**	**46**	**72**		**8.083333333**
23/02/2015	**14:00**	**51**	**43**	**72**		**7.475**
23/02/2015	**15:00**	**47**	**41**	**65**		**6.966666667**
23/02/2015	**16:00**	**45**	**39**	**66**		**5.266666667**
23/02/2015	17:28	44	34	72		2.733333333
23/02/2015	18:28	50	38	75		3.116666667
24/02/2015	**07:28**	**42**	**35**	**67**		**3.566666667**
24/02/2015	**08:28**	**49**	**38**	**71**		**4.883333333**
24/02/2015	**09:28**	**52**	**44**	**69**		**7.125**
24/02/2015	**10:28**	**53**	**45**	**67**		**7.375**
24/02/2015	**11:28**	**54**	**47**	**70**		**7.875**
24/02/2015	**12:28**	**52**	**40**	**70**		**6.591666667**
24/02/2015	**13:28**	**49**	**40**	**67**		**5.766666667**

24/02/2015	14:28	49	37	68		5.508333333
24/02/2015	15:28	51	41	69		6.166666667
24/02/2015	16:28	47	40	68		5.533333333
24/02/2015	17:28	51	37	71		6.541666667
24/02/2015	18:28	37	29	54		2.958333333
25/02/2015	07:28	46	35	70		0.008333333
25/02/2015	08:28	46	35	69		0.775
25/02/2015	09:28	42	33	69		1.175
25/02/2015	10:28	42	34	66		1.558333333
25/02/2015	11:28	52	33	76		1.55
25/02/2015	12:28	46	30	71		1.516666667
25/02/2015	13:28	47	29	73		0.733333333
25/02/2015	14:28	41	31	68		0.25
25/02/2015	15:28	39	34	60		1.25
25/02/2015	16:28	43	34	71		1.575
25/02/2015	17:28	45	30	66		2.333333333
25/02/2015	18:28	39	30	57		2.3
26/02/2015	07:28	44	37	69		2.533333333
26/02/2015	08:28	43	35	71		2.05
26/02/2015	09:28	45	36	71		3.758333333
26/02/2015	10:28	44	34	66		3.883333333
26/02/2015	11:28	42	35	64		4.2
26/02/2015	12:28	43	36	66		4.3
26/02/2015	13:28	44	34	68		3.816666667
26/02/2015	14:28	61	34	86		3.658333333
26/02/2015	15:28	49	39	75		5.541666667
26/02/2015	16:28	42	34	70		3.716666667
26/02/2015	17:28	40	30	71		2.616666667
26/02/2015	18:28	35	30	51		2.733333333
27/02/2015	07:28	44	34	76		1.016666667
27/02/2015	08:28	47	36	71		2.541666667
27/02/2015	09:28	43	33	70		3.491666667
27/02/2015	10:28	45	34	73		3.991666667
27/02/2015	11:28	47	35	73		4.675
27/02/2015	12:39	47	39	71		5.158333333
27/02/2015	13:39	49	38	72		5.658333333
27/02/2015	14:39	41	35	72		4.758333333
27/02/2015	15:39	43	35	68		4.291666667
27/02/2015	16:39	41	32	72		2
27/02/2015	17:39	39	29	72		0.466666667
27/02/2015	18:39	38	28	54		0.65
28/02/2015	07:39	45	37	75		3.266666667
28/02/2015	08:39	46	38	72		3.475
28/02/2015	09:39	43	37	69		3.1
28/02/2015	10:39	43	35	69		3.175
28/02/2015	11:39	42	34	69		2.65
28/02/2015	12:39	42	35	69		2.55
28/02/2015	13:39	41	30	75		2.391666667
28/02/2015	14:39	40	31	72		1.633333333
28/02/2015	15:39	42	35	69		1.925
28/02/2015	16:39	44	37	68		2.633333333
28/02/2015	17:39	46	38	66		3.083333333
28/02/2015	18:39	50	40	67		3.733333333
01/03/2015	07:39	50	44	68		7.725

01/03/2015	**08:39**	**49**	**43**	**69**		**7.333333333**
01/03/2015	**09:39**	**51**	**44**	**68**		**7.816666667**
01/03/2015	**10:39**	**54**	**47**	**70**		**7.983333333**
01/03/2015	**11:39**	**54**	**46**	**69**		**8.1**
01/03/2015	**12:39**	**56**	**47**	**71**		**9.316666667**
01/03/2015	**13:39**	**55**	**48**	**70**		**9.075**
01/03/2015	**14:39**	**48**	**41**	**64**		**7.3**
01/03/2015	**15:39**	**43**	**34**	**70**		**3.95**
01/03/2015	16:39	40	32	66		2.516666667
01/03/2015	17:39	36	26	55		2.058333333
01/03/2015	18:39	30	26	49		1.7
02/03/2015	**07:39**	**44**	**39**	**64**		**4.966666667**
02/03/2015	**08:39**	**44**	**35**	**74**		**4.408333333**
02/03/2015	**09:39**	**49**	**38**	**71**		**5.008333333**
02/03/2015	**10:39**	**48**	**41**	**64**		**6.075**
02/03/2015	**11:39**	**48**	**41**	**67**		**5.933333333**

Raw data and central tendencies for Alma House

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	31	25	49/47	-
Mean	38	30	58	-
Mean - 1 s.d.	31	23	-	-
Log Average	44	-	-	-

Table 3: Evening period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	19:00	32	23	54		0.516666667
16/02/2015	20:00	29	23	53		0.983333333
16/02/2015	21:00	32	23	56		1.791666667
16/02/2015	22:00	30	24	48		2.208333333
17/02/2015	19:00	35	26	52		2.025
17/02/2015	20:00	31	25	50		2
17/02/2015	21:00	34	25	55		2.916666667
17/02/2015	22:00	31	25	51		1.716666667
18/02/2015	19:00	37	29	55		2.175
18/02/2015	20:00	38	32	62		2.891666667
18/02/2015	21:00	39	28	66		2.833333333
18/02/2015	22:00	35	28	56		2.658333333
19/02/2015	19:00	36	25	55		1.775
19/02/2015	20:00	34	25	58		0.808333333
19/02/2015	21:00	31	23	49		1.533333333
19/02/2015	22:00	30	22	49		0.25
20/02/2015	19:00	36	26	53		0.683333333
20/02/2015	20:00	31	25	49		2.55
20/02/2015	21:00	38	25	54		0.4
20/02/2015	22:00	34	24	48		0
21/02/2015	19:00	33	23	47		0.433333333
21/02/2015	20:00	31	23	47		0.908333333
21/02/2015	21:00	29	22	47		1.283333333
21/02/2015	22:00	27	22	44		0.091666667
22/02/2015	**19:00**	**49**	**42**	**69**		**4.158333333**
22/02/2015	**20:00**	**46**	**38**	**68**		**4.183333333**
22/02/2015	**21:00**	**46**	**34**	**64**		**5.075**
22/02/2015	**22:00**	**48**	**40**	**67**		**5.991666667**
23/02/2015	**19:28**	**48**	**41**	**68**		**4.325**
23/02/2015	**20:28**	**49**	**40**	**71**		**5.233333333**
23/02/2015	**21:28**	**45**	**39**	**70**		**5.091666667**
23/02/2015	**22:28**	**37**	**32**	**58**		**3.616666667**
24/02/2015	**19:28**	**38**	**30**	**57**		**3.55**
24/02/2015	**20:28**	**45**	**36**	**63**		**4.966666667**
24/02/2015	**21:28**	**39**	**30**	**57**		**3.933333333**
24/02/2015	22:28	34	27	51		3.116666667
25/02/2015	19:28	37	27	57		1.625
25/02/2015	20:28	39	31	62		2.266666667
25/02/2015	21:28	43	35	61		2.725
25/02/2015	22:28	41	31	61		2.558333333

26/02/2015	19:28	33	25	51		1.783333333
26/02/2015	20:28	31	24	47		1.625
26/02/2015	21:28	31	24	49		1.933333333
26/02/2015	22:28	29	22	48		1.541666667
27/02/2015	19:39	36	27	67		1.141666667
27/02/2015	20:39	34	27	53		1.466666667
27/02/2015	21:39	38	30	62		1.975
27/02/2015	22:39	43	33	63		2.566666667
28/02/2015	**19:39**	**51**	**41**	**75**		**3.808333333**
28/02/2015	**20:39**	**52**	**43**	**73**		**4.45**
28/02/2015	**21:39**	**50**	**44**	**75**		**5.116666667**
28/02/2015	**22:39**	**57**	**47**	**74**		**7.633333333**
01/03/2015	19:39	40	32	59		3.375
01/03/2015	**20:39**	**41**	**29**	**61**		**4.6**
01/03/2015	**21:39**	**42**	**34**	**59**		**3.95**
01/03/2015	**22:39**	**45**	**38**	**64**		**5.308333333**

Raw data and central tendencies for Alma House

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	40/26	20/22	48	-
Mean	35	28	57	-
Mean - 1 s.d.	27	21	-	-
Log Average	44	-	-	-

Table 4: Night-time period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	23:00	30	21	52		1.991666667
17/02/2015	00:00	21	19	41		0.916666667
17/02/2015	01:00	20	19	47		0.6
17/02/2015	02:00	25	20	57		1.416666667
17/02/2015	03:00	21	20	41		0.458333333
17/02/2015	04:00	25	20	44		0.225
17/02/2015	05:00	32	26	60		0.075
17/02/2015	06:00	40	29	69		0.266666667
17/02/2015	23:00	28	24	48		1.8
18/02/2015	00:00	31	25	57		2.158333333
18/02/2015	01:00	29	24	50		1.8
18/02/2015	02:00	27	23	47		1.433333333
18/02/2015	03:00	29	22	55		1.691666667
18/02/2015	04:00	26	22	42		0.85
18/02/2015	05:00	35	26	54		1.791666667
18/02/2015	06:00	38	31	66		1.9
18/02/2015	23:00	37	29	65		2.333333333
19/02/2015	00:00	37	32	60		2.683333333
19/02/2015	01:00	39	32	62		2.675
19/02/2015	02:00	40	32	62		2.65
19/02/2015	03:00	40	31	63		2.541666667
19/02/2015	04:00	37	30	59		2.533333333
19/02/2015	05:00	42	33	66		2.666666667
19/02/2015	06:00	46	38	67		3.241666667
19/02/2015	23:00	27	22	44		0.058333333
20/02/2015	00:00	27	21	45		0.566666667
20/02/2015	01:00	26	22	44		1.3
20/02/2015	02:00	27	22	48		0.441666667
20/02/2015	03:00	29	22	51		0.075
20/02/2015	04:00	28	21	48		0.191666667
20/02/2015	05:00	33	24	51		0.916666667
20/02/2015	06:00	40	30	57		1.225
20/02/2015	23:00	31	23	52		0.116666667
21/02/2015	00:00	28	20	50		0.4
21/02/2015	01:00	27	21	48		0.141666667
21/02/2015	02:00	21	20	46		1.066666667
21/02/2015	03:00	23	20	42		0.841666667
21/02/2015	04:00	26	20	44		0.533333333
21/02/2015	05:00	39	25	76		0.125
21/02/2015	06:00	40	27	59		0.066666667

21/02/2015	23:00	26	21	43		0.808333333
22/02/2015	00:00	28	21	49		0.133333333
22/02/2015	01:00	28	21	66		0.166666667
22/02/2015	02:00	21	20	42		0.166666667
22/02/2015	03:00	25	20	46		0.058333333
22/02/2015	04:00	23	20	48		0.216666667
22/02/2015	05:00	26	22	44		0.058333333
22/02/2015	06:00	37	28	58		0.158333333
22/02/2015	**23:00**	**45**	**35**	**69**		**5.691666667**
23/02/2015	**00:00**	**44**	**34**	**62**		**5.091666667**
23/02/2015	**01:00**	**44**	**36**	**59**		**5.4**
23/02/2015	**02:00**	**42**	**33**	**60**		**4.991666667**
23/02/2015	03:00	36	25	58		3.1
23/02/2015	**04:00**	**40**	**33**	**70**		**3.541666667**
23/02/2015	**05:00**	**39**	**30**	**59**		**4.05**
23/02/2015	06:00	39	32	59		2.766666667
23/02/2015	23:28	31	24	51		3.283333333
24/02/2015	**00:28**	**40**	**35**	**60**		**5.65**
24/02/2015	**01:28**	**38**	**33**	**58**		**5.325**
24/02/2015	**02:28**	**38**	**27**	**56**		**4.941666667**
24/02/2015	03:28	34	25	53		3.1
24/02/2015	**04:28**	**38**	**29**	**55**		**3.991666667**
24/02/2015	**05:28**	**42**	**34**	**61**		**4.35**
24/02/2015	**06:28**	**40**	**33**	**61**		**3.775**
24/02/2015	**23:28**	**40**	**26**	**62**		**4.333333333**
25/02/2015	00:28	25	24	44		2.25
25/02/2015	01:28	31	23	56		0.933333333
25/02/2015	02:28	39	34	56		1.2
25/02/2015	03:28	28	22	51		0.108333333
25/02/2015	04:28	30	22	54		0.025
25/02/2015	05:28	35	29	58		0.125
25/02/2015	06:28	39	33	69		0.041666667
25/02/2015	23:28	38	29	57		2.191666667
26/02/2015	00:28	30	25	48		1.575
26/02/2015	01:28	32	25	51		1.491666667
26/02/2015	02:28	34	26	55		1.916666667
26/02/2015	03:28	35	28	57		2.016666667
26/02/2015	04:28	40	30	59		2.5
26/02/2015	05:28	40	33	65		2.433333333
26/02/2015	06:28	44	37	63		2.983333333
26/02/2015	23:28	26	21	49		1.3
27/02/2015	00:28	23	21	44		1.275
27/02/2015	01:28	25	20	45		0.975
27/02/2015	02:28	26	22	48		2.425
27/02/2015	03:28	25	21	47		1.325
27/02/2015	04:28	29	22	48		0.275
27/02/2015	05:28	36	28	61		0.775
27/02/2015	06:28	41	32	68		0.308333333
27/02/2015	23:39	44	35	65		2.8
28/02/2015	00:39	46	37	67		3.058333333
28/02/2015	01:39	46	37	66		3.225
28/02/2015	02:39	43	34	63		3.008333333
28/02/2015	03:39	45	35	67		3.491666667
28/02/2015	04:39	45	36	65		3.091666667

28/02/2015	**05:39**	**46**	**39**	**71**		**3.533333333**
28/02/2015	**06:39**	**46**	**40**	**68**		**3.75**
28/02/2015	**23:39**	**55**	**48**	**72**		**9.116666667**
01/03/2015	**00:39**	**54**	**47**	**71**		**8.316666667**
01/03/2015	**01:39**	**55**	**48**	**73**		**8.85**
01/03/2015	**02:39**	**53**	**47**	**67**		**8.458333333**
01/03/2015	**03:39**	**55**	**47**	**70**		**8.533333333**
01/03/2015	**04:39**	**55**	**49**	**71**		**8.808333333**
01/03/2015	**05:39**	**55**	**49**	**68**		**8.925**
01/03/2015	**06:39**	**51**	**43**	**71**		**8.083333333**
01/03/2015	**23:39**	**41**	**32**	**58**		**4.641666667**
02/03/2015	**00:39**	**42**	**32**	**59**		**4.55**
02/03/2015	01:39	34	26	52		3.258333333
02/03/2015	02:39	34	23	51		3.416666667
02/03/2015	03:39	31	23	50		3.375
02/03/2015	04:39	30	23	49		2.908333333
02/03/2015	05:39	37	29	65		1.808333333
02/03/2015	06:39	43	34	73		1.483333333

Raw data and central tendencies for Kirby O Carr

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	**Lx**
Mode	53	36	75	-
Mean	55	39	75	-
Mean - 1 s.d.	52	32	-	-
Log Average	56	-	-	-

Table 2: Daytime period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	16:05	55	34	76		0.133333333
16/02/2015	17:05	54	32	75		0.566666667
16/02/2015	18:05	52	30	76		0.375
17/02/2015	07:05	57	36	75		0.341666667
17/02/2015	08:05	56	37	74		0.491666667
17/02/2015	09:05	57	38	75		1.458333333
17/02/2015	10:05	54	38	76		3.125
17/02/2015	**11:05**	**55**	**45**	**77**		**5.675**
17/02/2015	**12:05**	**53**	**43**	**74**		**6.241666667**
17/02/2015	**13:05**	**53**	**41**	**73**		**5.725**
17/02/2015	**14:05**	**56**	**45**	**77**		**5.8**
17/02/2015	**15:05**	**59**	**56**	**74**		**4.533333333**
17/02/2015	**16:05**	**55**	**34**	**76**		**3.666666667**
17/02/2015	17:05	55	32	74		2.125
17/02/2015	18:05	54	31	77		2.491666667
18/02/2015	07:05	58	41	75		2.591666667
18/02/2015	08:05	55	36	76		2.533333333
18/02/2015	09:05	58	37	75		2.125
18/02/2015	10:05	55	34	74		2.05
18/02/2015	**11:05**	**54**	**38**	**74**		**4.475**
18/02/2015	**12:05**	**54**	**32**	**77**		**4.225**
18/02/2015	**13:05**	**55**	**45**	**79**		**5.366666667**
18/02/2015	**14:05**	**56**	**42**	**74**		**5.275**
18/02/2015	**15:05**	**59**	**57**	**75**		**4.65**
18/02/2015	**16:05**	**55**	**36**	**72**		**4.341666667**
18/02/2015	17:05	55	35	77		3.108333333
18/02/2015	**18:05**	**52**	**35**	**74**		**3.575**
19/02/2015	07:05	53	34	72		2.691666667
19/02/2015	08:05	56	37	85		2.841666667
19/02/2015	09:05	57	44	75		2.608333333
19/02/2015	10:05	53	45	75		2.541666667
19/02/2015	11:05	53	42	81		2.408333333
19/02/2015	12:05	53	33	75		2.975
19/02/2015	**13:05**	**53**	**34**	**77**		**3.775**
19/02/2015	14:05	54	37	74		3.183333333
19/02/2015	15:05	58	55	76		2.991666667
19/02/2015	16:05	57	35	85		3.391666667
19/02/2015	**17:05**	**53**	**32**	**76**		**3.825**
19/02/2015	18:05	52	31	74		1.25
20/02/2015	07:05	57	38	75		0.816666667

20/02/2015	08:05	55	41	74		0.55
20/02/2015	09:05	58	42	76		2.408333333
20/02/2015	10:05	55	39	75		1.841666667
20/02/2015	11:05	55	36	76		3.083333333
20/02/2015	**12:05**	**52**	**33**	**76**		**4.741666667**
20/02/2015	**13:05**	**53**	**34**	**75**		**4.15**
20/02/2015	**14:05**	**57**	**34**	**78**		**4.283333333**
20/02/2015	**15:05**	**60**	**57**	**78**		**4.3**
20/02/2015	16:05	62	57	92		2.991666667
20/02/2015	17:05	52	31	74		2.55
20/02/2015	18:05	51	30	74		1.533333333
21/02/2015	07:05	54	33	75		0.191666667
21/02/2015	08:05	53	33	73		0.091666667
21/02/2015	09:05	55	31	74		1.691666667
21/02/2015	10:05	54	32	72		2.791666667
21/02/2015	**11:05**	**57**	**36**	**82**		**3.7**
21/02/2015	12:05	56	37	84		3.408333333
21/02/2015	**13:05**	**53**	**35**	**77**		**3.85**
21/02/2015	**14:05**	**52**	**41**	**74**		**3.883333333**
21/02/2015	**15:05**	**57**	**46**	**75**		**4.366666667**
21/02/2015	16:05	59	57	77		2.941666667
21/02/2015	**17:05**	**56**	**33**	**76**		**3.633333333**
21/02/2015	18:05	51	31	76		1.3
22/02/2015	07:05	57	40	73		0.425
22/02/2015	08:05	52	32	73		1.683333333
22/02/2015	09:05	50	31	75		1.85
22/02/2015	10:05	52	33	75		2.341666667
22/02/2015	11:05	53	36	74		3.066666667
22/02/2015	12:05	52	40	73		3.45
22/02/2015	**13:05**	**52**	**38**	**76**		**3.866666667**
22/02/2015	**14:05**	**56**	**41**	**73**		**4.141666667**
22/02/2015	**15:05**	**58**	**50**	**76**		**4.275**
22/02/2015	**16:05**	**53**	**44**	**73**		**3.866666667**
22/02/2015	**17:05**	**54**	**46**	**71**		**4.116666667**
22/02/2015	**18:05**	**53**	**46**	**75**		**4.441666667**
23/02/2015	07:05	56	36	75		1.8
23/02/2015	08:05	57	40	75		3.291666667
23/02/2015	**09:05**	**56**	**44**	**75**		**4.425**
23/02/2015	**10:05**	**54**	**44**	**75**		**6.683333333**
23/02/2015	**11:05**	**53**	**45**	**74**		**7.908333333**
23/02/2015	**12:05**	**54**	**44**	**74**		**8**
23/02/2015	**13:05**	**55**	**46**	**75**		**8.083333333**
23/02/2015	**14:05**	**56**	**45**	**74**		**7.475**
23/02/2015	**15:05**	**59**	**56**	**74**		**6.966666667**
23/02/2015	**16:05**	**54**	**39**	**74**		**5.266666667**
23/02/2015	17:44	53	35	76		2.733333333
23/02/2015	18:44	51	39	74		3.116666667
24/02/2015	**07:44**	**55**	**36**	**79**		**3.566666667**
24/02/2015	**08:44**	**59**	**47**	**74**		**4.883333333**
24/02/2015	**09:44**	**55**	**46**	**74**		**7.125**
24/02/2015	**10:44**	**56**	**48**	**74**		**7.375**
24/02/2015	**11:44**	**57**	**48**	**74**		**7.875**
24/02/2015	**12:44**	**54**	**39**	**74**		**6.591666667**
24/02/2015	**13:44**	**55**	**39**	**79**		**5.766666667**

24/02/2015	14:44	58	55	75		5.508333333
24/02/2015	15:44	56	44	76		6.166666667
24/02/2015	16:44	55	39	78		5.533333333
24/02/2015	17:44	54	35	77		6.541666667
24/02/2015	18:44	51	32	76		2.958333333
25/02/2015	07:44	57	37	77		0.008333333
25/02/2015	08:44	57	36	76		0.775
25/02/2015	09:44	54	36	74		1.175
25/02/2015	10:44	53	37	74		1.558333333
25/02/2015	11:44	56	36	75		1.55
25/02/2015	12:44	53	33	76		1.516666667
25/02/2015	13:44	54	33	74		0.733333333
25/02/2015	14:44	57	56	74		0.25
25/02/2015	15:44	55	37	73		1.25
25/02/2015	16:44	56	35	77		1.575
25/02/2015	17:44	52	33	75		2.333333333
25/02/2015	18:44	53	32	76		2.3
26/02/2015	07:44	56	35	75		2.533333333
26/02/2015	08:44	56	38	75		2.05
26/02/2015	09:44	50	35	72		3.758333333
26/02/2015	10:44	52	37	75		3.883333333
26/02/2015	11:44	52	37	75		4.2
26/02/2015	12:44	52	37	77		4.3
26/02/2015	13:44	61	38	86		3.816666667
26/02/2015	14:44	60	57	76		3.658333333
26/02/2015	15:44	56	38	76		5.541666667
26/02/2015	16:44	54	34	74		3.716666667
26/02/2015	17:44	53	32	75		2.616666667
26/02/2015	18:44	49	31	72		2.733333333
27/02/2015	07:44	57	37	75		1.016666667
27/02/2015	08:44	60	44	74		2.541666667
27/02/2015	09:44	56	36	77		3.491666667
27/02/2015	10:44	57	39	74		3.991666667
27/02/2015	11:44	56	40	75		4.675
27/02/2015	13:33	57	41	76		5.158333333
27/02/2015	14:33	60	57	75		5.658333333
27/02/2015	15:33	59	35	75		4.758333333
27/02/2015	16:33	56	33	75		4.291666667
27/02/2015	17:33	55	32	76		2
27/02/2015	18:33	54	31	75		0.466666667
28/02/2015	07:33	52	40	72		3.75
28/02/2015	08:33	54	41	75		3.266666667
28/02/2015	09:33	53	40	74		3.475
28/02/2015	10:33	54	37	75		3.1
28/02/2015	11:33	54	36	79		3.175
28/02/2015	12:33	55	37	76		2.65
28/02/2015	13:33	53	29	76		2.55
28/02/2015	14:33	58	32	75		2.391666667
28/02/2015	15:33	60	59	73		1.633333333
28/02/2015	16:33	58	36	73		1.925
28/02/2015	17:33	52	36	73		2.633333333
28/02/2015	18:33	51	36	72		3.083333333
01/03/2015	07:33	56	45	76		8.083333333
01/03/2015	08:33	54	42	79		7.725

01/03/2015	**09:33**	**56**	**45**	**77**		**7.333333333**
01/03/2015	**10:33**	**55**	**45**	**74**		**7.816666667**
01/03/2015	**11:33**	**56**	**46**	**74**		**7.983333333**
01/03/2015	**12:33**	**57**	**48**	**73**		**8.1**
01/03/2015	**13:33**	**57**	**49**	**76**		**9.316666667**
01/03/2015	**14:33**	**59**	**55**	**73**		**9.075**
01/03/2015	**15:33**	**53**	**38**	**77**		**7.3**
01/03/2015	**16:33**	**51**	**35**	**74**		**3.95**
01/03/2015	17:33	49	32	74		2.516666667
01/03/2015	18:33	47	31	73		2.058333333
02/03/2015	07:33	59	41	78		1.483333333
02/03/2015	**08:33**	**59**	**42**	**79**		**4.966666667**
02/03/2015	**09:33**	**56**	**41**	**80**		**4.408333333**
02/03/2015	**10:33**	**56**	**42**	**77**		**5.008333333**
02/03/2015	**11:33**	**55**	**41**	**77**		**6.075**
02/03/2015	**12:33**	**55**	**38**	**72**		**5.933333333**

Raw data and central tendencies for Kirby O Carr

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	47	30	72	-
Mean	47	33	72	-
Mean - 1 s.d.	43	28	-	-
Log Average	48	-	-	-

Table 3: Evening period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	19:05	51	30	74		0.516666667
16/02/2015	20:05	44	30	70		0.983333333
16/02/2015	21:05	47	30	72		1.791666667
16/02/2015	22:05	49	30	75		2.208333333
17/02/2015	19:05	50	30	73		2.025
17/02/2015	20:05	47	30	71		2
17/02/2015	21:05	50	30	76		2.916666667
17/02/2015	22:05	45	22	71		1.716666667
18/02/2015	19:05	50	33	72		2.175
18/02/2015	20:05	47	33	73		2.891666667
18/02/2015	21:05	49	31	75		2.833333333
18/02/2015	22:05	39	31	65		2.658333333
19/02/2015	19:05	51	30	75		1.775
19/02/2015	20:05	48	30	72		0.808333333
19/02/2015	21:05	42	30	70		1.533333333
19/02/2015	22:05	43	30	72		0.25
20/02/2015	19:05	51	30	75		0.683333333
20/02/2015	20:05	45	30	73		2.55
20/02/2015	21:05	42	30	68		0.4
20/02/2015	22:05	42	30	71		0
21/02/2015	19:05	50	30	73		0.433333333
21/02/2015	20:05	47	30	71		0.908333333
21/02/2015	21:05	41	30	71		1.283333333
21/02/2015	22:05	43	30	72		0.091666667
22/02/2015	**19:05**	**52**	**45**	**72**		**4.158333333**
22/02/2015	**20:05**	**47**	**39**	**72**		**4.183333333**
22/02/2015	**21:05**	**48**	**36**	**74**		**5.075**
22/02/2015	**22:05**	**49**	**40**	**72**		**5.991666667**
23/02/2015	**19:44**	**51**	**43**	**69**		**4.325**
23/02/2015	**20:44**	**49**	**40**	**69**		**5.233333333**
23/02/2015	**21:44**	**46**	**36**	**70**		**5.091666667**
23/02/2015	**22:44**	**41**	**33**	**69**		**3.616666667**
24/02/2015	**19:44**	**50**	**32**	**74**		**3.55**
24/02/2015	**20:44**	**46**	**35**	**70**		**4.966666667**
24/02/2015	**21:44**	**50**	**31**	**74**		**3.933333333**
24/02/2015	22:44	44	30	72		3.116666667
25/02/2015	19:44	47	31	72		1.625
25/02/2015	20:44	47	32	72		2.266666667
25/02/2015	21:44	48	34	73		2.725
25/02/2015	22:44	46	33	72		2.558333333

26/02/2015	19:44	48	31	73		1.783333333
26/02/2015	20:44	49	31	76		1.625
26/02/2015	21:44	45	31	71		1.933333333
26/02/2015	22:44	42	30	71		1.541666667
27/02/2015	19:33	49	31	72		0.65
27/02/2015	20:33	47	31	73		1.141666667
27/02/2015	21:33	44	29	70		1.466666667
27/02/2015	22:33	43	29	71		1.975
28/02/2015	**19:33**	**51**	**40**	**81**		**3.733333333**
28/02/2015	**20:33**	**53**	**45**	**72**		**3.808333333**
28/02/2015	**21:33**	**53**	**46**	**72**		**4.45**
28/02/2015	**22:33**	**56**	**46**	**73**		**5.116666667**
01/03/2015	19:33	49	32	74		1.7
01/03/2015	20:33	45	33	71		3.375
01/03/2015	**21:33**	**44**	**34**	**71**		**4.6**
01/03/2015	**22:33**	**42**	**35**	**68**		**3.95**

Raw data and central tendencies for Kirby O Carr

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	58	18	72	-
Mean	43	32	64	-
Mean - 1 s.d.	31	18	-	-
Log Average	53	-	-	-

Table 4: Night-time period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	23:05	42	20	72		1.991666667
17/02/2015	00:05	22	19	46		0.916666667
17/02/2015	01:05	22	20	45		0.6
17/02/2015	02:05	24	20	43		1.416666667
17/02/2015	03:05	40	19	71		0.458333333
17/02/2015	04:05	38	19	69		0.225
17/02/2015	05:05	58	56	72		0.075
17/02/2015	06:05	58	57	72		0.266666667
17/02/2015	23:05	39	22	70		1.8
18/02/2015	00:05	33	25	50		2.158333333
18/02/2015	01:05	35	25	59		1.8
18/02/2015	02:05	30	23	49		1.433333333
18/02/2015	03:05	41	20	74		1.691666667
18/02/2015	04:05	39	20	71		0.85
18/02/2015	05:05	56	30	71		1.791666667
18/02/2015	06:05	59	58	75		1.9
18/02/2015	23:05	41	34	69		2.333333333
19/02/2015	00:05	40	33	70		2.683333333
19/02/2015	01:05	41	33	63		2.675
19/02/2015	02:05	42	31	70		2.65
19/02/2015	03:05	41	33	55		2.541666667
19/02/2015	04:05	39	30	54		2.533333333
19/02/2015	05:05	58	57	70		2.666666667
19/02/2015	06:05	58	55	74		3.241666667
19/02/2015	23:05	22	18	43		0.058333333
20/02/2015	00:05	22	18	45		0.566666667
20/02/2015	01:05	22	18	41		1.3
20/02/2015	02:05	21	18	41		0.441666667
20/02/2015	03:05	41	18	72		0.075
20/02/2015	04:05	34	18	67		0.191666667
20/02/2015	05:05	56	31	71		0.916666667
20/02/2015	06:05	58	57	73		1.225
20/02/2015	23:05	39	30	70		0.116666667
21/02/2015	00:05	45	18	71		0.4
21/02/2015	01:05	39	18	69		0.141666667
21/02/2015	02:05	19	17	42		1.066666667
21/02/2015	03:05	31	17	59		0.841666667
21/02/2015	04:05	38	18	68		0.533333333
21/02/2015	05:05	56	54	72		0.125
21/02/2015	06:05	57	41	71		0.066666667

21/02/2015	23:05	47	29	71		0.808333333
22/02/2015	00:05	46	29	73		0.133333333
22/02/2015	01:05	40	29	67		0.166666667
22/02/2015	02:05	22	18	41		0.166666667
22/02/2015	03:05	28	17	51		0.058333333
22/02/2015	04:05	28	18	54		0.216666667
22/02/2015	05:05	56	31	58		0.058333333
22/02/2015	06:05	58	57	70		0.158333333
22/02/2015	**23:05**	**43**	**34**	**63**		**5.691666667**
23/02/2015	**00:05**	**43**	**35**	**59**		**5.091666667**
23/02/2015	**01:05**	**44**	**35**	**69**		**5.4**
23/02/2015	**02:05**	**43**	**30**	**64**		**4.991666667**
23/02/2015	03:05	31	23	54		3.1
23/02/2015	**04:05**	**42**	**31**	**66**		**3.541666667**
23/02/2015	**05:05**	**56**	**33**	**72**		**4.05**
23/02/2015	06:05	59	57	75		2.766666667
23/02/2015	23:44	41	30	72		3.283333333
24/02/2015	**00:44**	**43**	**36**	**57**		**5.65**
24/02/2015	**01:44**	**42**	**34**	**58**		**5.325**
24/02/2015	**02:44**	**37**	**23**	**57**		**4.941666667**
24/02/2015	03:44	38	23	72		3.1
24/02/2015	**04:44**	**55**	**28**	**71**		**3.991666667**
24/02/2015	**05:44**	**60**	**58**	**75**		**4.35**
24/02/2015	**06:44**	**58**	**43**	**75**		**3.775**
24/02/2015	**23:44**	**41**	**29**	**73**		**4.333333333**
25/02/2015	00:44	23	19	38		2.25
25/02/2015	01:44	36	22	58		0.933333333
25/02/2015	02:44	39	23	58		1.2
25/02/2015	03:44	40	20	72		0.108333333
25/02/2015	04:44	53	20	73		0.025
25/02/2015	05:44	58	57	75		0.125
25/02/2015	06:44	59	45	75		0.041666667
25/02/2015	23:44	42	28	72		2.191666667
26/02/2015	00:44	28	20	47		1.575
26/02/2015	01:44	33	21	60		1.491666667
26/02/2015	02:44	38	23	65		1.916666667
26/02/2015	03:44	34	25	54		2.016666667
26/02/2015	04:44	52	32	73		2.5
26/02/2015	05:44	58	56	73		2.433333333
26/02/2015	06:44	56	41	74		2.983333333
26/02/2015	23:44	38	19	69		1.3
27/02/2015	00:44	20	18	38		1.275
27/02/2015	01:44	23	18	44		0.975
27/02/2015	02:44	23	19	41		2.425
27/02/2015	03:44	31	18	60		1.325
27/02/2015	04:44	54	19	72		0.275
27/02/2015	05:44	59	58	73		0.775
27/02/2015	06:44	60	59	74		0.308333333
27/02/2015	23:33	45	31	72		2.566666667
28/02/2015	00:33	44	34	68		2.8
28/02/2015	01:33	43	33	63		3.058333333
28/02/2015	02:33	45	31	73		3.225
28/02/2015	03:33	47	38	67		3.008333333
28/02/2015	04:33	52	32	62		3.491666667

28/02/2015	05:33	59	56	69		3.091666667
28/02/2015	**06:33**	**55**	**43**	**74**		**3.533333333**
28/02/2015	**23:33**	**53**	**46**	**69**		**7.633333333**
01/03/2015	**00:33**	**54**	**46**	**68**		**9.116666667**
01/03/2015	**01:33**	**54**	**46**	**72**		**8.316666667**
01/03/2015	**02:33**	**53**	**46**	**72**		**8.85**
01/03/2015	**03:33**	**54**	**47**	**71**		**8.458333333**
01/03/2015	**04:33**	**55**	**47**	**69**		**8.533333333**
01/03/2015	**05:33**	**60**	**57**	**72**		**8.808333333**
01/03/2015	**06:33**	**60**	**56**	**76**		**8.925**
01/03/2015	**23:33**	**41**	**29**	**67**		**5.308333333**
02/03/2015	**00:33**	**40**	**30**	**69**		**4.641666667**
02/03/2015	**01:33**	**31**	**23**	**52**		**4.55**
02/03/2015	02:33	31	20	51		3.258333333
02/03/2015	03:33	38	21	69		3.416666667
02/03/2015	04:33	49	20	71		3.375
02/03/2015	05:33	59	58	74		2.908333333
02/03/2015	06:33	60	49	74		1.808333333

Raw data and central tendencies for No 5 Shire Grove

Measure of central tendency	L_{Aeq} **(dB)**	L_{A90} **(dB)**	L_{AFMax} **(dB)**	**Lx**
Mode	53	42	72	-
Mean	51	41	74	-
Mean - 1 s.d.	47	37	-	-
Log Average	52	-	-	-

Table 2: Daytime period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	16:08	47	39	70		0.133333333
16/02/2015	17:08	48	36	74		0.566666667
16/02/2015	18:08	40	31	58		0.375
17/02/2015	07:08	52	43	72		0.341666667
17/02/2015	08:08	53	44	70		0.491666667
17/02/2015	09:08	53	43	73		1.458333333
17/02/2015	10:08	52	42	71		3.125
17/02/2015	**11:08**	**53**	**46**	**84**		**5.675**
17/02/2015	**12:08**	**50**	**46**	**68**		**6.241666667**
17/02/2015	**13:08**	**51**	**44**	**80**		**5.725**
17/02/2015	**14:08**	**51**	**44**	**68**		**5.8**
17/02/2015	**15:08**	**49**	**43**	**68**		**4.533333333**
17/02/2015	**16:08**	**47**	**40**	**77**		**3.666666667**
17/02/2015	17:08	52	39	81		2.125
17/02/2015	18:08	43	35	76		2.491666667
18/02/2015	07:08	57	45	74		2.591666667
18/02/2015	08:08	55	43	73		2.533333333
18/02/2015	09:08	54	43	72		2.125
18/02/2015	10:08	56	45	83		2.05
18/02/2015	**11:08**	**53**	**43**	**70**		**4.475**
18/02/2015	**12:08**	**53**	**43**	**74**		**4.225**
18/02/2015	**13:08**	**54**	**42**	**78**		**5.366666667**
18/02/2015	**14:08**	**49**	**42**	**77**		**5.275**
18/02/2015	**15:08**	**52**	**43**	**71**		**4.65**
18/02/2015	**16:08**	**56**	**42**	**81**		**4.341666667**
18/02/2015	17:08	56	39	81		3.108333333
18/02/2015	**18:08**	**47**	**35**	**83**		**3.575**
19/02/2015	07:08	58	42	73		2.691666667
19/02/2015	08:08	55	44	74		2.841666667
19/02/2015	09:08	54	44	74		2.608333333
19/02/2015	10:08	54	43	71		2.541666667
19/02/2015	11:08	52	44	69		2.408333333
19/02/2015	12:08	53	42	70		2.975
19/02/2015	**13:08**	**50**	**42**	**69**		**3.775**
19/02/2015	14:08	51	42	68		3.183333333
19/02/2015	15:08	52	43	83		2.991666667
19/02/2015	16:08	54	42	72		3.391666667
19/02/2015	**17:08**	**55**	**41**	**84**		**3.825**
19/02/2015	18:08	45	33	68		1.25
20/02/2015	07:08	54	44	72		0.816666667

20/02/2015	08:08	53	44	86		0.55
20/02/2015	09:08	56	44	78		2.408333333
20/02/2015	10:08	53	42	72		1.841666667
20/02/2015	11:08	54	44	76		3.083333333
20/02/2015	**12:08**	**48**	**39**	**69**		**4.741666667**
20/02/2015	**13:08**	**50**	**40**	**71**		**4.15**
20/02/2015	**14:08**	**47**	**39**	**69**		**4.283333333**
20/02/2015	**15:08**	**57**	**42**	**81**		**4.3**
20/02/2015	16:08	50	39	73		2.991666667
20/02/2015	17:08	48	36	75		2.55
20/02/2015	18:08	41	33	65		1.533333333
21/02/2015	07:08	53	42	72		0.191666667
21/02/2015	08:08	51	42	69		0.091666667
21/02/2015	09:08	52	42	79		1.691666667
21/02/2015	10:08	51	42	81		2.791666667
21/02/2015	**11:08**	**52**	**42**	**70**		**3.7**
21/02/2015	12:08	50	41	80		3.408333333
21/02/2015	**13:08**	**49**	**40**	**75**		**3.85**
21/02/2015	**14:08**	**48**	**42**	**71**		**3.883333333**
21/02/2015	**15:08**	**51**	**42**	**83**		**4.366666667**
21/02/2015	16:08	51	40	82		2.941666667
21/02/2015	**17:08**	**51**	**39**	**75**		**3.633333333**
21/02/2015	18:08	41	31	70		1.3
22/02/2015	07:08	52	41	77		0.425
22/02/2015	08:08	52	40	70		1.683333333
22/02/2015	09:08	49	38	78		1.85
22/02/2015	10:08	51	42	78		2.341666667
22/02/2015	11:08	55	42	87		3.066666667
22/02/2015	12:08	54	45	78		3.45
22/02/2015	**13:08**	**54**	**45**	**78**		**3.866666667**
22/02/2015	**14:08**	**53**	**45**	**71**		**4.141666667**
22/02/2015	**15:08**	**53**	**46**	**71**		**4.275**
22/02/2015	**16:08**	**51**	**46**	**65**		**3.866666667**
22/02/2015	**17:08**	**53**	**47**	**82**		**4.116666667**
22/02/2015	**18:08**	**51**	**47**	**65**		**4.441666667**
23/02/2015	07:08	52	43	73		1.8
23/02/2015	08:08	54	45	71		3.291666667
23/02/2015	**09:08**	**54**	**46**	**83**		**4.425**
23/02/2015	**10:08**	**55**	**49**	**72**		**6.683333333**
23/02/2015	**11:08**	**54**	**49**	**71**		**7.908333333**
23/02/2015	**12:08**	**55**	**49**	**77**		**8**
23/02/2015	**13:08**	**55**	**49**	**73**		**8.083333333**
23/02/2015	**14:08**	**53**	**46**	**71**		**7.475**
23/02/2015	**15:08**	**51**	**42**	**70**		**6.966666667**
23/02/2015	**16:08**	**48**	**41**	**69**		**5.266666667**
23/02/2015	17:36	49	37	75		2.733333333
23/02/2015	18:36	51	40	75		3.116666667
24/02/2015	**07:36**	**53**	**42**	**76**		**3.566666667**
24/02/2015	**08:36**	**54**	**46**	**75**		**4.883333333**
24/02/2015	**09:36**	**54**	**48**	**70**		**7.125**
24/02/2015	**10:36**	**54**	**47**	**68**		**7.375**
24/02/2015	**11:36**	**54**	**50**	**66**		**7.875**
24/02/2015	**12:36**	**53**	**44**	**79**		**6.591666667**
24/02/2015	**13:36**	**51**	**45**	**71**		**5.766666667**

24/02/2015	**14:36**	**50**	**42**	**69**		**5.508333333**
24/02/2015	**15:36**	**51**	**45**	**85**		**6.166666667**
24/02/2015	**16:36**	**48**	**41**	**76**		**5.533333333**
24/02/2015	**17:36**	**50**	**41**	**85**		**6.541666667**
24/02/2015	18:36	42	32	64		2.958333333
25/02/2015	07:36	53	45	73		0.008333333
25/02/2015	08:36	52	43	69		0.775
25/02/2015	09:36	53	41	72		1.175
25/02/2015	10:36	51	42	74		1.558333333
25/02/2015	11:36	55	42	77		1.55
25/02/2015	12:36	51	40	68		1.516666667
25/02/2015	13:36	51	38	72		0.733333333
25/02/2015	14:36	50	41	68		0.25
25/02/2015	15:36	50	41	77		1.25
25/02/2015	16:36	47	40	68		1.575
25/02/2015	17:36	48	36	69		2.333333333
25/02/2015	18:36	47	36	79		2.3
26/02/2015	07:36	54	44	79		2.533333333
26/02/2015	08:36	54	46	83		2.05
26/02/2015	**09:36**	**50**	**41**	**68**		**3.758333333**
26/02/2015	**10:36**	**51**	**41**	**79**		**3.883333333**
26/02/2015	**11:36**	**49**	**39**	**68**		**4.2**
26/02/2015	**12:36**	**47**	**38**	**70**		**4.3**
26/02/2015	**13:36**	**62**	**39**	**88**		**3.816666667**
26/02/2015	**14:36**	**50**	**37**	**75**		**3.658333333**
26/02/2015	**15:36**	**49**	**41**	**73**		**5.541666667**
26/02/2015	**16:36**	**49**	**38**	**80**		**3.716666667**
26/02/2015	17:36	48	33	75		2.616666667
26/02/2015	18:36	38	30	60		2.733333333
27/02/2015	07:36	55	44	80		1.016666667
27/02/2015	08:36	53	43	72		2.541666667
27/02/2015	09:36	53	41	82		3.491666667
27/02/2015	**10:36**	**53**	**40**	**78**		**3.991666667**
27/02/2015	**11:36**	**52**	**40**	**71**		**4.675**
27/02/2015	**12:43**	**49**	**41**	**66**		**5.158333333**
27/02/2015	**13:43**	**51**	**41**	**76**		**5.658333333**
27/02/2015	**14:43**	**47**	**39**	**66**		**4.758333333**
27/02/2015	**15:43**	**55**	**39**	**76**		**4.291666667**
27/02/2015	16:43	53	38	81		2
27/02/2015	17:43	48	35	73		0.466666667
27/02/2015	18:43	40	31	67		0.65
28/02/2015	07:43	53	40	72		3.266666667
28/02/2015	08:43	52	42	70		3.475
28/02/2015	09:43	53	42	81		3.1
28/02/2015	10:43	50	41	74		3.175
28/02/2015	11:43	51	38	70		2.65
28/02/2015	12:43	52	40	73		2.55
28/02/2015	13:43	49	39	75		2.391666667
28/02/2015	14:43	47	38	71		1.633333333
28/02/2015	15:43	50	39	69		1.925
28/02/2015	16:43	55	38	88		2.633333333
28/02/2015	17:43	49	38	74		3.083333333
28/02/2015	**18:43**	**43**	**38**	**59**		**3.733333333**
01/03/2015	**07:43**	**55**	**47**	**79**		**7.725**

01/03/2015	**08:43**	**53**	**46**	**78**		**7.333333333**
01/03/2015	**09:43**	**52**	**45**	**80**		**7.816666667**
01/03/2015	**10:43**	**54**	**47**	**70**		**7.983333333**
01/03/2015	**11:43**	**54**	**46**	**81**		**8.1**
01/03/2015	**12:43**	**56**	**48**	**69**		**9.316666667**
01/03/2015	**13:43**	**57**	**49**	**73**		**9.075**
01/03/2015	**14:43**	**48**	**42**	**70**		**7.3**
01/03/2015	**15:43**	**48**	**39**	**78**		**3.95**
01/03/2015	16:43	45	36	73		2.516666667
01/03/2015	17:43	47	31	68		2.058333333
01/03/2015	18:43	35	28	58		1.7
02/03/2015	**07:43**	**53**	**44**	**75**		**4.966666667**
02/03/2015	**08:43**	**50**	**40**	**70**		**4.408333333**
02/03/2015	**09:43**	**53**	**44**	**70**		**5.008333333**
02/03/2015	**10:43**	**51**	**43**	**82**		**6.075**
02/03/2015	**11:43**	**49**	**42**	**72**		**5.933333333**

Raw data and central tendencies for No 5 Shire Grove

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	37	29	56	-
Mean	42	32	67	-
Mean - 1 s.d.	36	26	-	-
Log Average	47	-	-	-

Table 3: Evening period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	19:08	51	29	82		0.516666667
16/02/2015	20:08	41	28	79		0.983333333
16/02/2015	21:08	36	29	56		1.791666667
16/02/2015	22:08	49	27	81		2.208333333
17/02/2015	19:08	39	31	58		2.025
17/02/2015	20:08	36	29	60		2
17/02/2015	21:08	44	29	83		2.916666667
17/02/2015	22:08	33	28	53		1.716666667
18/02/2015	19:08	40	34	57		2.175
18/02/2015	20:08	37	32	54		2.891666667
18/02/2015	21:08	40	29	74		2.833333333
18/02/2015	22:08	43	27	76		2.658333333
19/02/2015	19:08	41	30	68		1.775
19/02/2015	20:08	37	28	59		0.808333333
19/02/2015	21:08	34	26	56		1.533333333
19/02/2015	22:08	47	25	83		0.25
20/02/2015	19:08	39	29	57		0.683333333
20/02/2015	20:08	52	27	82		2.55
20/02/2015	21:08	36	26	56		0.4
20/02/2015	22:08	47	25	79		0
21/02/2015	19:08	37	28	59		0.433333333
21/02/2015	20:08	36	27	56		0.908333333
21/02/2015	21:08	35	26	53		1.283333333
21/02/2015	22:08	52	25	91		0.091666667
22/02/2015	**19:08**	**50**	**45**	**72**		**4.158333333**
22/02/2015	**20:08**	**46**	**41**	**57**		**4.183333333**
22/02/2015	**21:08**	**44**	**36**	**61**		**5.075**
22/02/2015	**22:08**	**48**	**39**	**81**		**5.991666667**
23/02/2015	**19:36**	**50**	**44**	**64**		**4.325**
23/02/2015	**20:36**	**51**	**43**	**65**		**5.233333333**
23/02/2015	**21:36**	**48**	**38**	**81**		**5.091666667**
23/02/2015	**22:36**	**39**	**35**	**56**		**3.616666667**
24/02/2015	**19:36**	**40**	**31**	**71**		**3.55**
24/02/2015	**20:36**	**44**	**36**	**66**		**4.966666667**
24/02/2015	**21:36**	**43**	**30**	**79**		**3.933333333**
24/02/2015	22:36	34	26	54		3.116666667
25/02/2015	19:36	41	31	69		1.625
25/02/2015	20:36	39	32	61		2.266666667
25/02/2015	21:36	46	34	82		2.725
25/02/2015	22:36	37	31	56		2.558333333

26/02/2015	19:36	53	28	87		1.783333333
26/02/2015	20:36	35	26	53		1.625
26/02/2015	21:36	45	26	81		1.933333333
26/02/2015	22:36	31	25	52		1.541666667
27/02/2015	19:43	37	27	57		1.141666667
27/02/2015	20:43	37	27	73		1.466666667
27/02/2015	21:43	36	29	66		1.975
27/02/2015	22:43	44	31	80		2.566666667
28/02/2015	**19:43**	**47**	**40**	**78**		**3.808333333**
28/02/2015	**20:43**	**53**	**44**	**66**		**4.45**
28/02/2015	**21:43**	**53**	**46**	**82**		**5.116666667**
28/02/2015	**22:43**	**57**	**47**	**69**		**7.633333333**
01/03/2015	19:43	37	30	57		3.375
01/03/2015	**20:43**	**35**	**30**	**54**		**4.6**
01/03/2015	**21:43**	**48**	**33**	**81**		**3.95**
01/03/2015	**22:43**	**39**	**33**	**51**		**5.308333333**

Raw data and central tendencies for No 5 Shire Grove

Measure of central tendency	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx
Mode	32	24	53	-
Mean	39	31	57	-
Mean - 1 s.d.	30	24	-	-
Log Average	47	-	-	-

Table 4: Night-time period

Date	Time	L_{Aeq} (dB)	L_{A90} (dB)	L_{AFMax} (dB)	Lx	Wind speed
16/02/2015	23:08	33	28	57		1.991666667
17/02/2015	00:08	32	26	53		0.916666667
17/02/2015	01:08	30	26	48		0.6
17/02/2015	02:08	31	26	46		1.416666667
17/02/2015	03:08	31	26	45		0.458333333
17/02/2015	04:08	32	26	49		0.225
17/02/2015	05:08	46	28	71		0.075
17/02/2015	06:08	55	38	71		0.266666667
17/02/2015	23:08	32	28	49		1.8
18/02/2015	00:08	31	29	47		2.158333333
18/02/2015	01:08	32	28	52		1.8
18/02/2015	02:08	31	26	44		1.433333333
18/02/2015	03:08	35	26	64		1.691666667
18/02/2015	04:08	32	26	52		0.85
18/02/2015	05:08	37	29	67		1.791666667
18/02/2015	06:08	50	35	70		1.9
18/02/2015	23:08	35	30	50		2.333333333
19/02/2015	00:08	37	34	56		2.683333333
19/02/2015	01:08	39	36	47		2.675
19/02/2015	02:08	40	36	49		2.65
19/02/2015	03:08	37	34	55		2.541666667
19/02/2015	04:08	36	32	51		2.533333333
19/02/2015	05:08	41	36	53		2.666666667
19/02/2015	06:08	52	42	71		3.241666667
19/02/2015	23:08	29	25	47		0.058333333
20/02/2015	00:08	32	24	61		0.566666667
20/02/2015	01:08	29	24	44		1.3
20/02/2015	02:08	29	24	41		0.441666667
20/02/2015	03:08	32	25	51		0.075
20/02/2015	04:08	31	25	46		0.191666667
20/02/2015	05:08	37	28	64		0.916666667
20/02/2015	06:08	53	38	75		1.225
20/02/2015	23:08	34	26	54		0.116666667
21/02/2015	00:08	32	24	50		0.4
21/02/2015	01:08	32	23	51		0.141666667
21/02/2015	02:08	29	23	51		1.066666667
21/02/2015	03:08	31	24	42		0.841666667
21/02/2015	04:08	31	24	47		0.533333333
21/02/2015	05:08	37	28	67		0.125
21/02/2015	06:08	51	37	70		0.066666667

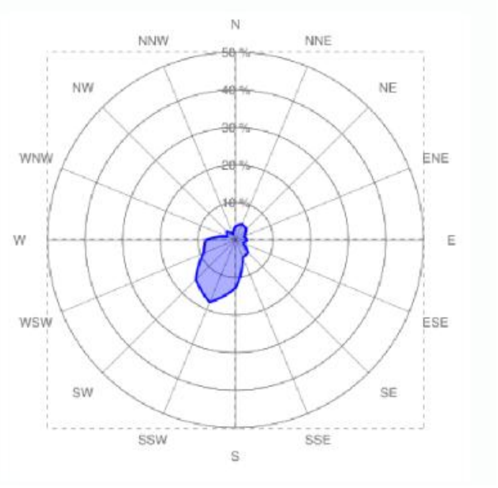
21/02/2015	23:08	32	25	52		0.808333333
22/02/2015	00:08	32	25	54		0.133333333
22/02/2015	01:08	29	24	49		0.166666667
22/02/2015	02:08	24	22	41		0.166666667
22/02/2015	03:08	27	22	47		0.058333333
22/02/2015	04:08	27	23	45		0.216666667
22/02/2015	05:08	32	25	66		0.058333333
22/02/2015	06:08	50	35	72		0.158333333
22/02/2015	**23:08**	**39**	**33**	**55**		**5.691666667**
23/02/2015	**00:08**	**40**	**32**	**55**		**5.091666667**
23/02/2015	**01:08**	**40**	**35**	**51**		**5.4**
23/02/2015	**02:08**	**39**	**31**	**60**		**4.991666667**
23/02/2015	03:08	31	25	44		3.1
23/02/2015	**04:08**	**41**	**33**	**56**		**3.541666667**
23/02/2015	**05:08**	**41**	**32**	**58**		**4.05**
23/02/2015	06:08	49	36	70		2.766666667
23/02/2015	23:36	35	27	49		3.283333333
24/02/2015	**00:36**	**41**	**37**	**56**		**5.65**
24/02/2015	**01:36**	**37**	**34**	**50**		**5.325**
24/02/2015	**02:36**	**38**	**29**	**51**		**4.941666667**
24/02/2015	03:36	34	26	52		3.1
24/02/2015	**04:36**	**36**	**29**	**50**		**3.991666667**
24/02/2015	**05:36**	**47**	**38**	**70**		**4.35**
24/02/2015	**06:36**	**55**	**42**	**72**		**3.775**
24/02/2015	**23:36**	**35**	**24**	**52**		**4.333333333**
25/02/2015	00:36	27	22	51		2.25
25/02/2015	01:36	45	23	56		0.933333333
25/02/2015	02:36	51	37	60		1.2
25/02/2015	03:36	33	26	59		0.108333333
25/02/2015	04:36	38	25	69		0.025
25/02/2015	05:36	48	30	74		0.125
25/02/2015	06:36	54	43	74		0.041666667
25/02/2015	23:36	36	32	53		2.191666667
26/02/2015	00:36	32	28	51		1.575
26/02/2015	01:36	34	28	53		1.491666667
26/02/2015	02:36	35	29	54		1.916666667
26/02/2015	03:36	35	30	54		2.016666667
26/02/2015	04:36	39	32	61		2.5
26/02/2015	05:36	45	34	70		2.433333333
26/02/2015	06:36	55	43	72		2.983333333
26/02/2015	23:36	29	24	54		1.3
27/02/2015	00:36	25	24	36		1.275
27/02/2015	01:36	26	24	42		0.975
27/02/2015	02:36	26	24	53		2.425
27/02/2015	03:36	28	24	41		1.325
27/02/2015	04:36	37	25	67		0.275
27/02/2015	05:36	49	30	70		0.775
27/02/2015	06:36	54	43	73		0.308333333
27/02/2015	23:43	39	34	53		2.8
28/02/2015	00:43	40	34	53		3.058333333
28/02/2015	01:43	41	35	52		3.225
28/02/2015	02:43	41	34	57		3.008333333
28/02/2015	03:43	42	35	55		3.491666667
28/02/2015	04:43	42	32	55		3.091666667

28/02/2015	**05:43**	**51**	**41**	**73**		**3.533333333**
28/02/2015	**06:43**	**54**	**44**	**76**		**3.75**
28/02/2015	**23:43**	**54**	**47**	**67**		**9.116666667**
01/03/2015	**00:43**	**53**	**47**	**67**		**8.316666667**
01/03/2015	**01:43**	**55**	**47**	**68**		**8.85**
01/03/2015	**02:43**	**51**	**45**	**63**		**8.458333333**
01/03/2015	**03:43**	**54**	**47**	**66**		**8.533333333**
01/03/2015	**04:43**	**55**	**48**	**69**		**8.808333333**
01/03/2015	**05:43**	**56**	**50**	**74**		**8.925**
01/03/2015	**06:43**	**57**	**45**	**75**		**8.083333333**
01/03/2015	**23:43**	**36**	**31**	**46**		**4.641666667**
02/03/2015	**00:43**	**37**	**30**	**50**		**4.55**
02/03/2015	01:43	29	26	45		3.258333333
02/03/2015	02:43	31	25	44		3.416666667
02/03/2015	03:43	31	24	47		3.375
02/03/2015	04:43	33	25	54		2.908333333
02/03/2015	05:43	48	33	69		1.808333333
02/03/2015	06:43	52	41	68		1.483333333

Report: List of model attributes
Model: Copy of Rev 8 Pre-Stim Workover at Night

Model property	
Description	Copy of Rev 8 Pre-Stim Workover at Night
Responsible	RKirkaldy
Calculation method	ISO 9613.1/2
Created by	RKirkaldy on 15/09/2014
Last accessed by	PC06 on 02/05/2015
Model created using	Predictor V9.11
Default terrain level	20
Contour calculation height	1.5
Detail level receiver results	Source results
Detail level grid results	Group results
Meteorological correction	Single value, C0: 2.00
Ground attenuation	General method, ground factor = 0.8
Temperature [K]	283.15
Pressure [kPa]	101.330
Air humidity [%]	60.0
Cluster buildings	Yes
Remove inner walls	Yes
Air absorption [dB/km]	0.04 0.14 0.44 1.05 1.89 3.86 11.08 38.78 135.77
Fetching radius	--
Dynamic Error Margin	--

Comments



Rensmart wind rose for RAF Waddington, near Lincoln

RenSMART Power Wind Rose Table

Direction	Percentage
N	3.71
NNE	4.62
NE	4.12
ENE	2.47
E	3.12
ESE	2.12
SE	4.71
SSE	5.05
S	12.79
SSW	17.95
SW	14.93
WSW	9.16
W	7.88
WNW	2.41
NW	3.32
NNW	1.64

Only 17% of time downwind to Pos 2 at Kirby O Carr and therefore this is not common nor a reasonable basis for predicting noise.. An averaging of levels under a range of wind directions (conservatively estimated as equal likelihood in any direction) is considered reasonable using a Cmet = 2

A P P E N D I X 11.3

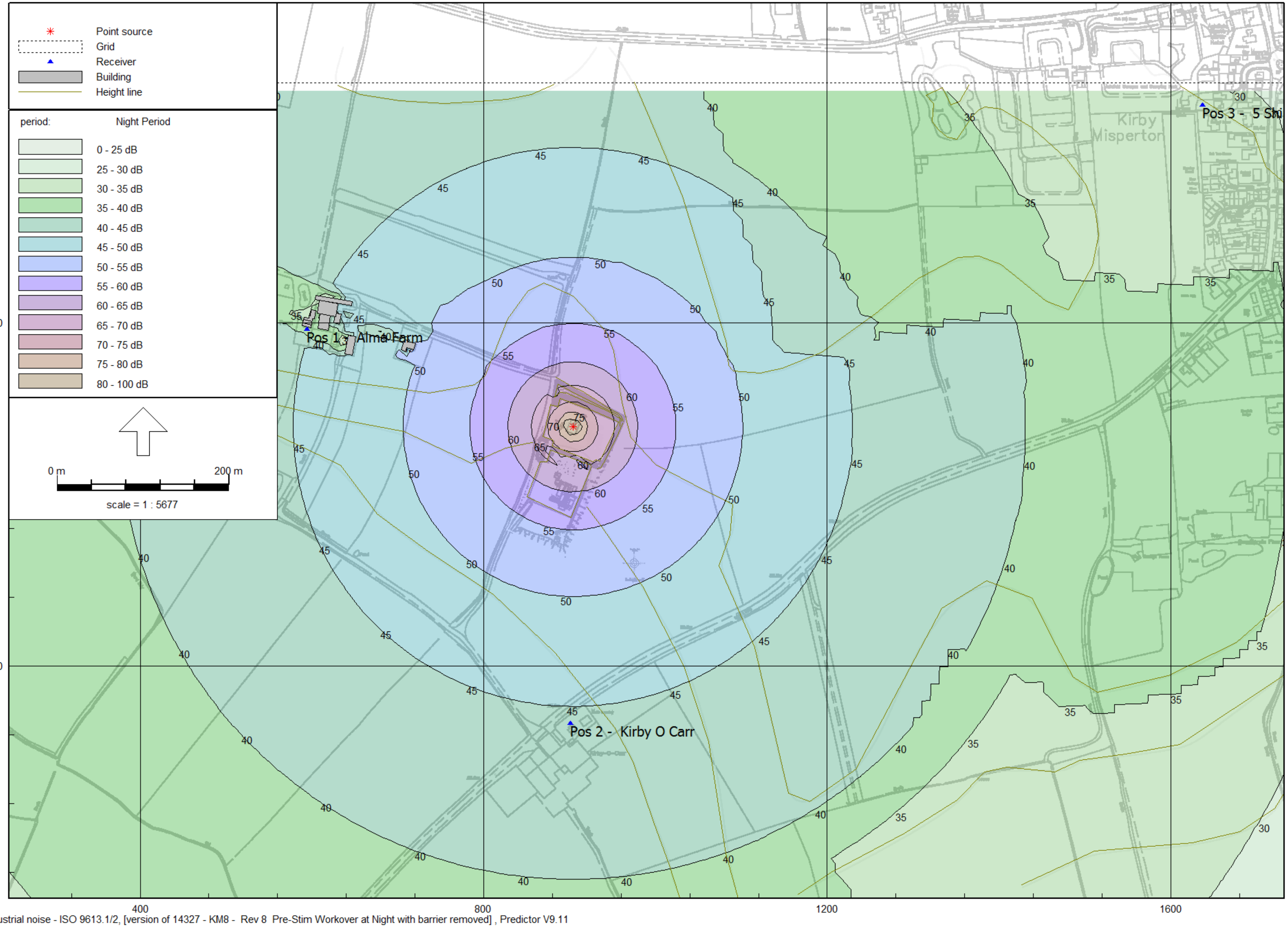
CRTN calculation of change in road traffic noise

		Total vehicles both ways / hour							*L10 = 42.2 + 10 log q. In (dBA) .Where q is vehicles per hour, and V = 75 km/hr*	*Correction = 33*log10((f8)+40+500/(f8))+10*log10(1+5*f9/f8)-68.8*	*Correction = -8*(log10(f5/200))*(log10(f5/200))*	**NB this value does not include corrections for gradient and for road surface*
		CURRENT	**CURRENT**	**EXTRA**	**EXTRA**							
Location	**Phase in development**	**Heavy**	**Light**	**Heavy**	**Light**	**Mean traffic speed (v) km/hr**	**Vehlcles per hour (q)**	**% Heavy vehicles (p) - %**	**Basic Noise Level - chart 2**	**Correction for mean traffic speed (v) and % HGV (p) - chart 4**	**Correction (K) for low flow (50<q<200) - chart 12**	**Corrected Basic Noise Level at 10m (Hourly LA10)***
Location 1 Habton Road	Current	1.3	26.7			68	**28**	**5**	**56.7**	**0.5**	**-5.8**	**51.4**
Location 2 Kirby Misperton Road	Current	6.1	95.9			69	**102**	**6**	**62.3**	**0.9**	**-0.7**	**62.5**
Location 1 Habton Road	Noise barrier	1.3	26.7	4	2	68	**34**	**16**	**57.5**	**2.6**	**-4.7**	**55.3**
Location 2 Kirby Misperton Road	Noise barrier	6.1	95.9	4	2	69	108	9	62.5	1.6	-0.6	63.6
Location 1 Habton Road	PS Workover	1.3	26.7	4	6	68	38	14	58.0	2.3	-4.2	56.1
Location 2 Kirby Misperton Road	PS Workover	6.1	95.9	4	6	69	112	9	62.7	1.5	-0.5	63.7
Location 1 Habton Road	HF and well test	1.3	26.7	4	10	68	42	13	58.4	2.1	-3.7	56.9
Location 2 Kirby Misperton Road	HF and well test	6.1	95.9	4	10	69	116	9	62.8	1.5	-0.4	63.9
Location 1 Habton Road	Restoration	1.3	26.7	4	3	68	35	15	57.6	2.5	-4.6	55.6
Location 2 Kirby Misperton Road	Restoration	6.1	95.9	4	3	69	109	9	62.6	1.6	-0.6	63.6

APPENDIX 11.4

Predicted noise results

- Noise contour maps and results tables (pre simulation workover) without and with noise barrier
- Noise contour maps and results tables (HF and well test) without and with noise barrier (daytime)
- Noise contour maps and results tables (HF and well test) without and with noise barrier (night time)
- Noise contour maps and results table (normal production)



Rev 9 Pre Stim Workover with noise barrier removed
29 Apr 2015, 20:41

Spectrum Acoustics Consultants, UK

Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 8 Pre-Stim Workover at Night with barrier removed] , Predictor V9.11

Report: Table of Results
Model: Rev 8 Pre-Stim Workover at Night with barrier removed
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Night Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	39	11	31	32	30	35	32	27	16	-28
_B	Pos 1 - Alma Farm	4.50	42	11	31	32	33	37	36	33	24	-17
_A	Pos 2 - Kirby O Carr	1.50	44	14	35	33	29	38	41	36	26	-16
_B	Pos 2 - Kirby O Carr	4.50	46	14	35	32	34	42	41	36	26	-16
_A	Pos 3 - 5 Shire Close	1.50	31	-3	18	22	21	27	26	17	-6	-95
_B	Pos 3 - 5 Shire Close	4.50	32	-3	18	22	24	28	26	17	-6	-95

All shown dB values are A-weighted

Rev 8 Pre Stim Workover
29 Apr 2015, 20:41

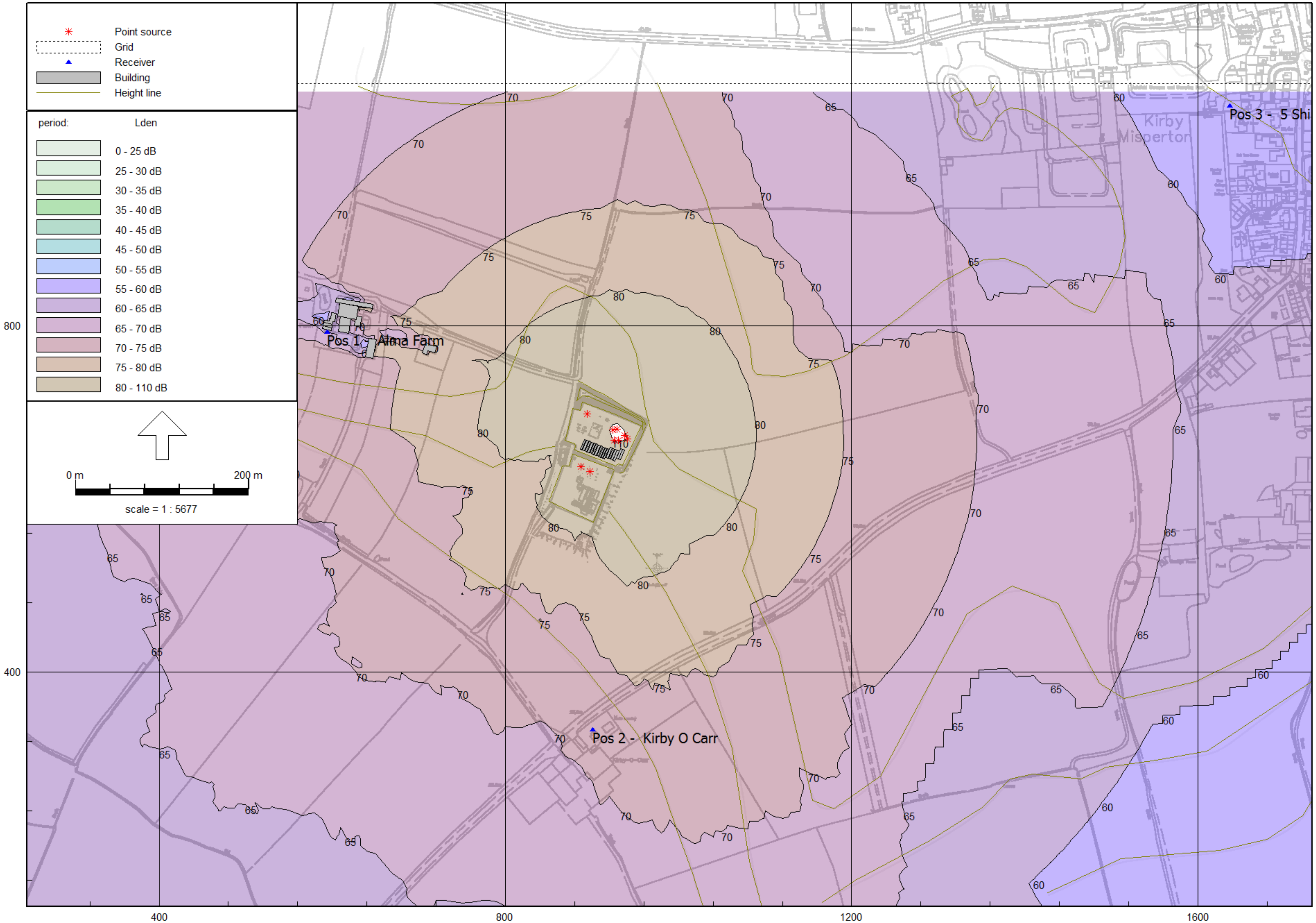
Spectrum Acoustics Consultants, UK

Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 8 Pre-Stim Workover at Night] , Predictor V9.11

Report: Table of Results
Model: Rev 8 Pre-Stim Workover at Night
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Night Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	32	2	21	27	26	26	22	15	5	-36
_B	Pos 1 - Alma Farm	4.50	34	3	21	28	27	28	24	17	5	-36
_A	Pos 2 - Kirby O Carr	1.50	45	14	35	34	31	38	41	36	26	-16
_B	Pos 2 - Kirby O Carr	4.50	46	14	35	33	35	42	41	36	26	-16
_A	Pos 3 - 5 Shire Close	1.50	29	-3	17	22	21	25	21	10	-15	--
_B	Pos 3 - 5 Shire Close	4.50	31	-3	17	22	22	27	24	13	-12	-104

All shown dB values are A-weighted



Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 13 HF etc daytime without noise barrier] , Predictor V9.11

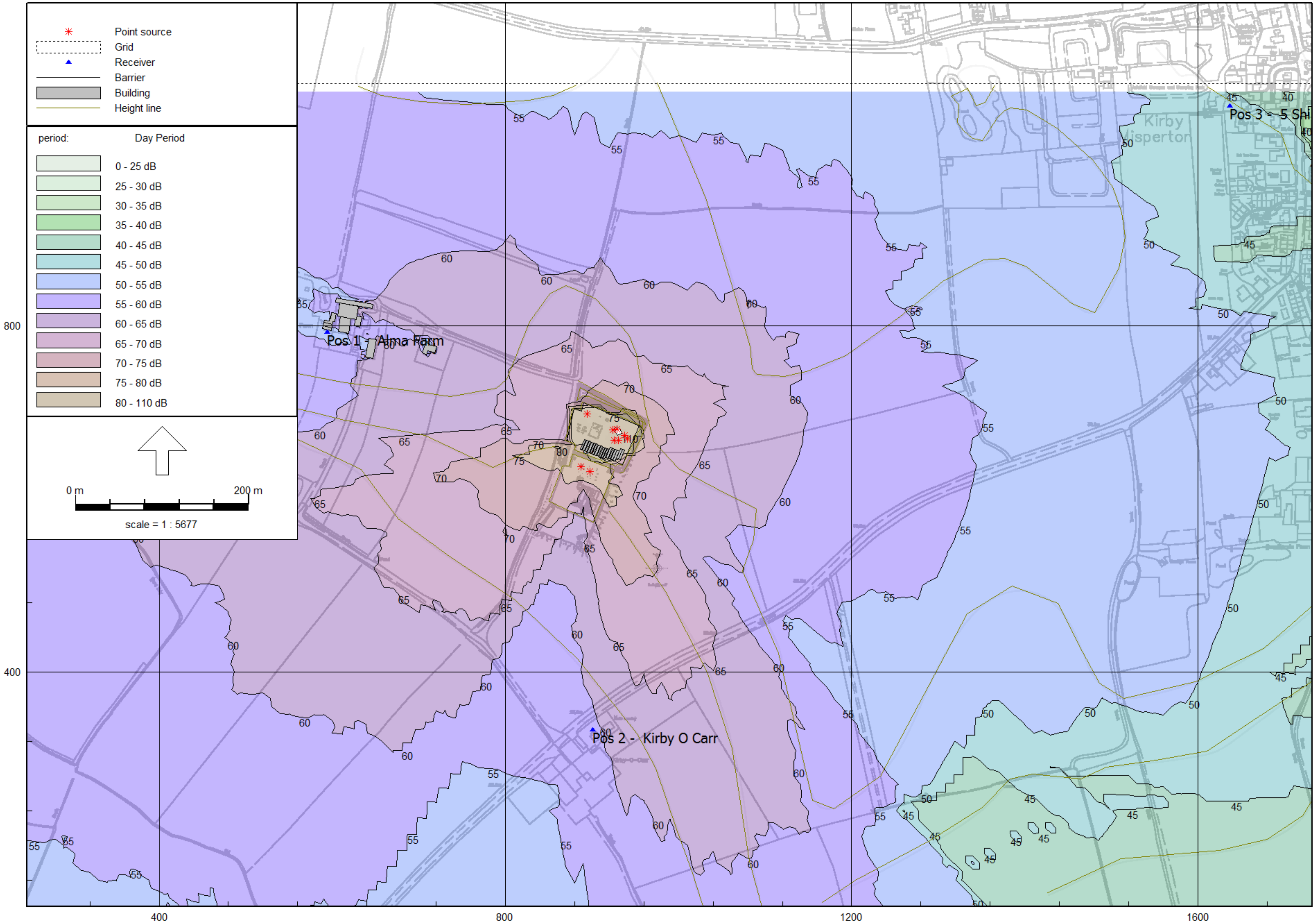
Rev 13 HF daytime without noise barrier
29 Apr 2015, 20:41

Spectrum Acoustics Consultants, UK

Report: Table of Results
Model: Rev 13 HF etc daytime without noise barrier
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	59	23	46	53	49	53	54	51	35	-11
_B	Pos 1 - Alma Farm	4.50	62	23	46	54	51	55	57	56	43	-1
_A	Pos 2 - Kirby O Carr	1.50	65	27	49	55	49	56	61	60	46	3
_B	Pos 2 - Kirby O Carr	4.50	65	26	49	54	53	58	61	60	46	3
_A	Pos 3 - 5 Shire Close	1.50	52	10	34	44	41	46	48	42	16	-71
_B	Pos 3 - 5 Shire Close	4.50	52	10	34	45	43	46	48	42	16	-71

All shown dB values are A-weighted



Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 12 HF etc daytime with barrier] , Predictor V9.11

Rev 12 HF daytime with noise barrier
29 Apr 2015, 20:41

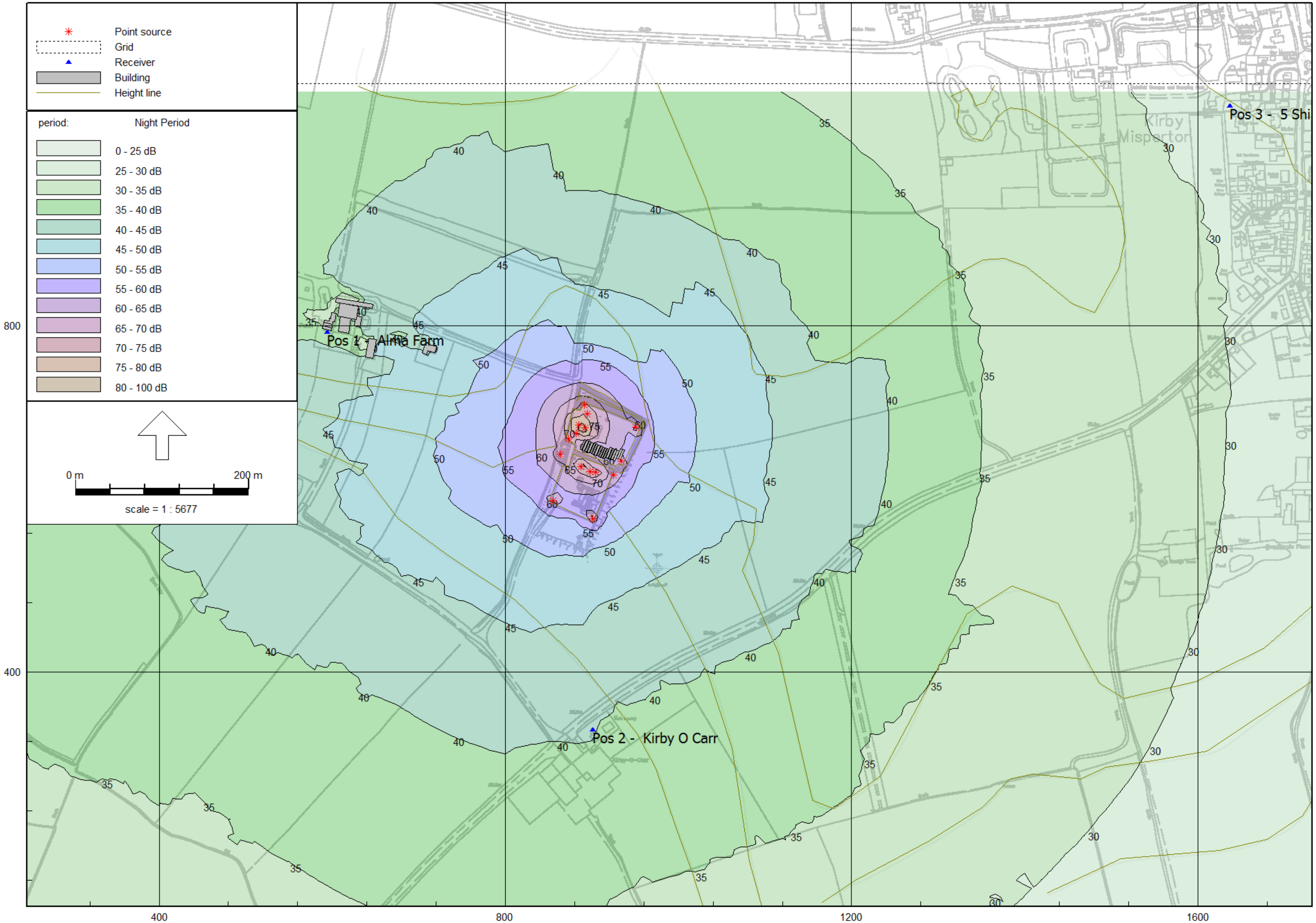
Spectrum Acoustics Consultants, UK

Report: Table of Results
Model: Rev 12 HF etc daytime with barrier
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Day Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	54	16	41	50	46	46	45	41	25	-20
_B	Pos 1 - Alma Farm	4.50	56	17	42	52	47	48	47	43	27	-19
_A	Pos 2 - Kirby O Carr	1.50	59	18	42	52	48	49	53	55	41	-4
_B	Pos 2 - Kirby O Carr	4.50	60	18	43	53	49	50	53	55	41	-3
_A	Pos 3 - 5 Shire Close	1.50	48	9	33	43	40	42	41	33	4	-85
_B	Pos 3 - 5 Shire Close	4.50	49	9	33	43	41	42	42	34	5	-84

All shown dB values are A-weighted

Rev 11 HF at night without noise barrier
29 Apr 2015, 20:41



Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 11 HF etc night without noise barrier] , Predictor V9.11

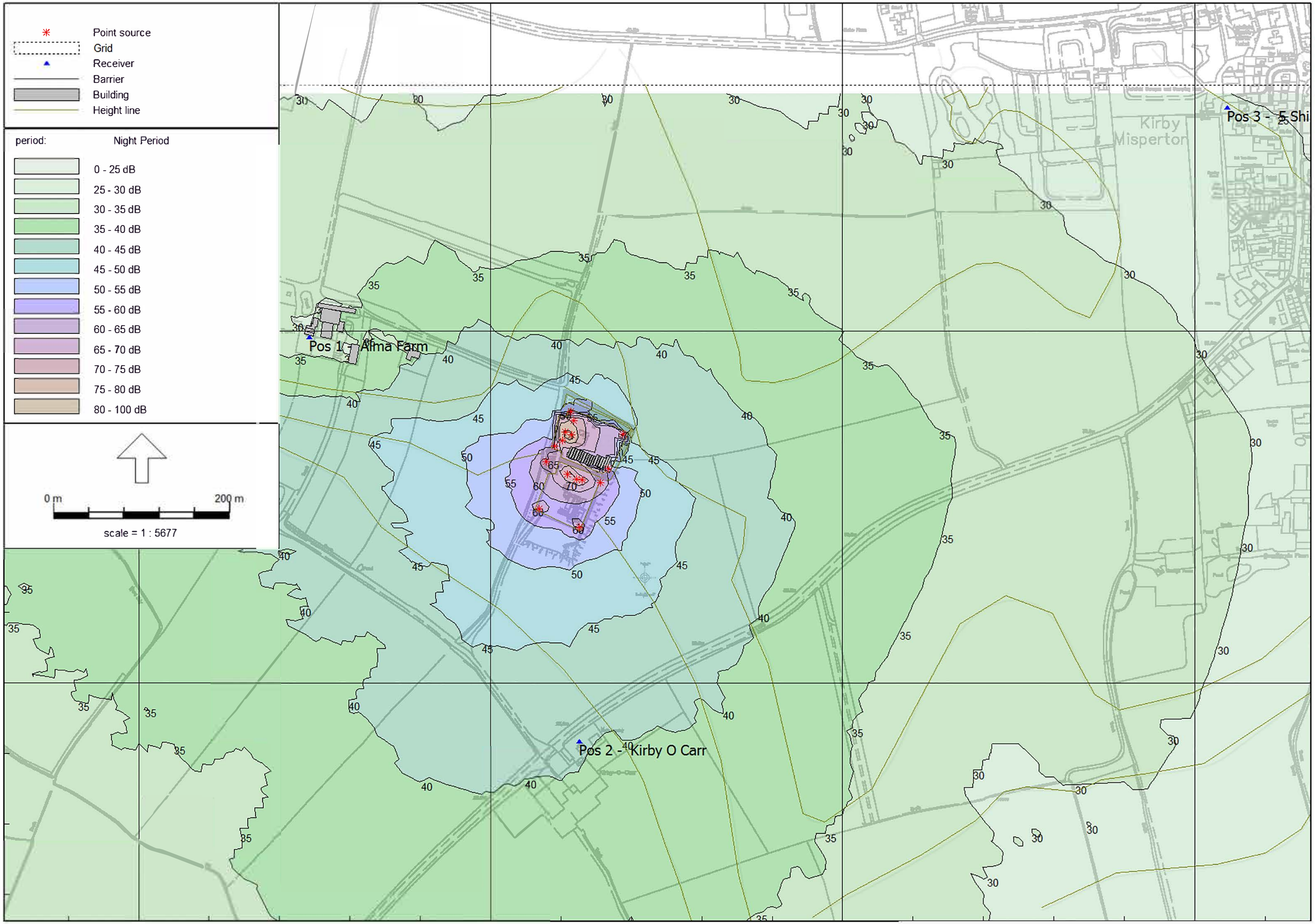
Spectrum Acoustics Consultants, UK

Report: Table of Results
Model: Rev 11 HF etc night without noise barrier
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Night Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	37	15	27	33	29	32	28	24	8	-30
_B	Pos 1 - Alma Farm	4.50	40	15	27	33	34	35	32	30	17	-19
_A	Pos 2 - Kirby O Carr	1.50	40	18	31	34	28	33	35	31	18	-17
_B	Pos 2 - Kirby O Carr	4.50	42	18	30	33	33	37	36	31	18	-17
_A	Pos 3 - 5 Shire Close	1.50	29	4	16	22	20	25	21	13	-15	-101
_B	Pos 3 - 5 Shire Close	4.50	30	5	16	22	25	25	22	13	-14	-100

All shown dB values are A-weighted

Rev 10 HF at night with noise barrier
29 Apr 2015, 20:41



Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 10 HF etc night with barrier] , Predictor V9.11

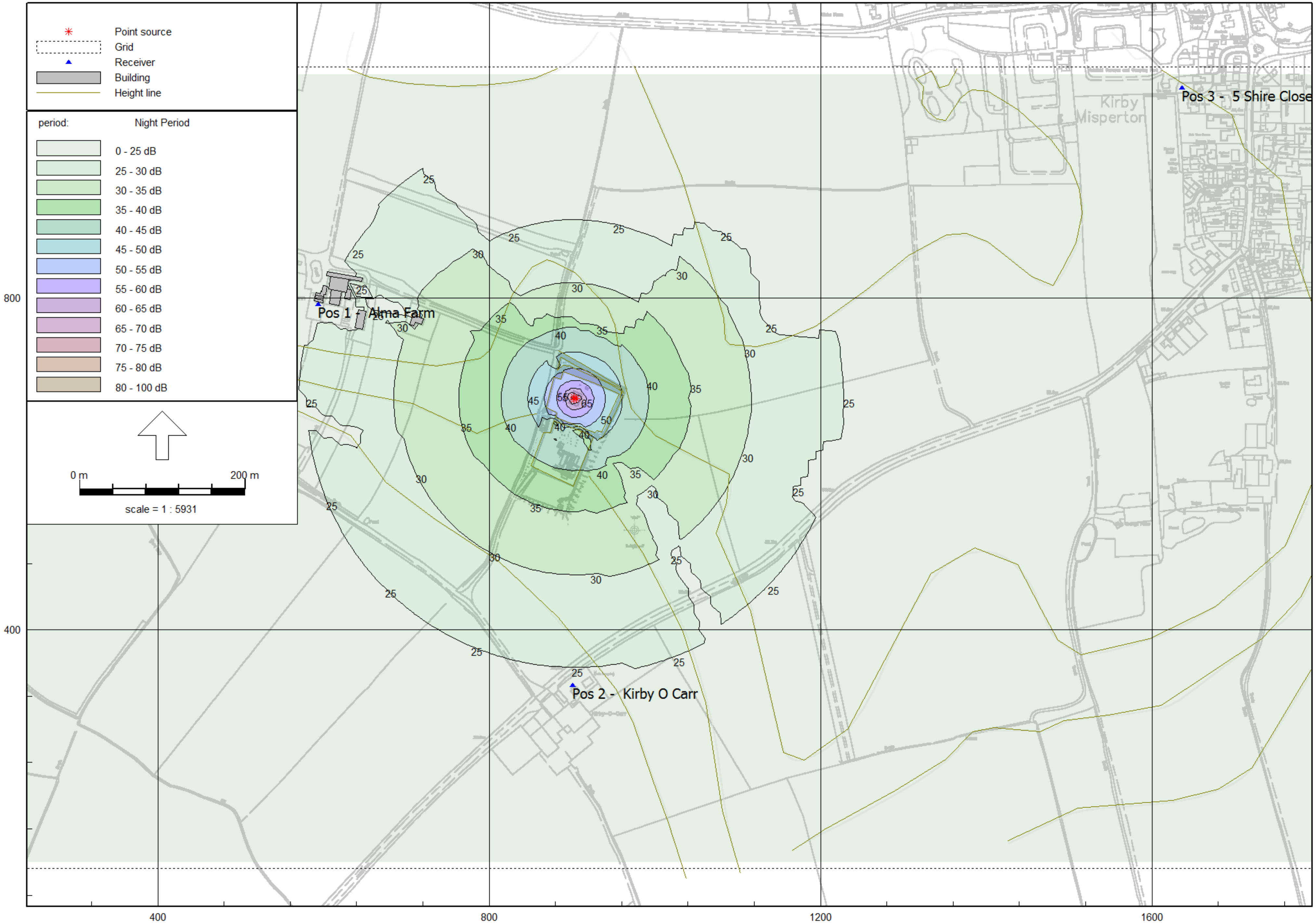
Spectrum Acoustics Consultants, UK

Report:	Table of Results
Model:	Rev 10 HF etc night with barrier
LAeq per octave:	total results for receivers
Group:	(main group)
Group Reduction:	No

Name Receiver	Description	Height	Night Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	32	9	21	27	26	26	22	17	2	-36
_B	Pos 1 - Alma Farm	4.50	35	9	21	28	29	29	26	21	8	-30
_A	Pos 2 - Kirby O Carr	1.50	41	18	31	35	30	34	35	31	18	-17
_B	Pos 2 - Kirby O Carr	4.50	42	18	30	34	34	37	36	31	18	-17
_A	Pos 3 - 5 Shire Close	1.50	27	1	14	23	21	21	16	6	-24	-118
_B	Pos 3 - 5 Shire Close	4.50	28	1	14	23	23	22	16	6	-24	-118

All shown dB values are A-weighted

Rev 7 normal operation
29 Apr 2015, 20:41



Industrial noise - ISO 9613.1/2, [version of 14327 - KM8 - Rev 7 normal operation] , Predictor V9.11

Spectrum Acoustics Consultants, UK

Report: Table of Results
Model: Rev 7 normal operation
LAeq per octave: total results for receivers
Group: (main group)
Group Reduction: No

Name Receiver	Description	Height	Night Total	31	63	125	250	500	1000	2000	4000	8000
_A	Pos 1 - Alma Farm	1.50	17	-21	-9	0	0	7	11	13	1	-37
_B	Pos 1 - Alma Farm	4.50	22	-21	-9	1	5	10	16	20	10	-26
_A	Pos 2 - Kirby O Carr	1.50	24	-22	-9	0	0	9	19	22	12	-25
_B	Pos 2 - Kirby O Carr	4.50	25	-18	-5	1	4	13	20	22	12	-25
_A	Pos 3 - 5 Shire Close	1.50	8	-35	-22	-10	-8	0	6	3	-20	-104
_B	Pos 3 - 5 Shire Close	4.50	9	-35	-22	-10	-4	1	6	4	-19	-103

All shown dB values are A-weighted

A P P E N D I X 11.5

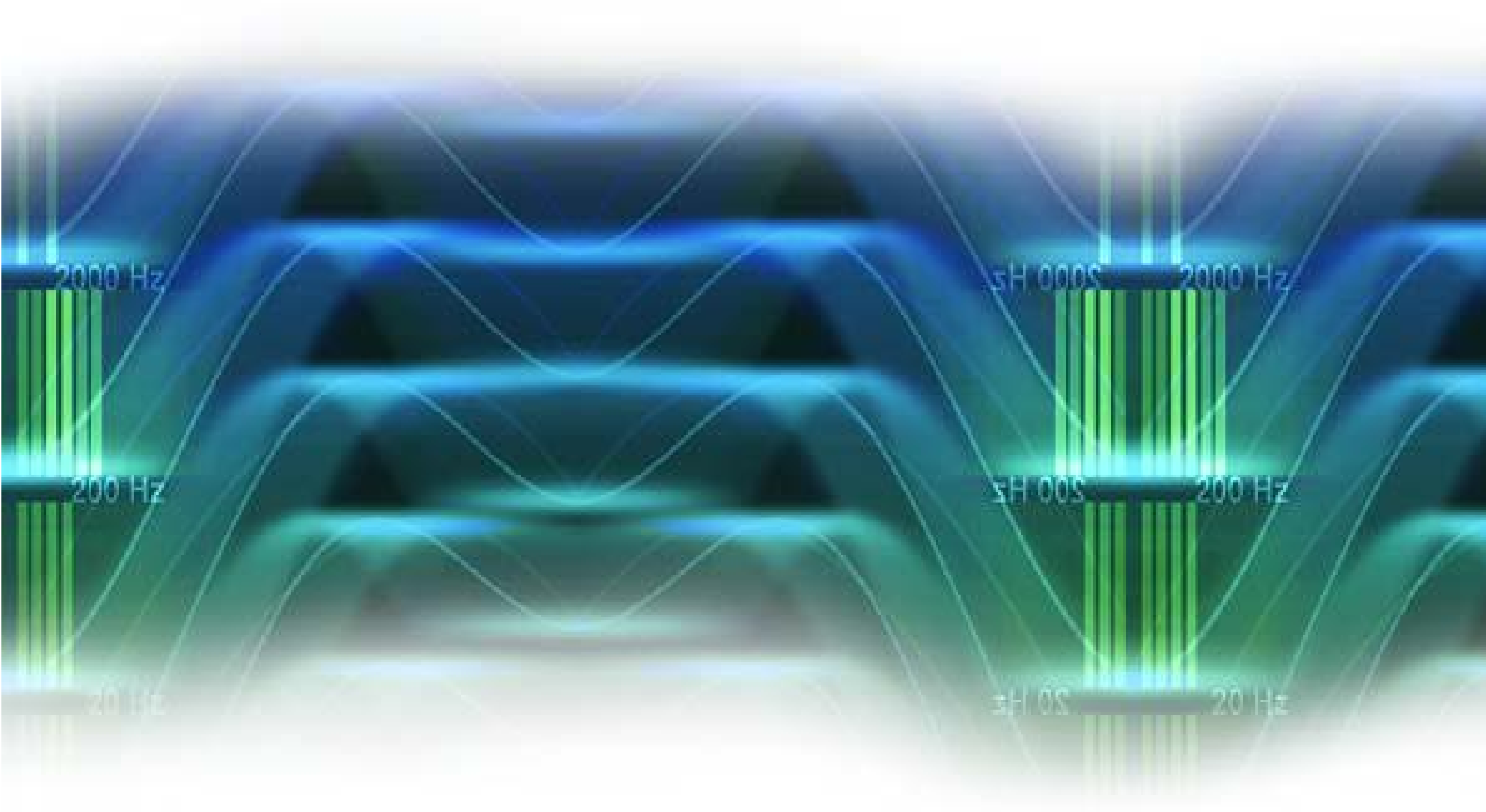
Noise Management and Monitoring Plan

KM 8 Well HF Development and Production
Noise Management and Monitoring Plan

Report ref.
ARC6672/14327

Date
May 13th 2015

Issued to
Third Energy Gas (UK) Limited



Issued by
Andrew Corkill MSc, MIOA
Director

Spectrum
ACOUSTIC CONSULTANTS

1. INTRODUCTION

As part of the Environmental Permit application on this project, the Environment Agency (EA) have requested Third Energy UK Gas Limited submit a Noise Monitoring Plan for their approval. This document details the arrangements to be made for both monitoring noise and managing the actions required in the event that monitoring shows high noise levels arising. It also deals with actions required when complaints on noise are received. The noise monitoring is the key element in an overall Noise Management Plan.

This plan is also prepared in response to a formal request made in writing by Ryedale District Council1 and also following a subsequent clarification meeting2 with them.

2. PURPOSE

The purpose of an overall Noise Management Plan (NMP) is defined within the relevant noise guidance from the Environment Agency3. Section 2.4.1.1 of the guidance, covering impact assessment, states:

Once the assessment work is complete and mitigation measures have been put into place, ongoing monitoring, maintenance and feedback arrangements are vital to sustained improvement. These form the cornerstone of a Noise Management Plan (see Appendix 4).

Section 3.3.4, of the Environmental Agency guidance (ongoing management of noise) goes on to say:

On some sites that are large, or complex, and on others where there is a significant noise issue, then the development of a Noise Management Plan can be a very effective tool to ensure that both the Operator and the Regulator adequately address noise issues. This is described in Appendix 4. The prepared plan may not need to include all the elements in the outline and it may also include other elements specific to the site under consideration.

Most NMPs are developed to cover longer term operations of a development. In the case of this development, the longer term production of gas is expected to generate very low levels of noise, whereas it is the short term initial phases of the development where noise levels are potentially significant.

It should also be noted that NMPs are normally developed in situations where noise impacts are significant and already causing a degree of noise pollution. For this development, the predictions show that with the mitigation that has been developed, residual noise levels are expected not to be significant, and consequently there is not expected to be a community response to noise. The NMP here is a precautionary procedure which does have value as predicted levels are as yet provisional only and made using computer simulations. If the levels measured are broadly consistent with the predictions, the effects to the community will not be significant and action to reduce noise will not be a priority.

Appendix 4 of the EA guidance sets out a potential structure of an NMP. It states that the level of detail given should correspond to the risk of giving reasonable cause for annoyance at sensitive receptors. It suggests the following information might be given:

a) Receptors (scaled maps and site plans should be provided as appropriate to show relative locations of receptors, sources and monitoring points)

b) Noise sources (Information relating to individual sources and emissions)

c) Demonstration of BAT

d) Supplementary information required for complex and/or high–risk installations

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[1] Scoping opinion from Mr Steve Richmond of Ryedale District Council, Health and Environment Manager, 25th February 2015

[2] Meeting 5th March 2015 with Mr Steve Richmond

[3] Environmental Permitting: H3 Part 2 – Noise Assessment and Control, Environment Agency, V3, June 2004 (Part 1 cancelled)

It then stresses the need to keep proper logs and records of checks made and noise measurement/monitoring where this has been carried out.

With the predicted levels of noise being well below significance thresholds, there is only a very low risk of a significant noise impact arising. With the EA guidance advising that the level of detail given in the NMP should correspond to the risk of causing annoyance; as that risk is very low, then the level of detail required is also low.

In relation to the requirements a)-d) above, there is real value in carrying out noise measurements to check predictions, and the NMP includes details of receptors at which monitoring will be carried out (a). Details of noise sources (b) over and above the full details on noise already included in the EIA noise chapter, is not considered necessary unless noise levels reach SOAELS (significance thresholds) and monitoring proposed will then detail sources and their levels. Additional noise mitigation is detailed within the EIA noise chapter in the form of a temporary 10m high acoustic barrier on 3 ½ sides and that is considered to form part of BAT (c) for the temporary activities in the early phases of the development. The final requirement (d) of supplementary information for high risk or complex installations is not considered necessary as there is no risk of noise levels being significantly above those levels predicted, nor has such a potential risk been highlighted as a potential issue by the EA.

The focus of the NMP is therefore on the validation of the computer noise predictions through monitoring and then the comparison of these with the significant effect thresholds referenced within the noise chapter of the EIA.

3. SIGNIFICANCE THRESHOLDS

The EIA shows a summary table of assessment thresholds. The threshold for significant effect, SOAEL (significant observable adverse effect level), and the threshold of any effect, LOAEL (lowest observable adverse effect level) are shown in table 1 for various phases of the project, and for different times.

Noise Impact	SOAEL	LOAEL	Critical time
Off-site road traffic	3dB inc. in $L_{A10,18hr}$	1dB inc. in the $L_{A10,18hr}$	Daytime
Pre-stimulation workover	$L_{Aeq,1hr}$ 45 dB	$L_{Aeq,\ l\ hr}$ 40 dB	Night
HF and well testing - HF	$L_{Aeq,\ l\ hr}$ 70 dB (HF)	-	HF during day
HF and well testing - General	$L_{Aeq,\ l\ hr}$ 45 dB (other)	$L_{Aeq,\ l\ hr}$ 40 dB	Other activities at night
Normal production	$L_{Aeq,T}$ 42 dB (night)	$L_{Aeq,\ l\ hr}$ 40 dB (night)	Night
Restoration	$L_{Aeq,\ l\ hr}$ 65 dB	-	Daytime

Table 1: Summary of Noise Assessment Thresholds at Critical Times

4. PREDICTED EFFECT

The noise chapter within the EIA for this development evaluates the various effects for each phase and the summary of these is shown in table 2.

Activity	Significance	Mitigation	Residual Effect
Pre-stimulation workover			
Off-site road traffic noise	Not significant	None	Not significant
On site activity	Not significant	Noise barrier	Not significant
HF and well testing			
Off-site road traffic noise	Not significant	None	Not significant
On site activity	Not significant	Noise barrier	Not significant
Normal production			
On site activity	Not significant	None	Not significant
Site restoration			
Off-site road traffic noise	Not significant	None	Not significant

On site activity	Not significant	None	Not significant

Table 2: EIA noise assessment summary

Even before the proposed introduction of the temporary noise barrier, the effects during each phase are predicted as being not significant. The presence of the noise barrier for the early phases will significantly reduce the adverse effects to the further benefit of the community, especially those living within the village of Kirby Misperton.

5. Predicted Noise Levels vs SOAEL Significance Thresholds

The predicted effects in all phases of the development are within the SOAEL thresholds. The predicted noise levels generating these effects; the times in which they occur, and the numerical SOAEL threshold for that particular phase of the development are shown in table 3.

Noise Impact	Predicted level, $L_{Aeq,1hr}$ (no barrier/with barrier)			SOAEL, $L_{Aeq,1hr}$	LOAEL, $L_{Aeq,1hr}$
	Alma House	Kirby O Carr	5 Shire Grove		
Pre-stimulation workover	42/34	46/46	32/31	45 (night)	40 (night)
HF and well testing-HF	59/54	65/59	52/48	70 (day)	-
HF and well testing-General	40/35	42/42	30/28	45 (night)	40 (night)
Restoration	52 (16hr)	-	-	65 (day)	-

Table 3: Summary of Predicted Noise Levels and Thresholds at Critical Times (no barrier/with barrier)

During prestimulation workover the noise levels with the noise barrier in place will, for the substantial majority of nearby receptors, typically be in the range $L_{Aeq,1hr}$ 31-34 dB, which is 11-14dB below the SOAEL. This margin is very large and it would not normally be recommended that detailed noise monitoring would be necessary. Kirby O Carr however is unavoidably in line with the opening in the noise barrier, and therefore noise levels do not reduce here. It is however expected that final detailing of the noise barrier should be able to slightly reduce the noise to this single location by a further 1-2 dB as described within the EIA. The priority is to monitor at Kirby O Carr, during the late evening or early night during this phase.

During the HF and well testing phase the daytime noise levels with the noise barrier will generally be in the range $L_{Aeq,1hr}$ 48-54 dB at all receptors which is 16-20 dB below the SOAEL. This margin is large and noise monitoring would not normally be recommended as being necessary. Again the levels at Kirby O Carr are slightly higher at 59 dB, still 11dB below the SOAEL.

At night during the HF and well testing phase, minor activities and analysis continues, and predicted levels with the noise barrier are generally $L_{Aeq,1hr}$ 28-35 dB, which is 10-17 dB below the SOAEL. Again, noise monitoring would not normally be necessary at these positions. At Kirby O Carr however, the level is 42 dB which is just 3dB below the SOAEL.

The longer term production phase noise levels range over $L_{Aeq,1hr}$ 9-25 dB. At 17-33dB below the SOAEL level, monitoring would be unlikely to detect any discernible noise at any receptor.

During restoration the $L_{Aeq,16hr}$ at the nearest house, Alma House is 52 dB. At other receptors, the levels will be lower. This is 13 dB below the SOAEL during the day. Noise monitoring would not normally be required with impacts so low.

Noise associated with off-site vehicle movements on public roads is not predicted to significantly increase. Monitoring of road traffic noise is not generally undertaken. If validation of the traffic noise calculation is required, this is best undertaken by checking the assumptions made in the traffic noise calculation for vehicles arriving and departing the site. This could be taken from a site log of vehicles potentially held at the security gate.

6. NOISE MONITORING LOCATIONS

Although predicted noise levels are generally well below levels that are significant, a precautionary approach is proposed to be adopted whereby substantial and detailed noise monitoring will be undertaken. Noise monitoring is proposed to be undertaken at two locations. These are:

- Kirby O Carr 320m south of KM8 well. The measurement position is in the front garden of the bungalow, and does not benefit from screening by the temporary noise barrier, as it is opposite the gap in the barrier required for access to and from the wellsite.

- 5 Shire Grove 820m NE of KM8 well. This is representative of a large number of properties within Kirby Misperton village, both closer and further away. It is a position where complaints have been received in the past. It is a 3 storey residential property with bedrooms at the third level.

The locations of these noise monitoring positions are shown in Appendix A along with photos of instrumentation in position during the baseline noise monitoring already undertaken.

It is considered that monitoring noise at these two locations will adequately capture the noise generated by each phase of the development. Monitoring at the third location at which background noise monitoring was taken (Alma House) is not now proposed as at this position, the temporary noise barrier will be especially effective in reducing noise to much lower levels than at the very much less screened Kirby O Carr. Both are single properties rather than representing a larger group of houses.

7. NOISE MONITORING PLAN

It is proposed that monitoring will be carried out during the phases and times shown in table 4

Noise Impact	Time when monitored
Pre-stimulation workover	Night primarily
HF and well testing	Day and night
Normal production	Not monitored
Restoration	Day only

Table 4: Development phases and times to be monitored

Monitoring will be carried out simultaneously using unattended logging equipment capable of remote checking and downloading of data (subject to adequate mobile phone signal). This will monitor $L_{A10,1hr}$, $L_{A90,1hr}$ and $L_{Aeq,1hr}$ continuously day, evening and night, for the initial period of each phase until the levels are shown to be stable. A wind monitoring station will be located at Kirby O Carr to establish wind direction so this can be compared with noise data.

Results will be reviewed initially on a daily basis and then weekly if levels become stable and levels are not expected to change. During the 5 daytime HF events; levels will be reviewed within 24 hours.

At each of the locations, a second noise monitor and microphone will record a 10s sample sound file every 30-60 minutes. Where levels are high, then the noise specialist will visit site and these sound recording samples (very large data files) will be downloaded by removing data storage cards from meters and transferring to a portable pc for analysis and listening. During this visit, the noise specialist will undertake a brief survey of noise of equipment on the site and report these values along with comments to the Site Manager.

Table 5 shows three Action Levels (1,2 and 3) and the actions to take place when these levels are breached.

Phase	Action Level		
	1	2 (SOAEL)	3
Notify Site Manager of results from noise monitor	✓	✓	✓
Visual check of wellsite equipment	✓	✓	✓
Download and listen to sound recordings		✓	✓
Noise tests close to equipment and recommendations		✓	✓
Consider restricting equipment operating			✓

Table 5: Actions proposed to be carried out on breaching Action Levels 1, 2 and 3.

The actions proposed start at notifying the site manager of the noise monitor results and recommending a visual check of check wellsite equipment (Action Level 1), through to a noise specialist visiting site to download the sound recordings from the second meters and measuring noise levels on the wellsite with a portable meter (Action Level 2) through to considering restricting equipment operation (Action Level 3).

The numerical values associated with the Action Levels for each phase of work are shown in table 6. Action Level 2 is the SOAEL level, Action Level 1 is 5dB below the SOAEL and Action Level 3 is 5dB above the SOAEL. In considering the duration over which an Action Level may be breached, wind direction will be a significant influencing factor, with levels being highest under downwind propagation conditions, and being typically as much as 5-15dB lower under upwind conditions. The predicted levels are given for an average of wind conditions which will be 2dB lower than the highest values likely under downwind conditions. The receptor with predicted levels closest to the SOAEL is Kirby O Carr to the south of the wellsite. Downwind propagation will only arise here infrequently when there is a NW, N or NE wind.

Phase	Time	Action Level, $L_{Aeq,1hr}$		
		1	2 (SOAEL)	3
Pre-stimulation workover	Night only	40	45	50
HF and well testing	Day	65	70	75
HF and well testing	Night	40	45	50
Restoration	Day only	60	65	70

Table 6: $L_{Aeq,1hr}$ values for Action Levels 1, 2 and 3 for each phase of the development.

8. REPORTING

Reporting the results of inspections, reviews and monitoring is a key element in the NMP, and provides Stakeholders or the EA with information against which to determine compliance with permit terms and conditions.

Formal reports will be issued on completion of each of the three phases during which noise is planned to be monitored. These will give all the results from the noise monitors, including post-processing to extract the levels during the day, evening and night, discounting data where the wind velocities are in excess of 5m/s and also if appropriate considering results grouped by wind direction. In addition a short sample of 10s large sized sound files will be available for listening taken from the second noise monitor located at each of the two proposed NMP monitoring positions.

Where monitoring shows Action Level 1 being breached, the noise specialist will advise the numerical results to the site manager with a recommendation for a site based engineer to inspect the equipment, ensure all noise control elements are effective, and make any relevant observations. This should be recorded formally in a short form report or log.

Where monitoring shows Action Level 2 or 3 being breached, the noise specialist will advise the numerical results to the site manager with a recommendation for the noise specialist to visit the site at the earliest opportunity to download the sound files from the sound recording meters; listen to a sample and comment within a short form report or log. During this visit the noise specialist will measure noise from each equipment item on the wellsite and record values again within a short form report, along with comments and if necessary recommendations where this is practical. This report would be formally issued within one week of the noise specialist's visit.

The site manager will be responsible for coordinating the various inspection and storing of logs and reports made, and issuing these as required to the EA and stakeholders.

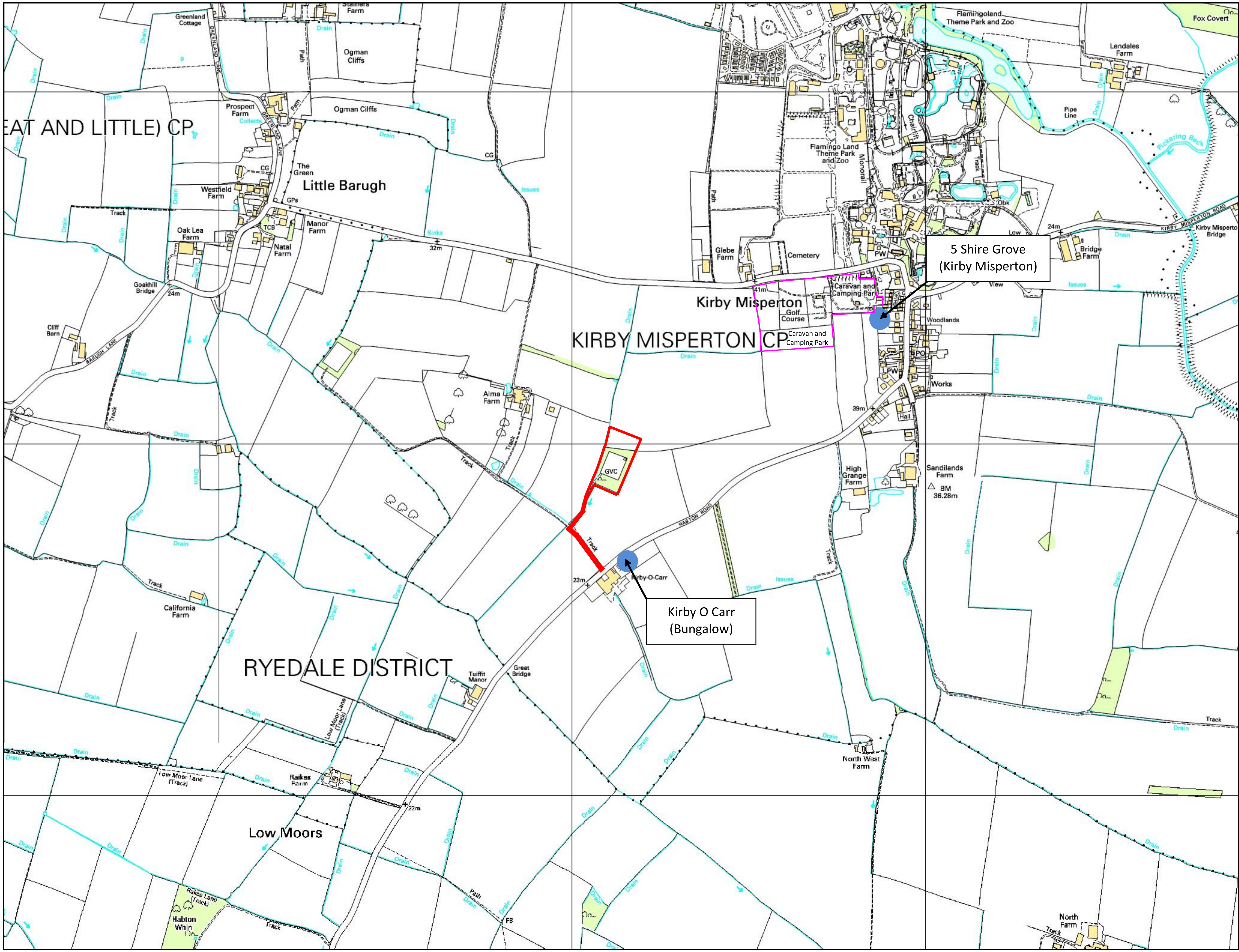
9. COMPLAINTS

In the event of complaints being received, these should be formally logged by the site manager, along with the time of the complaint and details of the description of the noise, its duration, timing and characteristics, as described by the complainant. Having received an immediate update of the latest noise monitoring results from the noise specialist (remotely accessed via modem), the site manager may then consider this equivalent to a breach of the Action Level 2, and require the noise specialist to visit to download, listen and analyse audio sound file recordings and take measurements close to equipment on the wellsite, to establish any changes in noise level and to make appropriate recommendations.

APPENDIX A

Noise Monitoring Locations

- NMP monitoring location map
- Photos showing noise and weather monitoring equipment



Key:

Site Location

Noise Monitoring Position

Caravan Park

PSSL
Petroleum Safety Services Limited

Petroleum Safety Services
23a Milton Street
Saltburn by the Sea
TS12 1DJ

Client:
Third Energy UK Gas Limited

Project:
KM8 Hydraulic Fracturing Operation

Drawing Title:
Noise Monitoring Location Plan

Scale:
1: 10,000 (Printed A3)

Drawn By:
Jonathan Foster

Date Drawn:
10/06/2015

Approved By:
Jonathan Foster

Date Approved:
10/06/2015

Drawing No:
PSSL/TE/KM8/HFS/PA/N/02

Rev: 1

Location 1: Alma House – weather station

Location 1 Alma House: Noise monitor

Location 2: Kirby O Carr

Location 2 : Kirby O Carr

Location 3: 5 Shire Grove

Location 5 Shire Grove

Photos of noise and weather monitoring equipment