# Assessment of Acoustic Impact for the Proposed Drum Farm Energy Storage Project

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Revision History

| Issue | Date | Author | Nature & Location of Change |
|---|---|---|---|
| 01 | 21 April 2022 | Andrew Birchby | First created |

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## 1.0 INTRODUCTION & SCOPE

This report contains an assessment of the acoustic impact of a proposed Drum Farm energy storage project. Two Members of the Institute of Acoustics have been involved in its production. Details of their experience and qualifications can be found in Appendix A.

The scope includes predicting sound levels due to the proposed development in order to assess the level of impact in accordance with relevant planning guidance.

## 2.0 PLANNING GUIDANCE

Within Scotland, the treatment of noise is defined in the planning context by 'Planning Advice Note (PAN) 1/2011: Planning and Noise'[1], which details the Government's planning policies and how these are expected to be applied. The PAN provides advice on the role of the planning system in helping to prevent and limit the adverse effects of noise, stating that planning policies and decisions should aim to avoid noise giving rise to significant adverse impacts, whilst at the same time mitigating and reducing to a minimum other adverse impacts on health and quality of life. The Technical Advice Note (TAN)[2] provides guidance to assist in the technical evaluation of noise assessment and aims to assist in assessing the significance of noise impact.

## 3.0 METHODOLOGY

### *3.1 Overview*

An assessment in accordance with BS 4142: 2014[3] has been undertaken in order to determine the acoustic impact of the proposed development.

### *3.2 Baseline Conditions*

In order to complete a BS 4142: 2014 assessment of the proposal, the background sound level at the times when the new sound source is intended to be operational should be measured. The background sound level is defined as the A-weighted sound pressure level that is exceeded for 90 % of the measurement time interval, or $L_{A90,\,T}$.

Measurements should be made at a location that is representative of the assessment locations, the time interval should be sufficient to obtain a representative value, and the duration should be long enough to reflect the range of background sound levels over the period of interest.

Precautions should be taken to minimise the influence on the results from sources of interference. Weather conditions that may affect the measurements should be recorded and an effective wind shield used to minimise turbulence at the microphone.

A statistical analysis, following the example given by BS 4142: 2014, shall be used to determine an appropriate background sound level for the analysis from the range of results obtained.

### *3.3 Propagation*

The ISO 9613-2[4] propagation model shall be used to predict the specific sound levels due to the proposed development at nearby residential properties. The propagation model takes account of sound attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 °C and 70 % respectively.

[1] "Planning Advice Notice 1/2011: Planning and Noise", Scottish Government policy, March 2011
[2] "Technical Advice Note: Assessment of Noise", Scottish Government policy, March 2011
[3] "Methods for rating and assessing industrial and commercial sound", The British Standards Institution 2014
[4] "Acoustics - Attenuation of Sound During Propagation Outdoors, Part 2: General Method of Calculation", International Organisation for Standardisation 1996

Ground effects are also taken into account by the propagation model, with a ground factor of 0.5 adopted to reflect a mix of hard and porous ground between the site and the assessment locations. A 4 m receiver height shall be used. Terrain shall be considered but the effect of surface features such as buildings and trees shall not be included in the model. There is a degree of conservatism built into the model as a result of the adoption of these settings.

ISO 9613-2 is a downwind propagation model. Where conditions less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the proposed development, the sound levels would be expected to be less and the downwind predictions presented here would be regarded as conservative i.e. greater than those experienced in practice.

### *3.4 Assessment*

Once the specific sound levels due to the proposed new sound source have been predicted the rating sound level can be calculated, it is this which is compared to the existing background sound level to determine the level of impact. The rating level is obtained by adding any penalties due to character that may be applicable to the predicted specific sound level.

Table 1 details how the difference between the rating sound level and background sound level is used to come to a judgement about the level of impact under BS 4142: 2014, although it is noted that any assessment is context specific.

**Table 1 – BS 4142: 2014 Assessment Criteria**

| Rating Level | BS 4142 Assessment |
|---|---|
| Below background | Indicates low impact |
| 5 dB above background | Indicates adverse impact |
| 10 dB above background | Indicates significant adverse impact |

Depending upon the diurnal variation in the background sound level, and the times when the proposed new sound source is scheduled to operate, it may be appropriate to undertake separate assessments for certain times of day e.g. day, evening and night.

## 4.0 BASELINE DATA

Background sound measurements were undertaken at Drum Farm from 13:30 on 31st January 2022 until 09:15 on 2nd January 2022. The survey position is shown on the map in Figures 1 & 2 (Appendix B).

A Rion NL-31 sound level meter was used which is certified as meeting IEC 61672-1[5] Class 1 precision standards. The microphone was approximately 1.2 m above ground level and an outdoor wind shield supplied by the manufacturer was deployed.

The sound level meter was placed away from reflective surfaces and vegetation as shown in the photos in Appendix C. The equipment was calibrated at the start and end of the campaign and 0.1 dB of drift was detected which is within the acceptable range. All instrumentation had been subject to laboratory calibration traceable to national standards within the previous 24 months with the calibration dates and references provided in Table 2.

[5] "Electroacoustics – Sound level meters – Part 1: Specifications", International Electrotechnical Commission 2013

Table 2 – Instrumentation Records

| | Meter | Calibrator |
|---|---|---|
| **Type** | Rion NL-31 | Rion NC-74 |
| **Serial No.** | 952274 | 34851904 |
| **Calibration Certificate No.** | UCRT21/1190 | UCRT21/1184 |
| **Date of Issue** | 10/02/21 | 10/02/21 |
| **Microphone Serial No.** | 321532 | - |
| **Preamp Serial No.** | 17126 | - |

The background sound environment included contributions from the wind in the trees, birds, farm animals and traffic on nearby roads. There was also an occasional contribution from distant construction work on the housing development on Banff Road but no noticeable contribution from the substation.

Wind speed measured at microphone height at the start and end of the survey did not exceed 5 $ms^{-1}$ although high wind speeds were forecast on the night of the 31st January and during the day on the 1st February. As high wind speeds could potentially interfere with the results the impact of filtering this data out was checked. There was no impact on the background sound levels determined via the statistical analysis method recommended by BS 4142: 2014 as this serves to filter out any periods where the background sound levels were atypically high. Filtering this data out had no impact on the daytime residual sound level but did have an impact on the residual sound level at night. The residual level at night is therefore calculated with this data filtered out.

Other weather conditions during the survey were such that interference with the results would not be expected. Occasional rain was forecast but it was not extensive enough to have impacted the results. Temperature during the survey period varied between 3 and 9 °C, comfortably within the operating range of the meter. Cloud cover at the start and end of the survey was judged to be 8 oktas. The wind direction was predominantly from the west which is expected to be representative of the long-term.

The data recorded during the measurement period is detailed in Figures 3-5 (Appendix B). Figure 3 shows the variation in the background sound level and residual sound level with time. Figure 4 shows the frequency at which a given level of background sound occurred and Figure 5 shows the frequency at which a given level of residual sound occurred. A summary of the observations made during periods where the measurements were attended can be found in Appendix D.

The diurnal variation in the background sound level is such that a clear distinction can be drawn between day and night-time periods. When split into day and night-time periods, the most frequently occurring background sound level was 40 dB $L_{A90,\ 15min}$ during the day and 31 dB $L_{A90,\ 15min}$ at night. The most frequently occurring residual sound level was 44 dB $L_{Aeq,\ 15min}$ during the day and 35 dB $L_{Aeq,\ 15min}$ at night.

## 5.0 ASSESSMENT

Details of the nearest properties to the proposed development are provided in Table 3. H1 and H2 are unoccupied farm buildings and H12 is an unoccupied substation building so these properties are not considered in the assessment. In addition, properties H5, H8 & H9 are owned by the landowner of the project.

Table 3 – Locations of Nearby Properties

| House ID | House Name | X | Y |
|---|---|---|---|
| H1 | DRUM FARM | 344430 | 850675 |
| H2 | DRUM FARM | 344486 | 850698 |
| H3 | MORANBANK | 344712 | 850041 |

| House ID | House Name | X | Y |
|---|---|---|---|
| H4 | ARDIEMANNOCH | 344686 | 850116 |
| H5 | 3 DRUM COTTAGES | 344449 | 850699 |
| H6 | 2 DRUM COTTAGES | 344521 | 850772 |
| H7 | 1 DRUM COTTAGES | 344511 | 850771 |
| H8 | DRUM | 344387 | 850720 |
| H9 | 4 DRUM COTTAGES | 344438 | 850697 |
| H10 | 5 DRUM COTTAGES | 344556 | 850778 |
| H11 | FAIRVIEW DRUM | 344149 | 850744 |
| H12 | SUB STATION | 343903 | 850479 |
| H13 | 2 ELECTRIC SUB STATION VILLAS | 343854 | 850434 |
| H14 | 3 ELECTRIC SUB STATION VILLAS | 343799 | 850444 |
| H15 | 1 ELECTRIC SUB STATION VILLAS | 343850 | 850442 |

The main sources of sound within the proposed development are the cooling fans for the two inverters housed within the nine Power Conversion System (PCS) units, air conditioning for the Energy Storage Systems (ESS) and the transformers. The 36 ESS units are expected to be continuously charging and discharging. If there are any rest periods for the PCS units these are likely to be infrequent and the Heating Ventilation and Air Conditioning systems (HVAC) will still be functioning. There are four HVAC units per ESS unit, two at each end.

Acoustic emission data for the proposed equipment is detailed in Table 4. The data corresponds to the maximum acoustic emission for each device as advised by the manufacturer. Predictions based on this data therefore represent the worst case and the sound levels would be expected to be less when the site isn't operating at maximum capacity.

**Table 4 - Acoustic Emission Data**

| Equipment | Sound Pressure Level at 1m, dB $L_{Aeq}$ |
|---|---|
| Inverter within PCS unit | 79 |
| ESS HVAC unit (>=35˚C) | 75 |
| ESS HVAC unit (20˚C) | 70 |
| Auxiliary transformer | 63 |

It is proposed to install a 3 m acoustic fence around the site. Predicted specific sound levels at nearby properties with this mitigation measure in place are detailed in Table 5 for daytime periods and Table 6 for night. Modelling the scheme at its maximum acoustic emission during the night is overly conservative as the need for cooling would be less due to the lower ambient temperature. Separate day and night predicted noise levels are therefore shown corresponding to ambient temperatures of >=35˚C during the day and 20˚C at night. Illustrative sound footprints for the proposed development showing the predicted specific sound level for day and night-time periods are provided in Figures 1 & 2 (Appendix B).

The sound emitted by the inverter cooling fans and HVAC units can have distinctive character. Under the subjective method described in BS 4142: 2014, a correction of 2 dB has been applied in the event that tones are just perceptible at the assessment locations. The resulting rating sound levels for day and night-time periods are shown in Tables 5 & 6. The rating levels are then compared to the background sound level in these same tables to assess the impact at each location for each time period.

Table 5 - BS 4142: 2014 Assessment Results - Day

| House ID | Specific Level, dB $L_{Aeq}$ | Rating Level, dB $L_{Aeq}$ | Rating vs Background, dB | Impact |
|---|---|---|---|---|
| H3 | 31 | 33 | -7 | Low |
| H4 | 32 | 34 | -6 | Low |
| H5 | 36 | 38 | -2 | Low |
| H6 | 34 | 36 | -5 | Low |
| H7 | 34 | 36 | -4 | Low |
| H8 | 36 | 38 | -3 | Low |
| H9 | 36 | 38 | -2 | Low |
| H10 | 33 | 35 | -5 | Low |
| H11 | 33 | 35 | -5 | Low |
| H13 | 32 | 34 | -6 | Low |
| H14 | 29 | 31 | -10 | Low |
| H15 | 32 | 34 | -6 | Low |

Table 6 - BS 4142: 2014 Assessment Results - Night

| House ID | Specific Level, dB $L_{Aeq}$ | Rating Level, dB $L_{Aeq}$ | Rating vs Background, dB | Impact |
|---|---|---|---|---|
| H3 | 29 | 31 | 0 | Low |
| H4 | 30 | 32 | 1 | Minor |
| H5 | 33 | 35 | 4 | Minor |
| H6 | 31 | 33 | 2 | Minor |
| H7 | 31 | 33 | 2 | Minor |
| H8 | 33 | 35 | 4 | Minor |
| H9 | 33 | 35 | 4 | Minor |
| H10 | 30 | 32 | 1 | Minor |
| H11 | 30 | 32 | 1 | Minor |
| H13 | 29 | 31 | 0 | Low |
| H14 | 26 | 28 | -3 | Low |
| H15 | 29 | 31 | 0 | Low |

The impact of the proposed development is low where the rating sound level does not exceed the existing background sound level. This is the case at all properties during daytime periods and at four properties at night. No observed effect on health or quality of life would be expected where the impact is low.

The rating level at eight properties at night is above the threshold where minor, non-adverse impacts would be anticipated to start occurring. Some impact is therefore anticipated at these locations although this is not expected to be adverse as the rating level is below the threshold where such impacts would be expected to begin to occur.

A comparison of the predicted ambient sound level with the proposed development in operation to the measured residual sound level is shown in Table 7. The proposed site is predicted to result in a 0-1 dB change in the ambient sound level during the day which is consistent with the site having a low impact. Whilst the 1-2 dB increase in the ambient sound level predicted at night suggests that there would be some impact, the magnitude of the change does not imply that this would be adverse (3 dB representing the smallest perceptible change in the level of a given sound and 10 dB a doubling in loudness).

Table 7 - Predicted Change in Ambient Sound Level

| House ID | Day Ambient Level, dB $L_{Aeq}$ | Night Ambient Level, dB $L_{Aeq}$ | Day Change, dB $L_{Aeq}$ | Night Change, dB $L_{Aeq}$ |
|---|---|---|---|---|
| H3 | 44 | 36 | 0 | 1 |
| H4 | 44 | 36 | 0 | 1 |
| H5 | 45 | 37 | 1 | 2 |
| H6 | 44 | 36 | 0 | 1 |
| H7 | 44 | 36 | 0 | 1 |
| H8 | 45 | 37 | 1 | 2 |
| H9 | 45 | 37 | 1 | 2 |
| H10 | 44 | 36 | 0 | 1 |
| H11 | 44 | 36 | 0 | 1 |
| H13 | 44 | 36 | 0 | 1 |
| H14 | 44 | 36 | 0 | 1 |
| H15 | 44 | 36 | 0 | 1 |

A level of conservatism has been built into the assessment to compensate for the potential impact of uncertainty. The predicted specific sound levels presented in this assessment, and the sound footprints shown in Figures 1 and 2, reflect this. The amenity of nearby residents can be further protected by the imposition of a planning condition relating to sound. A suggested appropriate form of wording for such a condition is provided in Appendix E. The margin by which the background sound level can be exceeded has been discussed and agreed with the Environmental Health Department of Moray Council.

## 6.0 CONCLUSIONS

The acoustic impact of the proposed Drum Farm energy storage project has been assessed in accordance with BS 4142: 2014. The results show that, with the implementation of appropriate mitigation measures, a low impact during daytime periods would be anticipated and, whilst a greater impact is predicted at night, it is not expected to be adverse.

## APPENDIX A – EXPERIENCE & QUALIFICATIONS

Author:

| Name | Andrew Birchby |
|---|---|
| Experience | Acoustic Specialist, Renewable Energy Systems, 2017-Present<br>Senior Acoustic Analyst, Renewable Energy Systems, 2014-2016<br>Acoustic Analyst, Renewable Energy Systems, 2012-2014<br>Technical Analyst, Renewable Energy Systems, 2006-2012 |
| Qualifications | MIOA, Member of the Institute of Acoustics<br>MSc Environmental Governance, Manchester University<br>IOA Postgraduate Diploma in Acoustics and Noise Control<br>MEng Systems Engineering, Loughborough University |

Checker/Approver:

| Name | Dr Jeremy Bass |
|---|---|
| Experience | Head of Specialist Services/Senior Technical Manager, Renewable Energy Systems, 2000-Present<br>Technical Analyst/Senior Technical Analyst, Renewable Energy Systems, 1990-2000<br>Foreign Exchange Researcher, Mechanical Engineering Laboratory, Tsukuba, Japan, 1989-1990<br>Research Associate, Energy Research Unit, Rutherford Appleton Laboratory, 1986-1989 |
| Qualifications | MIOA, Member of the Institute of Acoustics<br>MInstP, Member of the Institute of Physics<br>PhD, The Potential of Combined Heat & Power, Wind Power & Load Management for Cost Reduction in Small Electricity Supply Systems, Department of Applied Physics, University of Strathclyde<br>BSc Physics, University of Durham |

## APPENDIX B – FIGURES

**Figure 1 – Predicted Sound Footprint - Day**

The $L_{Aeq}$ descriptor has been used
Red receiver icon indicates survey location

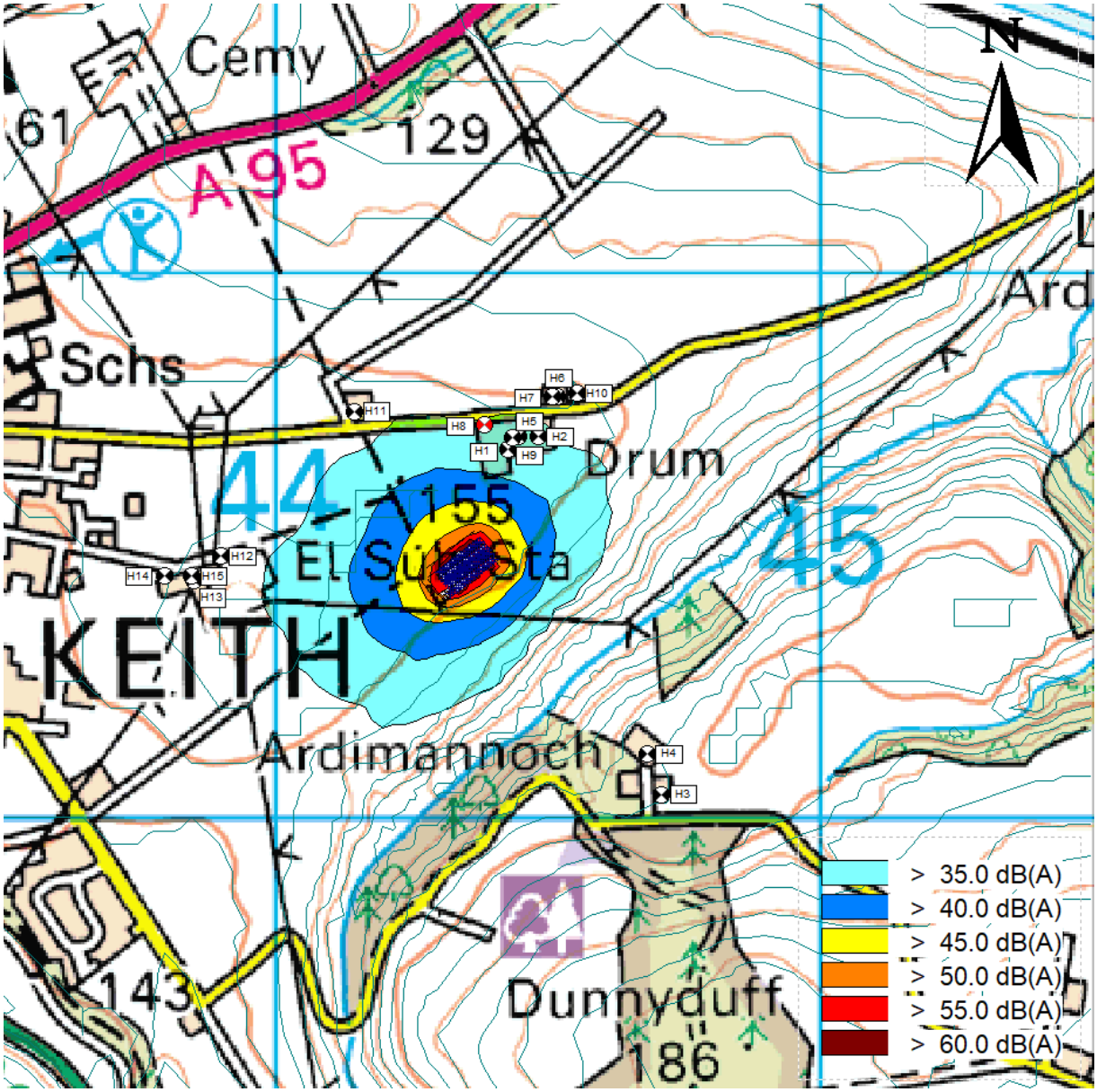
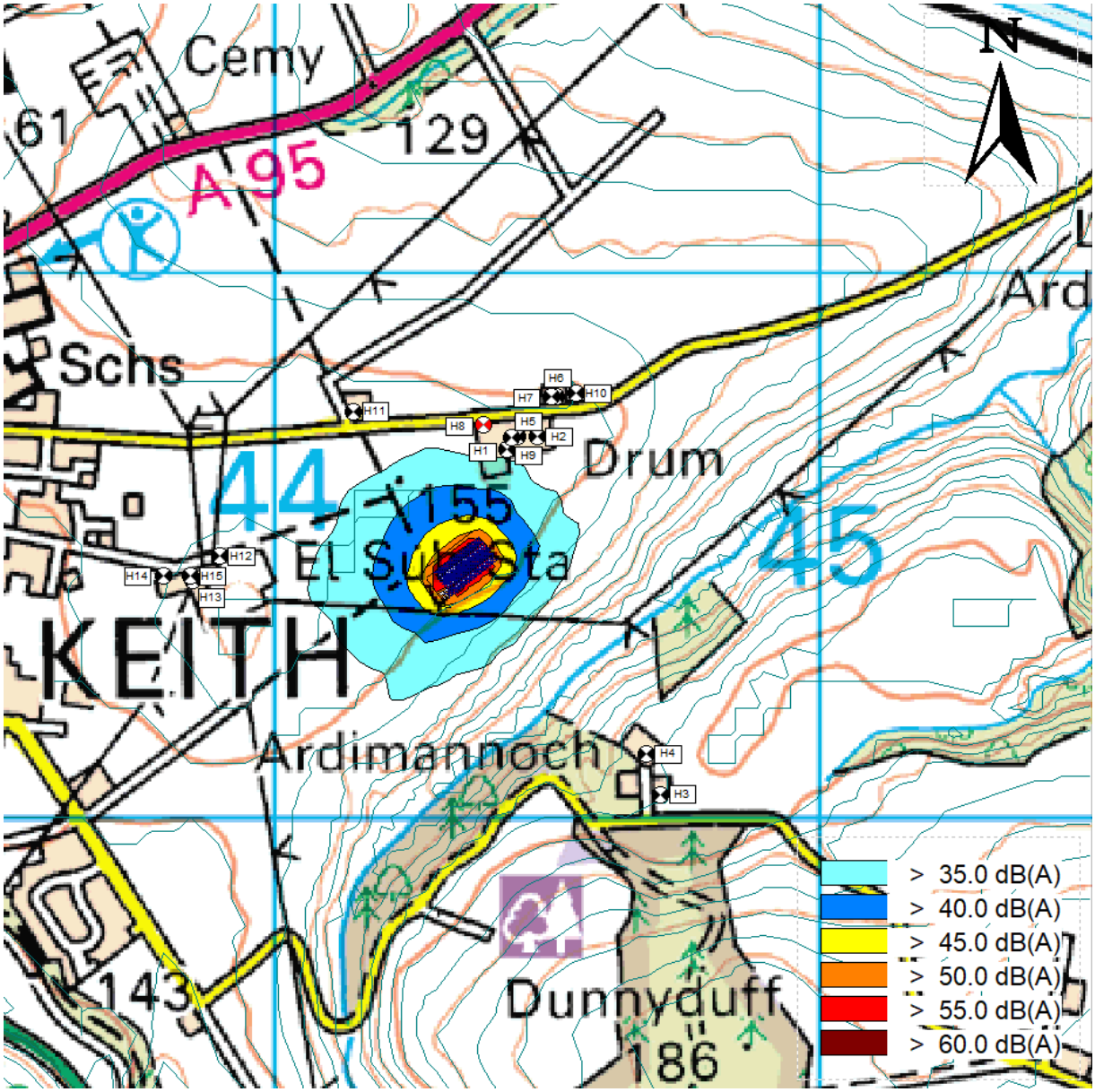
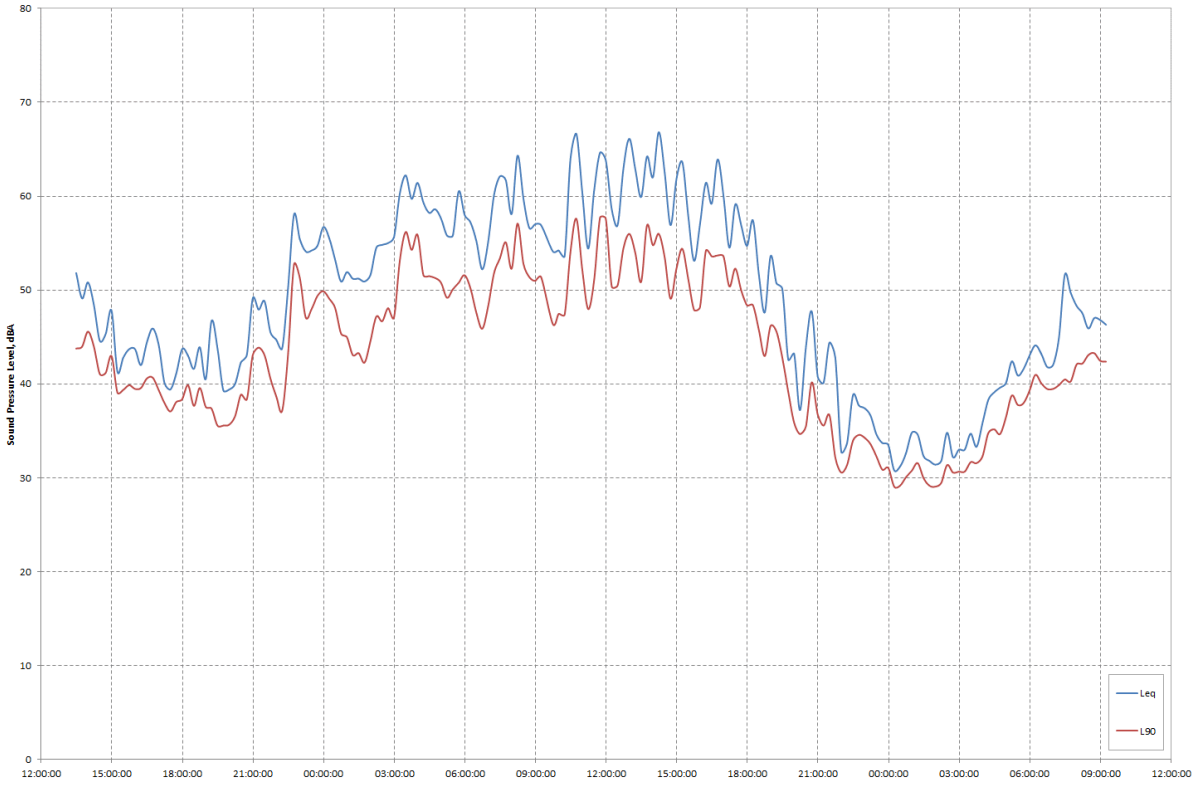


**Figure 2 – Predicted Sound Footprint - Night**

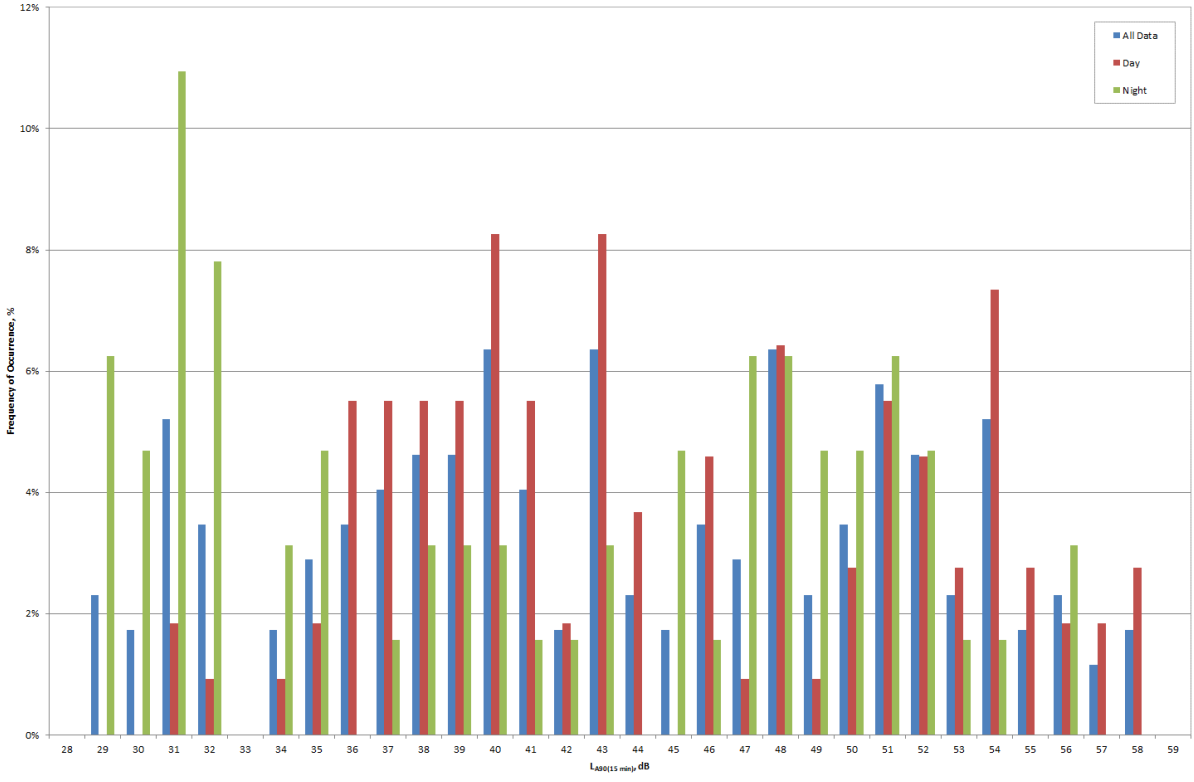
The $L_{Aeq}$ descriptor has been used
Red receiver icon indicates survey location



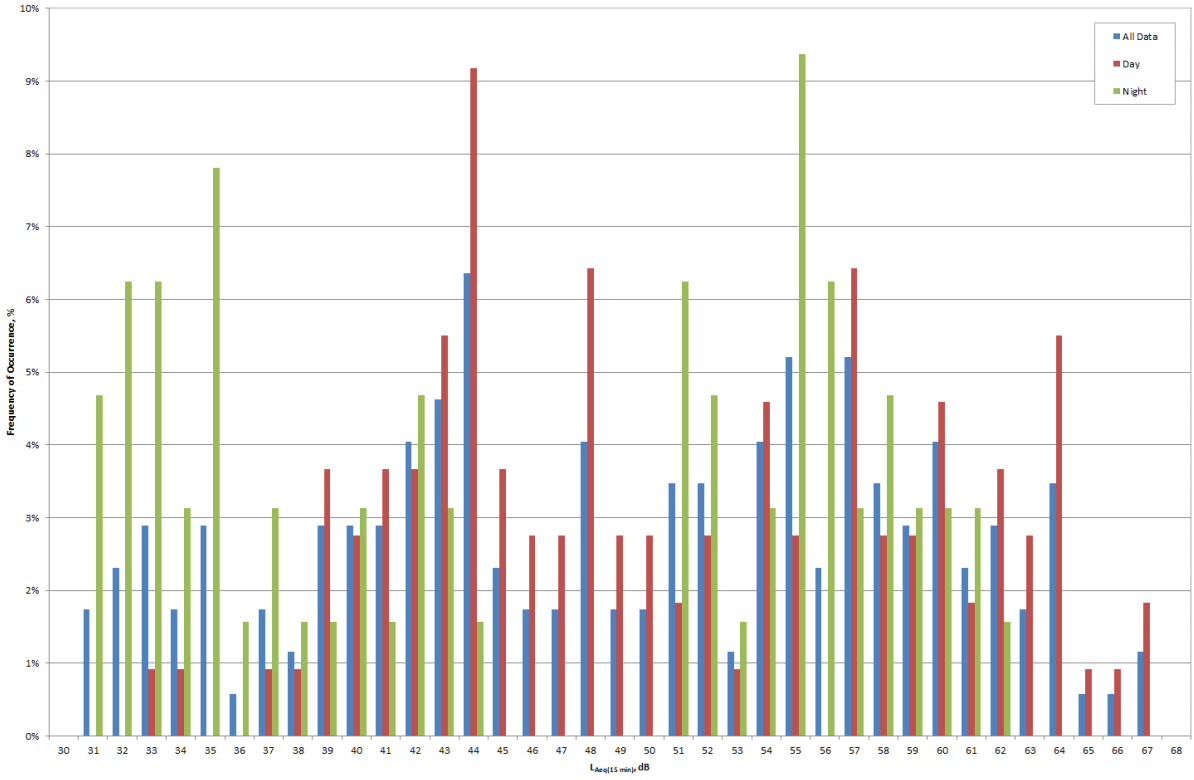
## Figure 3 - Timeline of Background Sound Data




## Figure 4 - Histogram of Background Sound Data



## Figure 5 - Histogram of Residual Sound Data



## APPENDIX C – PHOTOGRAPHS OF SURVEY LOCATION

View north

View east

View south

View west

## APPENDIX D – ATTENDED MEASUREMENT OBSERVATIONS

| Date | $L_{Aeq,\ 15min}$ | $L_{A90,\ 15min}$ | Observations |
|---|---|---|---|
| 31/01/22 13:30 | 51.8 dB | 43.8 dB | Noise sources included:<br>Animals (cows, sheep & dogs)<br>Wind in the trees<br>Traffic on nearby roads<br>Reversing warning from farm vehicle |
| 01/01/22 09:45 | 54.1 dB | 46.4 dB | Noise sources included:<br>Wind in the trees<br>Construction work on houses in distance |
| 02/01/22 09:15 | 46.3 dB | 42.4 dB | Noise sources included:<br>Animals (birds, cows, dogs & sheep)<br>Traffic on nearby roads<br>Wind in the trees<br>Distant construction work |

## APPENDIX E – SUGGESTED PLANNING CONDITION WORDING

The energy storage facility shall be designed and operated to ensure that the rating sound level, determined using the BS4142: 2014 methodology, shall not exceed the background sound level plus 5 dB(A) during both daytime and night-time periods at the nearest residential properties (as identified in RES report 04872-3761753-01). The background sound levels shall be as detailed in RES Report 04872-3761753-01, or those obtained in an updated survey, whichever are greater.