Noise Impact Assessment for Altcar Moss Wellsite

Altcar Moss, Great Altcar, Lancashire

For Aurora Energy Resources

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Quality Management

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1 Introduction

1.1 Aurora Energy Resources Limited (Aurora) intends to develop a new wellsite in Altcar Moss, Great Altcar, Lancashire. The proposed wellsite is located in worked farm land, immediately to the northwest of Sutton's Lane, Great Altcar. The site is located within Great Altcar Parish, in the district of West Lancashire and the relevant minerals planning authority (MPA) is Lancashire County Council (LCC).

1.2 RPS Group has been commissioned by Aurora to undertake a noise assessment and this report presents the findings and recommendations from the study. This report details the methodology and results of the assessment along with a specification for mitigation methods to be adopted.

1.3 At this time, the exact drilling rig type to be used is unknown (this will depend upon drilling rig availability at the time drilling is due to commence). Therefore, the assessment is based on three example drilling rigs which exhibit different noise levels and characteristics that are considered to provide a range of typical/maximum adverse noise impacts, representative of that which may arise from any rig that is eventually selected. Although the drilling rigs assessed within this report may not be available at the time of drilling, they represent a typical range of rig noise characteristics and RPS' experience in undertaking drilling rig noise assessments has been applied to specification of mitigation. It is therefore anticipated that a similar degree of noise control can be applied to whichever drilling rig is eventually deployed.

1.4 There are no anticipated impacts that would arise due to ground borne vibration resulting directly from the operations. The drills are rotary bored only and therefore impart relatively small amounts of energy into the ground, for example compared to percussive pilling techniques. Data available for continuous flight augers suggests that ground borne vibration would be imperceptible at distances of around 20 metres from source. Vibration levels from the drilling operations are not expected to be significantly different in magnitude. Consequently, at the nearest human/property receptors (typically over 850 metres from the drilling rig) ground borne vibration would be considerably lower and, is highly unlikely to be perceptible. With respect to the hydraulic fracturing activities, the mitigation for this would include a traffic light system to monitor seismic activities. Consequently, vibration linked to seismic activity is also highly unlikely to occur. Vibration has therefore been scoped out

2 Acoustic Terminology and Concepts

2.1 This section provides an overview of the fundamentals of how sound propagates away from a source.

2.2 Increasing the distance from a noise source normally results in the level of noise getting quieter, due primarily to the spreading of the sound with distance, analogous to the way in which the ripples in a pond spread after a stone has been thrown in. Another important factor relates to the type of ground over which the sound is travelling. Acoustically "soft" ground, (such as grassland, ploughed fields etc.) will result in lower levels of noise with increasing distance from the noise source as compared to acoustically "hard" surfaces (e.g. concrete, water, paved areas). The reduction in noise level depends, however, on the frequency of the sound.

2.3 Wind also affects the way in which sound propagates, with noise levels downwind of a source being louder than upwind. This is partly due to the sound 'rays' being bent either upwards or downwards by the wind in a similar way that light is bent by a lens, as shown in Figure 2.1. Varying temperatures in the atmosphere can also cause sound 'rays' to be bent, adding to the complexity of sound propagation.

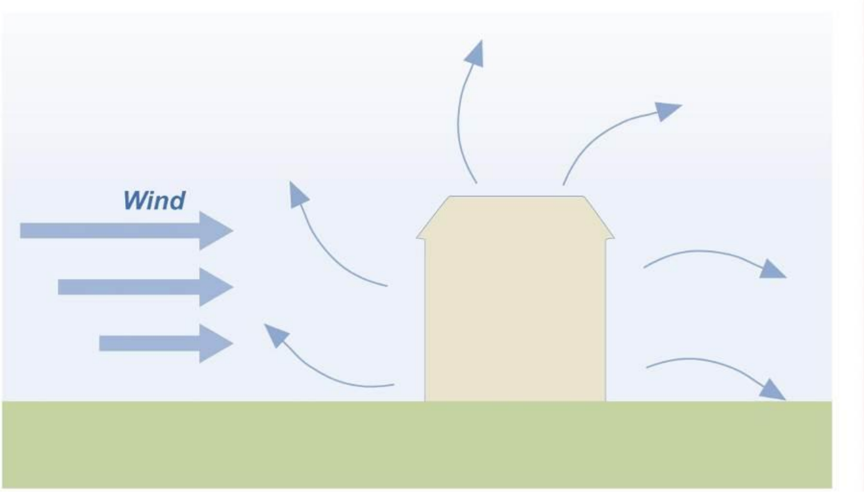


Figure 2.1: Refraction of sound waves due to wind gradients (increasing wind speed with height)

2.4 Another attenuation mechanism is absorption of sound by the molecules of the atmosphere. Higher pitched (higher frequency) sounds are more readily absorbed than lower pitched (lower frequency) sounds. The factors affecting the extent to which the sound is absorbed are the temperature and the water content of the atmosphere (relative humidity).

2.5 The effect of varying temperature and humidity is usually minimal when compared to other factors, such as wind and ground effects. However, where high frequency sounds are encountered, there may well be a significant variation between measured sound levels on different days due to variations in temperature and humidity.

2.6 When hearing noise which occurs out in the open (e.g. from road traffic, aircraft, birds, wind in the trees etc.), it is common experience that the noise level is not constant in loudness but is changing in amplitude all of the time. Therefore, in order to numerically describe the noise levels, it is beneficial to use statistical parameters. It has become practice to use indices which describe the noise level which has been exceeded for a certain percentage of the measurement period, and also an index which gives a form of average of the sound energy over a particular time interval. The former are termed percentile noise levels and are notated L_{A90}, L_{A50}, L_{A10} etc. and the latter is termed the equivalent continuous noise level and is notated by L_{Aeq}. It is worth noting that if the noise level does not vary with time, then all the parameters, in theory, normalise to a single value.

2.7 With regard to the percentile levels, the L_{A90} is the sound pressure level which is exceeded for 90% of the measurement time. It is generally used as the measure of background noise (i.e. the underlying noise) in environmental noise standards.

2.8 The L_{Aeq} (sometimes denoted $L_{Aeq,T}$) is the A-weighted equivalent continuous noise level and is an energy averaged value of the actual time varying sound pressure level over the time interval, T. It is used in the UK as a measure of the noise level of a specific industrial noise source when assessing the level of the specific source against the background noise. It is also used as a measure of ambient noise (i.e. the “all-encompassing” sound field).

2.9 Other useful parameters for describing noise include the maximum and minimum sound pressure level encountered over the time period, denote L_{Amax} and L_{Amin} respectively.

2.10 The term 'A' weighting implies a measurement made using a filter with a standardised frequency response which approximates the frequency response of the human ear at relatively low levels of noise. The resulting level, expressed in 'A' weighted decibels, or dBA, is widely used in noise standards, regulations and criteria throughout the world.

2.11 For a more detailed analysis of the frequency characteristics of a noise source, then noise measurements can be made in bands of frequencies, usually one octave wide. The resulting levels are termed octave band sound pressure levels. The standard octave band centre frequencies range from 31.5 Hz (about three octaves below middle ‘C’ on the piano) to 8 kHz (about five octaves above middle ‘C’). This covers most of the audible range of frequencies (usually taken to be around 20 Hz to 20 kHz). Octave band noise levels are usually quoted as linear data – i.e. without an ‘A’ weighting filter being applied. For more detailed analysis narrowband filters are useful for analysing tones.

2.12 The term decibel is a relative quantity and should always be referenced to an absolute level. In this report, all sound pressure levels (denoted L_P) are expressed in dB re 20 µPa. Hence, a sound pressure level of 0 dBA refers to a pressure level of 20 µPa, which is generally taken as the lowest level of sound that the human ear can detect. A negative dBA value usually implies that the sound is below the threshold of human hearing.

2.13 Subjectively, and for steady noise levels, a change in noise level of 3 dB is normally just discernible to the human ear. However, a noise change of less than 3 dB could be discernible if it has particular frequency characteristics or if it varies in loudness over time. A difference of 10 dB represents a doubling or halving of subjective loudness.

2.14 Sound power (denoted L_W) is the acoustical power radiated from a sound source. The advantage of using the sound power level, rather than the sound pressure level, in reporting noise from a source is that the sound power is independent of the location of the source, distance from the measurement point and environmental conditions. If the sound power of a source is known, then it is possible to calculate the sound pressure level at a distance away from the source, accounting for the attenuation due to propagation, as discussed above. Sound power levels are referenced to power rather than pressure; hence sound power levels are expressed in dB re 1 pW.

3 Description of Proposed Development

3.1 Aurora Energy proposes to construct a wellsite, of approximately 1 hectare in area, within which it will drill and core a vertical borehole, followed by the drilling of a second borehole, with a horizontal section approximately 1,500 m in length. Both boreholes will then undergo hydraulic fracture stimulation. Each borehole will then be separately flow tested and, subject to the results obtained, the horizontal borehole may then undergo an extended well test (up to 90 days). The development will consist of the following eight phases:

- **Phase 1 – Wellsite and Access Track Construction:** Access track construction works, followed by the construction of a level hardstanding and drilling cellars, with underlying impermeable membrane and surface water containment system. This will be followed by the mobilisation of a surface conductor rig which will drill and set conductor casing to a depth of approximately 40mTVDGL for each borehole, followed by demobilisation.
- Phase 1 works are expected to take 16 weeks to complete (8 weeks for access track construction and 8 weeks for wellsite construction) and will be restricted to the following hours of operation:
  - Monday to Friday 07:00 hrs to 19:00 hrs;
  - Saturday 07:00 hrs to 13:00 hrs; and
  - No works permitted on Sundays and Bank Holidays.
- **Phase 2 – Drilling and Coring of a Vertical Borehole (Borehole #1):** Mobilisation of a drilling rig (mast height up to 60 m) and ancillary equipment, the drilling and coring of a single vertical borehole to a depth of approximately 2963 m TVDGL. The actual drilling rig to be used at the Altcar Moss wellsite has not been confirmed and will be subject to availability. Phase 2 works are anticipated to take up to five months to complete and will require 24 hour working, to ensure hole stability and well control.
- **Phase 3 – Drilling of a Horizontal Borehole (Borehole #2):** Following a detailed evaluation of the geological data acquired during the Phase 2 works, a second borehole will be drilled from the site. The second borehole will be drilled down to the target zone and then drilled horizontally within this zone for up to 1,500m followed by demobilisation of the drilling rig and ancillary equipment. Phase 3 works are anticipated to take up to five months to complete and will require 24 hour working, to ensure hole stability and well control.
- **Phase 4 – Hydraulic Fracture Stimulation of the Vertical and Horizontal Boreholes:** Mobilisation of a workover rig and/or coil tubing unit, hydraulic fracture stimulation equipment

and well test equipment. Hydraulic fracture stimulation of each borehole will be undertaken in turn, followed by demobilisation of the hydraulic fracture stimulation equipment. The duration of Phase 4 works will be dependent on the final number of hydraulic fracture stages in each borehole although it is not expected to exceed sixty days in total. Whilst Phase 4 operations will require 24 hour working, the operation of the pump units to perform the actual hydraulic fracture stimulation will only be carried out during times to be agreed with the MPA and will typically last for a period of up to 4 hours per hydraulic fracture stage.

- **Phase 5 - Initial Flow Testing:** A number of separate zones within the hydraulically-fractured interval in the vertical borehole will be flow tested to ascertain if stabilised flow of hydrocarbons can be established from the various units within the Bowland Shale/Hodder Mudstone sequence. Each tested zone may comprise more than one fracture stage. Once initial flow testing of the vertical borehole is complete, initial flow testing of the horizontal borehole will be undertaken. Initial flow testing of the boreholes is expected to take up to sixty days. Produced gas is to be incinerated on site via ground flare. Any liquid hydrocarbons would be separated and stored on site prior to removal by tanker. Phase 5 works are anticipated to take sixty days to complete and will require 24 hour working.
- **Phase 6 – Extended Well Test (Horizontal Borehole):** The production of natural gas under flow test for a period of up to ninety days. Produced gas to be incinerated on site via ground flare. Any liquid hydrocarbons would be separated and stored on site prior to removal by tanker to a refinery for sale. Phase 6 works are anticipated to take ninety days to complete and will require 24 hour working.
- **Phase 7 – Decommissioning and Borehole Abandonment:** Decommissioning of all surface equipment followed by borehole abandonment, including the mobilisation and demobilisation of a workover rig and/or coil tubing unit and ancillary equipment. Phase 7 works are anticipated to take four weeks to complete and will require 24 hour working.
- **Phase 8 – Wellsite Restoration:** Wellsite restoration to pre-development condition, as agreed with the MPA and Landowner, followed by a five year aftercare scheme. Phase 8 works are expected to take 8 weeks to complete. Works will be restricted to the following hours of operation:
    - Monday to Friday 07:00 hrs to 19:00 hrs;
    - Saturday 07:00 hrs to 13:00 hrs; and
    - Sunday and Bank Holiday No works permitted.

4 Summary of relevant Policy, Guidance and Standards

Noise Policy Statement for England

4.1 The Noise Policy Statement for England (NPSE) [1] sets out the long term overarching vision of Government noise policy, which is to promote good health and a good quality of life through the management of noise within the context of Government policy on sustainable development. Whilst the NPSE does not seek to change pre-existing policy, the document is intended to aid decision makers by making explicit the implicit underlying principles and aims regarding noise management and control that are to be found in existing policy documents, legislation and guidance.

4.2 The NPSE describes a Noise Policy Vision and three Noise Policy Aims and states that these vision and aims provide:

"the necessary clarity and direction to enable decisions to be made regarding what is an acceptable noise burden to place on society."

4.3 In other words, the purpose of the document is to provide guidance for the decision maker on whether or not the noise impact is an acceptable burden to bear in order to receive the economic and other benefits of the proposal.

4.4 Where existing policy and guidance does not provide adequate guidance then decision makers can go back to the aims of the policy statement to provide overriding guidance. The "Noise Policy Vision" is to "promote good health and good quality of life through the effective management of noise within the context of Government policy on sustainable development". This long term vision is supported by the following aims, through effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:

i. avoid significant adverse impacts of health and quality of life;

ii. mitigate and minimise adverse impacts on health and quality of life; and

iii. where possible, contribute to the improvement of health and quality of life.

4.5 The aims of the policy differentiate between noise impacts on health (e.g. sleep disturbance, hypertension, stress etc.) and noise impacts on quality of life (e.g. amenity, enjoyment of property etc.). The aims also differentiate between "significant adverse impacts" and "adverse impacts". The explanatory note to the NPSE clarifies that a significant adverse impact is deemed to have occurred if the "Significant Observed Adverse Effect Level" (SOAEL) is exceeded. An adverse effect, on the other hand, lies between the "Lowest Observed Adverse Effect Level" (LOAEL) and the SOAEL.

4.6 In assessing whether a development should be permitted, there are therefore four questions that should be answered, with reference to the principles of sustainable development, viz. will the development result in:

a) a significant adverse impact to health;

b) a significant adverse impact to quality of life;

c) an adverse impact to health; or

d) an adverse impact to quality of life?

4.7 If the answer to question a) or b) is yes, then the NPSE provides a clear guidance that the development should be viewed as being unacceptable (item i. above). If the answer to question c) or d) is yes, then the NPSE provides a clear steer that the impact should be mitigated and minimised (item ii. above).

National Planning Policy Framework

4.8 The National Planning Policy Framework (NPPF) [2] sets out the Government's planning policies for England and how these are expected to be applied. The emphasis of the Framework is to allow development to proceed where it can be demonstrated to be sustainable. In relation to noise, Paragraph 180 of the Framework states:

"Planning policies and decisions should ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from the development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason; and

c) limit the impact of light pollution from artificial light on local amenity, intrinsically dark landscapes and nature conservation."

4.9 Point 'a)' refers to 'significant adverse impacts' which relates to the 'significant observed adverse effect level' (SOAEL) in the Noise Policy Statement for England (NPSE), though the term 'effect' is used instead of 'impact' these are interchangeable in this context.

4.10 Paragraph 203 of the Framework notes that *"It is essential that there is a sufficient supply of minerals to provide the infrastructure, buildings, energy and goods that the country needs. Since minerals are a finite natural resource, and can only be worked where they are found, best use needs to be made of them to secure their long-term conservation."* Paragraph 204 goes on to state that *"Planning policies should:… g) when developing noise limits, recognise that some noisy short-term activities, which may otherwise be regarded as unacceptable, are unavoidable to facilitate minerals extraction…"*

4.11 The NPPF therefore explicitly recognises that it may be necessary to allow noise levels due to minerals extraction to give rise to higher short term impacts than would otherwise be acceptable for other types of industry.

Planning Practice Guidance - Noise

4.12 Planning Practice Guidance on Noise (PPG-N) [3] provides guidance to local planning authorities to ensure effective implementation of the planning policy set out in the National Planning Policy Framework. The PPG suggests that planning authorities should ensure that unavoidable noise emissions are controlled, mitigated or removed at source and establish appropriate noise limits for extraction in proximity to noise sensitive properties.

4.13 The PPG-N reiterates general guidance on noise policy and assessment methods provided in the NPPF, NPSE and British Standards and contains examples of acoustic environments commensurate with various effect levels. Paragraph 006 of the PPG-N explains that:

"The subjective nature of noise means that there is not a simple relationship between noise levels and the impact on those affected. This will depend on how various factors combine in any particular situation."

4.14 According to the PPG-N, factors that can influence whether noise could be of concern include:

- the source and absolute level of the noise together with the time of day it occurs;
- for non-continuous sources of noise, the number of noise events, and the frequency and pattern of occurrence of the noise;
- the spectral content and the general character of the noise;
- the local topology and topography along with the existing and, where appropriate, the planned character of the area;

- where applicable, the cumulative impacts of more than one source should be taken into account along with the extent to which the source of noise is intermittent and of limited duration;
- whether adverse internal effects can be completely removed by closing windows and, in the case of new residential development, if the proposed mitigation relies on windows being kept closed most of the time;
- in cases where existing noise sensitive locations already experience high noise levels, a development that is expected to cause even a small increase in the overall noise level may result in a significant adverse effect occurring even though little to no change in behaviour would be likely to occur;
- where relevant, Noise Action Plans, and, in particular the Important Areas identified through the process associated with the Environmental Noise Directive and corresponding regulations;
- the effect of noise on wildlife;
- if external amenity spaces are an intrinsic part of the overall design, the acoustic environment of those spaces; and
- the potential effect of a new residential development being located close to an existing business that gives rise to noise should be carefully considered. This is because existing noise levels from the business even if intermittent (for example, a live music venue) may be regarded as unacceptable by the new residents and subject to enforcement action. To help avoid such instances, appropriate mitigation should be considered, including optimising the sound insulation provided by the new development's building envelope. In the case of an established business, the policy set out in paragraph 182 of the NPPF should be followed.

4.15 The PPG-N provides a relationship between various perceptions of noise, effect level and required action in accordance with the NPPF. This is reproduced in Table 4.1, below.

Table 4.1: Noise Exposure Hierarchy based on the Likely Average Response

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	

Perception	Examples of Outcomes	Increasing Effect Level	Action
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

4.16 The PPG-N describes sound that is not noticeable to be at levels below the No Observed Effect Level (NOEL). It describes exposures that are noticeable but not to the extent there is a perceived change in quality of life as below the LOAEL and need no mitigation. The audibility of sound from a development is not, in itself, a criterion to judge noise effects that is commensurate with national planning policy.

4.17 The PPG-N suggests that noise exposures above the LOAEL cause small changes in behaviour. Examples of noise exposures above the LOAEL provided in the PPG-N include:

- having to turn up the volume on the television;
- needing to speak more loudly to be heard;
- where there is no alternative ventilation, closing windows for some of the time because of the noise; or
- a potential for some reported sleep disturbance.

4.18 In line with the NPPF and NPSE, the PPG-N states that consideration needs to be given to mitigating and minimising effects above the LOAEL but taking account of the economic and social benefits being derived from the activity causing the noise.

4.19 The PPG-N suggests that noise exposures above the SOAEL cause material changes in behaviour. Examples of noise exposures above the SOAEL provided in the PPG-N are:

- where there is no alternative ventilation, keeping windows closed for most of the time or avoiding certain activities during periods when the noise is present; and/or
- there is a potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep.

4.20 In line with the NPPF and NPSE, the PPG-N states that effects above the SOAEL should be avoided and that, whilst the economic and social benefits being derived from the activity causing the noise must be taken into account, such exposures are undesirable.

4.21 The PPG-N suggests that a noise impact may be partially offset if the residents of affected dwellings have access to a relatively quiet part of their dwelling, private external amenity area and/or external public or private amenity space nearby.

Planning Practice Guidance on Minerals (PPG-M)

4.22 The PPG-M [4] provides guidance to mineral planning authorities to ensure effective implementation of the planning policy set out in the NPPF. The PPG-M adopted the criteria from the Technical Guidance which initially accompanied the NPPF (and was withdrawn on 7th March 2014) and this adopted the criteria previously set out in the replaced Minerals Policy Statement (MPS) 2, Annex 2 and the earlier Minerals Planning Guidance (MPG) 11.

4.23 The PPG-M suggests that minerals planning authorities should ensure that unavoidable noise emissions are controlled, mitigated or removed at source and appropriate noise limits established for extraction in proximity to noise sensitive properties.

4.24 The PPG-M also suggests that development proposals should include a noise emissions assessment, to include identification of all sources of noise and, for each source, consider the proposed operating locations, procedures, schedules and duration of work for the life of the operation. The proposals for the 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;
- proposals to minimise, mitigate or remove noise emissions at source;
- assessing the existing noise climate around the site of the proposed operations, including background noise levels at nearby noise-sensitive properties;
- estimating the likely future noise from the development and its impact on the neighbourhood of the proposed operations;

- monitoring noise emissions to ensure compliance with appropriate environmental standards.

4.25 The guidance goes on to state that planning authorities will need to consider whether the overall effect of the noise exposure would be above or below the SOAEL and LOAEL, and whether a good standard of amenity can be achieved taking account of the prevailing acoustic environment.

4.26 The PPG-M sets out noise level criteria to be achieved by mineral extraction operations:

"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 ($L_{A90,1h}$) by more than 10 dBA during normal working hours (0700 – 1900). Where it will be difficult not to exceed the background level by more than 10 dBA 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 55 dB $L_{Aeq,1h}$ (free field). For operations during the evening (1900-2200) the noise limits should not exceed the background noise level ($L_{A90,1h}$) by more than 10 dBA and should not exceed 55 dBA $L_{Aeq,1h}$ (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 42 dBA $L_{Aeq,1h}$ (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. L_{max} 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."

4.27 All mineral operations will have some particularly noisy short-term activities that cannot meet the limits set for normal operations. Examples include 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. However, these activities can bring longer-term environmental benefits. In relation to this, the PPG-M states:

"Increased temporary daytime noise limits of up to 70 dBA $L_{Aeq,1h}$ (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 70 dBA $L_{Aeq,1h}$ (free field) limit referred to above should be regarded as the normal maximum."*

4.28 The noise limits contained within the PPG-M have been reproduced in Table 4.2 below. The limits contained in the table apply to emissions from the minerals activities evaluated outside a residential noise sensitive receptor (NSR). Whilst not explicitly stated in the PPG-M, noise levels in excess of the limits are likely to be indications of exposures above the SOAEL, depending on the context as described in the NPSE, NPPF and PPG-N.

Table 4.2: PPGM Noise Limits

Activity	Period	Noise Limit, dB $L_{Aeq,1h}$
Normal Operations (long term extraction)	07:00 – 19:00 hours	10 dB above the background sound level and ≤ 55
	19:00 – 22:00 hours	10 dB above the background sound level and ≤ 55
	22:00 – 07:00 hours	42
Short-term Activities (limited to 8 weeks in any year – soil stripping/bund construction/restoration etc.)	Daytime activities	70

4.29 The noise limits in the guidance for minerals extraction sites is higher than would normally be tolerated for permanent industrial development of the same scale for two reasons, namely:

- the options for the location of minerals extraction sites is limited by the location of the natural resource; and
- minerals extraction activities are usually limited in duration due to the resources eventually running out.

4.30 Both of the above factors also apply to this development.

British Standard 4142

4.31 British Standard 4142:2014 [5] describes a method for rating and assessing sound of an industrial and/or commercial nature. The standard is applicable to the determination of the rating level of industrial or commercial sound as well as the ambient, background and residual noise levels for the purposes of investigating complaints, assessing sound from proposed new, modified or additional sources or assessing sound at proposed new dwellings. The determination of whether a noise amounts to a nuisance is beyond the scope of the standard, as is rating and assessment of indoor noise levels.

4.32 The standard compares the "rating level" of the noise (i.e. the specific noise level from the site under investigation adjusted using penalties for acoustic character such as tonality or impulsiveness) with the pre-existing background noise level.

4.33 The standard specifies that:

- typically, the greater the difference between rating level and background noise, the greater the magnitude of impact;
- 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; 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 or a significant adverse impact. 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.

4.34 The standard notes that where background sound levels and rating levels are both “low”, absolute noise levels might be as, or more, relevant than the margin by which the rating level exceeds the background, especially at night.

4.35 With regards to the rating correction, paragraph 9.2 of BS 4142:2014 states:

“Consider the subjective prominence of the character of the specific sound at the noise-sensitive locations and the extent to which such acoustically distinguishing characteristics will attract attention.”

4.36 The commentary to paragraph 9.2 of BS 4142:2014 suggests the following subjective methods for the determination of the rating penalty for tonal, impulsive and/or intermittent specific sounds:

“Tonality - For sound ranging from not tonal to prominently tonal the Joint Nordic Method gives a correction of between 0 dB and +6 dB for tonality. Subjectively, this can be converted to a rating penalty of 2 dB for a tone which is just perceptible at the noise receptor, 4 dB where it is clearly perceptible, and 6 dB where it is highly perceptible.

Impulsivity – A correction of up to +9 dB can be applied for sound that is highly impulsive, considering both the rapidity of the change in sound level and the overall change in sound level. Subjectively, this can be converted to a penalty of 3 dB for impulsivity which is just perceptible at the noise receptor, 6 dB where it is clearly perceptible, and 9 dB where it is highly perceptible.

Other sound characteristics - Where the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

Intermittency - When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference *time interval which contains the greatest total amount of on time. … If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied."*

British Standard 5228

4.37 British Standard 5228: 2009+A1:2014 "Code of practice for noise and vibration control on construction and open sites" [6] is the most relevant standard relating to construction noise. The standard is split into two parts: Part 1 dealing with noise and Part 2 dealing with vibration.

4.38 The standard notes that for some large infrastructure projects that require an EIA, construction noise is sometimes assessed by comparing the predicted construction noise (plus pre-construction ambient noise) with the pre-construction ambient noise. However, it notes that a greater difference might be tolerated than for a permanent industrial source.

4.39 For dwellings, times of site activity outside of normal working hours will need special consideration. It suggests that evening noise limits might have to be as much as 10 dBA below the daytime limit and that very strict noise control targets might need to be applied for night-time working.

4.40 Annex E (*informative*) of the standard provides examples of criteria that can be used for the assessment of the significance of effects due to construction noise. It notes three main reasons for undertaking such an assessment:

- For Environmental Impact Assessments;
- Assessments for developments that do not require EIA; and
- Control of Pollution Act Section 61 applications.

4.41 Annex E describes two main approaches for assessing the significance of effects, as follows:

- Significance based upon fixed (absolute) limits and eligibility for noise insulation and temporary re-housing. This is primarily based on guidance given in Advisory Leaflet 72 and is described below; and
- Significance based upon noise change. The standard notes that this assessment method reflects more conventional EIA methodologies for noise.

4.42 With respect to noise change, the standard gives two examples of assessment techniques; the first being the "ABC" method and the latter being the 5 dB change method. The ABC method has been used in this assessment.

4.43 The ABC method criteria are based on a comparison of the predicted L_{Aeq} level due to construction works with the pre-existing L_{Aeq} before the construction works, rounded to the nearest 5 dB. If the rounded pre-existing L_{Aeq} level is less than the values listed in Category A, then the noise levels listed in the Category A column should be used as the threshold level for significance of construction noise. If the pre-existing L_{Aeq} level is equal to the values listed in Category A, then the noise levels listed in the Category B column should be used as the threshold level for significance. Finally, if the pre-existing L_{Aeq} level is greater than the values listed in Category A, then the noise levels listed in the Category C column should be used.

Table 4.3: Construction noise threshold of potentially significant effect at dwellings

Assessment Category	**Threshold Value (dB) $L_{Aeq,T}$**		
	Category A [a)]	**Category B** [b)]	**Category C** [c)]
Night-time (23:00 – 07:00)	45	50	55
Evenings and Weekends [d)]	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
Note 1: A potentially significant effect is indicated if the $L_{Aeq,T}$ noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level. *Note 2: If the ambient noise level exceeds the Category C threshold values given in the table (i.e. the ambient noise level is higher than the above values) then a potentially significant effect is indicated if the total $L_{Aeq,T}$ noise level for the period increases by more than 3 dB due to site noise.* *Note 3: Applies to residential receptors only.*			
Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. *Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values.* *Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values.* *19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.*			

4.44 The 5 dB change method is based upon a significant effect being deemed to occur where noise from construction activities exceeds pre-construction ambient levels by 5 dBA or more, subject to lower cut-off values of 65, 55 and 45 dB $L_{Aeq,period}$ for the daytime, evening and night-time periods respectively.

4.45 Annex E also includes guidance on setting noise limits for construction activities which will involve long-term earth moving activities (as is the case for the borrow pit and some construction aspects of the Project). It states that this type of activity is more akin to surface mineral extraction sites and suggests that a limit of 55 dB $L_{Aeq,1h}$ is adopted for these types of activities but only where the works are likely to occur for a period in excess of six months.

4.46 The standard also includes criteria for assessing the requirement for provision of sound insulation or temporary re-housing where, in spite of the mitigation measures applied and any Section 61 consents under the Control of Pollution Act, noise levels at some properties exceed particular trigger levels.

4.47 According to the scope of the standard, it is intended to give "recommendations for basic methods of noise control relating to construction sites, including sites where demolition, remediation, ground treatment or related civil engineering works are being carried out, and open sites, where work activities/operations generate significant noise levels". The proposed activities at Altcar Moss Wellsite (e.g. use of a drilling rig and flaring) do not fall within the definition of an "open site" provided for in paragraph 3.11 of the standard, but the standard is applicable to construction of the wellsite and access track.

British Standard 8233

4.48 British Standard 8233:2014 [7] has been used for many years for general guidance on acceptable noise levels in and around buildings. The latest revision to the standard, BS 8233:2014, provides guidance on design criteria for internal ambient noise levels in new (or refurbished) buildings. The scope of the standard states that it should not be used to assess the effects of changes in the external noise level to occupants of an existing building.

4.49 In relation to external noise levels, the second paragraph of 7.7.3.2 states that:

"For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments..."

World Health Organisation (WHO) Guidelines

4.50 In 2009 a report was published presenting the conclusions of a World Health Organisation (WHO) working group responsible for preparing guidelines for exposure to noise during sleep entitled "Night Noise Guidelines for Europe" [8]. The document can be seen as an extension to the original 1999 WHO Guidelines for Community Noise. Various effects are described including biological effects, sleep quality, and well-being. The document gives threshold levels for observed effects expressed as $L_{max, inside}$ and $L_{night, outside}$. The L_{night} is a *year-long average* night-time noise level, not taking into account the façade effect of a building. In an exposed population a noise exposure of 40 dB $L_{night, outside}$ is stated as equivalent to the "lowest observed adverse effect level" for night noise. Above this level adverse health effects observed are self-reported sleep disturbance, environmental insomnia and increased use of somnifacient drugs and sedatives. Above 55 dB $L_{night, outside}$ cardiovascular effects become the major public health concern. Threshold levels for waking in the night, and/or too early in the morning are given as 42 dB $L_{Amax, inside}$. Lower thresholds are given that may change sleep structure.

4.51 The effects of different levels of night noise on the population's health in the NNGs are summarised in Table 4.4.

Table 4.4: Summary of Observed Health Effects in the Population (WHO NNG)

Noise Level, $L_{night, outside}$	Observed Effect
up to 30 dBA	No substantial biological effects are observed.
30 to 40 dBA	A number of effects are observed to increase: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and on the number of events, even in the worst cases the effects seem modest.
40 to 55 dBA	Adverse health effects are observed along the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are now severely affected.
Above 55 dBA	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a high percentage of the population is highly annoyed and there is limited evidence that the cardiovascular system is coming under stress.

4.52 It is relevant to note that taking into account typical night to night variation in noise levels that will often occur due to meteorological effects and the effects of a façade, the night noise guidelines are similar to those previously given in the 1999 WHO report [9] (an external façade noise level of 45 dB L_{Aeq}), although defined in a different way.

4.53 The WHO guideline values give the lowest threshold noise levels below which the occurrence rates of particular effects can be assumed to be negligible. Exceedances of the WHO guideline values do not necessarily imply significant noise impact and, indeed, it may be that significant impacts do not occur until much higher degrees of noise exposure are reached.

4.54 Guidance on desirable levels of environmental noise is also given in the 1999 report. Section 4.3.1 of the document states that *"to protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces and outdoor living areas should not exceed 55 dB L_{Aeq} for a steady continuous noise. To protect the majority of people from being moderately annoyed during the daytime, the sound pressure level should not exceed 50 dB L_{Aeq}. These values are based on annoyance studies but most countries in Europe have adopted 40 dB L_{Aeq} as the maximum allowable level for new developments."*

4.55 The daytime value of 40 dB L_{Aeq} for new developments is very low and is not considered to be consistent with the criteria adopted for new developments (be it new noise sensitive development or new noise sources) in the UK. The values for moderate and serious annoyance are, however, consistent with UK planning policy.

4.56 The WHO guidelines have not been formally adopted into UK legislation or guidance, hence it remains a source of information reflecting a high level of health care with respect to noise, rather than a standard to be rigidly applied. The guideline values give the lowest threshold noise levels below which the occurrence rates of particular effects can be assumed to be negligible. Exceedances of the WHO guideline values do not necessarily imply significant noise impact and indeed, it may be that significant impacts do not occur until much higher degrees of noise exposure are reached.

4.57 The major concern in Europe is with respect to noise from transportation systems, and most of the studies on which these guidelines are based relate to this type of noise source. There can be no certainty that the same effects will be observed from noise of an industrial nature, but in the absence of any more detailed information some weight should be attached to the WHO guidance when assessing industrial noise as well.

4.58 In 2001 the Defra-funded National Noise Incidence Survey [10] measured external noise levels outside 1,160 dwellings throughout the UK over 24-hour periods spread over the course of the year. The study concluded that an estimated 55% of the population of the United Kingdom live in dwellings exceeding the recommended WHO daytime noise level threshold of 55 dB L_{Aeq} and that 67% live in dwellings exceeding the night-time threshold for sleep disturbance of 45 dB L_{Aeq}.

5 Baseline Noise Description

Noise Sensitive Receptors

5.1 The proposed wellsite is located in worked farm land, immediately to the northwest of Sutton's Lane, Great Altcar. The site is located within Great Altcar Parish, in the district of West Lancashire.

5.2 The nearest noise sensitive receptors to the development include:

- **Formby's Farm** – located approximately 950 m south-west of the proposed wellsite boundary;
- **Tyrer's Farm** – located approximately 900 m south-west of the proposed wellsite boundary;
- **Sutton's Farm** – located approximately 1 km south-west of the proposed wellsite boundary;
- **Properties on Lord Sefton Way** (B5195) – located approximately 950 m to 1 km south-south-west of the wellsite boundary;
- **Properties on Aspinall Crescent** – located approximately 940 m to 1 km south of the proposed wellsite boundary;
- **Southern Heys Farm and Properties on Downholland Moss Lane** – located approximately 1.3 km west of the proposed wellsite boundary.

5.3 The above distances refer to the distance between the wellsite boundary and the NSR. Distances to the access track are shorter for some of the NSRs.

Noise Monitoring Dates and Locations

5.4 Noise monitoring was undertaken at a number of locations in order to characterise the baseline environment. The noise monitoring locations and methodology were agreed with the MPA prior to undertaking the survey. The survey comprised a combination of long-term unattended measurements at locations where agreement could be obtained from the landowner to set up equipment, supplemented by short term attended surveys on public land in order to determine representative noise levels at other locations.

5.5 These measurement locations are shown in Figure 5.1 and described in Table 5.1.

Table 5.1: Noise measurement locations

Location No	Survey type	Description
LT1	Long-term / unattended	East of Formby's Farm
LT2	Long-term / unattended	East of Aspinall Crescent
LT1a	Long-term / unattended	East of Formby's Farm (note – taken during hours of attended surveying)
LT2a	Long-term / unattended	East of Aspinall Crescent (note – taken during hours of attended surveying)
ST1	Short-term / Attended	Formby's Farm
ST2/2a	Short-term / Attended	Tyrer's Farm (note – survey location moved to 2a due to noise from farm considered not to be representative of wider area)
ST3	Short-term / Attended	North of Aspinall Crescent
ST4	Short-term / Attended	Southern Heys Farm and Properties on Downholland Moss Lane
ST5	Short-term / Attended	Old Moss Lane

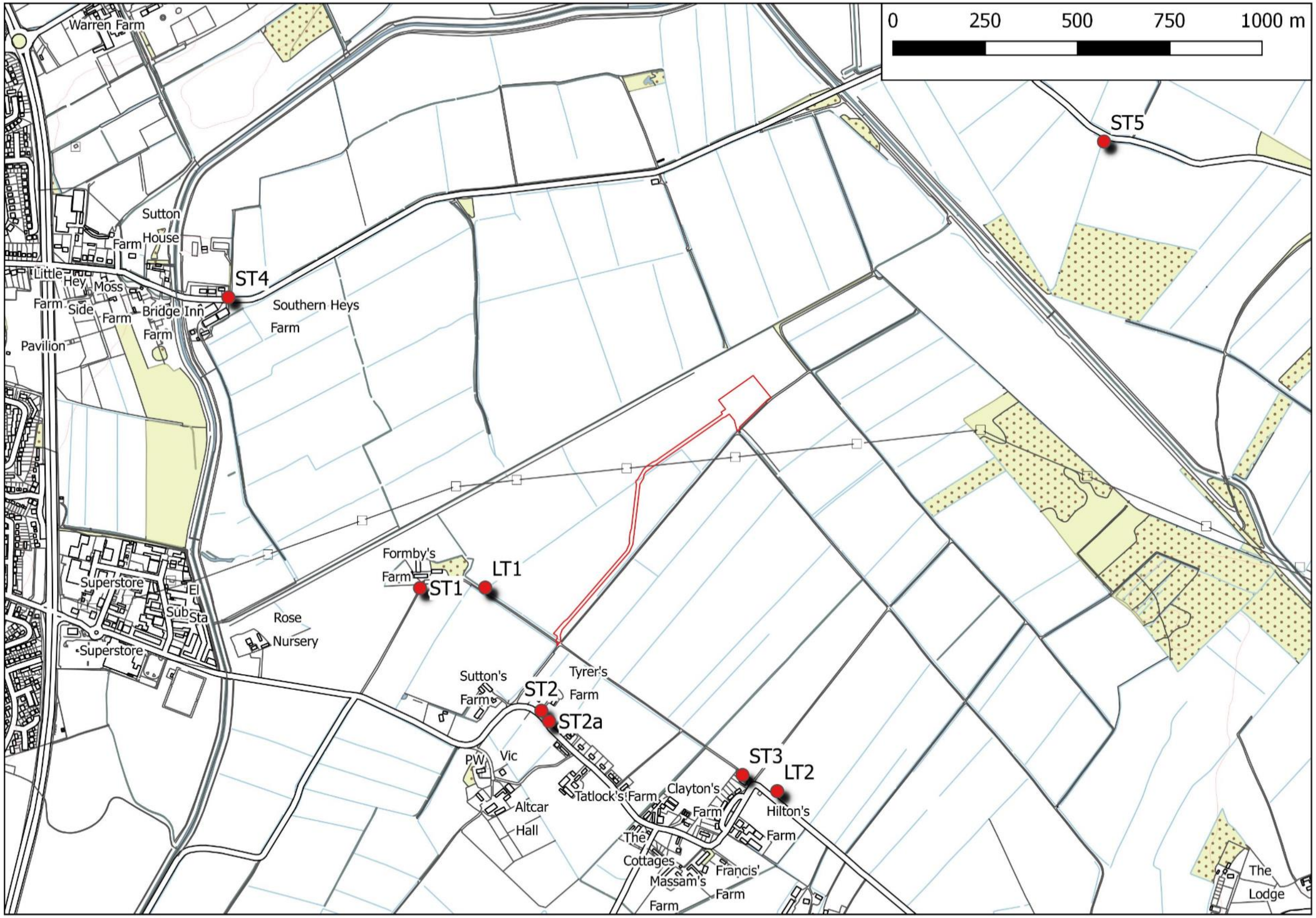


Figure 5.2: Noise Measurement Locations

5.7 Unattended long-term noise monitoring was undertaken from 17th May to 25th May 2018, and from 4th June to 6th June 2018. The noise surveys were undertaken using Rion type NL-52 sound level meters. The meters were programmed to measure various parameters including the L_{Aeq}, L_{AFmax} and L_{A90} values, logging at contiguous 15 minute intervals throughout the monitoring period. Microphone positions were 1.5 metres above the ground and at least 3.5 metres from any vertical reflecting surface. The equipment calibration level was checked prior to, and after, the monitoring periods – no significant changes (±0.2 dB) were noted.

5.8 Attended measurements were also conducted over a period during the daytime and at night at locations representative of the nearest noise sensitive premises on 4th / 5th June 2018. Overall A-weighted and octave band sound pressure levels were recorded and a note was made by the surveyor of the sources of noise contributing to the baseline noise environment for each measurement (including any events contributing to the recorded levels). In addition, measurements and observations were made of meteorological conditions including wind speed and direction, cloud cover (in octants), relative humidity and temperature.

5.9 The measurements conformed to the requirements of BS 7445:2003 [11].

Meteorological Conditions

5.10 Weather conditions were monitored throughout the survey period using a metrological data logger. Winds varied in direction throughout the monitoring period. Wind speeds were generally low (less than 5 m/s). Periods of rain were noted during the nights of 21st May, and 25th May. Analysis of the results has determined that the wind speed or rainfall did not significantly affect the baseline noise levels used in the assessment therefore no data have been excluded due to meteorological conditions.

Results and Discussion

5.11 The time history noise plots for the long term monitoring are provided in Figures A1 and A2 at the back of this report. Noise levels in the locality are influenced by distant traffic, aircraft and rural activities. A summary of the measured baseline noise levels at LT1 (Formby's Farm) is given in Table 5.2 and for LT2 (Aspinall Crescent) in Table 5.3

Table 5.2: Measured baseline noise level ranges, LT1 - Formby's Farm

	Ambient noise, dB $L_{Aeq,T}$			Background noise, dB L_{A90}			Maximum noise, dB L_{Amax}		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Range	37 - 67	29 - 53	24 - 48	30 - 52	25 - 50	22 - 41	52 - 89	42 - 81	29 - 78
25th percentile	43	38	31	35	32	26	64	53	45
Median	45	42	36	37	34	30	69	66	52
75th percentile	48	46	42	38	37	34	75	70	65
Arithmetic Average	46	42	36	37	35	30	69	62	54
Standard deviation	4	5	6	4	4	5	7	10	11

Table 5.3: Measured baseline noise level ranges, LT2 - Aspinall Crescent

	Ambient noise, dB $L_{Aeq,T}$			Background noise, dB L_{A90}			Maximum noise, dB L_{Amax}		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Range	52 - 79	48 - 77	24 - 64	34 - 50	24 - 47	22 - 42	73 - 108	71 - 109	35 - 95
25th percentile	61	56	42	40	32	25	79	75	68
Median	62	58	48	42	35	28	81	78	73
75th percentile	63	61	51	44	39	34	85	87	75
Arithmetic Average	62	59	45	42	35	29	83	82	67
Standard deviation	3	6	9	3	5	5	6	9	13

5.12 The spread of the measured noise data is also shown in the box and whisker plots in Figure 5.3.

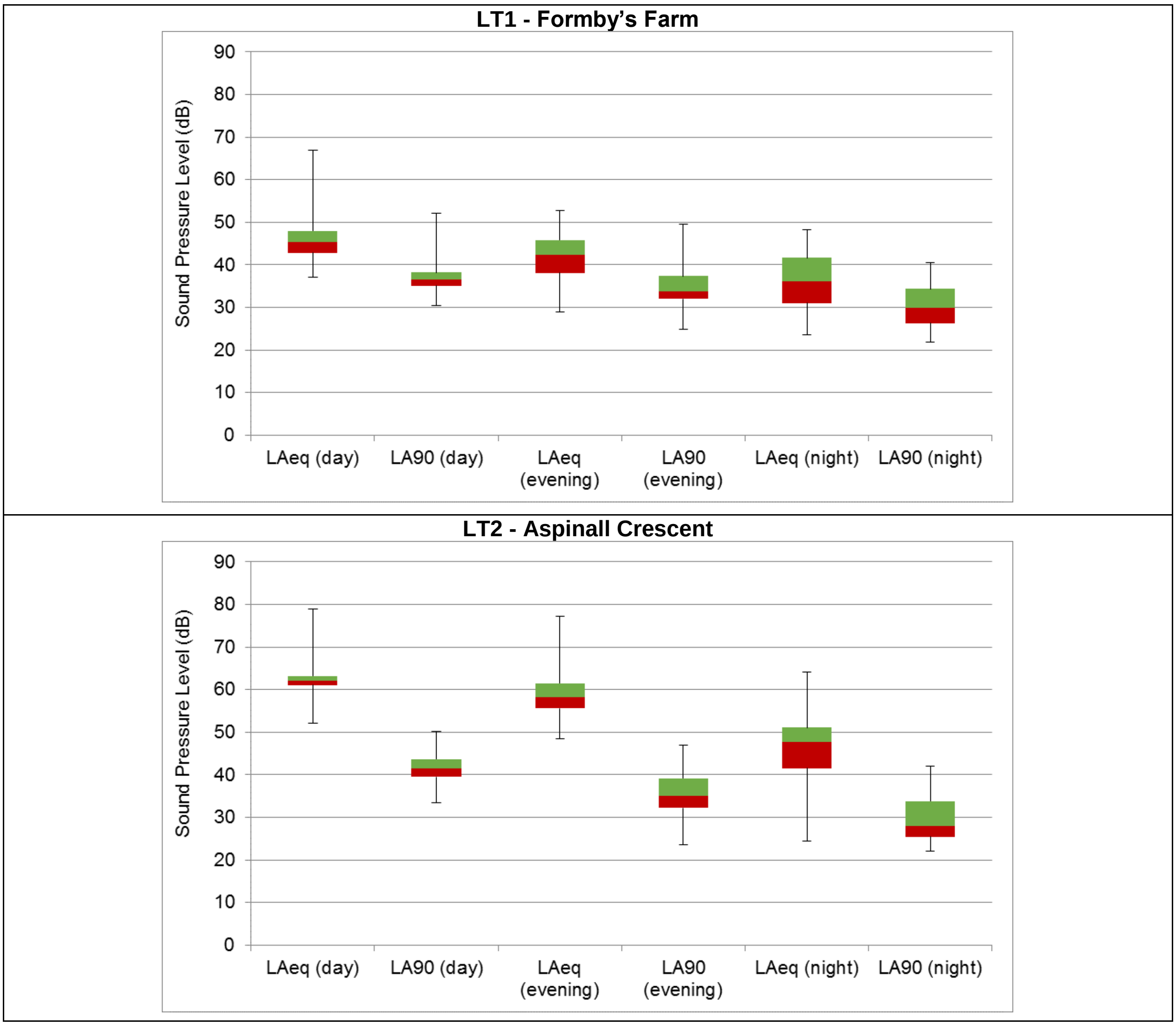


Figure 5.3: Box and whisker plots of noise monitoring data

5.13 The results of the attended noise monitoring are summarised in Table 5.4.

Table 5.4: Summary of attended noise measurement results (5 minute samples)

Location	Daytime / Evening				Night time			
	Start Date/Time	L_{Aeq}	L_{Amax}	L_{A90}	Start Date/Time	L_{Aeq}	L_{Amax}	L_{A90}
ST1 - Formby's Farm	04/06/18 14:35	38	55	33	04/06/18 23:52	37	52	33
	04/06/18 16:15	42	56	35	05/06/18 00:50	33	60	28
	04/06/18 17:08	40	63	35	05/06/18 01:47	32	45	28
	04/06/18 18:06	44	58	36	05/06/18 02:45	38	48	35
ST2 - Tyrer's Farm	04/06/18 15:38	64	82	45	05/06/18 00:17	39	54	36
	04/06/18 16:36	68	85	50	05/06/18 01:15	38	45	35
	04/06/18 17:30	68	86	45	05/06/18 02:13	35	45	32
	04/06/18 18:27	69	92	45	05/06/18 03:10	37	53	33
ST3 - Aspinall Crescent	04/06/18 14:52	55	65	36	05/06/18 00:05	42	59	31
	04/06/18 16:26	52	61	45	05/06/18 01:03	32	50	25
	04/06/18 17:19	54	68	45	05/06/18 02:01	28	42	24
	04/06/18 18:17	58	72	43	05/06/18 02:57	28	44	24
ST4 - Southern Heys Farm	04/06/18 15:58	53	74	46	05/06/18 00:33	47	76	30
	04/06/18 16:52	53	73	42	05/06/18 01:31	36	44	33
	04/06/18 17:50	49	63	48	05/06/18 02:30	36	48	31
	04/06/18 18:44	57	77	45	05/06/18 03:26	36	49	33
ST5 - Old Moss Lane	04/06/18 19:01	42	66	30	05/06/18 03:43	30	48	23

5.14 The attended surveys were supplemented with long term surveys at LT1 (Formby's farm) and LT2 (Aspinall Crescent). It should be noted that periods of inflated noise levels due to the surveyor accessing the area in their car for attended measurements have been excluded from the data. The results of the unattended surveys are shown in

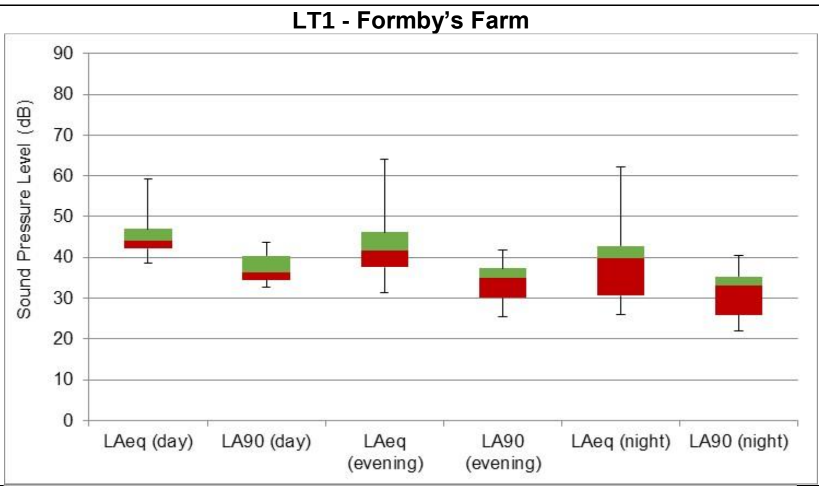
Table 5.5: Supplementary measured baseline noise level ranges, LT1 - Formby's Farm

	Ambient noise, dB $L_{Aeq,T}$			Background noise, dB L_{A90}			Maximum noise, dB L_{Amax}		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Range	39 - 59	31 -64	26 – 62	33 -34	25 -42	22 - 41	50 - 80	41 - 92	35 – 90
25th percentile	42	48	31	35	30	26	58	54	26
Median	44	42	40	36	35	33	62	62	33
75th percentile	47	46	43	40	37	35	67	67	35
Arithmetic Average	45	42	39	37	34	31	62	62	54
Standard deviation	4	7	8	3	5	5	7	12	11

Table 5.6: Supplementary measured baseline noise level ranges, LT2 - Aspinall Crescent

	Ambient noise, dB $L_{Aeq,T}$			Background noise, dB L_{A90}			Maximum noise, dB L_{Amax}		
	Day	Eve	Night	Day	Eve	Night	Day	Eve	Night
Range	58 - 73	48 - 65	24 - 58	35 - 45	26 - 42	20 - 41	74 - 102	69 - 94	39 – 87
25th percentile	61	54	41	49	31	26	78	75	64
Median	61	57	47	41	33	33	81	79	72
75th percentile	62	60	51	43	36	34	84	82	74
Arithmetic Average	62	57	45	41	33	30	82	79	67
Standard deviation	2	4	8	2	4	5	5	6	11

5.15 The spread of the measured noise data is also shown in the box and whisker plots in Figure 5.4.



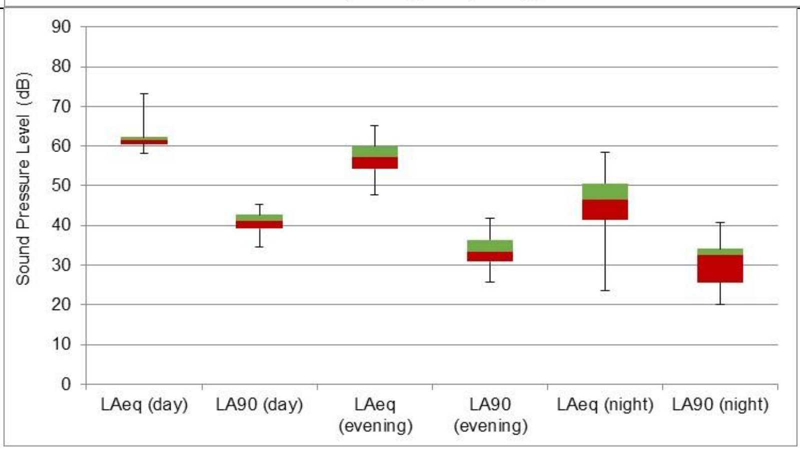


Figure 5.4: Box and whisker plots of supplementary noise monitoring data

5.16 BS 4142:2014 requires that the background sound levels adopted for the assessment be representative for the period being assessed. However, the Standard states that there is no 'single' background sound level that can be derived from such measurements. It is particularly difficult to determine what is 'representative' of the night-time period because it can be subject to a wide variation in background sound level between the shoulder night periods. The accompanying note to paragraph 8.1.4 states that *"a representative level ought to account for the range of background sounds levels and ought not automatically to be assumed to be either the minimum or modal value".*

5.17 The 25th percentile value from the unattended monitoring has been used as a starting point in order to characterise the baseline noise environment. This value is not the lowest sound level encountered but is lower than obtained using the average. It therefore represents somewhere in the range of lower sound levels that are likely to be encountered and therefore represents a precautionary assessment. Use of the 25th percentile also ensures that any periods during which higher wind speeds could have affected the measured baseline noise levels do not unduly affect the analysis.

5.18 Baseline noise levels at other locations have been derived based on the typical difference in ambient and background noise between the short-term and supplementary long-term locations. The baseline noise levels used in the assessment for the nearest residential receptors are summarised in Table 5.7.

5.19 Noise levels at Formby's Farm are significantly lower than those at the other receptors. This is mainly due to the farm's positioning at the end of a private track, with the only vehicle movements being tractors for the surrounding fields. As the survey locations were located close to the main road, all receptors, other than Formby's Farm, have had values adjusted to reflect levels representative of the back gardens of the properties, away from the road.

Table 5.7: Baseline noise levels used in assessment

Period	Parameter	Formby's Farm	Tyrer's Farm	Sutton's Farm	Lord Sefton Way	Aspinall Crescent	Southern Heys Farm
Daytime	Baseline ambient noise level, dB L_{Aeq}	43	61	61	61	61	53
	Background noise level, dB L_{A90}	35	42	42	40	40	43
Evening	Baseline ambient noise level, dB L_{Aeq}	38	56	56	56	56	53
	Background noise level, dB L_{A90}	32	35	35	32	32	42
Night-time	Baseline ambient noise level, dB L_{Aeq}	31	35	35	35	42	36
	Background noise level, dB L_{A90}	26	25	25	25	25	28

6 Calculations and Modelling

Construction and Restoration

6.1 For the purposes of construction noise modelling, it has been assumed that, as a worst case, all of the equipment shown in Table 6.1 will be utilised on site at the same time for 100% of the time. In reality, it is likely that construction will be staged with only some of the equipment operating at any one time. It has been assumed that similar equipment will be utilised for site restoration.

Table 6.1: Construction noise data used for modelling

Plant item	Number on site at any time	Assumed % on time	BS 5228 reference	Sound power level, dBA
360 excavator	1	100	C4.66	97
Dumper truck	2	100	C8.2	107
Large roller	1	100	C2.37	107
Tracked dozer	1	100	C2.11	107
Mini digger	1	100	C4.68	93
Roller	2	100	C5.19	108
Tarmac paving machine	1	100	C5.3	104
Piling rig	1	100	C3.14	112
Land drainage trenching machine	1	100	C4.64	103

Traffic

6.2 Traffic noise calculations have been carried out based on daily figures with and without construction traffic, as shown in Table 6.2.

Table 6.2: Traffic data used for modelling

Phase	Light site vehicles	Site HGVs	Total site vehicles	18 hour traffic flow	18h HGVs	%HGVs
Baseline	-	-	-	3,980	129	3.2
Access Track Construction	14	24	38	4,018	153	3.8
Wellsite Construction	50	8	58	4,038	137	3.4
Drilling	50	7	57	4,037	136	3.4
Hydraulic Fracture Stimulation	42	55	97	4,077	184	4.5
Initial Flow Testing	40	14	54	4,034	143	3.5
Extended Well Testing	36	3	39	4,019	132	3.3
Decommissioning and Well Abandonment	30	13	43	4,023	142	3.5
Wellsite Restoration	14	44	58	4,038	173	4.3

Drilling

6.3 Drilling operations will occur on a 24 hour basis and, as such, it is the night-time situation rather than the daytime which will be more critical. At the present time, no decision on the exact drilling rig to be utilised on the site has been made. The choice of drilling rig will depend on several factors, including rig availability at the time the wells are to be drilled, if planning permission is granted. Consequently, the noise characteristics from three typical types of drilling rigs were assessed to determine the suitability of the site with regard to potential noise impacts and the types of mitigation required. This represents a typical worst case scenario in terms of the likely noise impacts from drilling. The drilling rig types assessed were the Boldon Drilling Rig 92, Drillmec HH-220 and the DrillTec VDD 370.

6.4 It should be noted that these three drilling rigs are typical of the type of rig that might be used. Different drilling rigs produce different noise levels and noise characteristics and the rigs selected were considered to give a representative range of the noise levels and characters that could occur from any selected rig. This would also enable different noise mitigation measures to be assessed as part of the Noise Impact Assessment. The drilling rigs assessed are typical and form part of the range of rigs in terms of power, capability, height and top drive that could be selected to drill the wells at Altcar Moss depending on availability. It is expected that other rigs of a comparable type will have a similar noise footprint. If an alternative rig were to be proposed, a further noise report would be prepared to determine how the noise emission differs from that presented in this report, and which mitigation measures it would be appropriate to apply, from those discussed in this report, in order to ensure that noise is reduced to as low as practicable and meets required daytime and night-time levels.

6.5 A workover rig may be utilised for Phases 4 and 7. Typically a workover rig would be smaller with a lower noise footprint than a full rotary equipped rig. Consequently, the noise levels predicted for the three rigs assessed would be lower during these phases than during the drilling phase.

Boldon Drilling Rig 92

6.6 One of the example rigs is the for drilling at Altcar Moss is the Boldon Drilling Rig 92, shown in Figure 6.1, which has an electric top drive. The rig has been used previously at Wytch Farm in Dorset and has been fitted with noise mitigation measures in order to operate in noise sensitive environments.

Figure 6.1: Photo of Boldon Rig 92

6.7 Although RPS has not undertaken a noise survey on the rig, sound power level data has been made available for the purposes of this assessment, as shown in Table 6.3.

Table 6.3: Boldon Rig 92 source sound power levels used in assessment, dB re 1 pW

Item	Overall, dBA	Linear octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Top drive- with enclosure	**95**	96	104	105	93	92	89	87	82	72
Top drive- without enclosure	**99**	93	98	99	97	95	94	92	86	78
Top drive blower	**96**	94	97	97	93	93	90	89	82	73
Mud pump enclosure	**102**	49	98	98	100	100	97	94	91	87
Generator (per generator)	**100**	108	111	108	101	96	93	90	87	92

Marriott Drillmec HH-220

6.8 The Drillmec HH-220 rig is operated by Marriott Drilling. The HH-220 rig is hydraulically operated and is erected using its own hydraulic pistons. Pipe handling is automated and computer controlled, and as a consequence there is significantly reduced manual handling of drill pipes, virtually eliminating the impact noise associated with more traditional pipe handling methods. The top drive is hydraulically powered. There is no brake drum as on a conventional drilling rig, and hence there is no characteristic brake drum “squeal”.

6.9 A photo of the Marriott HH-220 rig is shown in Figure 6.2.

Figure 6.2: Photo of Marriott HH-220 rig

6.10 In addition to the drilling rig trailer there are three packaged generators (of which two units are normally in operation) as well as other equipment including: mud pumps, shale shakers, centrifuges, a mud mixing units and a hydraulic power pack (HPU).

6.11 Mitigation measures installed on the HH-220 rig include:

- Hydraulic operated rig with automated pipe handling to reduce pipe handling noise;
- Enclosed shale shakers;
- Acoustically enclosed top drive;
- Acoustically enclosed generators with high specification exhaust silencers; and
- Acoustically enclosed HPU.

6.12 Sound power level data for the rig was obtained from a range of sources. The HPU and generators were measured at Marriott Drilling's yard in March 2018. Measurements were carried out using the sound intensity scanning methodology. The sound power levels were determined by measuring sound intensity levels (by scanning a microphone probe over each element) and integrating over the radiating area. In general, measuring sound intensity to determine sound power provides more accurate predictions than measuring sound pressure due to the ability to minimise/reject off axis/extraneous noise. Furthermore, the ability to measure more accurately in the near-field (compared to sound pressure level measurements) means that there is no requirement to include empirical near-field corrections in the sound power calculations.

6.13 Noise data for the top drive was based on detailed sound intensity measurements taken on an identical model top drive whilst drilling at Larkwhistle Farm in 2007. Data for the rig trailer, rig above the trailer and centrifuge are taken from surveys of the Larchford HH-220 rig whilst operating at operating at Albury, Humbly Grove, Singleton, Bletchingley, Larkwhistle Farm, Cold Hanworth and Welton wellsites. The source noise data have been refined over a number of years and compared against a significant quantity of environmental noise monitoring data at various sites such that there is a high level of confidence in the data.

6.14 Data for the mud pumps and shale shakers is based on detailed sound pressure level measurements carried out by Arup Acoustics at Horse Hill Wellsite in 2014.

6.15 A summary of the Marriott HH-220 rig noise data utilised to build the noise model is shown in Table 6.4 as overall A-weighted and linear octave band sound power levels.

Table 6.4: Octave band sound power level data for Marriott HH-220 rig, dB re 1 pW

Item	Overall, dBA	Linear octave band sound power level, dB re 1 pW								
		31.5	63	125	250	500	1k	2k	4k	8k
HH-220 Generator (Enclosed)	**97**	110	112	111	96	88	83	77	73	69
HH-220 Generator Exhaust	**95**	107	100	109	96	85	81	81	81	77
HH-220 Top Drive	**86**	-	86	83	86	84	81	76	69	63
HH-220 Mud Pump	**108**	98	103	111	110	104	103	100	97	93
HH-220 Shale Shakers	**94**	117	101	99	91	93	89	86	80	67
HH-220 Hydraulic Power Unit	**96**	97	90	93	104	89	84	78	71	64
HH-220 Rig Trailer	**91**	-	-	-	100	-	-	-	-	-
HH-220 Rig above Trailer	**90**	85	78	80	91	91	79	82	64	55
HH-220 Centrifuge (Enclosed)	**84**	86	94	90	75	81	80	73	63	57

DrillTec VDD 370

6.16 The DrillTec VDD 370 rig is a hydraulic rig with automated pipe handling. The DrillTec rig is hydraulically operated and is erected using its own hydraulic pistons. Pipe handling is automated and computer controlled, and as a consequence there is significantly reduced manual handling of drill pipes, virtually eliminating the impact noise associated with more traditional pipe handling methods. The top drive is hydraulically powered. There is no brake drum as on a conventional drilling rig, and hence there is no characteristic brake drum “squeal”.

6.17 A photo of the VDD 370 drilling rig is shown in Figure 6.3.

Figure 6.3: Photo of DrillTec VDD 370 rig

6.18 In addition to the drilling rig trailer there are four main packaged generators as well as other equipment including: mud pumps, shale shakers, centrifuges, mud mixing units and a hydraulic power pack (HPU).

6.19 Mitigation measures installed on the DrillTec rig include:

- Hydraulic operated drilling rig with automated pipe handling to reduce pipe handling noise;
- Acoustic enclosure fitted around top drive;
- Centrifuge enclosed within rig structure;
- Acoustically enclosed generators with high specification exhaust silencers; and
- Acoustically enclosed HPU.

6.20 A noise survey was undertaken whilst the rig was drilling a horizontal well at Preston New Road, Lancashire, on 22nd February 2018. Measurements included a combination of detailed sound pressure levels close to operating equipment as well as far-field measurements at the site boundary. A nearfield correction was applied to the measurements in close proximity of the equipment in accordance with procedures detailed in EEMUA Publication 140 “Noise procedure Specification”. The far-field measurements were used as a calibration to verify the sound power levels determined from the nearfield measurements and a good correlation was achieved (i.e. <1 dB difference between modelled and measured far-field sound pressure levels).

6.21 Supplementary data was measured in June 2018 using sound intensity methods. The sound power levels were determined by measuring sound intensity levels (by scanning a microphone probe over each element) and integrating over the radiating area. In general, measuring sound intensity to determine sound power provides more accurate predictions than measuring sound pressure due to the ability to minimise/reject off axis/extraneous noise. Furthermore, the ability to measure more accurately in the near-field (compared to sound pressure level measurements) means that there is no requirement to include empirical near-field corrections in the sound power calculations.

6.22 A summary of the DrillTec VDD 370 rig noise data utilised to build the noise model is shown in Table 6.5 as overall A-weighted and linear octave band sound power levels.

Table 6.5: Octave band sound power level data for DrillTec VDD 370 rig, dB re 1 pW

Item	Overall, dBA	Linear octave band sound power level, dB re 1 pW								
		31.5	63	125	250	500	1k	2k	4k	8k
VDD 370 Generator 1	**93**	103	110	104	89	88	83	83	78	73
VDD 370 Generator 1 Exhaust	**96**	94	116	106	100	86	84	80	74	66
VDD 370 Generator 2	**98**	100	120	107	100	91	89	83	80	75
VDD 370 Generator 2 Exhaust	**95**	98	116	106	100	85	82	78	75	68
VDD 370 Generator 4	**91**	103	106	102	91	87	83	80	74	71
VDD 370 Generator 4 Exhaust	**94**	90	108	108	98	84	80	73	69	60
VDD 370 Mud Pump Drive Motor	**100**	119	109	102	99	98	94	91	90	84
VDD 370 Mud Pump	**90**	102	93	91	93	87	84	82	76	73
VDD 370 Main HPU	**97**	104	106	98	102	94	87	85	84	77
VDD 370 Auxiliary HPU	**95**	105	110	97	99	93	82	82	81	67
VDD 370 Shale Shakers	**102**	127	112	109	103	100	94	92	89	87
VDD 370 Agitators	**96**	102	101	97	96	93	92	89	84	77
VDD 370 Centrifuge (Enclosed)	**92**	107	96	92	95	93	69	77	74	71
VDD 370 Top Drive (enclosed)	**93**	106	102	99	98	89	83	79	76	69

Hydraulic Fracture Stimulation

6.23 At the present time, no decision on the exact hydraulic fracturing spread to be utilised on the site has been made. Consequently, the noise characteristics from a typical frac spread used in the UK has been assessed to determine the suitability of the site with regard to potential noise impacts and the types of mitigation required.

6.24 The frac spread included in the assessment is based on measured sound power level data for hydraulic fracture operations at Preese Hall Explorations Site near Weeton, Lancashire. The significant noise generating plant include up to seven fracturing pumps and a blender. A photo of the spread in-situ is shown in Figure 6.4.

Figure 6.4: Photo of Frac Spread at Preese Hall Exploration Site

6.25 Although RPS has not undertaken a noise survey on the rig, sound power level data has been made available for the purposes of this assessment, as summarised in Table 6.6.

Table 6.6: Frac spread source sound power levels used in assessment, dB re 1 pW

Item	Overall, dBA	Linear octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Frac spread total sound power level	**122**	115	126	128	119	117	117	116	112	105

Flow Testing - Flaring

6.26 The primary source of noise during flow testing / appraisal will be the use of two ground flares, each with a maximum flow rate of 2.24 MMscfd. The source noise data used in this assessment has been based on the methodology presented in VDI 3732 [[12]]. Frequency spectrum data was not available and this was therefore based on measurements on other similar flares. The assumed source sound power level for the ground flares is as presented in Table 6.7.

Table 6.7: Source sound power level for flares used in assessment, dB re 1 pW

Item	Overall, dBA	Linear octave band centre frequency, Hz								
		31.5	63	125	250	500	1k	2k	4k	8k
Ground flare - 2.24 MMscfd	**104**	119	115	102	102	101	97	96	95	87

Noise Model Methodology

6.27 The noise emissions from the proposed activities have been modelled using the CadnaA environmental noise prediction software. This model calculates the contribution from each noise source input as a specified source type (e.g. point, line, area) octave band sound power levels at selected locations. It predicts noise levels under light down-wind conditions based on hemispherical propagation, atmospheric absorption, ground effects, screening and directivity based on the procedure detailed in ISO 9613.

6.28 The ground between the site and the receiver locations has been assumed to be soft although the site itself has been modelled as hard ground. Terrain contour data has also been entered in the model based on OS land contours, although the land is fairly flat. Buildings have been included and these provide some degree of screening as well as reflecting surfaces.

6.29 The model has been run using a receiver height of 4 metres in order to investigate the noise impact from night-time operations, i.e. at first floor bedroom window level.

6.30 The same noise modelling techniques have been used by RPS on several drilling rigs in the UK and worldwide and there is a high degree of confidence in the model. The main area of uncertainty relates to source noise level data for the rig that RPS has not undertaken the measurements on. However, once the final drilling rig has been chosen, RPS will be able to provide detailed noise control advice to ensure that the rig meets or exceeds the noise emission levels specified in this report.

7 Results and Assessment

Traffic Noise Assessment

7.1 Changes in traffic noise levels along Lord Sefton Way have been calculated using the methodology described in Calculation of Road Traffic Noise (CRTN). The traffic noise assessment is presented in Table 7.1, including a comparison against the Design Manual for Roads and Bridges (DMRB) classification of magnitude of noise impacts in the short term. The resulting changes in road traffic noise levels indicates that, for receptors along Lord Sefton Way, the resulting noise impacts are likely to be imperceptible and as a worst case are considered to be negligible and temporary in nature.

Table 7.1: Construction traffic noise assessment - Lord Sefton Way

Phase	Duration	Noise change, dB	Assessment
Access Track & Wellsite Construction	16 weeks	0.2	Negligible / temporary
Drilling & Coring of a Vertical Borehole	5 months	0.1	Negligible / temporary
Drilling & Coring of a Horizontal Borehole	5 months	0.1	Negligible / temporary
Hydraulic Fracture Stimulation of the Vertical & Horizontal Boreholes	60 days	0.5	Negligible / temporary
Initial Flow Testing of the Vertical & Horizontal Boreholes	60 days	0.2	Negligible / temporary
Extended Well Test of the Horizontal Borehole	90 days	0.1	Negligible / temporary
Decommissioning & Well Abandonment	4 weeks	0.1	Negligible / temporary
Wellsite restoration	8 weeks	0.4	Negligible / temporary

7.2 Site traffic on the access road has been assessed, where relevant, as part of the on-site noise level predictions for each phase.

Construction and Restoration Noise Assessment (Phases 1 and 8)

7.3 The results of the construction noise assessment are summarised in Table 7.2. The table includes the baseline ambient noise level for each location, the BS 5228 ABC method significance criteria, the specific noise due to construction and an assessment of whether the BS 5228 criteria are exceeded. Construction hours will be Monday to Friday 07:00 hrs to 19:00 hrs and Saturday 07:00 hrs to 13:00 hrs. No works will take place on Sundays and Bank Holidays or at night. In order to produce a worst case precautionary assessment, the lower BS 4142 criteria has been used even where baseline noise levels would otherwise place it within a higher band. The predicted noise levels include the contribution from construction on site as well as HGV movements on the access track and Suttons Lane.

Table 7.2: Construction (and restoration) noise assessment

Location	Baseline ambient sound level, dB L_{Aeq}		BS 5228 criteria		Specific sound level, dBA		Assessment	
	Day	Evening	Day	Evening / weekends	Access track construction	Site construction	Day	Evening / weekends
Formby's Farm	43	38	65	55	39	37	OK	OK
Tyrer's Farm	61	56	65	55*	50	44	OK	OK
Aspinall Crescent	61	56	65	55*	43	42	OK	OK
Southern Heys Farm	53	53	65	55	36	38	OK	OK
Lord Sefton Way	61	56	65	55*	49	43	OK	OK
Sutton's Farm	61	56	65	55*	51	44	OK	OK
** The lower BS 5228 criterion of 55 dB L_{Aeq} has been used in order to represent a precautionary assessment*								

7.4 It should be noted that the construction noise predictions are based on all plant items working for 100% of the time throughout the entire construction phase. In reality, this is an unrealistic scenario. Nevertheless, the assessment shows that even if all plant was to operate at one time, noise due to construction will be well below the BS 5228 criteria for significance. It should also be noted that construction and restoration will be temporary operations, lasting for a total of 16 weeks for site construction and 8 weeks for restoration. Consequently, it can be concluded that construction noise will **not result in a significant impact**.

Drilling Noise Assessment (Phases 2 and 3)

7.5 The PPG-M requires that "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 42 dBA $L_{Aeq,1h}$ (free field) at a noise sensitive property." The approach taken for this assessment has been to utilise best available techniques to reduce noise from the drilling rigs to as low as practicable without placing overly restrictive burdens on the operator. Consequently, the mitigation measures developed as part of this assessment take into account various factors including practicability, safety and technical constraints.

7.6 The drilling noise assessment is shown in Table 7.3 in comparison to the PPG-M noise limits.

Table 7.3: PPG-M noise assessment for drilling

Location	Background sound level, dB L_{A90}			PPG-M limit, dBA			Specific sound level, dBA			Assessment		
	Day	Eve	Night	Day	Eve	Night	B92	HH-220	VDD-370	Day	Eve	Night
Formby's Farm	35	32	26	45	42	42	28	33	29	OK	OK	OK
Tyrer's Farm	42	35	25	52	45	42	33	35	33	OK	OK	OK
Aspinall Crescent	40	32	25	50	42	42	33	35	34	OK	OK	OK
Southern Heys Farm	43	42	28	53	52	42	29	33	28	OK	OK	OK
Lord Sefton Way	40	32	25	50	42	42	33	35	32	OK	OK	OK
Sutton's Farm	42	35	25	52	45	42	32	38	33	OK	OK	OK

7.8 Noise modelling for the three example drilling rigs shows that noise levels will be below the 42 dB L_{Aeq} (free-field) noise limit from the PPG-M for all three rigs considered. Noise levels are also below the PPG-M noise limits for the daytime and evening periods for all three example drilling rigs.

7.9 Table 7.4 shows the baseline ambient noise levels and predicted drilling noise levels for the drilling rigs. With standard mitigation measures in place, it is expected that noise levels will be below the WHO guideline limit for the onset of sleep disturbance at all of the residential receptors. The assessment is based upon the maximum noise level produced by any of the three example rigs at any receptor and therefore represents a worst case scenario.

7.10 Phase 2 and Phase 3 drilling activities will last for 5 months each. Consequently, the noise impacts presented in the table will be a temporary impact lasting for no longer than 10 months in total.

Table 7.4: Temporary ambient noise level change assessment – drilling

Location	Ambient sound level, dB L_{Aeq}			Specific sound level, dBA			Max new ambient sound level, dBA			Change, dB		
	Day	Eve	Night	B92	HH-220	VDD-370	Day	Eve	Night	Day	Eve	Night
Formby's Farm	43	38	31	28	33	29	43	39	35	0	+1	+4
Tyrer's Farm	61	56	35	33	35	33	61	56	38	0	0	+3
Aspinall Crescent	61	56	35	33	35	34	61	56	38	0	0	+3
Southern Heys Farm	53	53	36	29	33	28	53	53	38	0	0	+2
Lord Sefton Way	61	56	35	33	35	32	61	56	38	0	0	+3
Sutton's Farm	61	56	35	32	38	33	61	56	40	0	0	+5

7.11 It is noted that there is potential for a temporary change in ambient noise levels whilst drilling is taking place. Consequently, it is likely that noise from drilling will be audible at the nearest residential premises during the night time. However, it is not considered feasible to conduct drilling operations in such a quiet area without introducing a temporary change in ambient noise. In this respect, it is important to note that the drilling rigs will be fitted with high-specification mitigation measures in order to reduce noise levels to as low as reasonably practicable.

Hydraulic Fracture Stimulation Noise Assessment (Phase 4)

7.12 The results of the assessment for hydraulic fracturing stimulation activities are presented in Table 7.5. It is anticipated that well stimulation will occur for a maximum of 60 days and hydraulic fracturing will occur during the **daytime** only. The predicted noise levels include the contribution from the frac spread on site as well as HGV movements on the access track and Suttons Lane.

Table 7.5: PPG-M noise assessment for hydraulic fracture well stimulation (daytime only)

Location	Background sound level, dB L_{A90}	PPG-M limit, dBA	Specific sound level, dBA	Assessment
Formby's Farm	35	45	42	OK
Tyrer's Farm	42	52	48	OK
Aspinall Crescent	40	50	47	OK
Southern Heys Farm	43	53	43	OK
Lord Sefton Way	40	50	45	OK
Sutton's Farm	42	52	47	OK

Table 7.6: Temporary ambient noise level change assessment – hydraulic fracture well stimulation

Location	Ambient sound level, dB L_{Aeq}	Specific sound level, dBA	New ambient sound level, dBA	Change, dB
Formby's Farm	43	42	45	+2
Tyrer's Farm	61	48	61	0
Aspinall Crescent	61	47	61	0
Southern Heys Farm	53	43	53	0
Lord Sefton Way	61	45	61	0
Sutton's Farm	61	47	61	0

7.13 From the tables it can be seen that noise from hydraulic fracture well stimulation will be within the PPG-M guideline noise limits and will not result in a significant change in ambient noise levels when it occurs.

7.14 There is also potential that a workover rig will be utilised during this phase. Noise levels produced by the workover rig are likely to be similar in character but lower in level than those produced during the main drilling phases, which have already been shown to be lower than the PPG-M noise limits. This is because well workover operations will not require use of the rotating capability of the rig and associated noise sources such as mud pumps.

Initial Flow Testing and Extended Well Test Noise Assessment (Phases 5 and 6)

7.15 Table 7.7 presents an assessment of noise due to flow testing (60 days initial flow test and 90 days extended well test) in accordance with the PPG-M. From the table it can be seen that noise levels during flow testing will be well within the PPG-M noise criteria during the daytime, evening and night.

Table 7.7: PPG-M noise assessment for initial flow testing and extended well test

Location	Background sound level, dB L_{A90}			PPG-M limit, dBA			Specific sound level, dBA	Assessment		
	Day	Eve	Night	Day	Eve	Night		Day	Eve	Night
Formby's Farm	35	32	26	45	42	42	29	OK	OK	OK
Tyrer's Farm	42	35	25	55	55	42	30	OK	OK	OK
Aspinall Crescent	40	32	25	50	42	42	35	OK	OK	OK
Southern Heys Farm	43	42	28	55	55	42	31	OK	OK	OK
Lord Sefton Way	40	32	25	55	55	42	35	OK	OK	OK
Sutton's Farm	42	35	25	55	55	42	35	OK	OK	OK

7.16 An assessment of the temporary change in ambient noise levels during initial flow testing and the extended well test is shown in Table 7.8.

Table 7.8: Temporary ambient noise level change assessment – initial flow testing and extended well test

Location	Ambient sound level, dB L_{Aeq}			Specific sound level, dBA	New ambient sound level, dBA			Change, dB		
	Day	Eve	Night		Day	Eve	Night	Day	Eve	Night
Formby's Farm	43	38	31	29	43	39	33	0	+1	+2
Tyrer's Farm	61	56	35	30	61	56	36	0	0	+1
Aspinall Crescent	61	56	35	35	61	56	38	0	0	+3
Southern Heys Farm	53	53	36	31	53	53	37	0	0	+1
Lord Sefton Way	61	56	35	35	61	56	38	0	0	+3
Sutton's Farm	61	56	35	35	61	56	38	0	0	+3

7.17 The assessment shows that sound due to flow testing (i.e. flaring) will not result in a noticeable change in ambient noise during the daytime or evening. At night, it is likely that the change in ambient noise would be perceptible, but ambient noise levels will still be well below the PPG-M guidelines and WHO criteria for onset of sleep disturbance of 42 dB L_{Aeq} (free-field).

Discussion

7.18 As discussed in Section 4, there are four key questions which need to be answered to determine whether the Government's noise policy aims have been met for a new development, these are.:

a) is there a significant adverse impact to health;

b) is there a significant adverse impact to quality of life;

c) is there an adverse impact to health; or

d) is there an adverse impact to quality of life?

7.19 If the answer to question a. or b. is yes, then the NPSE provides a clear steer that the development should be viewed as being unacceptable. If the answer to question c. or d. is yes, then the NPSE provides a clear steer that the impact should be mitigated and minimised. It follows that if the answer to all four questions is "no" then the development should normally be viewed as acceptable on noise grounds.

7.20 With respect to the impacts of noise on health, it is the effect on sleep that is likely to be the primary concern. The absolute noise level assessment shows that noise from the development can be mitigated in all phases so that it falls below the WHO guideline levels for onset of sleep disturbance effects and the PPG-M absolute noise limit of 42 dBA. **It can therefore be concluded that there will be no adverse impact on health.**

7.21 Although some residents living in close proximity to the site could experience higher noise levels at night during the drilling and well testing phases, compared to what they are used to, it is the daytime and evening periods that are of greatest concern with respect to the impact on quality of life (amenity, enjoyment of property etc.). This is because people will tend to be indoors or asleep during the night, whereas during the day and evening they are more likely to be using outdoor spaces for amenity purposes.

7.22 It has been established that the development will not result in an increase in ambient noise during the daytime, although ambient noise levels could temporarily increase during the evening during drilling and well testing phases. Although this change in noise level is likely to be perceptible at times, absolute noise levels will be significantly below the absolute noise limit criteria set out in the PPG-M for the daytime and evening. Thus, taking into account the relatively low absolute level of noise due to the proposed activities, it is unlikely that this would seriously affect the quality of life of even those living in close proximity to the site, especially when the short-term nature of the impact is taken into consideration. **It can therefore be concluded that the proposed development will not result in a significant adverse impact on the quality of life.**

7.23 It is an important consideration that any noise impact from the development will be temporary in nature. Furthermore, the impacts due to noise, modelled as part of this assessment, have been based on worst case assumptions, such as the receiver location always being down-wind from the site and the site equipment operating at its maximum capacity throughout the programme. In reality, this will not be the case and there will be significant periods within the development programme when noise levels will be less than predicted and assessed in this report.

8 Uncertainty

8.1 In all assessments, it is good practice to consider uncertainty which can arise from a number of different aspects. There are degrees of uncertainty associated with: instrumentation used for surveying; measurement technique and the variables influencing the measurement results such as transmission path and weather conditions; source terms used for modelling; calculation uncertainty; assessment uncertainty; and the subjective response of residents to noise sources.

8.2 Uncertainty due to instrumentation has been significantly reduced with the introduction of more modern instrumentation and is reduced further by undertaking field calibration checks on sound level meters before and after each measurement period and that all instrumentation is within accepted laboratory calibration intervals.

8.3 Every effort has been made to reduce the uncertainty of the baseline sound level measurements. The duration of the baseline survey is considered to significantly reduce the uncertainty associated with the baseline sound levels. Based on professional judgement including substantial experience of acquiring and analysing baseline data for numerous sites in various locations, and a desk based review of the site and surrounding area, it is considered that the baseline data acquired during the survey is typical of the area.

8.4 Calculation uncertainty and assessment uncertainty have been reduced by peer review of all baseline data, model input data, model results and assessment calculations, and by using the appropriate level of precision at each stage of the assessment calculations.

8.5 A quantitative assessment has been undertaken based on likely source levels measured by RPS personnel, provided by the project team for the proposed equipment or based on recognised and accepted empirical calculation methodologies. Where assumptions have been made they have favoured a worst case scenario.

8.6 With regards to subjective response, the noise standards adopted for the assessment will have been based upon the subjective response of the majority of the population or will be based upon the most likely response of the majority of the population. This is considered to be the best that can be achieved in a population of varying subjective response which will vary dependent upon a wide range of factors.

8.7 All areas and potential consequences of uncertainty have been minimised at every stage of the assessment process. On the basis of the above, and in the context of subjective response, the effects of uncertainty on the assessment are considered minimal.

9 Potential In-Design Mitigation

Approach

9.1 The approach taken for this development has been to utilise best available technology to reduce noise levels from the example drilling rigs to as low as reasonably practicable. Notwithstanding this, it is not known which drilling rig will be utilised. Consequently, it is difficult to specify the exact noise mitigation measures that will be installed. Nevertheless, it is possible to provide recommendations for best practice.

9.2 This chapter provides details of possible engineering noise control measures for the drilling rigs based on specific noise measurements on the example rigs combined with experience of carrying out noise control on other drilling rigs. These mitigation measures represent the range of typical techniques that could be applied. Mitigation measures will be finalised once the equipment has been chosen and a noise management plan will be prepared detailing the specific mitigation measures to be installed and their effect on ambient noise levels in the vicinity.

Hydraulic Power Unit

9.3 The hydraulic power unit (HPU) is a potentially significant source of noise for hydraulic drilling rigs. The majority of acoustic energy from the HPU is typically emitted via the HPU enclosure roof, caused by a combination of structure-borne and airborne transmission paths. A secondary acoustic enclosure can be utilised to reduce its contribution to noise levels. It is also possible to install acoustic lagging to hydraulic pipework if this proves to be a significant source. Based on experience on other drilling rigs, it is anticipated that these mitigation measures should reduce the contribution from the HPU by 5 to 10 dB. An example isometric drawing of an enclosure for a HPU is shown in Figure 9.1.

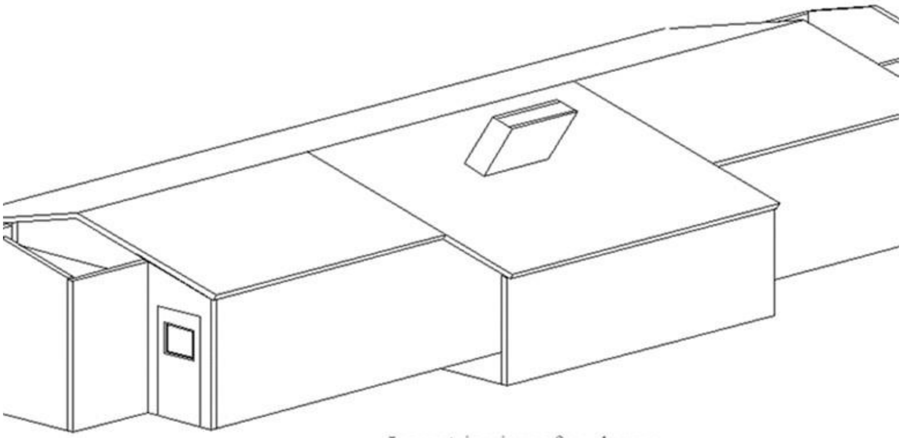


Figure 9.1: Temporary acoustic enclosure for HPU

Mud Pumps

9.4 Mud pumps can be either electrically powered or diesel driven and can vary significantly in the degree of noise control fitted as standard.

9.5 Whichever drilling rig is chosen, it is recommended that, if technically feasible, the mud pumps are installed in acoustic enclosures (e.g. similar to those shown in Figure 9.2) or screened and fitted with exhaust silencers if diesel driven. An alternative design to individual (packaged) enclosures around each mud pump is to install a larger housing in which all mud pumps can be installed (see Figure 9.3). Based on experience of other drilling rigs, it is expected that reductions of 10 dB can be achieved through properly designed enclosures and silencers.

Figure 9.2: Mud pump engine enclosure (note exhaust silencers)

Figure 9.3: Example mud pump housing

Generators

9.6 Power generators are usually installed in acoustic enclosures. Typically, these incorporate an acoustically absorptive internal lining and possibly an acoustic skirt (if there are significant emissions from the sub-skid). If necessary, depending on the design of generator enclosures on the drilling rig chosen, the acoustic performance of existing enclosures can be improved by installation of an additional mass layer between the mineral wool lining and steel outer cladding (mass loaded vinyl has been used with success in the past). The requirement for exhaust silencing will be dependent on the generators and what is already fitted, but generally a double (piggy-backed) silencer arrangement is preferable. Exhaust pipe hangers and supports often utilise resilient inserts to minimise the potential for structure-borne noise. Likewise, the engine itself can be mounted on AV mounts if it is feasible to do so. The air intakes and outlets typically utilise splitter silencers or acoustic louvers, depending on air flow and pressure drop requirements. Using a high specification enclosure, it should be possible to reduce the sound power level of most generators to less than 100 dBA. An example of an enclosure is shown in Figure 9.4

Figure 9.4: Example generator enclosure with high specification exhaust silencers

Shale shakers

9.7 Mitigation for the shale shakers could be in the form of either a full enclosure or by using local screening around the shakers. It is expected that up to 10 dB reduction in noise from the shale shakers could be achieved for a full enclosure (based on measurements on other drilling rigs) and 3 to 5 dB reduction for localised screening. The choice of screening or enclosure will depend upon the location and elevation of the shale shakers on the drilling rig chosen as well as their noise level (for example, on some rigs the shale shakers may already be screened by the rig structure).

Centrifuge

9.8 Centrifuges can be a significant noise source if they are not enclosed. It is recommended that the centrifuge is installed in an acoustic enclosure with an internal acoustically absorptive lining and suitable AV mounts to prevent structure-borne noise. An example enclosure is shown in Figure 9.5.

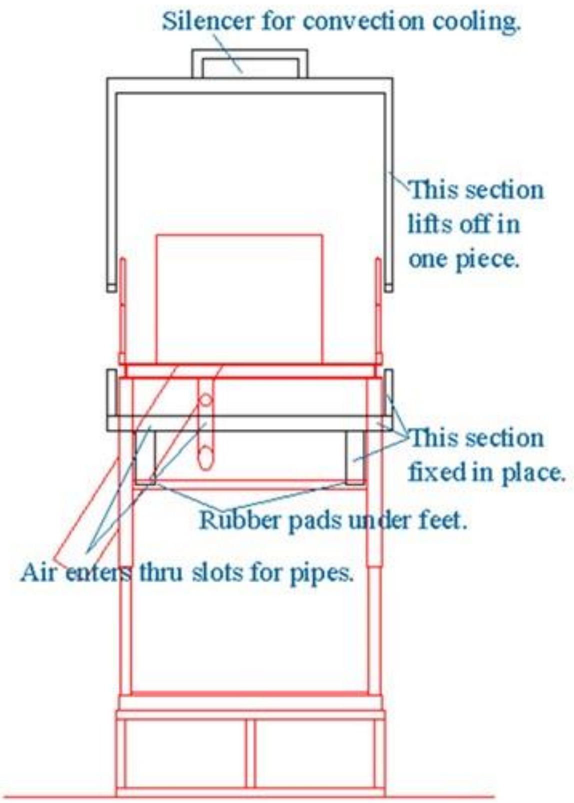


Figure 9.5: Example centrifuge enclosure

Acoustic screening

9.9 Depending on the drilling rig chosen, it may be possible to erect an acoustic screen around some parts of the rig. This could be in the form of a bespoke acoustic screen (e.g. Figure 9.6), close-boarded wooden fencing or stacked containers (e.g. Figure 9.7, showing triple stacked containers). Some in-site screening could be provided, for example, by erecting site stores and offices so that they are between the rig equipment and the residential receptors.

Figure 9.6: Example demountable acoustic barrier

Figure 9.7: Example barrier constructed from containers

Draw-works

9.10 Although not a continuous noise source, the draw-works is used for hoisting new sections of drill pipe via the travelling block once each section has been drilled, depending on the drilling rig design. It is also used for tripping. During operation of the draw-works, the top drive is not normally operational (instead the rotary table is used). Although the draw-works are usually located on the drill floor (which can sometimes be acoustically screened), the sound power level can be relatively high on some drilling rigs which can mean that this source of noise could intermittently be significant. It is therefore recommended that, depending on the characteristics of the chosen drilling rig and technical / safety constraints, an acoustic enclosure is fitted around the draw-works. This would typically include an acoustically lined "sleeve" for the draw-works cables to penetrate.

Top drive

9.11 Many drilling rig top drives can be fitted with an acoustic enclosure. For example, the three example drilling rigs used in this assessment all have acoustically enclosed top drives. It may be possible to fit a silencer to the cooling fan on electric top drives which would reduce noise levels from this source further. An example top drive enclosure is shown in Figure 9.8.

Figure 9.8: Example top drive enclosure

Hydraulic Fracturing Pumps

9.12 Noise levels for hydraulic fracturing used in this assessment were based on previous operations at Preese Hall Exploration Site. The sound power levels are based on unenclosed pumps. However, there are at least two frac spreads available in the UK which utilises enclosed hydraulic fracturing pumps, resulting in a 9 dB reduction in overall noise levels. It is not known at this time whether these frac spreads will be available or technically feasible for use at Altcar Moss, but consideration will be given to utilising enclosed units if it is practicable to do so. An alternative method for reducing noise from hydraulic fracturing operations is to install acoustic barriers between the pumps and the noise sensitive receptors.

9.13 Example enclosed frac spreads are shown in Figure 9.9.

Figure 9.9: Example frac pump enclosure

Flaring

9.14 Combustion noise in flares is a combination of two main mechanisms. Firstly, there is the jet noise due to the gas flowing through the orifice(s) and then noise produced from the combustion process. It is usually the former of these that dominates. The level of noise and frequency content is also affected by the flare nozzle – for example, the frequency content is a direct function of the dimensions of the orifices. Large reductions in sound emission can be attained by utilising a low noise flare tip but this needs to be balanced against other factors such as flare emissions, efficiency and flow handling capability.

9.15 Another important factor is the height of the flare. Ground flares will be less able to propagate than flares at a height. Furthermore, it may be possible to utilise screening around a ground flare in order to reduce noise. It is therefore recommended that a ground flare is utilised combined with an acoustic screen (i.e. a shrouded flare). An example enclosed ground flare is shown in Figure 9.10.

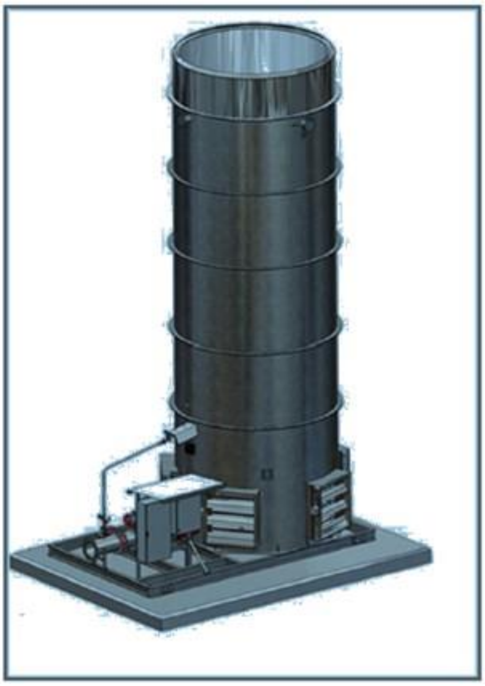


Figure 9.10: Example enclosed ground flare

9.16 Alternatively, it may be possible to utilise an enclosed combustor rather than a flare, although there may be technical difficulties due to gas emission compliance requirements meaning that this might not be feasible.

Noise Monitoring

9.17 In addition to the above engineering noise control measures, it is proposed to ensure that noise levels do not exceed the recommended PPG-M limits by undertaking noise monitoring at the nearest residential property to the site. The noise monitoring would be undertaken during the early stages of each phase or by utilising a remote noise monitoring system.

10 Summary and Conclusions

10.1 The results of the noise assessment carried out for the proposed development can be summarised as follows:

- Noise from site traffic on Lord Sefton Way will lead to a very small temporary increase in traffic noise which is likely to be barely noticeable and is therefore not considered a significant impact.
- The design of the drilling rig and other plant will incorporate mitigation measures to minimise noise levels to the lowest reasonably practicable level.
- Noise from the proposed development will be well below the noise standards contained in the PPG-M (which includes oil and gas extraction in its definition of minerals extraction sites) once mitigation measures have been applied.
- The predicted noise levels are below the WHO guideline limits for the onset of sleep disturbance effects at night.
- Noise levels will be well below the 55 dB L_{Aeq} absolute noise limit in the PPG-M for the daytime. It is unlikely that this would seriously affect the quality of life of even those living in close proximity to the site, especially when the short term nature of the impact is taken into consideration.

10.2 On the basis of the above and in conclusion, noise from the proposed exploratory wellsite will be mitigated such that it does not cause a significant adverse impact, as defined by the NPSE, NPPF and PPG-M. The potential for noise having an adverse impact on human health, the natural environment or general amenity has therefore been minimised.

Figures

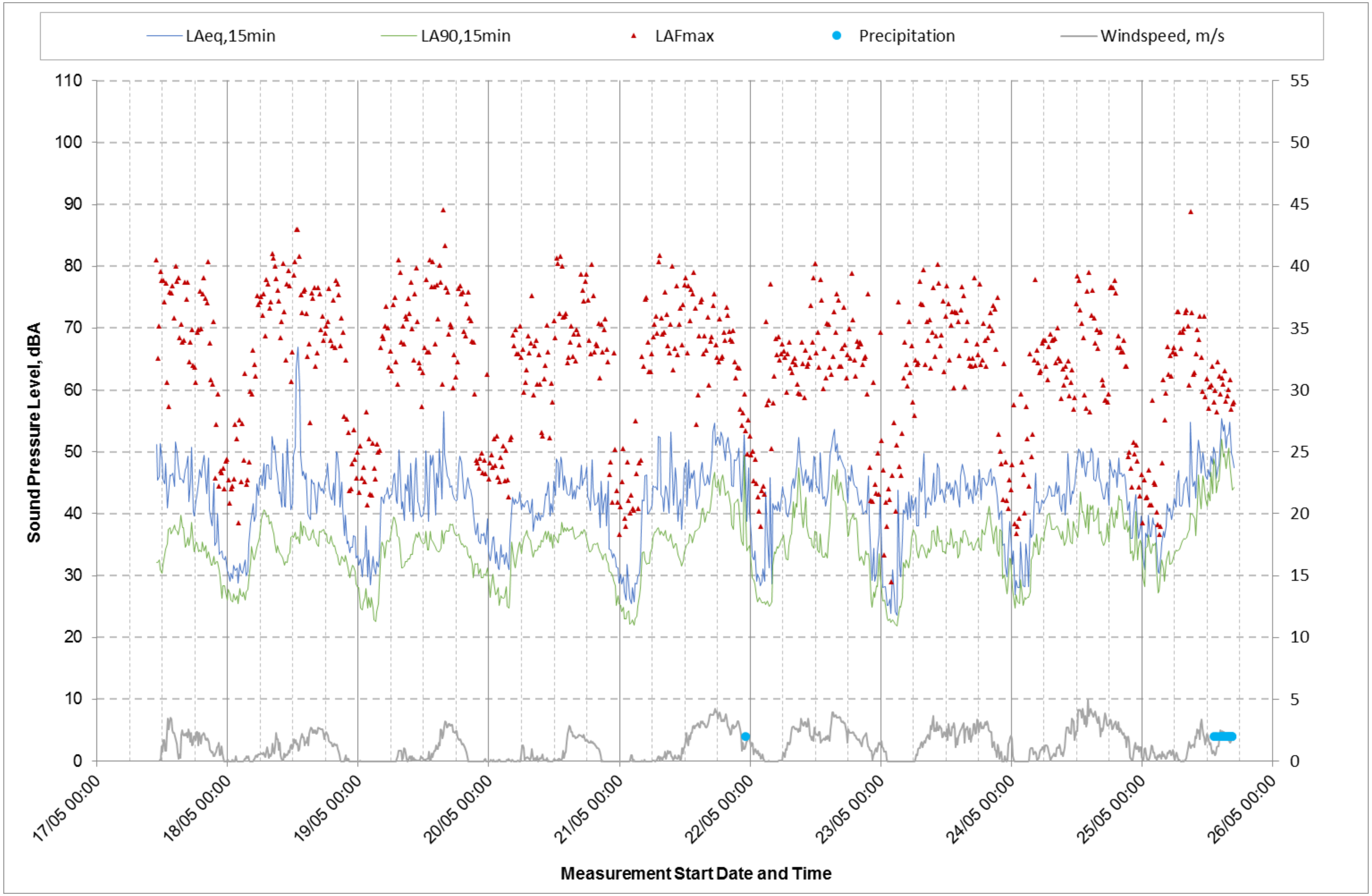


Figure A1: Noise monitoring time history Location LT1

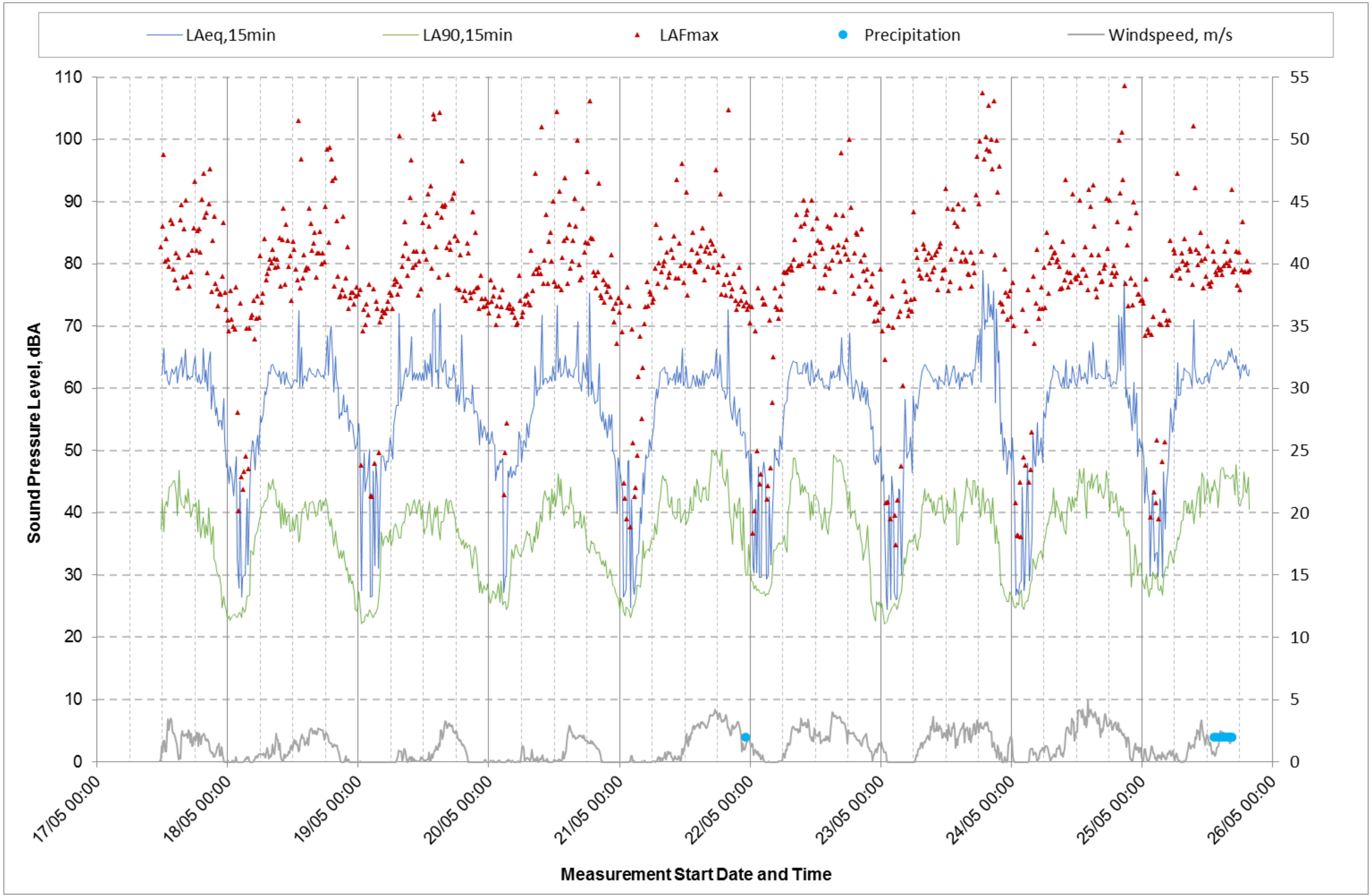
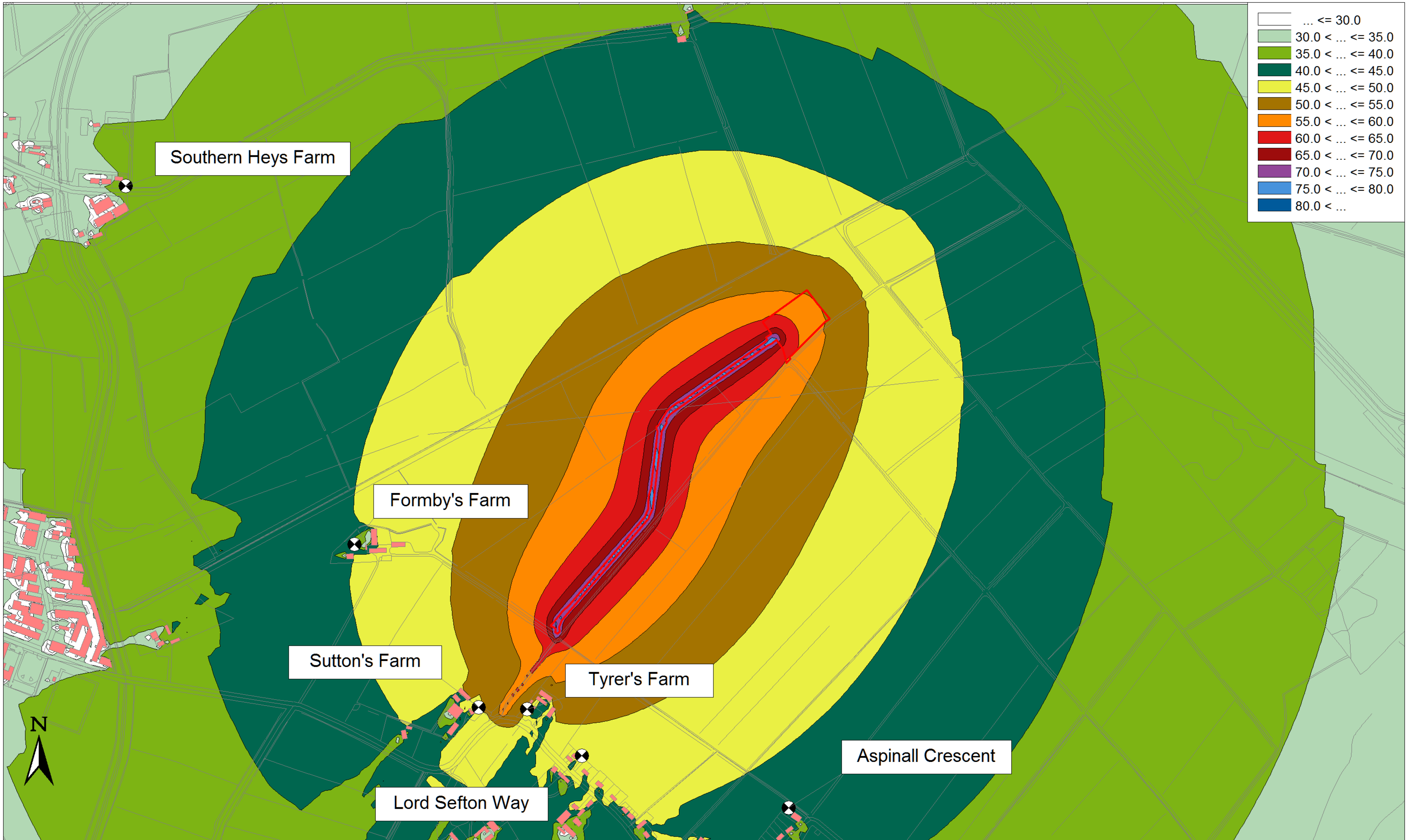


Figure A2: Noise monitoring time history Location LT2



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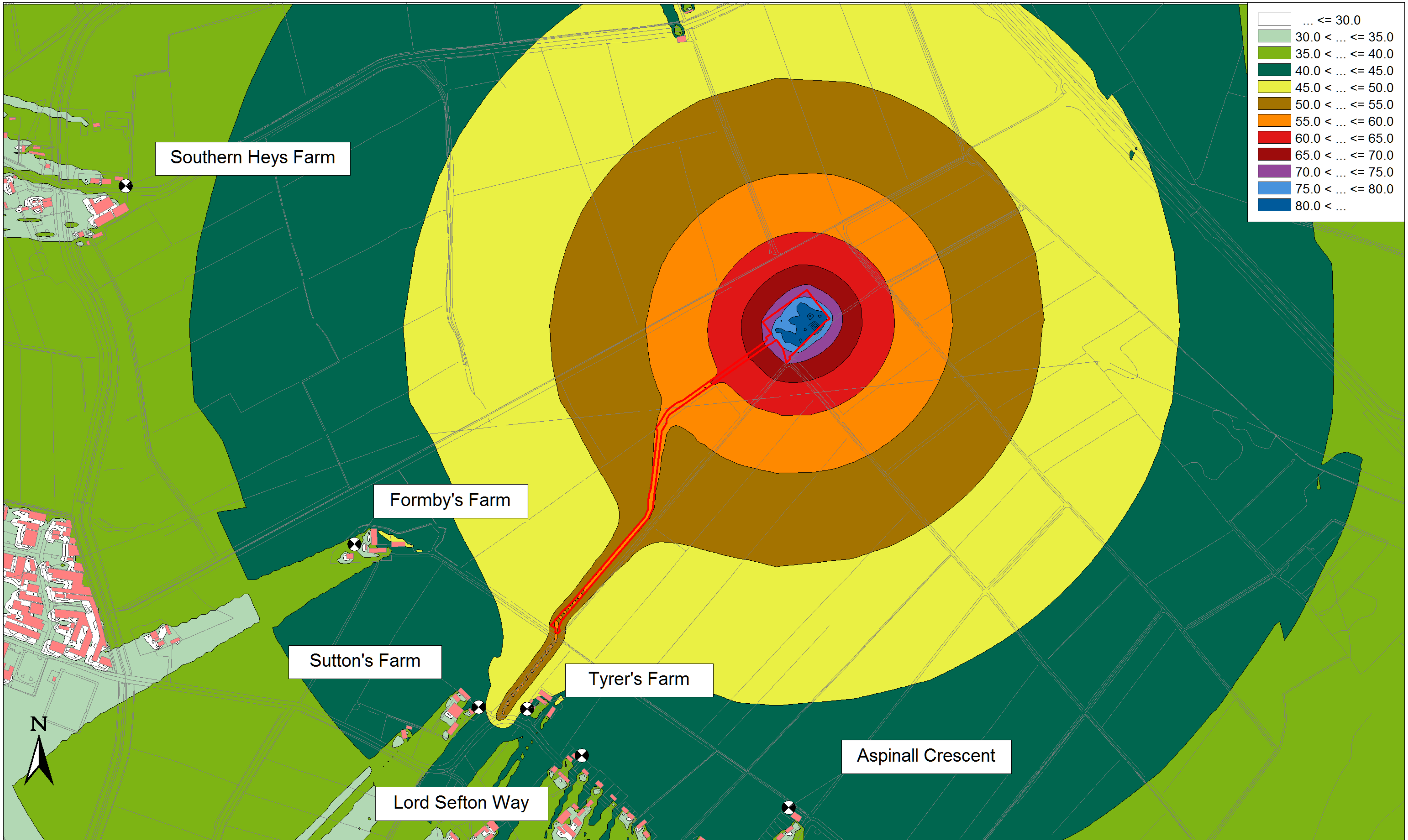
			Sheet 1 of 1	Date	19.03.19



Aurora Energy Resources

Author	SJS	Altcar Moss Wellsite Wellsite Construction and Remediation Noise Contours Sheet 1 of 1	Project No.	JAT10171
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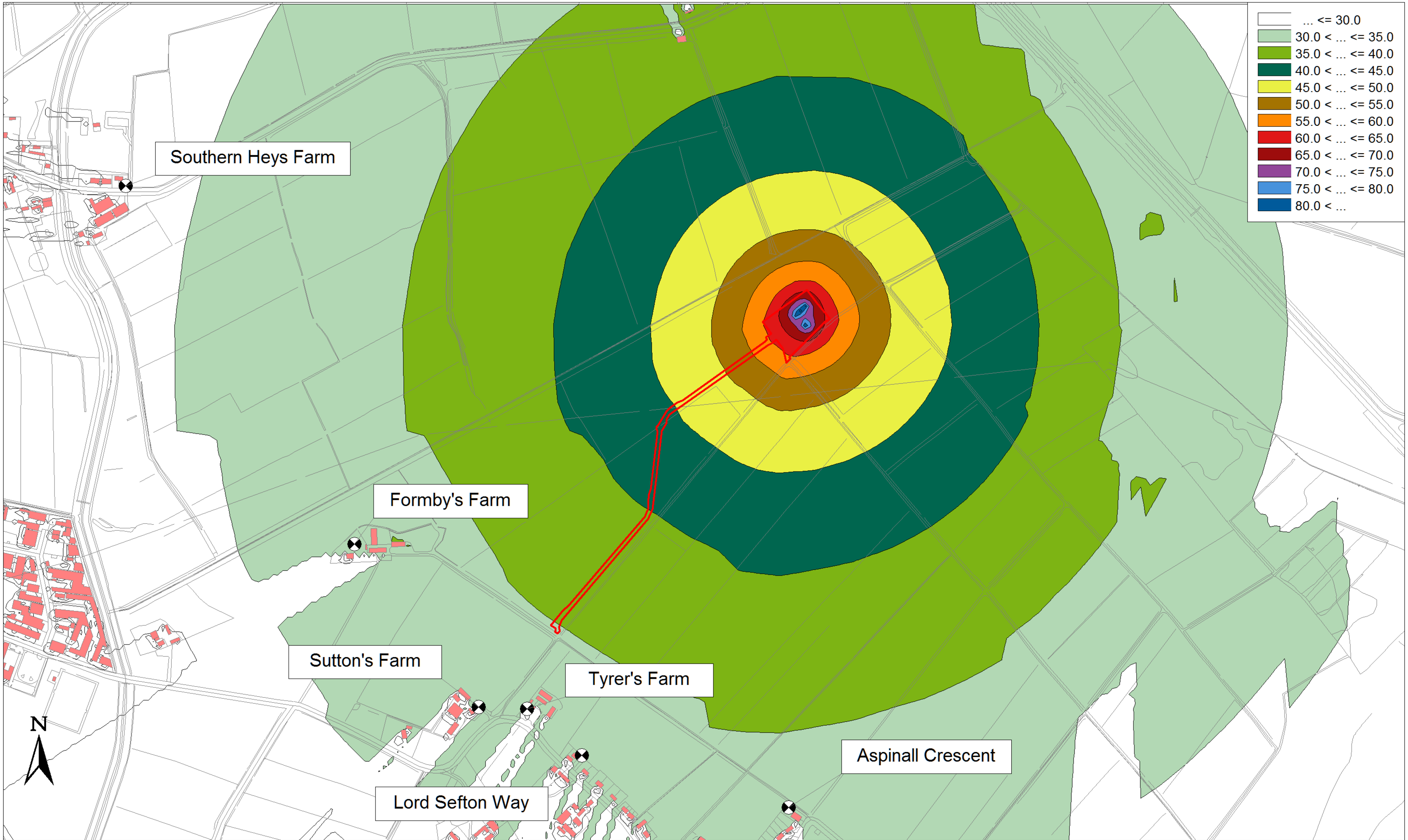

Aurora Energy Resources

Author	SJS	**Altcar Moss Wellsite** **Drilling** **B92 Noise Contours**	Project No.	JAT10171
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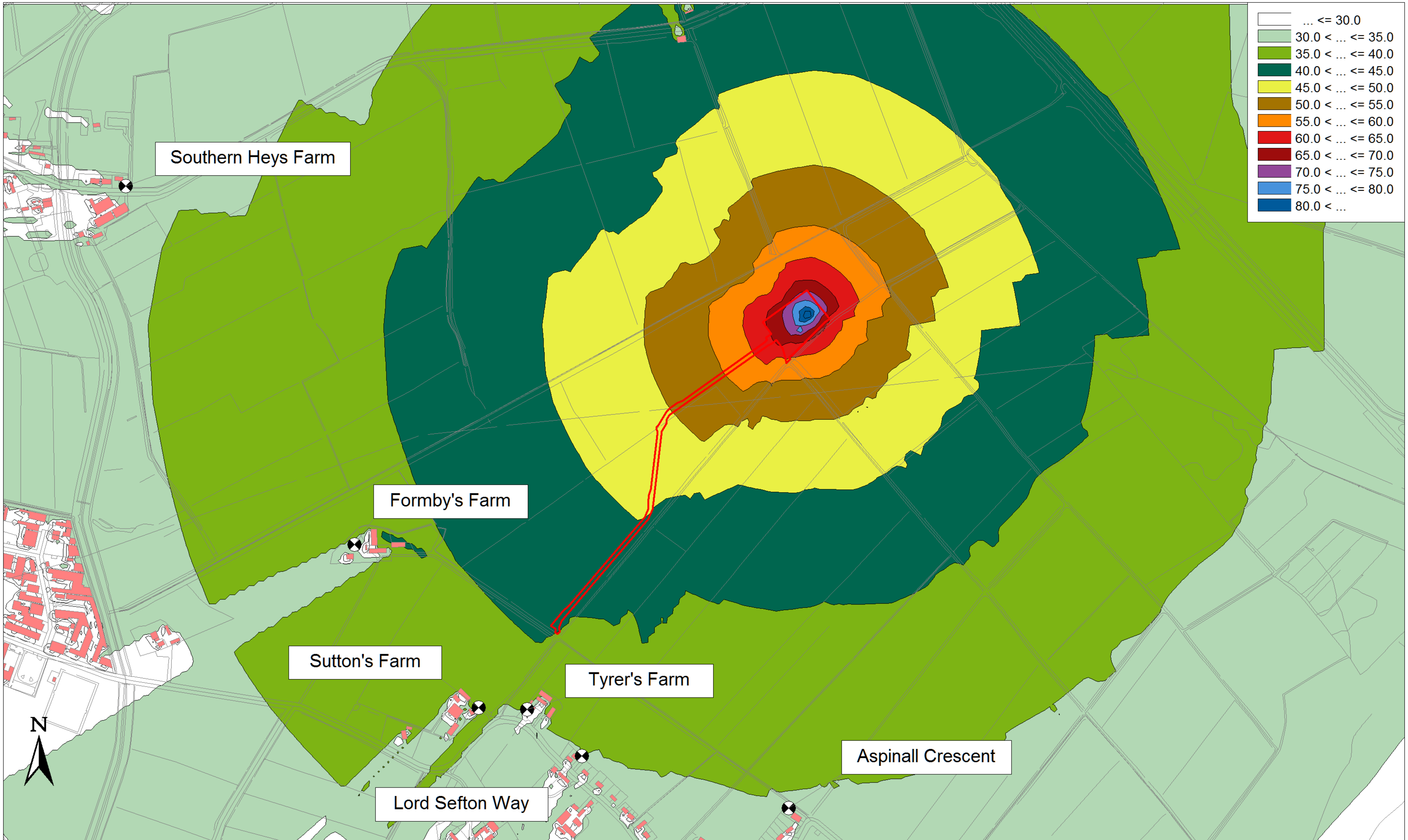

Aurora Energy Resources

Author	SJS	**Altcar Moss Wellsite** **Drilling** **HH-220 Noise Contours**	Project No.	JAT10171
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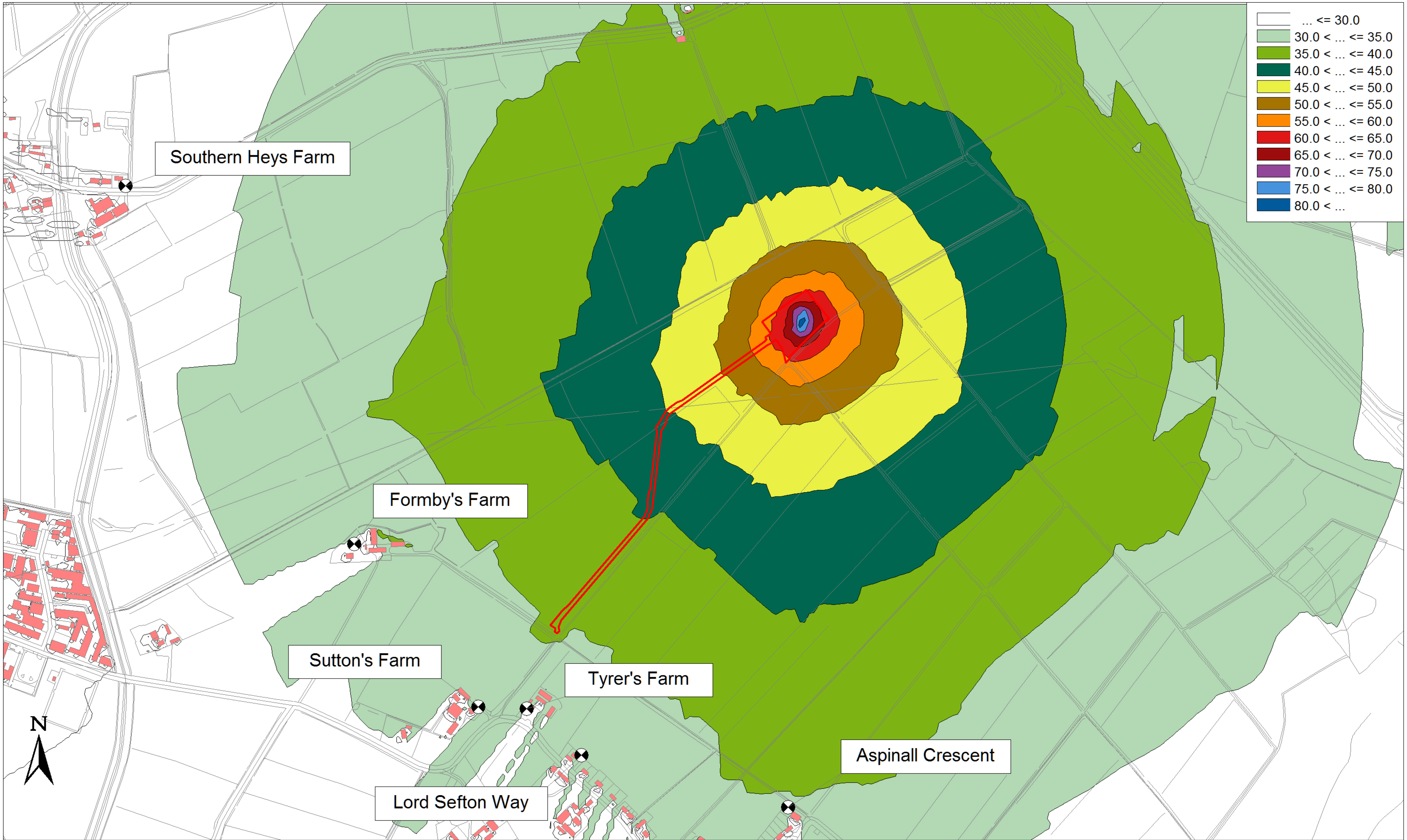

Aurora Energy Resources

Author	SJS
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Altcar Moss Wellsite
Drilling
VDD 370 Noise Contours

Sheet 1 of 1

Project No.	JAT10171
Project Title	Altcar Moss Wellsite
Drawing No.	Figure A7
Date	19.03.19

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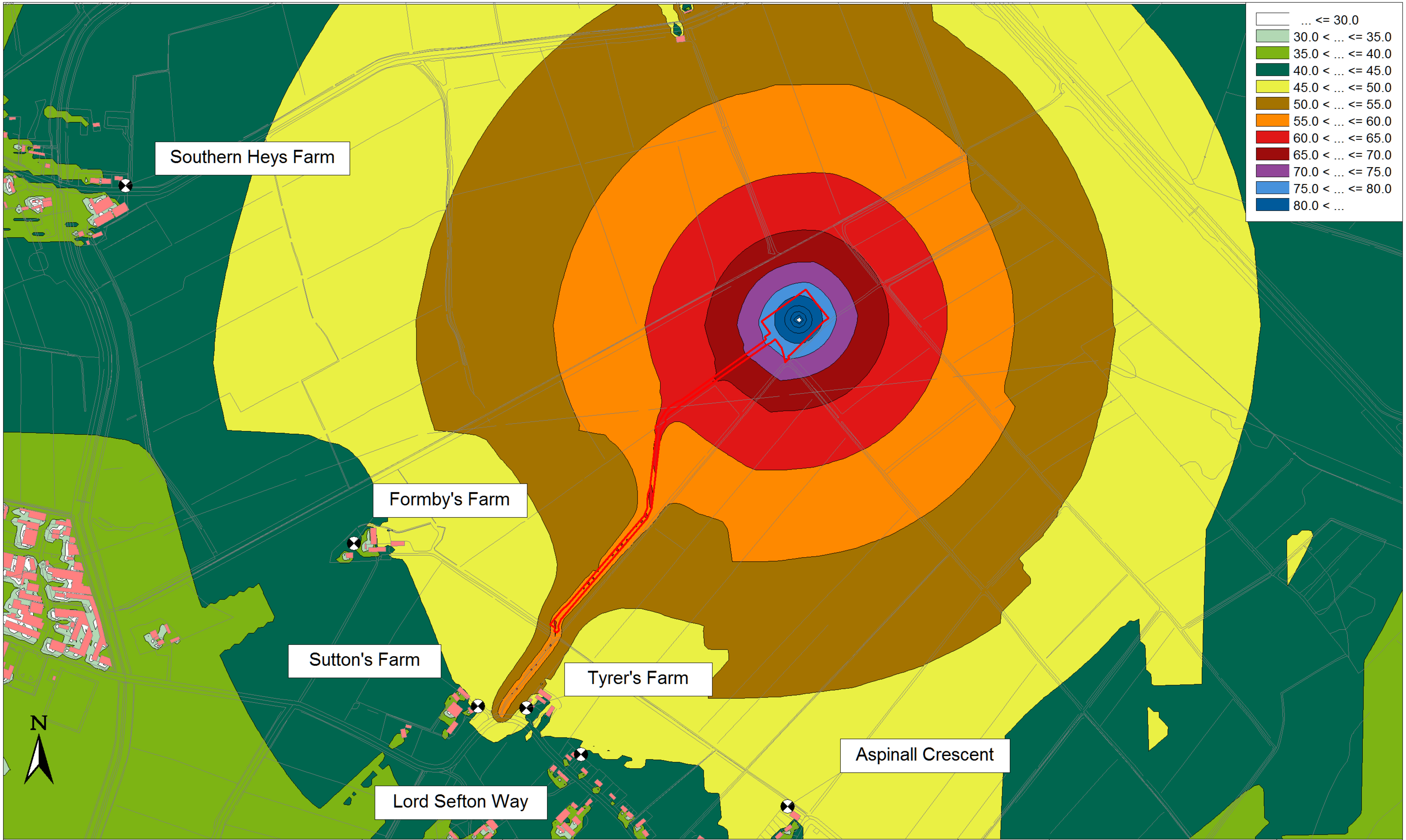

Aurora Energy Resources

Author	SJS	**Altcar Moss Wellsite** **Hydraulic Fracturing Well Stimulation Noise Contours**	Project No.	JAT10171
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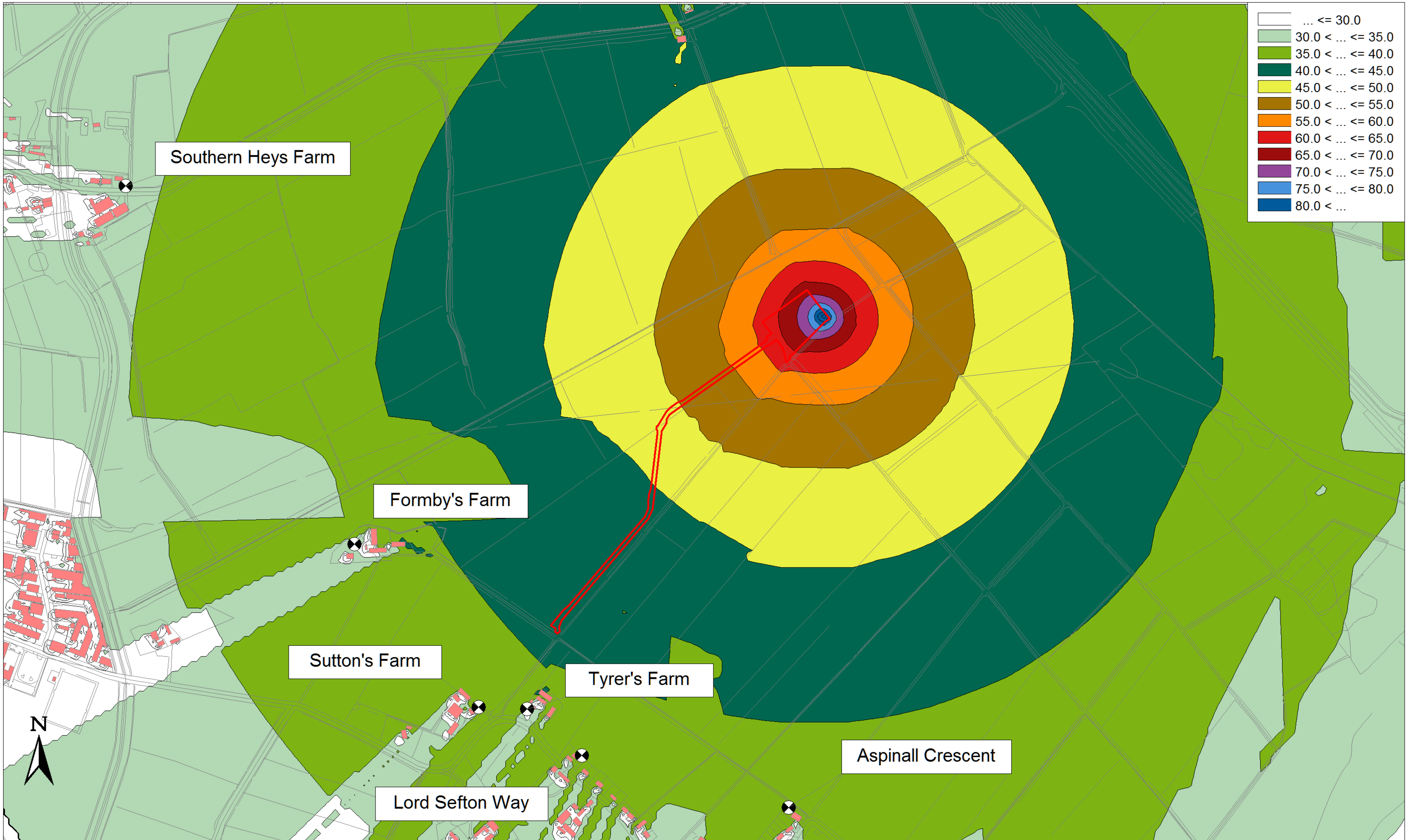

Aurora Energy Resources	Author	SJS	**Altcar Moss Wellsite** **Flow Testing (Flaring) Noise Contours** Sheet 1 of 1	Project No. JAT10171
	Scale	1:7500@A3		Project Title: Altcar Moss Wellsite
				Drawing No. Figure A9
				Date 19.03.19

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