# HOUSTON SOLAR PHOTOVOLTAIC (PV) AND ENERGY STORAGE FACILITY

## Noise Impact Assessment

NI2575
F01
29th September 2023

REPORT

## Document status

| Version | Purpose of document | Authored by | Reviewed by | Approved by | Review date |
|---|---|---|---|---|---|
| D01 | For Client Review | LP | CC | CC | 23.12.2022 |
| D02 | For Client Review | CC | CC | SMcA | 09.06.2023 |
| F01 | Final | CC | CC | SMcA | 29.09.2023 |

## Approval for issue

| | |
|---|---|
| Stephen McAfee | 29 September 2023 |

The report has been prepared for the exclusive use and benefit of our client and solely for the purpose for which it is provided. Unless otherwise agreed in writing by RPS Group Plc, any of its subsidiaries, or a related entity (collectively 'RPS') no part of this report should be reproduced, distributed or communicated to any third party. RPS does not accept any liability if this report is used for an alternative purpose from which it is intended, nor to any third party in respect of this report.  The report does not account for any changes relating to the subject matter of the report, or any legislative or regulatory changes that have occurred since the report was produced and that may affect the report.

The report has been prepared using the information provided to RPS by its client, or others on behalf of its client. To the fullest extent permitted by law, RPS shall not be liable for any loss or damage suffered by the client arising from fraud, misrepresentation, withholding of information material relevant to the report or required by RPS, or other default relating to such information, whether on the client's part or that of the other information sources, unless such fraud, misrepresentation, withholding or such other default is evident to RPS without further enquiry. It is expressly stated that no independent verification of any documents or information supplied by the client or others on behalf of the client has been made. The report shall be used for general information only.


**Prepared by:**

**RPS**

Lisa Payne
Associate Noise Consultant

Elmwood House
74 Boucher Road, Belfast
Co. Antrim BT12 6RZ

T +44 2890 667 914
E lisa.payne@rpsgroup.com

**Prepared for:**

**Elgin Energy EsCo Ltd**

Mr Gareth Gardener
Development Manager

6th Floor, Dashwood House
69 Old Broad Street
London, EC2M 1QS

# Contents

## Tables



## Figures



## Appendices

# 1 INTRODUCTION

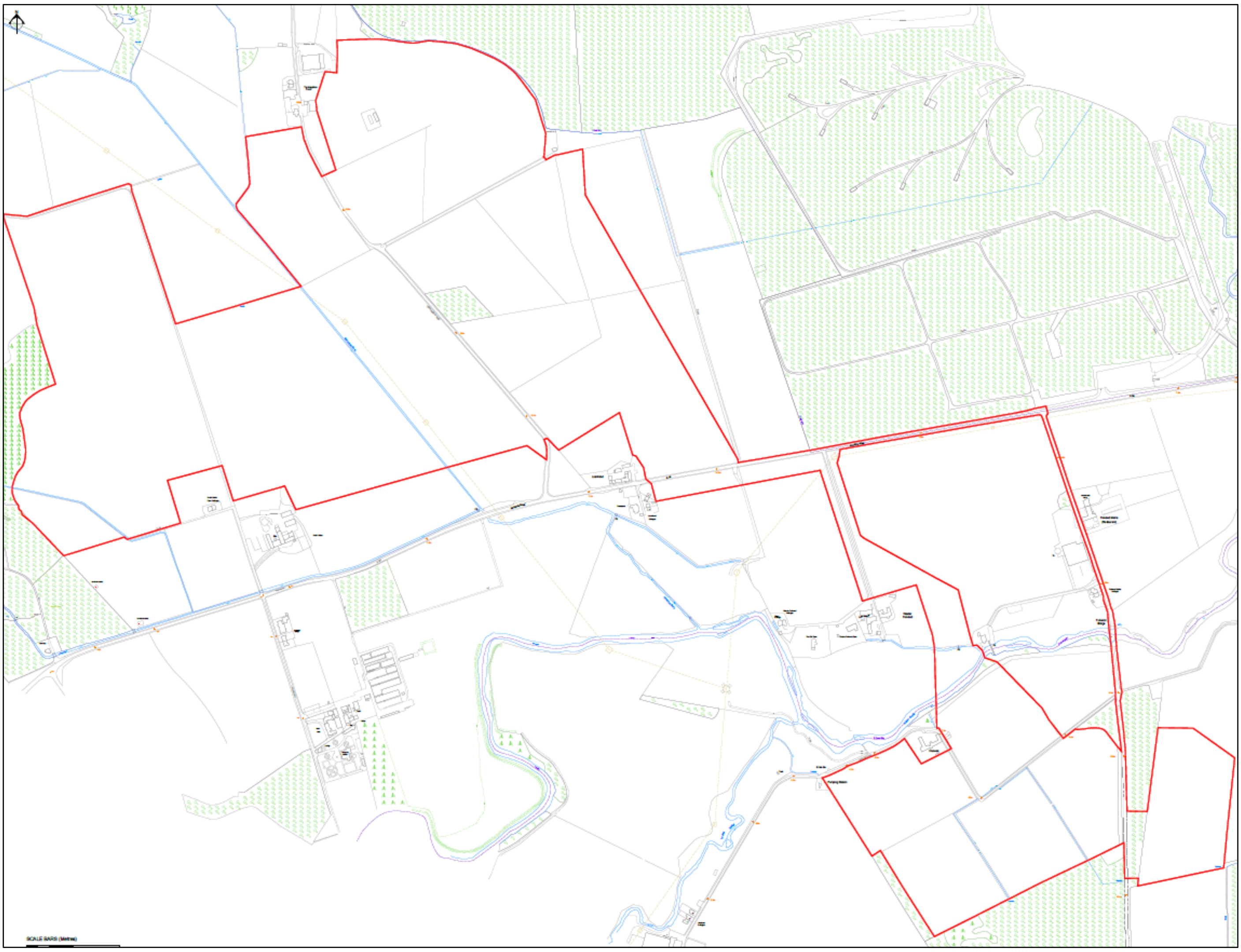
RPS has been commissioned by Elgin Energy EsCo Ltd to undertake a noise impact assessment for the operation of the proposed Solar Farm and Battery Energy Storage System (BESS) at Houston Farms, Houston, Renfrewshire.

## 1.1 Site Location

Houston Solar PV and energy storage facility, with associated infrastructure (the proposed development) is located on three parcels of land within the Renfrewshire Council Area. At its nearest point, the northernmost parcel of land (Houston North) is located approximately 0.5km northeast of Houston village. It is situated to the north of the B790 Houston Road and is bisected by Turningshaw Road. The other two land parcels (Houston South) are located to the south of the B790 Houston Road, situated to the east and west of Moss Road. At their nearest point the lands are located approximately 1km east of Houston village.

The site location of the proposed development is shown below in Figure 1.

**Figure 1: Site Location of Proposed Solar Farm**



## 1.2 Project Summary

The land-holding upon which the development is proposed measures c. 129 hectares / 318 acres. Panels will not be placed on this entire area. The proposed development area has emerged through a process of detailed baseline environmental assessment, site visits, constraints mapping and as a result of feedback from stakeholders during the pre-consent processes including engagement with the Council, statutory authorities, ECU and the public.

When constructed it is anticipated that the solar farm will have an installed capacity in excess of 50MW but not exceeding 100MW, consisting of a solar PV farm of approximately 75MW capacity and a battery energy storage system (BESS) facility of approximately 25MW. It is proposed to locate the battery facility beside the proposed Primary Substation within the site and near to the south-western boundary of one of the Houston South land parcels.

Additional project components are listed in the bullet points below and described in greater detail within subsequent text:

- Photovoltaic (PV) Solar Panels erected on steel frames in south-facing arrays;
- A primary substation, comprising electrical infrastructure and associated buildings –including control building - to enable the proposed solar facility to be controlled, monitored, metered and connected to the network. These elements will be located within a compound typically measuring c.20m x c.20m;
- It is proposed to connect the on-site primary substation at Houston South to Houston North via a small connecting substation, through an underground cable connection;
- 26 No. Inverter Substation Containers on concrete plinths, typically measuring between 7.5m and 10m (l) x 2.2m and 3m (w) x 2.2 and 3m (h) to be located across the site;
- A number of strategically located CCTV security cameras (3m high);
- Perimeter post and wire “deer” fencing (c.2.45m high);
- Associated Battery Energy Storage System (BESS) facility;
- Access to Houston North is via existing field entrances on either side of both N Mains Road and Turningshaw Road; and access to Houston South is via an entrance on Auchans Road and entrances on either side of Moss Road;
- Two No. temporary construction compounds to be located (one each) at Houston North and Houston South; and
- Associated internal service tracks.

When operational the site will support a dual renewable/farming use and the overwhelming land area will remain agricultural. Sheep grazing will take place across the entire area and will not be impeded by the proposed infrastructure.

## 1.3 Potential Noise Sources

The vast majority of the plant and equipment to be installed at the proposed development site will be solar panels and associated cabling, which do not generate noise. The main potential operational noise sources within the proposed development site are located within the following areas of the proposed development:

- Primary Substation;
- Inverter Stations, and;
- Battery Storage.

Details of each of these elements of the site and associated potential noise sources are summarised below.

## 1.3.1 Primary Substation

The substation and control building compound will accommodate all necessary equipment to enable the solar farm electrical system to be controlled, monitored, metered and connected to the network. The compound will accommodate a customer substation and DNO substation.

Equipment to be accommodated within the substation typically includes metering equipment, switchgear, transformers, the central computer system and electrical control panels. SCADA and telecommunications links will also be required at the site for the purposes of metering, remote control and protection communication to the Network Control Centre.

A storeroom will also be provided within the control building. The building will not be permanently staffed but will be periodically visited by maintenance personnel.

Both the customer and DNO substation building dimensions will vary depending on the specification at the time of order and build but are generally less than 40m2 each and both will sit atop a concrete pad. It is located within a larger compound measuring approximately 20m (l) x 20m (w) in area. The ground surface of the proposed security compound will be finished in permeable stone.

The sound power level for a typical transformer of this size is shown Figure 2 below:

**Figure 2: Typical Transformer Technical Datasheet**

**Technical Data Sheet**

Tender No. Q14E62W-1

| **Project** | | **The value that buyer requires** | **The value that vendor provides** |
|---|---|---|---|
| **Product standard** | | **AS** | **AS** |
| **Basic technical data** | | | |
| Type | | 3 phase, 2 winding | 3 phase, 2 winding |
| Rated power (MVA) | | 62 | 62 |
| Rated voltage (kV) HV/LV | | 66/22 | 66/22 |
| Rated current (A) HV/MV/LV | | 543/1627 | 543/1627 |
| Voltage ratio (kV) | | 66 ± 10 × 1.25%/22 | 66 ± 10 × 1.25%/22 |
| Cooling method | | ONAN/ONAF | ONAN/ONAF |
| Rated frequency (Hz) | | 50 | 50 |
| Connection symbol | | YNd11 | YNd11 |
| Loss | No-load loss (kW) (under rated power & rated voltage) | / | 30 (with tolerance according to AS) |
| | Load loss (kW) (under rated power & at principal tapping) | / | 250 (with tolerance according to AS) |
| | No-load current (%) | / | 0.5 (with tolerance according to AS) |
| Impedance voltage (%) (principal tapping) | | 12.5% | 12.5% (with tolerance according to AS) |
| Sound power level (dB(A)) | | / | 75 |
| **Rated insulation level** | | | |
| HV | Lighting impulse withstand voltage peak value (kVp) | / | 325 |
| | Short duration power-frequency withstand voltage r.m.s (kV) | / | 140 |
| HV | Lighting impulse withstand voltage peak value (kVp) | / | 250 |

## 1.3.2 Inverter Stations

These will be accommodated in modular cabin like buildings which will be sensitively positioned throughout the site. They are constructed atop raised concrete plinths, with approximate footprint dimensions of between 7.5m and 10m (l) x 2.2m and 3m (w) rising to a height of 3m. There will be 26 containers across the site. The inverter stations are connected to the arrays of panels by cabling which has been buried underground. The panels themselves generate Direct Current (DC) electricity which is converted into Alternating Current (AC) electricity by the inverter stations before being fed into the primary substation and then onward to the local electricity grid network.

The mechanism by which inverter stations generate noise is via the cooling fans, which are contained within the inverter modules. The inverters will only operate when the solar farm is generating electricity and are more active during periods of high temperature, i.e., typically during the middle of the day and in summer months.

The sound power level for a typical inverter is shown in Figure 3 below.

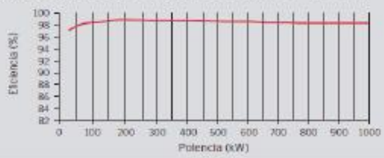
**Figure 3: Ingecon SUN PowerMax M400 Inverter Technical Datasheet**

**Ingecon SUN PowerMax M400 Inverter (2 inverters within each power station)**

| | | | |
|---|---|---|---|
| Otras protecciones | Fusibles AC, cortocircuitos y sobrecargas AC (por cada bloque de potencia) | | |
| **Prestaciones** | | | |
| Eficiencia máxima | 98,9% | 98,9% | 98,9% |
| Euroeficiencia | 98,7% | 98,7% | 98,7% |
| CEC | 98,2% | 98,2% | 98,2% |
| Consumo en stand-by(8) | 60 W | 90 W | 120 W |
| Consumo nocturno | 60 W | 90 W | 120 W |
| **Datos Generales** | | | |
| Temperatura de funcionamiento | -20°C a +65°C | -20°C a +65°C | -20°C a +65°C |
| Humedad relativa (sin condensación) | 0 - 95% | 0 - 95% | 0 - 95% |
| Grado de protección | IP20 | IP20 | IP20 |
| Altitud máxima(9) | 3.000 m | 3.000 m | 3.000 m |
| Sistema de refrigeración | Ventilación forzada con control térmico (suministro de 230 V fase + neutro) | | |
| Caudal de aire | 2.670 m³/h (consumo: 1.000 VA) | 4.640 m³/h (consumo: 1.300 VA) | 5.340 m³/h (consumo: 1.500 VA) |
| Emisión acústica | < 55 dB (A) a 4 m. y < 67 dB (A) a 1 m. con ventiladores funcionando a la potencia máxima | | |
| Certificación | CE | | |
| Normativa EMC y de seguridad | EN 61000-6-2, EN 61000-6-4, EN 61000-3-11, EN 61000-3-12, EN 50178, EN 62109-1, EN 62109-2, FCC Part 15, IEEE1547, IEEE1547.1 | | |
| Normativa de conexión a red | IEC 62116, RD1699/2011, DIN V VDE V 0126-1-1, CEI 0-16, BDEW-Mittelspannungsrichtlinie:2011, A70 Terna, P.O.12.3, South Africa Grid code, IEEE929, IEC61727 | | |

**Notas:** (1) Dependiendo del tipo de instalación y de la ubicación geográfica. Datos para condiciones STC (2) Considerar el aumento de tensión de los paneles 'Voc' a bajas temperaturas (3) Para otras configuraciones consultar con Ingeteam (4) Los MPPT conectados a un mismo transformador a través de inversores TL deberán tener la misma configuración de tensión (5) Potencia AC hasta 45°C de temperatura ambiente. Por cada °C de incremento, la potencia de salida se reducirá un 1,8% (6) Para Pac>25% de la potencia nominal (7) Para Pac>25% de la potencia nominal y tensión según IEC 61000-3-4 (8) Consumo desde el campo fotovoltaico (9) Por encima de 1.000 m, la temperatura para potencia nominal (45°C) se reduce a razón de 4,5°C por cada 1.000 m adicionales.

**Rendimiento INGECON® SUN 1000TL M400** Vdc = 650 V




- Equivalent SWL for each inverter unit is 75dB.

**Air-conditioning Unit For Power Stations (1 unit externally installed)**

**+ Características Acústicas**

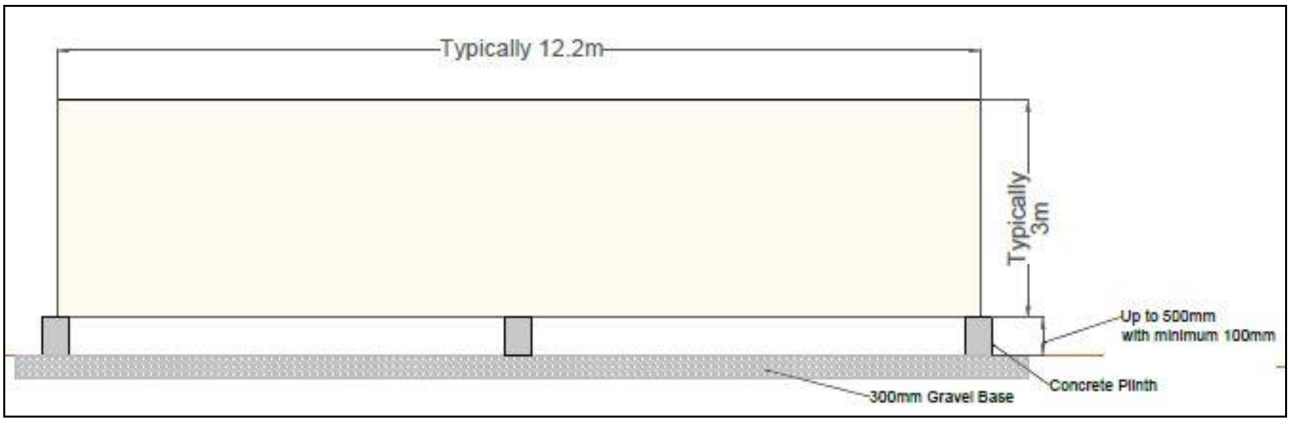
| Hz | 63 | 125 | 250 | 500 | 1k | 2k | 4k | 8k | Overall |
|---|---|---|---|---|---|---|---|---|---|
| Inlet (LwA) | 48 | 61 | 61 | 68 | 72 | 69 | 66 | 57 | 76 |
| Inlet LpA @ 1,5m | 34 | 47 | 47 | 53 | 58 | 55 | 51 | 43 | 61 |

### 1.3.3 Battery Storage

The battery storage facility will have a capacity of approximately 25MW and will comprise approximately 12 No. storage units typically measuring 12.2m (l) x 2.5m (w) x 3m (h) set side by side generally 3 metres apart. Each pair of storage units will be facilitated by an associated power conversion system (PCS) unit (6 in total) again typically measuring 12.2mm (l) x 2.5m (w) x 3m (h).

The battery storage and PCS units will sit atop plinths/upstands typically measuring 300mm high but within a range of 100mm to 500mm. Concrete will be limited to the extent of the upstands and will not be placed across the entirety of the Battery Storage Area. The storage units and proposed substation will be placed atop a permeable surface. The battery storage facility will be set adjacent to the Substation Compound located within the southern portion of the site.

**Figure 4: Typical Battery Storage Unit**




The candidate storage system consists of 12 battery cabinets with a single air-conditioned container for each battery cabinet.

AERMEC air/water chillers for external installation specifications have been provided and the Sound Power Level (SWL) is for versions:

- standard NRL,
- low noise NRL_L,
- high efficiency NRL_A and
- low noise high efficiency NRL_E.

Figure 5 summarises the ARMEC technical data to include both sound power and sound pressure levels of a range of units.

## Figure 5: ARMEC Technical Data

| | | | | 280 | 300 | 330 | 350 | 500 | 550 | 600 | 650 | 700 | 750 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Electrical data** | | | | | | | | | | | | | |
| Total input currente (cooling) | ° | (3) | A | / | / | / | / | 63 | 67 | 81 | 88 | 100 | 122 |
| | L | (3) | A | 36 | 40 | 44 | 51 | 70 | 75 | 90 | 99 | 111 | 113 |
| | A | (3) | A | / | / | / | / | 55 | 60 | 71 | 77 | 90 | 113 |
| | E | (3) | A | 30 | 34 | 37 | 45 | 60 | 64 | 78 | 89 | 97 | 109 |
| Maximum current (FLA) | | (3) | A | 46 | 53 | 58 | 63 | 76 | 81 | 100 | 112 | 122 | 144 |
| Starting current (LRA) | | (3) | A | 155 | 184 | 190 | 200 | 214 | 220 | 232 | 243 | 261 | 320 |
| **Scroll Compressor** | | | | | | | | | | | | | |
| Compressors / Circuit | | | n° | 2/2 | 2/2 | 2/2 | 2/2 | 3/2 | 3/2 | 4/2 | 4/2 | 4/2 | 4/2 |
| Refrigerant | | | Type | R410A | | | | | | | | | |
| **Heat exchanger system side** | | | | | | | | | | | | | |
| Exchanger | | | Type/n° | Plate/1 | | | | | | | | | |
| hydraulic connections (In/Out) | | | Ø | 2"½ | 2"½ | 2"½ | 2"½ | 2"½ | 2"½ | 2"½ | 2"½ | 2"½ | 3" |
| **Connection of Condensing unit C** | | | | | | | | | | | | | |
| Gas line | | | Ø | 28/28 | 28/28 | 28/28 | 28/28 | 35/28 | 35/28 | 35/35 | 35/35 | 42/42 | 42/42 |
| Liquid line | | | Ø | 15,88/15,88 | 15,88/15,88 | 15,88/15,88 | 18/18 | 18/18 | 18/18 | 22/22 | 22/22 | 28/28 | 28/28 |
| **Axial fans** | | | | | | | | | | | | | |
| Fans | ° | | Type/n° | / | / | / | / | std/2 | std/2 | std/2 | std/2 | std/2 | std/3 |
| | L | | Type/n° | Inverter/4 | Inverter/4 | Inverter/4 | Inverter/6 | std/2 | std/2 | std/2 | std/2 | std/2 | std/3 |
| | A | | Type/n° | / | / | / | / | std/2 | std/2 | std/2 | std/2 | std/2 | std/3 |
| | E | | Type/n° | Inverter/6 | Inverter/6 | Inverter/8 | Inverter/8 | std/2 | std/2 | std/2 | std/2 | std/2 | std/3 |
| Air flow rate (cooling) | ° | | $m^3/h$ | / | / | / | / | 34600 | 34600 | 34600 | 34600 | 33600 | 51400 |
| | L | | $m^3/h$ | 14200 | 14200 | 14200 | 20200 | 28400 | 28700 | 27700 | 29400 | 28600 | 42700 |
| | A | | $m^3/h$ | / | / | / | / | 34100 | 34100 | 32600 | 32600 | 50000 | 49000 |
| | E | | $m^3/h$ | 22000 | 22000 | 27000 | 27000 | 21100 | 22200 | 21800 | 22800 | 32500 | 35300 |
| **Sound data (cooling)** | | | | | | | | | | | | | |
| Sound power level | ° | | dB(A) | / | / | / | / | 82 | 82 | 82 | 83 | 83 | 85 |
| Sound pressure level | ° | | dB(A) | / | / | / | / | 50 | 50 | 50 | 51 | 51 | 53 |
| Sound power level | L | | dB(A) | 73 | 73 | 74 | 75 | 77 | 77 | 77 | 78 | 78 | 80 |
| Sound pressure level | L | | dB(A) | 41 | 41 | 42 | 43 | 45 | 45 | 45 | 46 | 46 | 48 |
| Sound power level | A | | dB(A) | / | / | / | / | 82 | 82 | 82 | 83 | 85 | 85 |
| Sound pressure level | A | | dB(A) | / | / | / | / | 50 | 50 | 50 | 51 | 53 | 53 |
| Sound power level | E | | dB(A) | 74 | 74 | 75 | 76 | 74 | 74 | 74 | 75 | 77 | 77 |
| Sound pressure level | E | | dB(A) | 42 | 42 | 43 | 44 | 42 | 42 | 42 | 43 | 45 | 45 |

(3) Unit standar configuration without hydronic kit

**Sound power** Aermec determines sound power values on the basis of measurements made in accordance with UNI EN ISO 9614-2, as required for Eurovent certification.

**Sound pressure** Sound pressure in free field, at 10 m distance from the external surface of the unit (in accordance with UNI EN ISO 3744).

**Note: For more information, refer to the selection program or the technical documentation available on the website www.aermec.com**

The sound power levels for the cooling ranges from 74 dB to 85 dB.

No spectral data has been provided; therefore, the SWL is assumed to be within the 500 Hz octave band frequency. Noise predictions have been undertaken based on SWL 80 dB.

## 1.4 Noise-Sensitive Receptors

A review of the nearest residential properties within 500 m of the proposed development site boundary has been carried out to identify receptors which may potentially be affected by noise from the proposed development (noise-sensitive receptors).

The proposed development is in a rural location, close to the village of Houston. The closest properties within Houston Village to the proposed development site boundary are those on Ardgryfe Crescent. These properties have been included as noise-sensitive receptors and are representative of other properties within Houston Village which are further from the proposed development site.

Other noise-sensitive receptors in the area include individual residential properties and farm houses in the surrounding countryside, including properties on Houston Road, Craigsend Road, Turningshaw Road, Moss Road and Auchans Road. These properties have been identified as noise sensitive receptors.

Where clusters of properties are located close together and predicted noise levels due to the proposed site are expected to be comparable, these may be represented by a single noise-sensitive receptor. Properties located further from the proposed development site than the noise-sensitive receptors identified in this noise impact assessment are expected to experience sound pressure levels due to the operation of the proposed development that are lower than the levels predicted in the noise modelling.

The noise-sensitive receptors associated with the Houston Solar Farm have been identified, and an ID assigned to each. The locations of the noise sensitive receptors are shown in Figure 6 below, with the co-ordinates for each shown in Appendix C along with an additional larger figure for clarity.

**Figure 6: Houston Noise Sensitive Receptor Locations**

# 2 METHODOLOGY

## 2.1 Noise Guidance

The noise assessment has considered the following relevant noise guidance documents:

- British Standard BS4142:2014 Methods for Rating and Assessing Industrial and Commercial Sound (BS, 2014);
- British Standard 8233: 2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice (BS, 2014);
- World Health Organisation (WHO) – Guidelines for Community Noise (1999, 2009 and 2018);
- British Standard BS 7445-1 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1).
- ISO9613: Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation

### 2.1.1 British Standard BS4142:2014 Methods for Rating Sound and Assessing Industrial and Commercial Sound

BS4142:2014 describes methods for rating and assessing sound of an industrial and/or commercial nature at residential noise-sensitive receptors, which includes:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

BS 4142 also provides procedures in determining if the noise in question is likely to give rise to complaints from residents in the vicinity.

BS 4142 states that one should '*obtain an initial estimate of the impact of the specific sound by subtracting the measured background sound level from the rating level and consider the following:*

*a. Typically, the greater this difference, the greater the magnitude of the impact.*

*b. A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

*c. A difference of around + 5 dB is likely to be an indication of an adverse impact, depending on the context.*

*d. 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.*

The aforementioned rating level is based upon the specific noise level of the noise source in question. A correction should be applied to the specific noise level to obtain an increased rating level if 'a tone, impulse or other characteristic occurs, or is expected to be present, for new or modified sound sources.

To summarise, BS4142 section 9.2 advises the following in regards to corrections for acoustic characteristics:

- 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 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, if the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied.

### 2.1.2 British Standard 8233:2014 Sound Insulation and Noise Reduction for Buildings – Code of Practice

BS8233:2014 provides guidance values for a range of ambient noise levels within residential properties as shown in below.

**Table 1: Internal Ambient Noise Levels**

| Activity | Location | 07:00 to 23:00 | 23:00 to 07:00 |
|---|---|---|---|
| Resting | Living Room | 35dB $L_{Aeq, 16hr}$ | - |
| Dining | Dining room/area | 40dB $L_{Aeq, 16hr}$ | - |
| Sleeping (daytime resting) | Bedroom | 35dB $L_{Aeq, 16hr}$ | 30dB $L_{Aeq, 8hr}$ |

The standard allows for a further relaxation in standards of up to 5dB where "development is considered necessary or desirable". In relation to external amenity areas such as gardens and patios, the standard states that it is desirable that external noise does not exceed 50 dB $L_{Aeq,T}$ with an upper guideline value of 55 dB $L_{Aeq,T}$.

### 2.1.3 British Standards BS 7445-1:2003 Description and Measurement of Environmental Noise – Part 1: Guide to Quantities and Procedures (BS, 7445-1)

British Standard BS7445 provides the framework within which environmental noise should be quantified. BS 7445: Part 1 provides guidance to quantities and procedures in relation to environmental noise monitoring. BS7445-1 states that sound level meters that are used should conform to specifications of Class or Type 1 (or Class or Type 2 as a minimum) as given in BESN 61672.

The Class of a noise level meter describes its accuracy as defined by the relevant international standards. Sound level meters are defined by International Standards such as IEC 61672-1:2013 (or BS EN61672-1:2003). These standards define a wide range of complex accuracy, performance and calibration criteria that instruments must meet to be fit for purpose. Within the Standard, there are two allowable levels of tolerance and these are known as Class 1 and Class 2. Class 1 is more accurate than Class 2.

These Class 1 and Class 2 tolerances are necessary as a way of dealing with variations in the instruments. The variations are caused by the different electronic components used inside the sound level meters and because of the way different meters have been designed and verified. Even the test equipment used to check the sound level meters during manufacture will introduce some variation.

All equipment shall be calibrated and the configuration for calibration shall be in accordance with the manufacturer's instructions. A comprehensive recalibration at certain time intervals (for example annually) may be prescribed by authorities responsible for the use of the measurement results. A field check shall be made by the user at least before and after each series of measurements, preferably including an acoustic check of the microphone

Meteorological conditions are not prescribed but it is recommended that wind speed should not exceed 5 m/s at height of 3-11m above ground, any temperature inversions near ground, or heavy precipitation.

## 2.2 Noise Modelling Methodology

### 2.2.1 CadnaA Noise Propagation Software

CadnaA (Computer Aided Noise Abatement) is a leading proprietary software for environmental noise propagation calculation, presentation and assessment. The CadnaA noise modelling software package was set up to use ISO9613 "Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation" prediction methodology along with a range of topographical and ordnance data collected on the surrounding area to build up a picture of the noise environment in the vicinity of one of noise sources.

The software was used to build a 3-dimensional model of all features which may affect the generation and propagation of noise in the vicinity of the Proposed Development and to predict the specific sound levels due to the Proposed Development at nearby residential properties (receptors).

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. Ground effects are also taken into account by the propagation model, with ground effects surrounding noise sources and receptors being of particular significance. CadnaA allows definition of ground absorption across a whole site or with a map of ground absorption. Hard ground is represented by Ground Absorption G=0, G=1 for soft ground and G=0.5 is typically adopted to reflect a mix of hard and porous ground.

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 lower and the downwind predictions presented would be regarded as conservative i.e. greater than those experienced in practice.

ISO9613 and other sound propagation methodologies are built into sound propagation software packages, such as CadnaA. For this project, ISO9613 has been selected as the sound propagation modelling algorithm within CadnaA.

### 2.2.2 ISO9613: Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation

ISO9613 (Part 2) specifies a methodology for calculating the attenuation of sound during propagation outdoors under meteorological conditions favourable to sound propagation. The standard applies to light downwind conditions and takes into account attenuation due to the following:

- Geometrical divergence;
- Atmospheric absorption;
- Ground effects:
- Reflection from surfaces;
- Screening by obstacles.

The methodology is used to predict equivalent continuous A-weighted sound pressure level ($L_{Aeq}$), including algorithms for octave-band source data from 63 Hz to 8 kHz.

ISO9613 and other sound propagation methodologies are built in to sound propagation software packages, such as CadnaA. For this project, ISO9613 has been selected as the sound propagation modelling algorithm within CadnaA.

# 3 BASELINE NOISE MONITORING SURVEY

Unattended baseline noise monitoring surveys were undertaken at two locations in the vicinity of the proposed Houston Solar Farm site between 16:30 hrs on Tuesday 6th December 2022 and 09:00 hrs on Monday 12th December 2022. Details of the baseline survey work are shown below.

## 3.1 Noise Monitoring Locations

Unattended baseline noise monitoring was undertaken on the proposed Houston Solar Farm site at the following two noise monitoring locations (NMLs), which were representative of the closest noise sensitive receptors. British Grid Reference Eastings and Northings for each NML are shown in Table 2 below:

**Table 2: Houston Noise Monitoring Locations (NMLs)**

| Noise Monitoring Location ID | Location | Easting | Northing |
|---|---|---|---|
| NML1 | Turningshaw Road | 242236 | 668054 |
| NML2 | Houston Road | 243424 | 666920 |

The noise monitoring locations are shown in Figure 7 below, with photographs of the noise monitoring survey equipment at each monitoring location included in Appendix B.

**Figure 7: Houston Noise Monitoring Locations**

### 3.1.1 Noise Monitoring Location 1 (NML1)

Noise Monitoring Location 1 (NML1) was located approximately 10 m southwest of a barn on Turningshaw Road, Houston. This location was representative of several nearby residential properties on Turningshaw Road to the north of the proposed development site. Unattended noise monitoring equipment and weather station were set up at NML1 on 6th December 2022, with noise and weather monitoring commencing at 16:30 hrs.

During set up, weather conditions were cold, still and dry. Subjectively, the dominant noise source was distant road traffic noise. Bird song was also audible at the time of the survey set-up. Intermittently audible were horses passing on the lane intermittently as they were brought in for the night and aircraft noise.

### 3.1.2 Noise Monitoring Location 2 (NML2)

Noise Monitoring Location 2 (NML2) was located in a field approximately 325m south-southeast of Houston Road, just north of a small cluster of houses access via a lane off Houston Road.

Unattended noise monitoring equipment was set up at NML2 on 6th December 2022, with noise monitoring commencing at 17:00 hrs.

During set up, weather conditions were cold, still and dry. Subjectively, road traffic noise was the dominant noise source. Birdsong and aircraft noise were also audible. One vehicle passed on the access lane to the residences while the survey was being set up.

## 3.2 Noise Monitoring Equipment

The baseline noise monitoring surveys at NML1 and NML2 were each carried out using a Rion NL-52 Class 1 Sound Level Analyser in conjunction with the following:

- Outdoor kit enhanced NL-52,
- Rion WS-03SO1 Windscreen head assembly (inc WS-03051);
- Rion EC-04 2m Extension Cable (7 Pin); and
- Bruel & Kjaer Type 4231 Class 1 Acoustic Calibrator.

The sound level meter specifications from the noise survey equipment at each location are detailed in Table 3 below.

**Table 3: Rion NL-52 Noise Instrument Records**

| NML1: Rion NL-52 Sound Level Meter | | | | |
|---|---|---|---|---|
| **Equipment** | **Model / Type** | **Serial Number** | **Calibration Certificate Number** | **Last Calibration Date** |
| Sound Level Meter | Rion NL-52 | 01087404 | UCRT22/1887 | 14/07/2022 |
| Preamplifier | NH-25 | 87610 | UCRT22/1887 | 14/07/2022 |
| Microphone | UC-59 | 14333 | UCRT22/1887 | 14/07/2022 |
| Calibrator | Bruel & Kjaer | 2445560 | UCRT21/2233 | 07/10/2021 |
| **NML2: Rion NL-52 Sound Level Meter** | | | | |
| **Equipment** | **Model / Type** | **Serial Number** | **Calibration Certificate Number** | **Last Calibration Date** |
| Sound Level Meter | Rion NL-52 | 00220558 | UCRT22/1780 | 16/06/2022 |
| Preamplifier | NH-25 | 10558 | UCRT22/1780 | 16/06/2022 |
| Microphone | UC-59 | 06710 | UCRT22/1780 | 16/06/2022 |
| Calibrator | Bruel & Kjaer | 2445560 | UCRT21/2233 | 07/10/2021 |

The calibration certificates and sound level meter specifications from the noise survey equipment are detailed in Appendix A.

The noise monitoring instrumentation conforms to the requirements for integrating averaging sound level meters (Type 1) as specified in BS EN 60804. The sound level meter was accurately calibrated before and after use. Calibration certificates of the noise monitoring equipment used can be found in Appendix A.

### 3.2.1 Weather Station

Meteorological conditions were surveyed at NML1 for the duration of the noise monitoring survey from 6th December 2022 to 12 December 2022.

A weather station fitted with a WS600 weather sensor was used to measure a range of meteorological parameters including air temperature and precipitation, as well as capturing wind speed and direction using its ultrasonic wind sensor. Details of the weather station used in the background survey are shown in Table 4 below, with the factory acceptance test (FAT) certificate relating to the weather station included in Appendix B.

**Table 4: WS600 Weather Station Records**

| Equipment | Model / Type | Serial Number | Factory Acceptance Test Date |
|---|---|---|---|
| Weather Station | WS600-UMB | 055.1221.0701.234 | 17 August 2022 |

The weather data gathered at NML1 is also representative of weather conditions at NML2, due to their proximity; they are located at a distance of approximately 2.5 km from one another.

## 3.3 Noise Monitoring Survey Methodology

The microphone was placed at a height of 1.2 - 1.5m above ground level. The sound level meter was accurately calibrated before and after use with no drift observed. Noise measurements were undertaken in 15-minute measurement durations.

A number of different parameters were recorded during the survey periods.

**$L_{Aeq}$** The continuous equivalent A-weighted sound pressure level. This is an “average” of the sound pressure level over the measurement duration.

**$L_{Amax}$** This is the maximum A-weighed sound level measured during the measurement duration.

**$L_{Amin}$** This is the minimum A-weighted sound level measured during the measurement duration.

**$L_{A10}$** This is the A-weighted sound level that is exceeded for noise for 10% of the measurement duration.

**$L_{A90}$** This is the A-weighted sound level that is exceeded for 90% of the measurement duration

## 3.4 Noise Monitoring Results

The noise data recorded during the unattended noise monitoring survey at each noise monitoring location was analysed and visualised using RPS in house software. The software is written in Python and uses advanced statistical and visualisation libraries.

The approach to analysing the recorded noise data involved compiling all observations into a single dataset for the noise monitoring location using their respective time stamps before reading into the software.

The main steps the software takes are described below:

- Total precipitation and average wind speed are used to remove instances of noise data where total precipitation or the average wind speed exceeded 0mm and 5m/s respectively;
- Before any further analysis, all monitoring data is visualised, and any dubious records are highlighted and removed;
- Data was divided into 2 sets; daytime (07:00 – 23:00hrs) and night-time (23:00- 07:00hrs)
- For daytime and night-time periods, the noise monitoring parameter distribution histograms were plotted for $L_{Aeq}$ and $L_{A90}$.

The time history results, including the noise and weather data, of the unattended noise monitoring at NML1 and NML2 are shown in Figure 8 - Figure 10.

**Figure 8:Noise Monitoring Location 1 Complete Noise Data (06/12/2022 – 12/12/2022)**

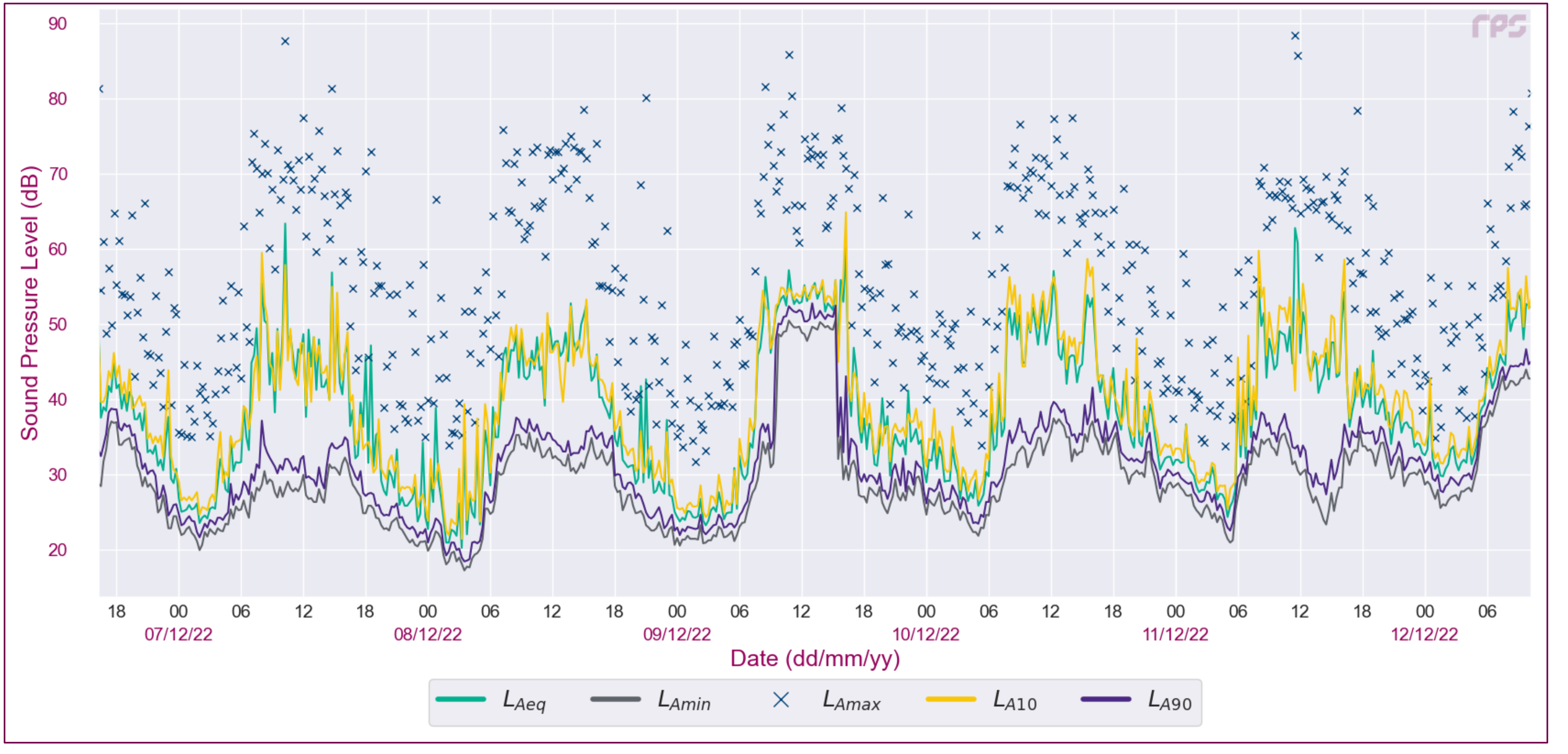


**Figure 9: Noise Monitoring Location 1 Noise and Weather Data (06/12/2022 – 12/12/2022)**

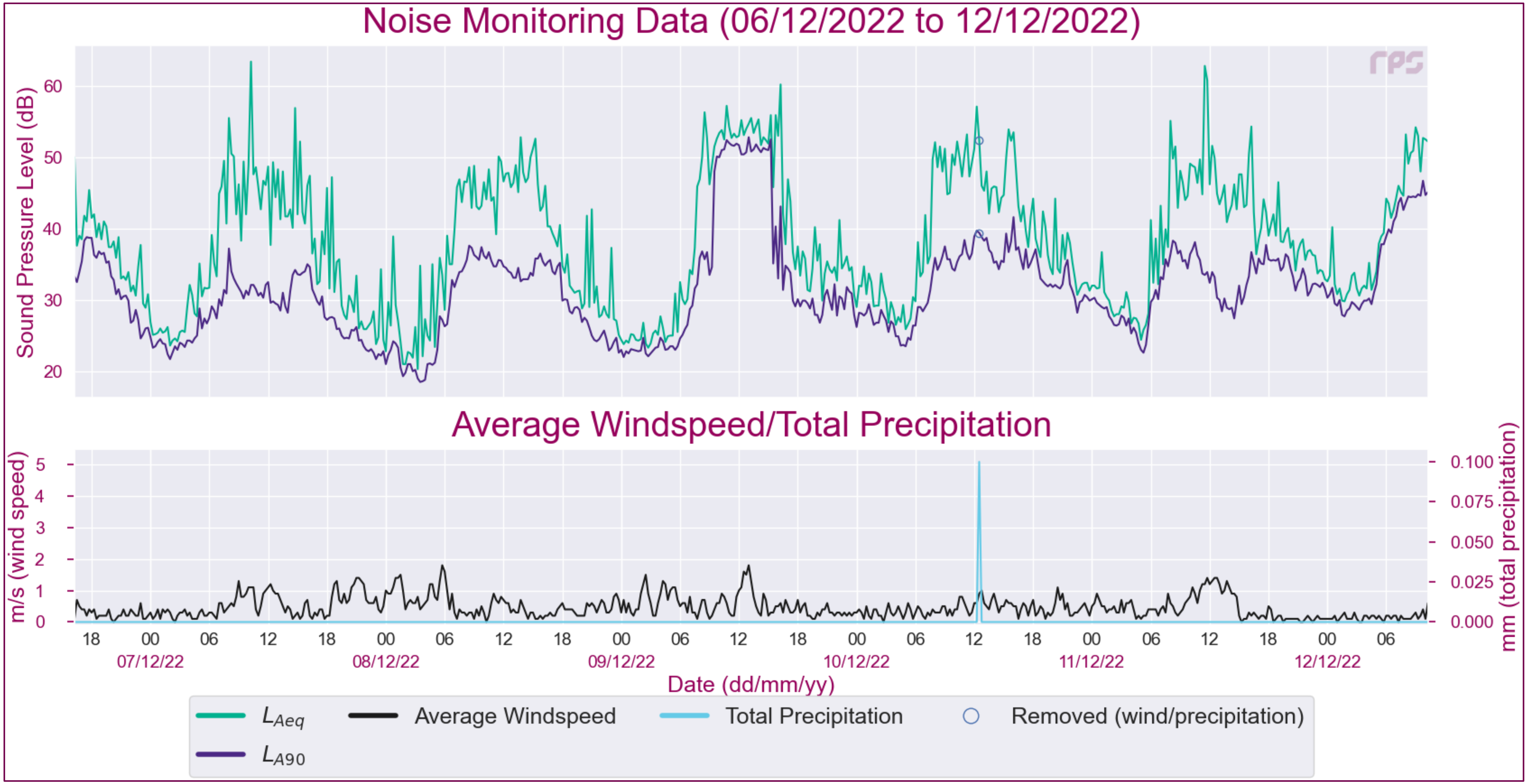


**Figure 10: Noise Monitoring Location 2 Complete Noise Data (06/12/2022 – 12/12/2022)**

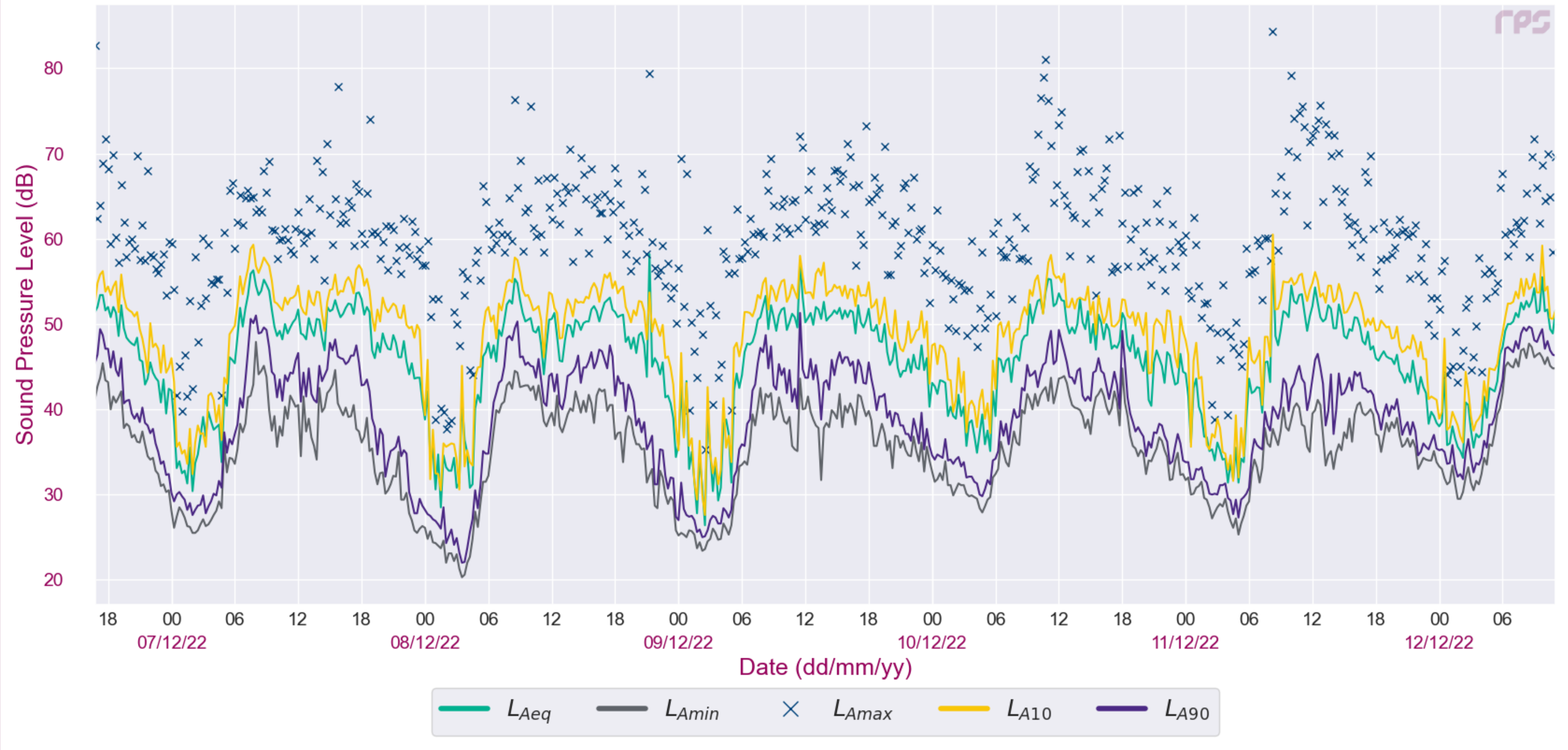
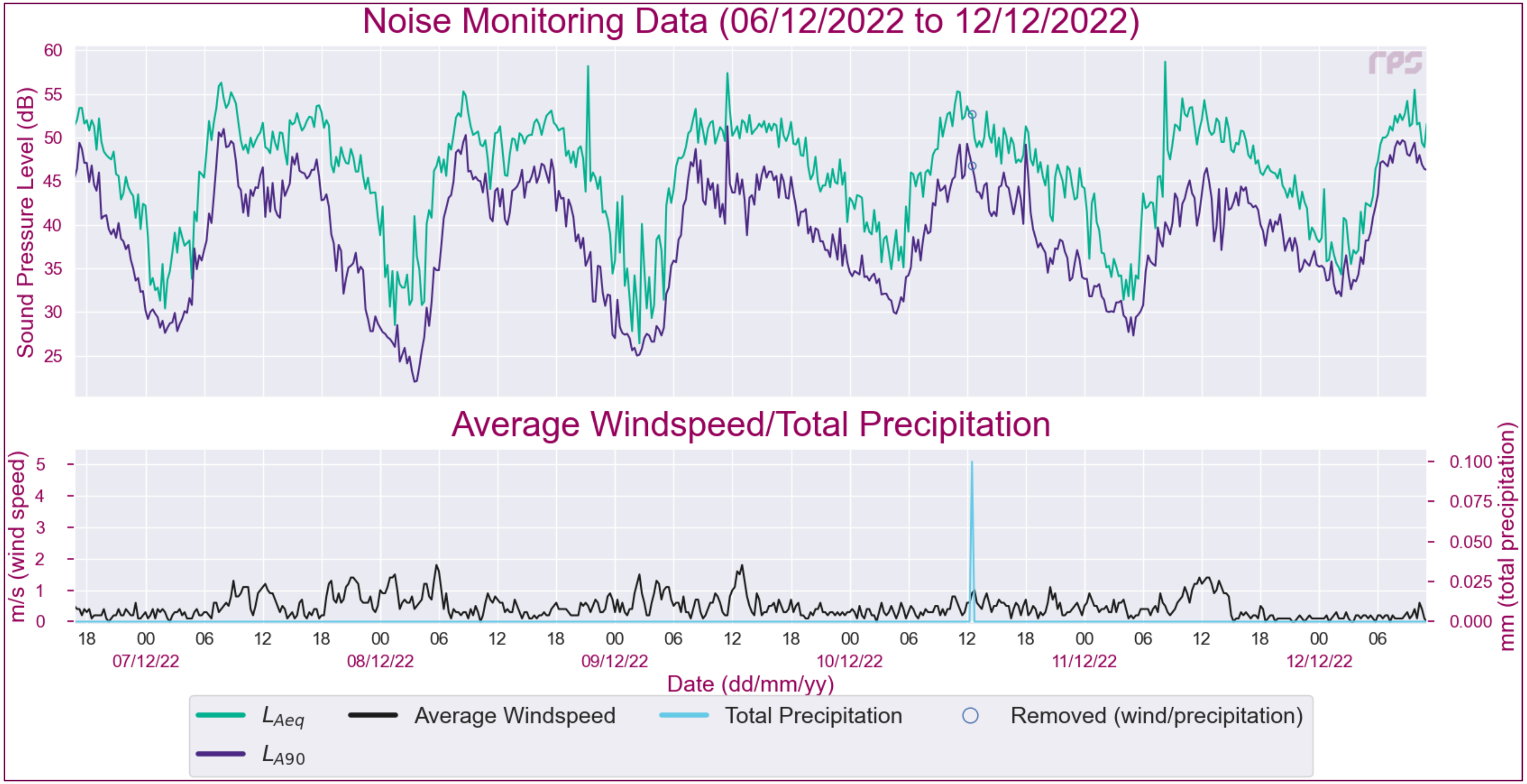


**Figure 11: Noise Monitoring Location 2 Noise and Weather Data (06/12/2022 – 12/12/2022)**



Noise monitoring results from each noise monitoring location were statistically analysed to determine the appropriate 'typical' background sound levels from both daytime and night-time noise monitoring periods.

Figure 12 - Figure 15 below show the frequency distribution histograms for the daytime and night-time $L_{Aeq}$ and $L_{A90}$ at both noise monitoring locations.

**Figure 12: Frequency Daytime $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at Noise Monitoring Location 1 (06/12/2022 – 12/12/2022)**

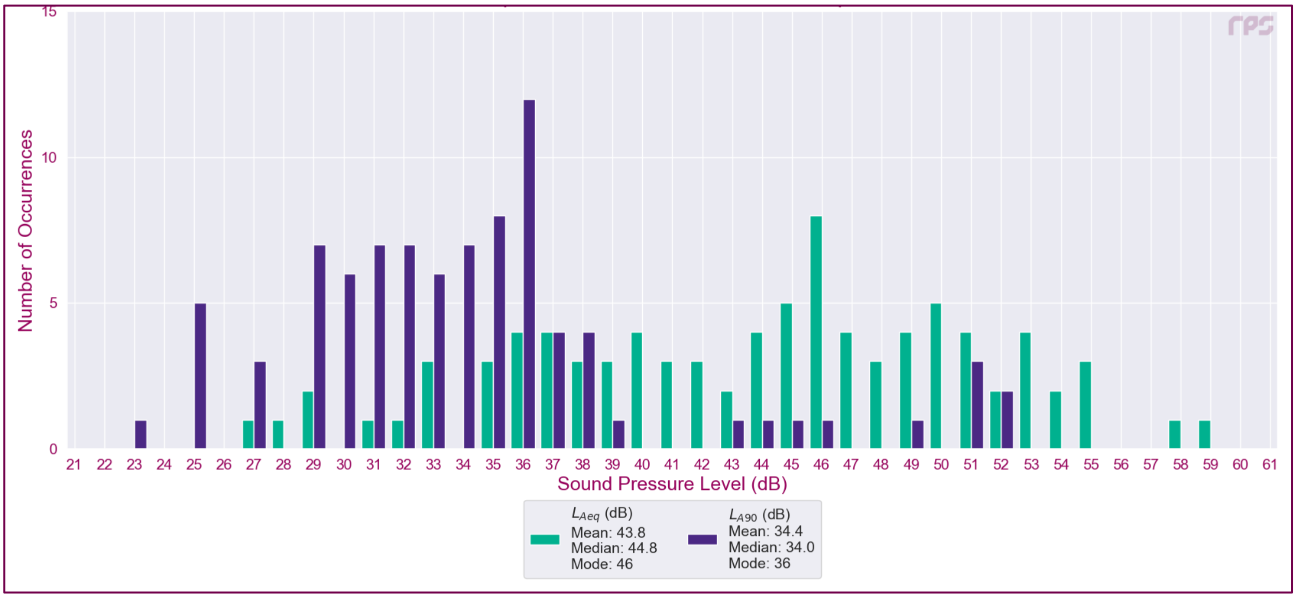



**Figure 13: Frequency Night time $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at Noise Monitoring Location 1 (06/12/2022 – 12/12/2022)**

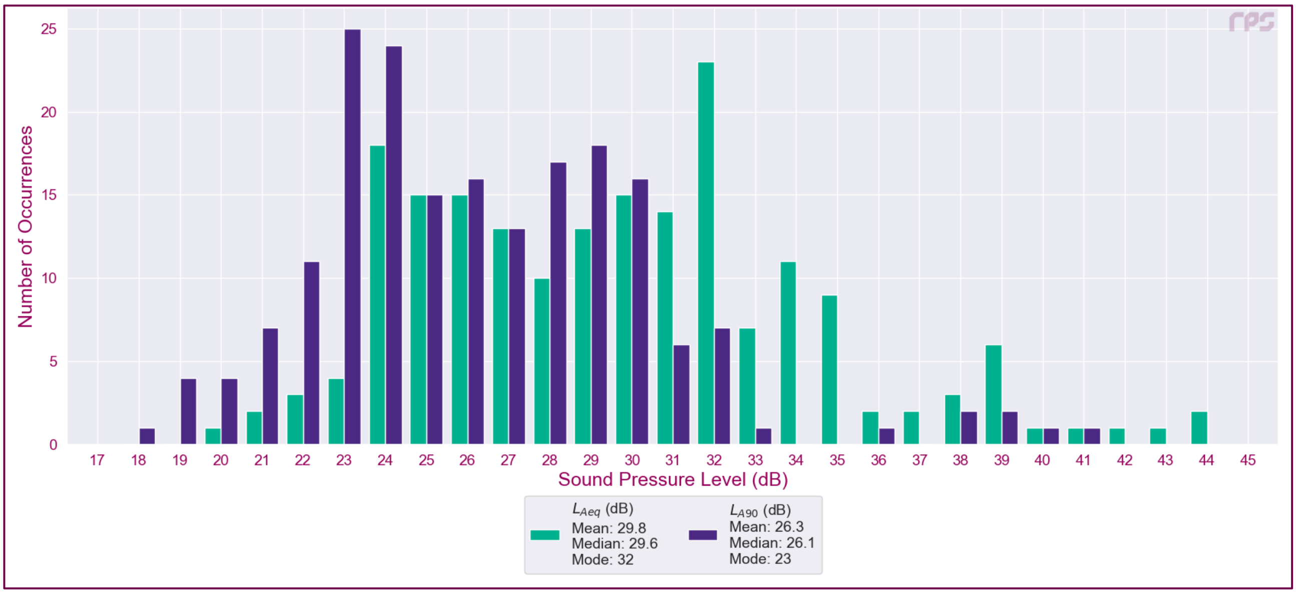


**Figure 14: Frequency Daytime $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at Noise Monitoring Location 2 (06/12/2022 – 12/12/2022)**

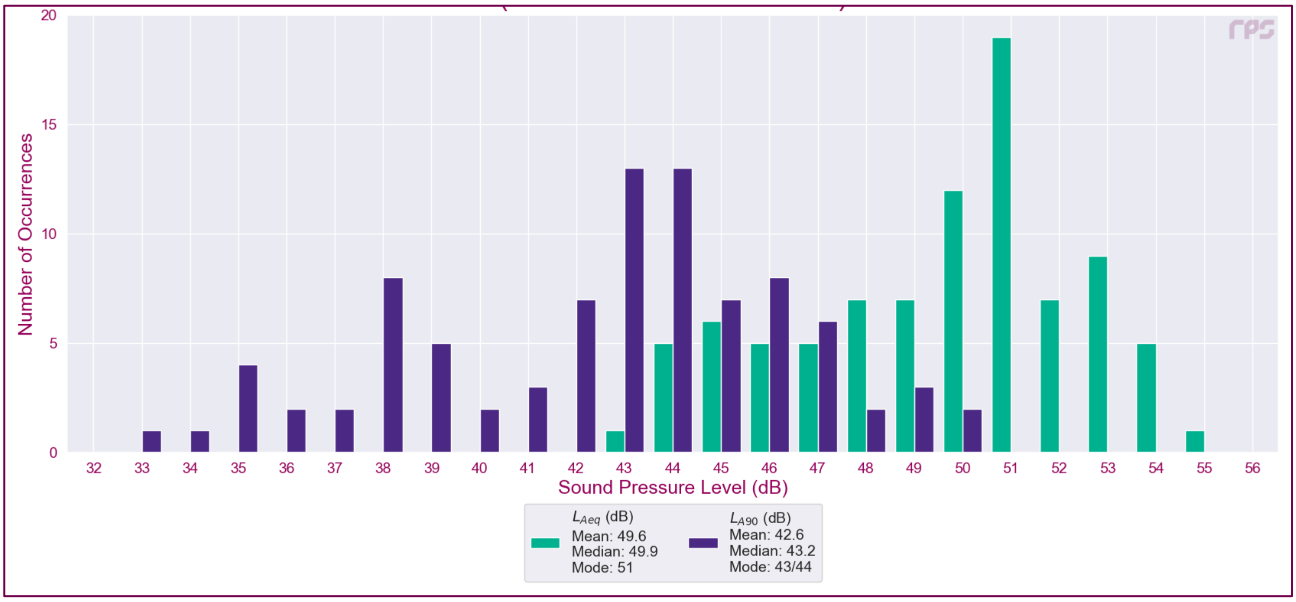
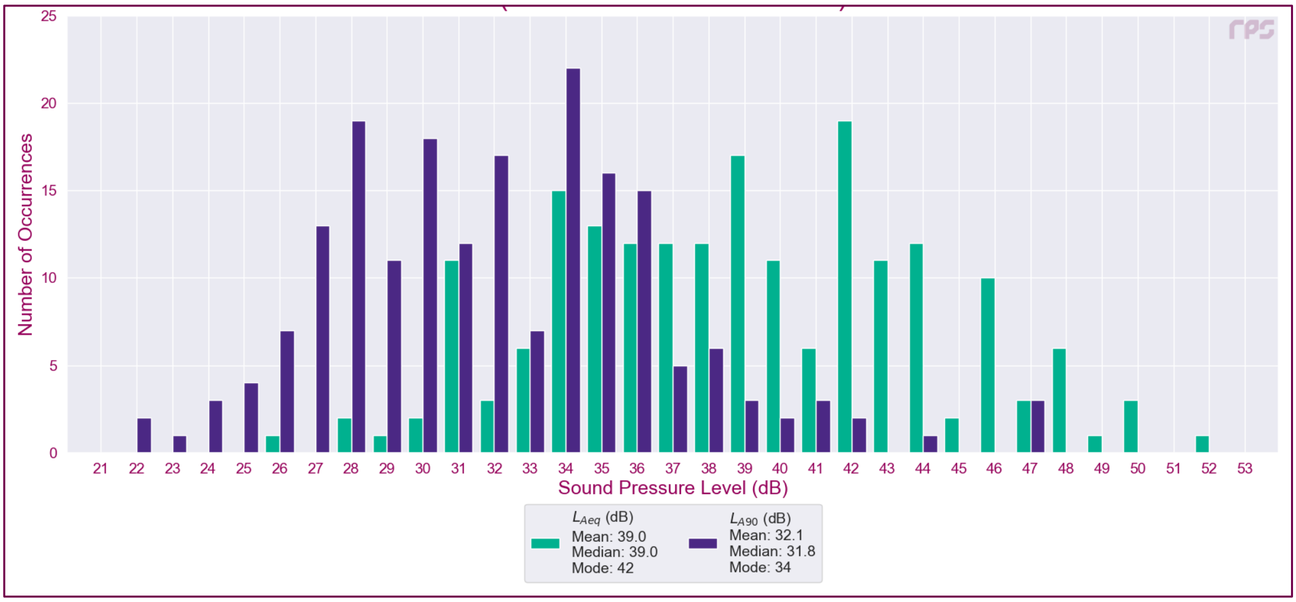



**Figure 15: Frequency Night time $L_{Aeq,\ 1hr}$ and $L_{A90\ 1hr}$ at Noise Monitoring Location 2 (06/12/2022 – 12/12/2022)**




The typical background noise levels in accordance with BS 4142 for the daytime and night-time periods are summarised below in Table 5.

**Table 5: Typical $L_{A90}$ and $L_{Aeq}$ Noise Levels at Noise Monitoring Location 1 (06/12/2022 – 12/12/2022)**

| Noise Monitoring Location | $L_{A90}$ Analysis | | $L_{Aeq}$ Analysis | |
|---|---|---|---|---|
| | Daytime (dB) | Night-time (dB) | Daytime (dB) | Night-time (dB) |
| 1 | 36 | 23 | 46 | 32 |
| 2 | 43/44 | 34 | 51 | 42 |

# 4 OPERATIONAL NOISE MODELLING

## 4.1 Noise Modelling Methodology

CadnaA (Computer Aided Noise Abatement) is a leading proprietary software for environmental noise propagation calculation, presentation and assessment. The CadnaA noise modelling software package was set up to use ISO9613 "Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation" prediction methodology along with a range of topographical and ordnance data collected on the surrounding area to build up a picture of the noise environment in the vicinity of one of noise sources.

The software was used to build a 3-dimensional model of all features which may affect the generation and propagation of noise in the vicinity of the proposed development and to predict the specific sound levels due to the proposed development at nearby residential properties (receptors).

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. 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.

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 would be regarded as conservative i.e. greater than those experienced in practice.

## 4.2 Noise Model Inputs

### 4.2.1 Residential Properties

In order to assess the potential operational phase noise impacts a noise model was created using CadnaA noise modelling software. There are a number of residential properties surrounding the proposed solar farm, which have the potential to be affected by noise attributable to the operational solar Farm. The coordinates of the residential properties are detailed in Appendix C.

Receptors were modelled at both 1.5m and 4m heights reflective of daytime and night time to take into account potential predominant downstairs and upstairs occupation.

### 4.2.2 Noise Source Data

A summary of the noise source data used in the acoustic model is shown in Table 6. The assumed source heights have been based on the geometry of the plant equipment as provided in the site layout.

**Table 6: Noise Model Input Sound Power Levels, dB**

| Source | No. | Overall LW | Assumed Source Height |
|---|---|---|---|
| Primary Substation Transformer ($L_WA$) | 2 | 75 | 3 |
| Inverter ($L_WA$) | 26 | 76 | 2 |
| Battery Energy Storage System | 1 | 80 | 2 |

### 4.2.3 Operational Scenarios

For the daytime operational noise model scenario, it has been assumed that all noise sources, i.e primary substation transformers, inverters and battery energy storage system, are operational with a 100 % 'on time'.

The night-time operational noise model includes the noise sources associated with the primary substation and battery energy storage system. The inverters will only operate when electricity is being generated (during daylight hours) and it is understood that the primary noise source associated with the inverters, i.e. the cooling fans will operate as required, typically in warmer weather – e.g. towards midday and afternoon. As such, the inverter units have not been in included in the night-time operational noise model.

## 4.3 Noise Modelling Results

The results of the daytime and night-time noise modelling at all receptor locations are presented in Table 17 contained within Appendix D with the highest 10 predicted baseline daytime and night-time sound pressure levels shown in Table 7 and The maximum predicted noise level from the proposed development daytime (substation and inverters fully operational) is 29.9 dB at residential receptor 60.

Table 8.

All daytime noise modelling results assume a receptor height of 1.5 m above ground level. The predicted night-time sound pressure levels assume a receptor height of 4 m above ground level.

**Table 7: Highest 10 Predicted Daytime Sound Pressure Levels**

| Receptor Location | Predicted Daytime Sound Pressure Level 1.5 m Receptor Height, dB $L_{Aeq, T}$ |
|---|---|
| 14 | 29.9 |
| 15 | 26.6 |
| 17 | 26.4 |
| 19 | 26.1 |
| 20 | 25.9 |
| 23 | 25.6 |
| 24 | 25.5 |
| 26 | 25 |
| 29 | 24.5 |
| 60 | 24 |

The maximum predicted noise level from the proposed development daytime (substation and inverters fully operational) is 29.9 dB at residential receptor 60.

**Table 8: Highest 10 Predicted Night-Time Sound Pressure Levels**

| Receptor Location | Predicted Night-Time Sound Pressure Level 4 m Receptor Height, dB $L_{Aeq, T}$ |
|---|---|
| 14 | 30.3 |
| 15 | 25.5 |
| 17 | 25.4 |
| 19 | 25.2 |
| 20 | 24.9 |
| 23 | 24.6 |
| 26 | 24.6 |
| 24 | 24.5 |
| 29 | 24.1 |
| 33 | 22.4 |

The maximum predicted noise level from the proposed development night time is 30.3 dB at modelled sensitive receptor 14.

Daytime and night-time noise contours for operational noise due to the proposed development are shown in Figure 16 and Figure 17 below. The daytime contour has been calculated with a receptor height of 1.5 m above ground level. The night-time contour has been calculated with a receptor height of 4 m above ground level.

**Figure 16: Daytime Operational Noise Contours, 1.5 m Receptor Height**

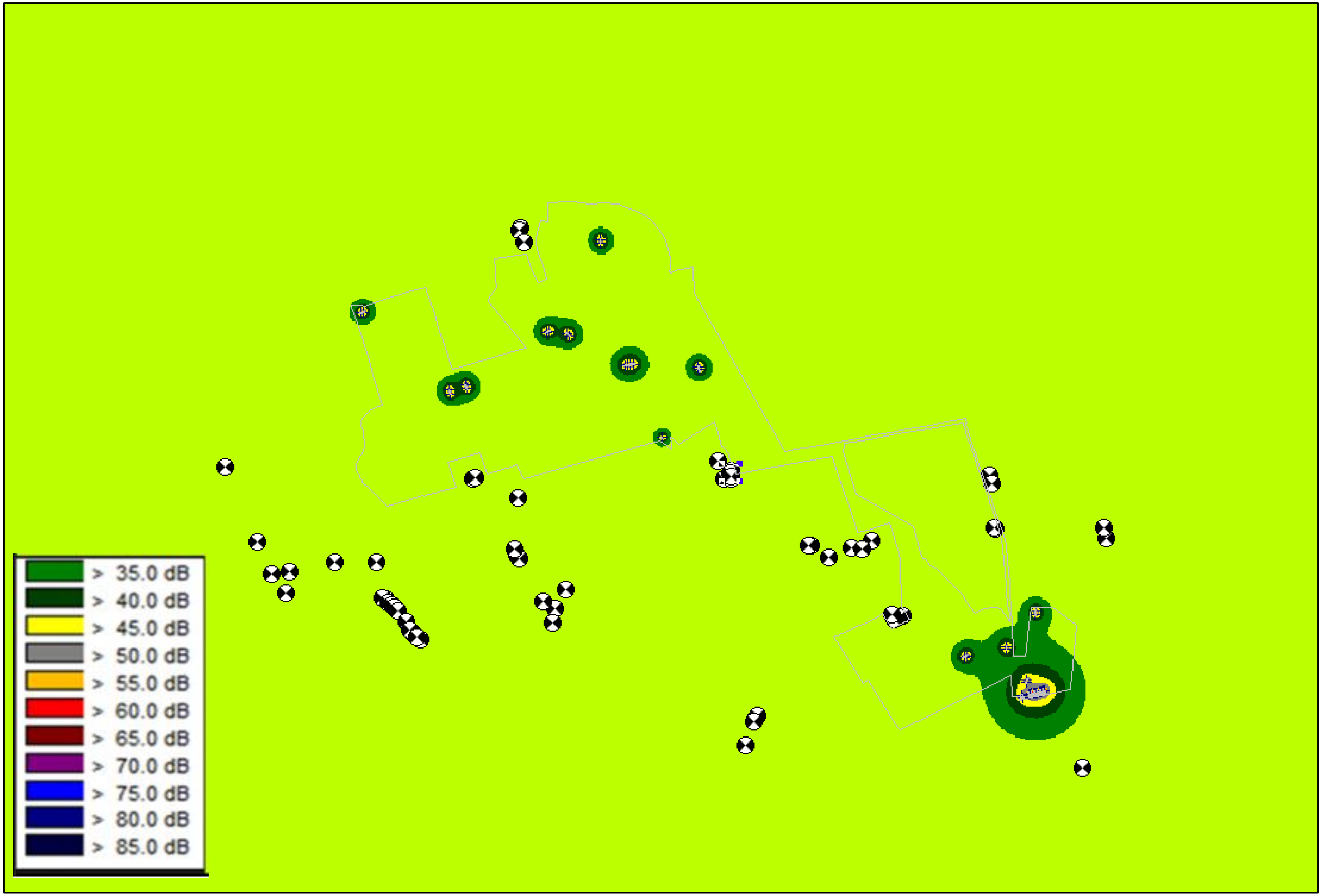
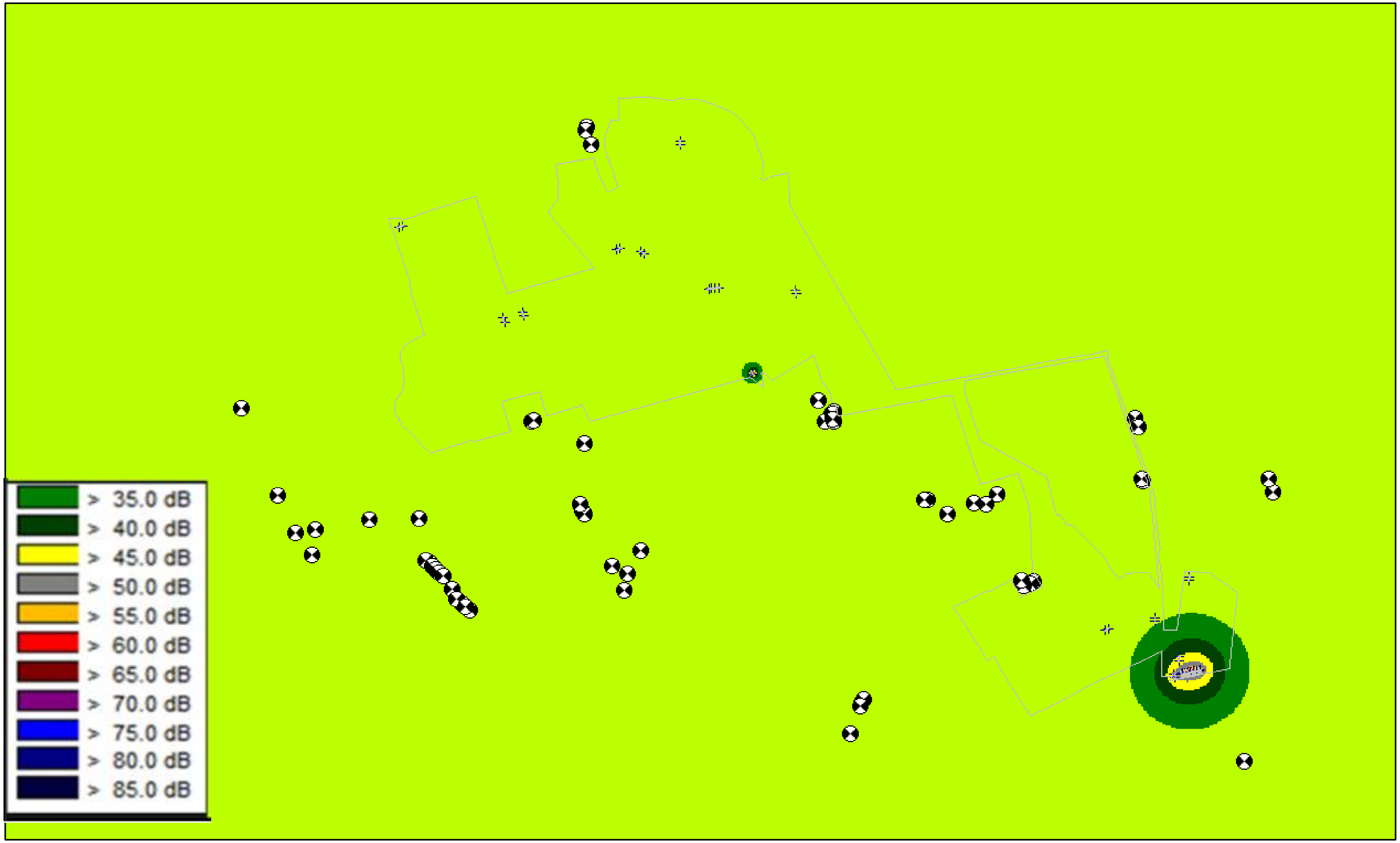


**Figure 17: Night-Time Operational Noise Contours, 4 m Receptor Height**



# 5 NOISE IMPACT ASSESSMENT

A noise impact assessment has been undertaken for the proposed Solar and Battery Energy Storage system which includes:

- A quantitative assessment made against the fixed noise guideline levels defined in BS 8233:2014 for sensitive receptors;
- A quantitative assessment made against the fixed noise guideline levels defined in WHO for sensitive receptors and
- A qualitative assessment undertaken in accordance with BS 4142:2014 for sensitive receptors only, taking into consideration the context of the development and the outcome of the quantitative assessment.

## 5.1 Assessment of Predicted Levels (BS8233:2014 and WHO)

An assessment of the predicted sound pressure levels at noise sensitive receptors has been carried out. The highest predicted daytime and night-time $L_{Aeq}$ at any receptor location has been assessed against the BS8233 and WHO guideline criteria for internal and external spaces.

Predicted sound pressure levels at all other receptors are lower than the maximum levels which have been assessed below, therefore any noise impact at other receptors will be equal to or lower than the outcome of the following assessment.

### 5.1.1 Ambient Sound Pressure Levels

A summary of the existing ambient $L_{Aeq}$ sound pressure levels at both noise monitoring locations is shown in Table 9, along with the maximum predicted sound pressure levels from the noise propagation modelling. These values are shown for both the daytime and night-time periods.

**Table 9: Summary of Ambient and Predicted Sound Pressure Levels**

| Time Period | Typical Ambient $L_{Aeq}$ NML1, dB | Typical Ambient $L_{Aeq}$ NML2, dB | Highest Predicted $L_{Aeq}$ , dB |
|---|---|---|---|
| Daytime | 46 | 51 | 29.9 (Receptor 14) |
| Night time | 32 | 42 | 30.3 (Receptor 14) |

When compared with the typical existing ambient $L_{Aeq}$ measured in the baseline noise monitoring survey, the highest predicted $L_{Aeq}$ daytime sound pressure level is >16 dB lower than the existing typical daytime $L_{Aeq}$ of 46 dB at NML1. The highest predicted night-time sound pressure level is >10 dB lower than the existing night-time $L_{Aeq}$ of 32 dB at NML1. The predicted noise levels are less than the existing ambient background noise levels, therefore the operation of the proposed development will not increase the ambient background levels.

This indicates that operational solar farm is unlikely to increase daytime or night-time ambient levels at the noise sensitive receptors.

### 5.1.2 Internal Assessment

The noise propagation software has predicted external sound pressure levels at the noise sensitive receptors. The equivalent internal sound pressure levels have been estimated assuming that an open window provides a sound reduction (Rw) of 10 -15 dB. This assumption is in accordance with British Standard 8233:2014 Guidance on Sound Insulation and Noise Reduction for Buildings. Section G1 of the guidance replicated below, *“Where windows are open for ventilation, then sound reduction is limited to 15dB. The internal criteria given may therefore be corrected by this factor, to derive external limit values for open windows*.” A closed double-glazed closed window may provide a Rw of 30 -33 dB.

The assessment against fixed noise levels is made against the most stringent of the guideline levels presented in BS8233:2014 .To determine a set of BS 8233 limits, 10- 15 dB has been added to the BS 8233 internal levels to allow for the attenuation that is provided by a partially open window, as detailed in Table 10.

**Table 10: BS 8233 and WHO Daytime and Night time Noise Limits**

| Time Period | BS 8233 and WHO Guideline dB, $L_{Aeq}$ | Open Window dB | External Criteria Level dB $L_{Aeq}$ |
|---|---|---|---|
| Daytime | 35 | 10 – 15 | 45 - 50 |
| Night time | 30 | 10 – 15 | 40 -45 |

**Table 11: BS 8233 and WHO Daytime and Night time Noise Assessment**

| Time Period | External Criteria Level dB, $L_{Aeq}$ | Highest Predicted Sound Pressure Level |
|---|---|---|
| Daytime | 45 - 50 | 30.6 |
| Night time | 40 -45 | 31.2 |

The highest predicted daytime sound pressure levels at a noise sensitive receptor is 29.9 dB $L_{Aeq}$. This is below the external criteria level, indicating that the proposed development will have no noise impact on internal daytime rest and amenity or on night-time sleep.

### 5.1.3 External Assessment

The maximum predicted noise level from the proposed development is 30.3 dB (receptor 14). This is more than 20 dB less than WHO daytime external noise level of 50 – 55 dB, indicating that the proposed development will have no significant noise impact on external amenity areas for noise-sensitive receptors.

## 5.2 BS4142:2014 Assessment

The highest predicted sound pressure levels due to the proposed development have been assessed in line with BS4142:2014, for both the daytime and night-time periods.

### 5.2.1 Specific Sound Level

Specific sound level is the sound pressure level due to an industrial or commercial source at a noise sensitive receptor. It is required to carry out a BS4142 assessment and can be either measured or predicted. The specific sound level of the proposed development has been predicted based on the available acoustic data, as detailed in Section 4 of this report. The maximum predicted sound pressure level at any noise sensitive receptor has been assessed for both the daytime and night-time periods.

- The maximum daytime predicted sound pressure level was 30.6 dB $L_{Aeq,T}$ as predicted at receptor 60, and
- The maximum night-time predicted sound pressure level was 31.2 dB $L_{Aeq,T}$ as predicted at receptor 14.

Predicted sound pressure levels at all other receptors are lower than the maximum levels which have been assessed below, therefore any noise impact at other receptors will be equal to or lower than the outcome of the following assessment.

### 5.2.2 Rating Level

BS4142 rating level comprises the predicted or measured specific sound level and noise character corrections, if required, due to tonality, impulsivity, intermittency or other sound characteristics within the specific sound source.

#### 5.2.2.1 Tonality

With regards to tonality, BS4142:2014 states: "*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 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*."

There is potential for tonality associated with the proposed noise sources. Transformers can have tones at 100 Hz and 200 Hz, whilst cooling fans have the possibility of tonal elements at higher frequencies. In order to provide a robust impact assessment, the tonal penalty of +4 dB has been applied.

#### 5.2.2.2 Impulsivity

With regards to impulsivity, BS4142:2014 states: "*A correction of up to +9dB 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 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible*."

Impulsivity is not considered to be a relevant sound characteristic of the proposed development noise sources.

#### 5.2.2.3 Intermittency

The intermittency of the sound source needs to be considered when it has identifiable on/off conditions with regards to intermittency, BS4142:2014 states: "*If the intermittency is readily distinctive against the residual acoustic environment, a penalty of 3 dB can be applied*."

The proposed noise sources, in particular the inverters, are expected to switch on and off automatically as required. However, the predicted levels due to the plant and equipment associated with the proposed development are more than 10 dB below the existing background and therefore any intermittency would not be 'readily distinctive' against the residual acoustic environment. As such, intermittency is not considered to be a relevant sound characteristic in relation to the operation of the proposed development and no penalty has been applied.

#### 5.2.2.4 Overall Rating Level

No additional acoustic characteristics have been identified as relevant for the proposed noise sources. Therefore, the overall rating level of +4 dB has been applied, which accounts for potential tonality, as discussed in Section 5.2.2.1 above.

### 5.2.3 Background Sound Level

The daytime $L_{A90,\ 1hr}$ and night-time $L_{A90,\ 15min}$ background levels measured in the noise monitoring survey at each noise monitoring location have been used here to represent the closest noise sensitive receptors. A summary of the background sound levels used for the daytime and night-time BS4142 assessments is shown in Table 12.

**Table 12: BS4142 Assessment Background Sound Level Summary**

| Noise Monitoring Location | Background Sound Level, $L_{A90}$ | |
|---|---|---|
| | Daytime (dB) | Night-time (dB) |
| 1 | 36 | 23 |
| 2 | 43/44 | 34 |

A review of all noise sensitive receptor locations with respect to the background noise monitoring locations was undertaken to establish the appropriate representative background noise level for each NML. This was based on the proximity of the properties to each noise monitoring location as well as their location relative nearby noise sources, primarily local roads. The relevant noise monitoring location selected to represent each noise sensitive receptor is shown in Appendix C.

### 5.2.4 Calculation of Rating Level

No character corrections have been applied, therefore the rating level is the same as the predicted noise levels i.e. specific noise levels.

### 5.2.5 Daytime BS4142 Assessment

The results of the BS4142 assessment of daytime noise due to operation of the proposed solar farm are summarised in Table 13. The relevant receptors to each of the noise monitoring locations were identified. The highest predicted daytime sound pressure level within each group of receptors was assessed against the appropriate background sound level.

**Table 13: Daytime BS4142 Assessment**

| Receptor Location | NML1 | NML2 |
|---|---|---|
| Representative Background Sound Level (Daytime) $L_{90,\ 1hr}$, dB | 36 | 43 |
| Specific Sound Level, $L_{Aeq,\ T}$ dB | 23.6 (ID 11) | 29.9 (ID14) |
| Acoustic Feature Correction, dB | +4 | +4 |
| Rating Level, dB | 27.6 | 34.9 |
| Excess Over Background, dB | -8.4 | -8.1 |
| Likely Impact | No Noise Impact | No Noise Impact |

### 5.2.6 Night-Time BS4142 Assessment

The results of the BS4142 assessment of night-time noise due to operation of the proposed solar farm are summarised in Table 14. The relevant receptors to each of the noise monitoring locations were identified. The highest predicted daytime sound pressure level within each group of receptors was assessed against the appropriate background sound level.

**Table 14: Night-Time BS4142 Assessment**

| Receptor Location | NML1 | NML2 |
|---|---|---|
| Representative Background Sound Level (Daytime) $L_{90,\ 1hr}$, dB | 23 | 34 |
| Specific Sound Level, $L_{Aeq,\ T}$ dB | 22<br>(ID 11 and 12) | 30.3<br>(ID 14) |
| Acoustic Feature Correction, dB | +4 | +4 |
| Rating Level, dB | 26 | 34.3 |
| Excess Over Background, dB | +3 | +0.3 |
| Likely Impact | No Noise Impact | No Noise Impact |

BS 4142 daytime and night time assessments have been undertaken as detailed above. BS 4142 states difference of +10 dB or more would be 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.

The submitted noise assessment includes:

- All modelled noise sources operating continuously, simultaneously and at maximum noise output;
- Considers the candidate plant and associated noise levels as provided by the applicant and does not consider any noise control measures that may be put in place which could reduce noise levels further;
- Operational noise levels from the proposed development will be consistent and expected to operate with little variation in output;
- Noise predictions are less that than the existing residual sound level.

## 5.3 Cumulative Assessment

A planning search identified planning applications for renewable development within 5km of the proposed Houston Solar Farm & BESS as summarised below in Table 15.

**Table 15: Renewable Development Applications within 5km of Proposed Development**

| Application Nr. | Application Address | Development | Status | Approx. Distance from Proposed Development |
|---|---|---|---|---|
| 22/0582/PP | Site Between Nether Southbar And East Fulwood Greenock Road Inchinnan | Erection of solar park and associated infrastructure including substations, boundary fencing and access tracks | Approved 24th Jan 2023 | Approximately 2.8km to Site Boundary at the northeast of the proposed Development Site |
| 21/1594/PN | Site 200 Metres West Of Whitehouse Of Milliken Bridge Of Weir Road Brookfield Johnstone | Erection of Battery Storage Facility up to 50MW including compound of energy storage equipment, meter building, security cameras, and fencing | Proposal of Application Notice Acceptable – 25th Nov 2021 | Approximately 2.8km to Site Boundary at the southwest of the proposed Development Site |
| 22/0746/PP | Site 150 Metres East Of Walkinshaw Gardens Barnsford Road & Caledonia Way Glasgow Airport Paisley | Proposed solar array development incorporating installation of ground-mounted, rooftop and carport solar panels (with a generating capacity of up to 19.9 megawatts (MW)) and associated access, plant and machinery, car port structures, infrastructure and planting. | Approved 6th April 2023 | Approximately 3.7km to Site Boundary at the southeast of the proposed Development Site |

Application Number 21/1594/PN Proposal of Application Notice Acceptable has not progressed planning submission and therefore not considered further in the cumulative assessment.

Application Number 22/0582/PP and 22/0746/PP are both considered at a distance that would warrant any further consideration in relation to noise due to distance separation.

# 6 CONCLUSION

RPS has been commissioned by Elgin Energy EsCo Ltd to undertake a noise impact assessment for the operation of the proposed Solar Farm and Battery Energy Storage System (BESS) at Houston Farms, Houston, Renfrewshire.

Unattended background noise monitoring was undertaken at two locations representative of noise-sensitive receptors in the vicinity of the site. Unattended noise monitoring equipment was deployed at two noise monitoring locations (NMLs) on agricultural land on Turningshaw Road (NML1) and approximately 325 m south of Houston Road.

The results of the unattended noise monitoring survey were processed, first removing any periods of precipitation or high wind speeds. At each noise monitoring location, the daytime and night-time datasets were analysed to establish a typical background $L_{A90}$ and a typical ambient $L_{Aeq}$ sound pressure level to inform the noise impact assessment. Each noise sensitive receptor was assigned one of the two noise monitoring locations as representative of the existing sound environment at that receptor, based on location and contributing noise sources at both the receptor location and the noise monitoring location.

Operational noise levels at the closest noise sensitive receptors were predicted using CadnaA noise prediction software which implemented the ISO9613 methodology for sound propagation. Typical sound power levels for the plant and equipment associated with the proposed development were input into the model along with the location of the closest receptors and topography and ground conditions in the vicinity of noise sources and receptors.

Assessment of absolute noise levels was carried out in line with BS8233:2014 and WHO guidance. The predicted noise from the proposed development was not found to have an impact on daytime amenity or quality of sleep at the closest noise-sensitive receptors.

An assessment of operational noise was carried out as per BS4142:2104; predicted sound pressure level at each noise sensitive receptor was compared with the measured background $L_{A90}$ sound pressure level at the relevant noise monitoring location. The results of the BS4142 showed that no noise impact is expected due to the operation of the proposed development.

# Appendix A
## Calibration Certificates

**Figure A1: Calibration Certificate of Rion NL-52 SLM at NML1**

ANV Measurement Systems

# CERTIFICATE OF CALIBRATION

ilac-MRA | UKAS CALIBRATION 0653

**Date of Issue: 14 July 2022**

**Certificate Number: UCRT22/1887**

Calibrated at & Certificate issued by:
ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages

Approved Signatory

B. Bogdan

| | |
|---|---|
| Customer | ANV Measurement Systems<br>Beaufort Court<br>17 Roebuck Way<br>Milton Keynes<br>MK5 8HL |
| Order No. | ANV MS HIRE |
| Description | Sound Level Meter / Pre-amp / Microphone / Associated Calibrator |

Identification

| *Manufacturer* | *Instrument* | *Type* | *Serial No. / Version* |
|---|---|---|---|
| Rion | Sound Level Meter | NL-52 | 01087404 |
| Rion | Firmware | | 2.1 |
| Rion | Pre Amplifier | NH-25 | 87610 |
| Rion | Microphone | UC-59 | 14333 |
| Rion | Calibrator | NC-74 | 34536109 |
| | Calibrator adaptor type if applicable | | NC-74-002 |

Performance Class 1

Test Procedure TP 10. SLM 61672-3:2013

*Procedures from IEC 61672-3:2013 were used to perform the periodic tests.*

Type Approved to IEC 61672-1:2013 Yes

*If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2013*

Date Received 13 July 2022 ANV Job No. UKAS22/07459

Date Calibrated 14 July 2022

The sound level meter submitted for testing has successfully completed the periodic tests of IEC 61672-3:2013, for the environmental conditions under which the tests were performed. As evidence was publicly available, from an independent testing organisation responsible for approving the results of pattern-evaluation tests performed in accordance with IEC 61672-2:2013, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013, the sound level meter submitted for testing conforms to the class 1 specifications of IEC 61672-1:2013.

| Previous Certificate | *Dated* | *Certificate No.* | *Laboratory* |
|---|---|---|---|
| | 30 March 2022 | UCRT22/1473 | 0653 |

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

**Figure A2: FAT Certificate of Smart Weather Sensor at NML1**

OTT HydroMet

Lufft — an OTT HydroMet brand —

OTT HydroMet Fellbach GmbH  Gutenbergstraße 20  70736 Fellbach  Deutschland  +49 711 518220  met-info@otthydromet.com  www.otthydromet.com

# FAT Certificate & Protocol – Smart Weather Sensor

| | |
|---|---|
| Model type | **WS600-UMB** |
| Serial number | **055.1221.0701.234** |

This is to certify, that this Lufft branded product has been tested according to the QM of the OTT HydroMet Fellbach GmbH manual in accordance with DIN EN ISO 9001. Ordering specifications are complied with. Execution of instruments / systems as well as testing of accuracy was carried out following OTT HydroMet quality assurance procedures. Quality inspection was successfully passed. This Lufft product has been calibrated according to specifications using references traceable to international standard units administrated by the national metrology institutes like PTB, NIST, NPL or other recognized national standard laboratories.

**Measurements**

| | *Reference value* | *Observed value* | *Error* | *Status* |
|---|---|---|---|---|
| Relative humidity | **15.0 % RH** | **15.0 % RH** | **0.0 % RH** | ✓ |
| Relative humidity | **75.0 % RH** | **75.0 % RH** | **0.0 % RH** | ✓ |
| Temperature | **0.01 °C** | **0.01 °C** | **0.00 °C** | ✓ |
| Air pressure | **997.4 hPa** | **997.4 hPa** | **0.0 hPa** | ✓ |

**Precipitation**

| | *Reference value* | *Observed value* | *Status* |
|---|---|---|---|
| Drop size small | **0.115 mm** | **0.116 mm** | ✓ |
| Drop size medium | **0.670 mm** | **0.671 mm** | ✓ |
| Drop size large | **2.730 mm** | **2.745 mm** | ✓ |

**Wind direction and speed**

Angular deviation (0° … 360° in steps of 22.5°)

| | *2.0 m/s* | *5.0 m/s* | *10.0 m/s* | *20.0 m/s* | *50.0 m/s* | *Status* |
|---|---|---|---|---|---|---|
| RMSE | **0.7°** | **0.6°** | **0.4°** | **0.5°** | **0.9°** | ✓ |

Wind speed

| | *2.0 m/s* | *5.0 m/s* | *10.0 m/s* | *20.0 m/s* | *50.0 m/s* | *Status* |
|---|---|---|---|---|---|---|
| RMS | **2.0 m/s** | **5.0 m/s** | **10.0 m/s** | **20.0 m/s** | **49.9 m/s** | ✓ |



Fellbach, 15.12.2021

EFFECTIVE

17 AUG 2022

CAL DATE

Qualitätssicherung
*Quality control*

i. A. Hartmut Schneider

Bearbeiter
*Person in charge*

i. A. Karola Riedner

**Figure A3: Calibration Certificate of Rion NL-52SLM at NML2**

ANV MEASUREMENT SYSTEMS

# CERTIFICATE OF CALIBRATION

ilac-MRA

UKAS CALIBRATION 0653

**Date of Issue: 16 June 2022**

**Certificate Number: UCRT22/1780**

Calibrated at & Certificate issued by:

ANV Measurement Systems
Beaufort Court
17 Roebuck Way
Milton Keynes MK5 8HL
Telephone 01908 642846 Fax 01908 642814
E-Mail: info@noise-and-vibration.co.uk
Web: www.noise-and-vibration.co.uk
Acoustics Noise and Vibration Ltd trading as ANV Measurement Systems

Page 1 of 2 Pages

Approved Signatory

K. Mistry

| | |
|---|---|
| Customer | ANV Measurement Systems<br>Beaufort Court<br>17 Roebuck Way<br>Milton Keynes<br>MK5 8HL |
| Order No. | ANV MS HIRE |
| Description | Sound Level Meter / Pre-amp / Microphone / Associated Calibrator |

Identification

| *Manufacturer* | *Instrument* | *Type* | *Serial No. / Version* |
|---|---|---|---|
| Rion | Sound Level Meter | NL-52 | 00220558 |
| Rion | Firmware | | 2.0 |
| Rion | Pre Amplifier | NH-25 | 10558 |
| Rion | Microphone | UC-59 | 06710 |
| Rion | Calibrator | NC-74 | 34536109 |
| | Calibrator adaptor type if applicable | | NC-74-002 |

Performance Class 1

Test Procedure TP 2.SLM 61672-3 TPS-49

*Procedures from IEC 61672-3:2006 were used to perform the periodic tests.*

Type Approved to IEC 61672-1:2002 YES Approval Number 21.21 / 13.02

*If YES above there is public evidence that the SLM has successfully completed the applicable pattern evaluation tests of IEC 61672-2:2003*

Date Received 08 June 2022 ANV Job No. UKAS22/06379

Date Calibrated 16 June 2022

The sound level meter submitted for testing has successfully completed the class 1 periodic tests of IEC 61672-3:2006, for the environmental conditions under which the tests were performed. As public evidence was available, from an independent testing organisation responsible for approving the results of pattern evaluation tests performed in accordance with IEC 61672-2:2003, to demonstrate that the model of sound level meter fully conformed to the requirements in IEC 61672-1:2002, the sound level meter submitted for testing conforms to the class 1 requirements of IEC 61672-1:2002.

| Previous Certificate | *Dated* | *Certificate No.* | *Laboratory* |
|---|---|---|---|
| | 30 June 2021 | UCRT21/1818 | 0653 |

# Appendix B
## Noise Monitoring Survey Photographs

**Table B1: Photographs of Rion NL-52 Sound Level Meter at NML 1 from Northern, Southern, Easterly and Westerly Directions (06/12/2022 – 12/12/2022)**

| North | East |
|---|---|
|  |  |
| **South** | **West** |
|  |  |

**Table B2: Photographs of Rion NL-52 Sound Level Meter at NML 2 from Northern, Southern, Easterly and Westerly Directions (06/12/2022 – 12/12/2022)**

| North | East |
|---|---|
|  |  |
| **South** | **West** |
|  |  |

# Appendix C
## Noise Sensitive Receptor Locations

**Figure 18: Noise Sensitive Receptors Map**

**Table 16: Houston Noise Sensitive Receptor Locations**

| Noise Sensitive Receptor ID | Easting | Northing | Representative Noise Monitoring Location |
|---|---|---|---|
| 1 | 242042 | 667122 | NML2 |
| 2 | 242050 | 667124 | NML2 |
| 3 | 242205 | 667053 | NML2 |
| 4 | 242930 | 667185 | NML2 |
| 5 | 242951 | 667120 | NML2 |
| 6 | 242978 | 667122 | NML2 |
| 7 | 242976 | 667129 | NML2 |
| 8 | 242972 | 667144 | NML2 |
| 9 | 242974 | 667144 | NML2 |
| 10 | 242977 | 667150 | NML2 |
| 11 | 242225 | 667978 | NML1 |
| 12 | 242211 | 668022 | NML1 |
| 13 | 242214 | 668032 | NML1 |
| 14 | 241145 | 667162 | NML2 |
| 15 | 241313 | 666775 | NML2 |
| 16 | 241375 | 666785 | NML2 |
| 17 | 241364 | 666708 | NML2 |
| 18 | 241539 | 666817 | NML2 |
| 19 | 241693 | 666819 | NML2 |
| 20 | 241713 | 666691 | NML2 |
| 21 | 241727 | 666683 | NML2 |
| 22 | 241736 | 666673 | NML2 |
| 23 | 241746 | 666664 | NML2 |
| 24 | 241756 | 666653 | NML2 |
| 25 | 241768 | 666641 | NML2 |
| 26 | 241799 | 666604 | NML2 |
| 27 | 241811 | 666571 | NML2 |
| 28 | 241827 | 666559 | NML2 |
| 29 | 241839 | 666547 | NML2 |
| 30 | 241851 | 666538 | NML2 |
| 31 | 242193 | 666866 | NML2 |
| 32 | 242192 | 666866 | NML2 |
| 33 | 242200 | 666846 | NML2 |
| 34 | 242207 | 666832 | NML2 |
| 35 | 242293 | 666675 | NML2 |

| Noise Sensitive Receptor ID | Easting | Northing | Representative Noise Monitoring Location |
|---|---|---|---|
| 36 | 242340 | 666651 | NML2 |
| 37 | 242379 | 666721 | NML2 |
| 38 | 242330 | 666599 | NML2 |
| 39 | 243069 | 666261 | NML1 |
| 40 | 243062 | 666250 | NML2 |
| 41 | 243059 | 666242 | NML1 |
| 42 | 243028 | 666154 | NML1 |
| 43 | 243258 | 666878 | NML2 |
| 44 | 243266 | 666879 | NML2 |
| 45 | 243329 | 666835 | NML2 |
| 46 | 243410 | 666868 | NML2 |
| 47 | 243449 | 666866 | NML2 |
| 48 | 243483 | 666895 | NML2 |
| 49 | 243557 | 666628 | NML1 |
| 50 | 243565 | 666611 | NML1 |
| 51 | 243584 | 666619 | NML1 |
| 52 | 243597 | 666626 | NML1 |
| 53 | 243930 | 666945 | NML2 |
| 54 | 243933 | 666938 | NML2 |
| 55 | 244324 | 666944 | NML1 |
| 56 | 244335 | 666904 | NML1 |
| 57 | 244248 | 666071 | NML1 |
| 58 | 243919 | 667105 | NML2 |
| 59 | 243911 | 667132 | NML2 |
| 60 | 241259 | 666894 | NML2 |

# Appendix D Noise Modelling Results

**Table 17: Noise Propagation Modelling Results**

| Receptor Location | Predicted Daytime Sound Pressure Level, dB $L_{Aeq, T}$ | Predicted Night-Time Sound Pressure Level, dB $L_{Aeq, T}$ |
|---|---|---|
| 1 | 22.7 | 19.4 |
| 2 | 22.6 | 19.5 |
| 3 | 23 | 22 |
| 4 | 19.6 | 13.8 |
| 5 | 19.5 | 13.9 |
| 6 | 20.3 | 19.7 |
| 7 | 18.4 | 14.5 |
| 8 | 19 | 14.9 |
| 9 | 18.4 | 14.2 |
| 10 | 20.3 | 19.7 |
| 11 | 22.2 | 21.1 |
| 12 | 22.6 | 21.6 |
| 13 | 22.8 | 22 |
| 14 | 29.9 | 30.3 |
| 15 | 26.6 | 25.5 |
| 16 | 23.2 | 5.5 |
| 17 | 26.4 | 25.4 |
| 18 | 23.3 | 5.6 |
| 19 | 26.1 | 25.2 |
| 20 | 25.9 | 24.9 |
| 21 | 22.6 | 8.2 |
| 22 | 22.6 | 8.3 |
| 23 | 25.6 | 24.6 |
| 24 | 25.5 | 24.5 |
| 25 | 23.6 | 20.2 |
| 26 | 25 | 24.6 |
| 27 | 21.6 | 12.5 |
| 28 | 22.7 | 19.4 |
| 29 | 24.5 | 24.1 |
| 30 | 22.7 | 19.4 |
| 31 | 22.5 | 19.3 |
| 32 | 22.5 | 19.3 |
| 33 | 23.1 | 22.4 |
| 34 | 22.9 | 21.9 |
| 35 | 21.7 | 20.4 |
| 36 | 19.8 | 13.8 |
| 37 | 19.8 | 13.8 |
| 38 | 21.6 | 20.3 |
| 39 | 19.7 | 19.2 |
| 40 | 18 | 14.4 |
| 41 | 16.7 | 3.4 |
| 42 | 20.2 | 19.6 |
| 43 | 15.8 | 2.1 |
| 44 | 15.6 | 3.1 |
| 45 | 15.6 | 3 |

| Receptor Location | Predicted Daytime Sound Pressure Level, dB $L_{Aeq, T}$ | Predicted Night-Time Sound Pressure Level, dB $L_{Aeq, T}$ |
|---|---|---|
| 46 | 15.6 | 3.1 |
| 47 | 15.5 | 3.2 |
| 48 | 15.5 | 3.2 |
| 49 | 15.4 | 3.2 |
| 50 | 15.1 | -0.4 |
| 51 | 15.2 | 3.3 |
| 52 | 14.9 | 3.2 |
| 53 | 14.9 | 3.2 |
| 54 | 14.5 | 0.8 |
| 55 | 14.1 | 0.3 |
| 56 | 13.9 | 0.5 |
| 57 | 14.5 | 0.2 |
| 58 | 14.9 | 3.3 |
| 59 | 14.9 | 3.2 |
| 60 | 24 | 6.1 |