XLINKS MOROCCO-UK POWER PROJECT

Preliminary Environmental Information Report

Volume 2, Appendix 6.3: Operational Noise Assessment

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Glossary

Term	Meaning
Converter Site	The Converter Site is proposed to be located to the immediate west of the existing Alverdiscott Substation site in north Devon. The Converter Site would contain two converter stations (known as Bipole 1 and Bipole 2) and associated infrastructure, buildings and landscaping.
Converter station	Part of an electrical transmission and distribution system. Converter stations convert electricity from Direct Current (DC) to Alternating Current (AC), or vice versa.
Decibel	A unit used to measure or compare the intensity of a sound by comparing it with a given reference level on a logarithmic scale.
Environmental Impact Assessment	The process of identifying and assessing the significant effects likely to arise from a project. This requires consideration of the likely changes to the environment, where these arise as a consequence of a project, through comparison with the existing and projected future baseline conditions.
National Grid Electricity Transmission	National Grid Electricity Transmission (NGET) owns and maintains the electricity transmission network in England and Wales.
Noise	An unwanted or unexpected sound.
Onshore HVDC Cable Corridor	The proposed corridor within which the onshore High Voltage Direct Current cables would be located.
Preliminary Environmental Information Report	A report that provides preliminary environmental information in accordance with the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. This is information that enables consultees to understand the likely significant environmental effects of a project, and which helps to inform consultation responses.
Propagation	The transmission of acoustic energy through a medium via a sound wave.
Proposed Development	The element of the Xlinks Morocco-UK Power Project within the UK, which includes the offshore cables (from the UK Exclusive Economic Zone to landfall), landfall site, onshore Direct Current and Alternating Current cables, converter stations, road upgrade works and, based on current assumptions, the Alverdiscott Substation Connection Development.
Sound	Fluctuations of pressure within a medium (gas, solid or fluid) within the audible range of loudness and frequencies which excite the sensation of hearing.
Spectrum	The presentation of sound in terms of the amount of energy at different frequencies.
Study area	This is an area which is defined for each environmental topic which includes the Proposed Development Draft Order Limits as well as potential spatial and temporal considerations of the impacts on relevant receptors. The study area for each topic is intended to cover the area within which an impact can be reasonably expected.
The national grid	The network of power transmission lines which connect substations and power stations across Great Britain to points of demand. The network ensures that electricity can be transmitted across the country to meet power demands.
Xlinks Morocco UK Power Project	The overall scheme from Morocco to the national grid, including all onshore and offshore elements of the transmission network and the generation site in Morocco (referred to as the 'Project').

Acronyms

Term	Meaning
AC	Alternating Current
AIS	Air Insulated Switchgear
DC	Direct Current
ISO	International Organisation for Standardisation
NGET	National Grid Electricity Transmission
OS	Ordnance Survey
PEIR	Preliminary Environmental Information Report

Units

Term	Meaning
dB	Decibel
Hz	Hertz
kV	Kilovolt
m	Metre

1 OPERATIONAL NOISE ASSESSMENT

1.1 Introduction

1.1.1 This document forms Volume 2, Appendix 6.3: Operational Noise Assessment, of the Preliminary Environmental Information Report (PEIR) prepared for the UK elements of the Xlinks Morocco-UK Power Project (referred to hereafter as 'the Proposed Development'). The PEIR presents the preliminary findings of the Environmental Impact Assessment (EIA) process for the Proposed Development.

1.1.2 This document provides the assessment criteria, methodology, and assumptions adopted for the 3D acoustic modelling undertaken to identify and assess operational noise impacts due to the operation of the converter stations for the Proposed Development.

1.1.3 The proposed converter stations will convert the electrical current supplied via the Onshore HVDC Cable Corridor from Direct Current (DC) to Alternating Current (AC) which will allow for connection to the national grid. The Converter Site would comprise two converter stations referred to as Bipole 1 and Bipole 2. Full details of the proposed Converter Site are presented in Volume 1, Chapter 3: Project Description, of the PEIR.

1.1.4 Additional works are proposed to the existing Alverdiscott Substation Site to accommodate the connection of the Converter Site to the national grid. Full details of the development parameters required by National Grid Electricity Transmission (NGET) are not yet known and thus the assessment has been undertaken based upon a 400 kV Air Insulated Switchgear (AIS) substation.

1.2 Study Area

1.2.1 The noise and vibration study area focuses on noise and vibration sensitive receptors landward of Mean High Water Springs (MHWS) where potential impacts are more likely to occur. A brief description of each study area is provided below with graphical representations provided in **Figure 1**.

1.2.2 The converter stations are the only operational noise sources which may impact the amenity of nearby receptors.

1.2.3 The noise and vibration study are relevant to this technical report is defined as:

- the area of land temporarily or permanently occupied during the construction, operation and maintenance, and decommissioning of the Proposed Development; and
- noise sensitive receptors located within 500 m of the operational noise sources.

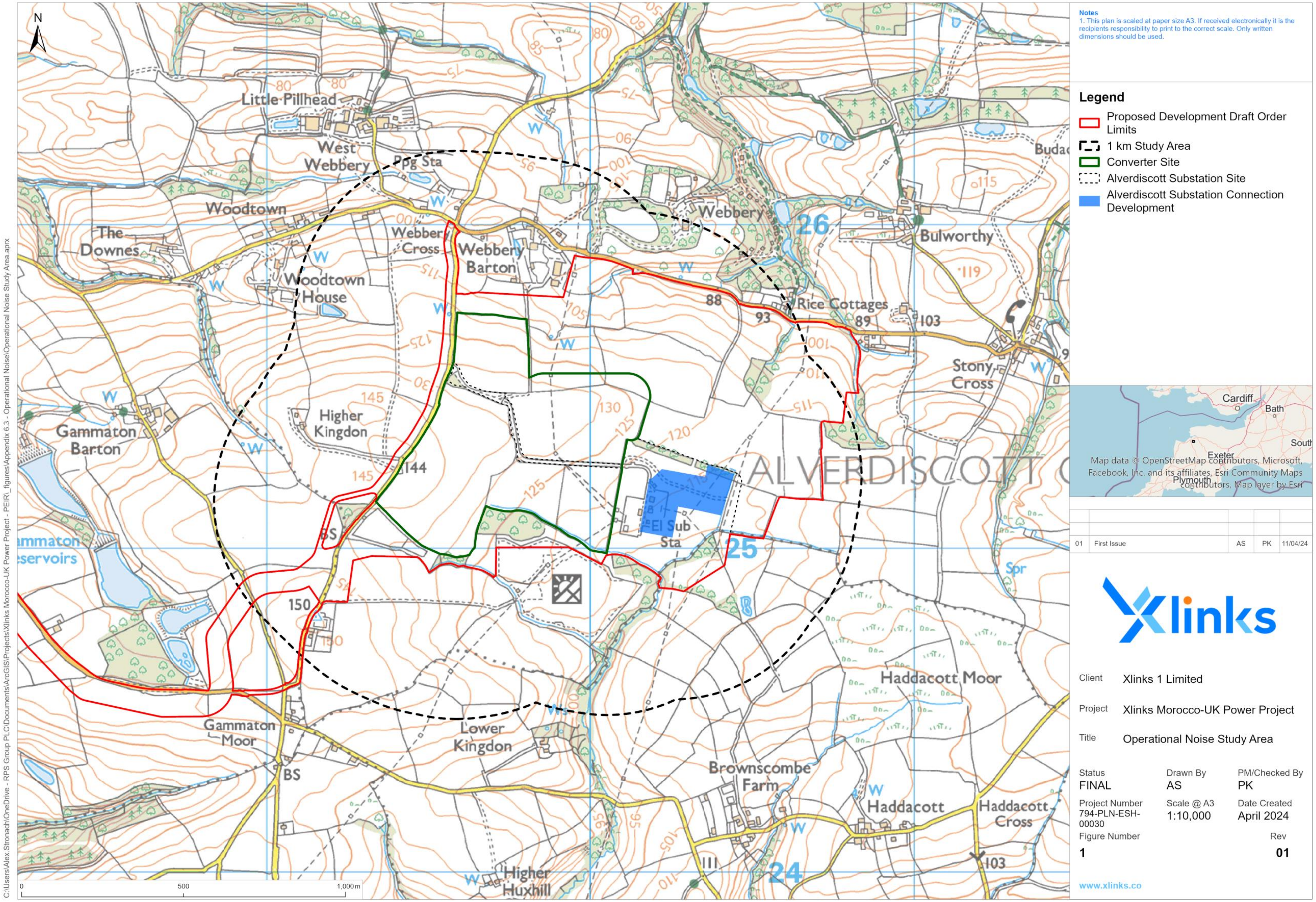

Figure 1: Operational Noise Study Area

1.3 Methodology

1.3.1 A 3D acoustic model has been constructed using the SoundPLAN v8.2 software package. This software implements the outdoor sound propagation method detailed within International Organisation for Standardisation (ISO) 9613-2:1996: 'Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation'. Sound levels have been predicted under light down-wind conditions based on hemispherical radiation with corrections added for atmospheric absorption, ground effects, screening, and source directivity, where each is appropriate. This standard is widely accepted as the industry-standard model.

1.3.2 The maximum design scenario is outlined in Volume 2, Chapter 6: Noise and Vibration, of the PEIR. The list of proposed plant items and maximum quantities is provided in **Table 1** below. The maximum design scenario is represented by all plant operating continuously at maximum operational duty 24/7. The location of each plant item has been obtained from preliminary layout drawings for the Converter Site.

1.3.3 The input parameters relevant to the Proposed Development include the following.

Local Topographical Features

1.3.4 Variable local topography can affect the 'line of sight' of a receptor to the source and result in greater or fewer obstacles between the source of noise and the receptor such as ground cover, hills, and buildings.

1.3.5 The receptors and other buildings which may provide screening effects have been obtained by importing Ordnance Survey (OS) Local Vector Layer for the Converter Site and surrounding area.

1.3.6 A digital ground model has been calculated using detailed OS Terrain 5 data for Converter Site. The indicative topography for the Converter Site platform, including the earth bunds proposed following the cut and fill exercise, have also been included in the digital ground model to account for the future ground conditions.

Ground Effects

1.3.7 Sound propagating outdoors comprises direct waves travelling straight from source to receiver and reflected waves which interact with the ground. Harder surfaces reflect more sound thereby resulting in enhanced noise levels at the receptor. Softer surfaces (such as grass, trees, or vegetation) have a higher porosity and thus can absorb reflected waves, resulting in lower noise levels at the receptor.

1.3.8 The acoustic properties of the ground are accounted for using the ground factor G which is a dimensionless parameter between 0 and 1. ISO 9613-2:1996 specifies a ground factor of 0 for hard surfaces and 1 for porous surfaces.

1.3.9 The area surrounding the Converter Site is predominantly grassland and thus has been assigned a ground factor of G = 0.6.

1.3.10 The converter station platform area is assumed to comprise hard ground with a ground factor of G = 0.3.

Plant Strategy and Layout

1.3.11 The primary model input is the source noise levels of the proposed plant strategy and the operating conditions for the Converter Site.

1.3.12 The proposed plant strategy is outlined in **Table 1** below with the typical noise levels associated with each plant item. Frequency spectra have been applied to the levels below which have been obtained from operational noise assessments for similar schemes such as The Celtic Interconnector and East Anglia ONE Offshore Windfarm. The full spectra are presented in **Annex A**.

1.3.13 The heights of each plant item and building have been obtained from an indicative 3D drawing of the Converter Site layout.

1.3.14 The proposed plant has been modelled in two ways:

- Industrial buildings: The industrial building feature in SoundPLAN allows for any larger plant items to be modelled as boxes with all outside surfaces radiating with an assigned sound power level. The sound power level per façade has been calculated by distributing the total sound power level over each individual face of the plant item based upon the area
- Point sources: Smaller plant items have been modelled as point sources which radiate in such a way that the sound attenuates proportionally with the square of the inverse of the distance from the source.

Table 1: Proposed Converter Station plant strategy

Plant Item	Quantity (per Bipole)	Modelled Height (m)	A-Weighted Sound Power Level, L_W, dB(A)	Modelled Source Type
Converter Transformers	6	5	90	Industrial Building
Converter Transformer Fans	60	5	90	Point
Valve Cooling Banks	10	3	89	Point
AC Filter Capacitors	6	7	80	Point
AC Filter Reactors	6	5	80	Point
Air Handling Units	8	3	82	Point

1.3.15 Additional notes on the assumptions adopted for the Converter Station plant noise emission levels are as follows:

- The number of converter transformer fans is not yet known and 10 fans per transformer has been assumed as a conservative approach. These fans are assumed to be radiators situated on the side of each transformer which transfer heat generated by the converter transformer operation to the surroundings.
- The number of valve cooling banks is assumed at this stage based on information obtained from similar schemes. The individual fans have been modelled as point sources atop a small industrial building to better simulate a top-discharging cooler unit. The sound power level has been split evenly to model a sound power level per fan.

- The exact operation of the air-handling units is not yet known. It has been assumed that the primary source of atmospheric noise emissions will be associated with the fresh air intake and exhaust termination points which have been modelled as point sources. Since the size of any ductwork or grilles is not yet known, the losses typically associated with the transmission of sound through ducts (duct losses, bend losses, end reflections, and grille directivity) have been omitted from the assessment at this stage as a conservative approach. It has been assumed that the levels from the fan termination points will be much greater than that associated with breakout noise from the casing of the air-handling unit and thus it has not been considered.
- Each of the two bipoles will contain two sets of three AC filter reactors and AC filter capacitors. These have been modelled as six individual point sources for each of the six individual phases.
- There are up to 12 reactors proposed within the valve and reactor hall building. Since these units will be housed internally, noise emissions are likely to be sufficiently controlled by the sound insulation performance of the external building fabric. These details are not yet known and thus this will be considered at a later design stage once more information is available. As such only externally sited plant items have been considered in this assessment.

1.3.16 The frequency content of similar plant which have been applied to the broadband sound power levels in **Table 1** highlight that the converter transformers typically contain tonal components to their noise emission spectra at low frequency which could potentially cause disturbance to nearby receptors. The fundamental frequency where the tonal components are generally present is the 100 Hz 1/3-octave frequency band, as shown in **Figure 2** below which shows the shape of a typical transformer spectrum (Gange, 2011). Subsequent harmonics to the fundamental frequency can be seen at higher frequencies. However, low frequency sound energy travels further due to the long wavelengths associated with the 100 Hz frequency band in comparison to the air through which the energy is transferred. As such, it is the low frequency sound rather than the higher frequency harmonics which requires most consideration.

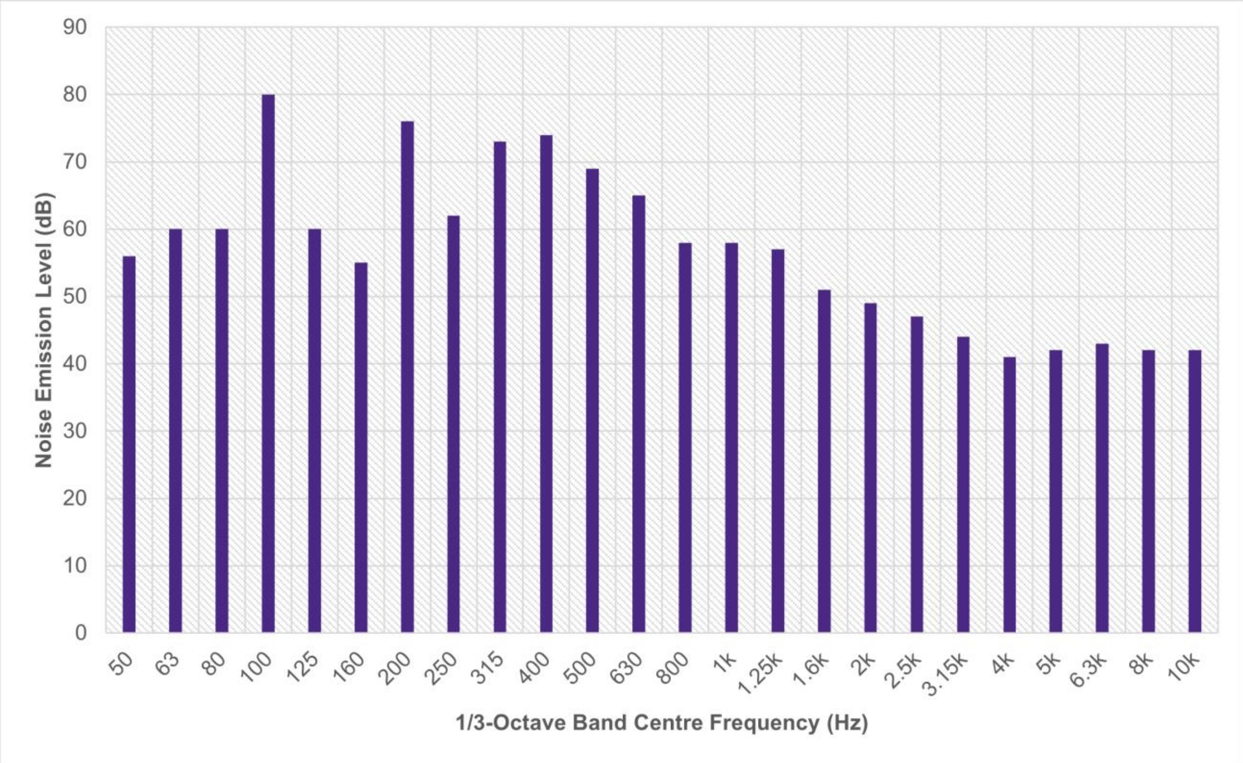

Figure 2: Typical high-voltage transformer noise emission spectrum.

1.3.17 As such, where these plant items are most influential to the overall receptor noise level, a correction of +2 dB, +4 dB, or +6 dB has been applied corresponding to ‘just perceptible’, ‘clearly perceptible’, and ‘highly perceptible’, respectively, in terms of BS 4142:2014+A1:2019.

Mitigation

1.3.18 Mitigation measures will be adopted as part of the design process to aid in the reduction of noise from the Converter Site plant at nearby receptors.

1.3.19 The plant layout will be designed to reduce noise impacts as much as is reasonably practicable and additional mitigation measures such as acoustic enclosures, attenuators, and acoustic barriers may be implemented as part of the Proposed Development. The exact measures will be determined as the design progresses and consideration has been given to the limiting plant noise emission levels and the type of mitigation measures which may allow for these levels to be achieved.

1.3.20 Acoustic enclosures are available which attenuate sound at 100 Hz by around 20 dB (National Grid, 2021). An enclosure which can achieve this amount of low frequency attenuation will reduce noise levels at higher frequencies by a greater amount. However, an overall noise reduction of 20 dB has been applied as a conservative assumption in the absence of a full enclosure specification.

1.3.21 Other mitigation options are available for the remaining plant items including, but not limited to:

- the selection of quieter plant;
- acoustic enclosures;
- acoustic barriers; and

- silencers for fans.

1.3.22 The losses for each measure and where they have been applied are presented in **Table 2** below.

Table 2: Indicative Mitigation Measures.

Plant Item	Acoustic Mitigation Measure	Insertion Loss (dB)
Converter Transformers	Enclosure	20
Converter Transformer Fans	Attenuator	16
Valve Cooling Banks	None	-
AC Filter Capacitors	Enclosure	7
AC Filter Reactors	Enclosures with top hats	10
Air Handling Units	Attenuator	16

Alverdiscott Substation Connection Development

1.3.23 As outlined in **paragraph 1.1.4**, the exact design parameters for the Alverdiscott Substation Connection Development are yet to be confirmed by NGET. As such, the acoustic model and assessment have been informed by assumptions derived from other NGET substation developments.

1.3.24 Typically, the most significant noise sources associated with a high voltage substation are the Super Grid Transformers. As outlined in **Figure 2** above, unmitigated transformer noise contains distinct low-frequency tonal components to their noise emission spectrum.

1.3.25 Other noise sources include standby generators and circuit breakers which will only operate in response to a fault or emergency. As such, these sources have been disregarded from the assessment.

1.3.26 Four transformers have been assumed with a maximum unmitigated sound power level under load (National Grid, 2021) as presented in **Table 3** below.

Table 3: Alverdiscott Substation Connection Development plant

Plant Item	Quantity	Modelled Height (m)	A-Weighted Sound Power Level, L_W, dB(A)	Modelled Source Type
Super Grid Transformer	2	5	88	Industrial Building
Converter Transformer Fans	60	5	84	Point

1.3.27 The indicative sound power levels in **Table 3** above have been adopted to inform the assessment of noise impacts and derive limiting levels for the Alverdiscott Substation Connection Development which ensure significant adverse effects are avoided.

1.4 Noise Sensitive Receptors

1.4.1 The nearest noise sensitive receptors to the Converter Site are presented graphically in **Figure 3** below.

1.4.2 The daytime noise emission levels have been assessed to a receptor situated 1 m from the most exposed façade of the noise-sensitive receptors at a height of 1.5 m above local ground level. This height corresponds roughly to the centre of a ground floor window.

1.4.3 The night-time noise emission levels have been assessed to a receptor situated 1 m from the most exposed façade at a height of 4.5 m above local ground level. This height corresponds roughly to the centre of a first-floor window since it is assumed residents will be in bedrooms situated on the first-floor during the night-time period.

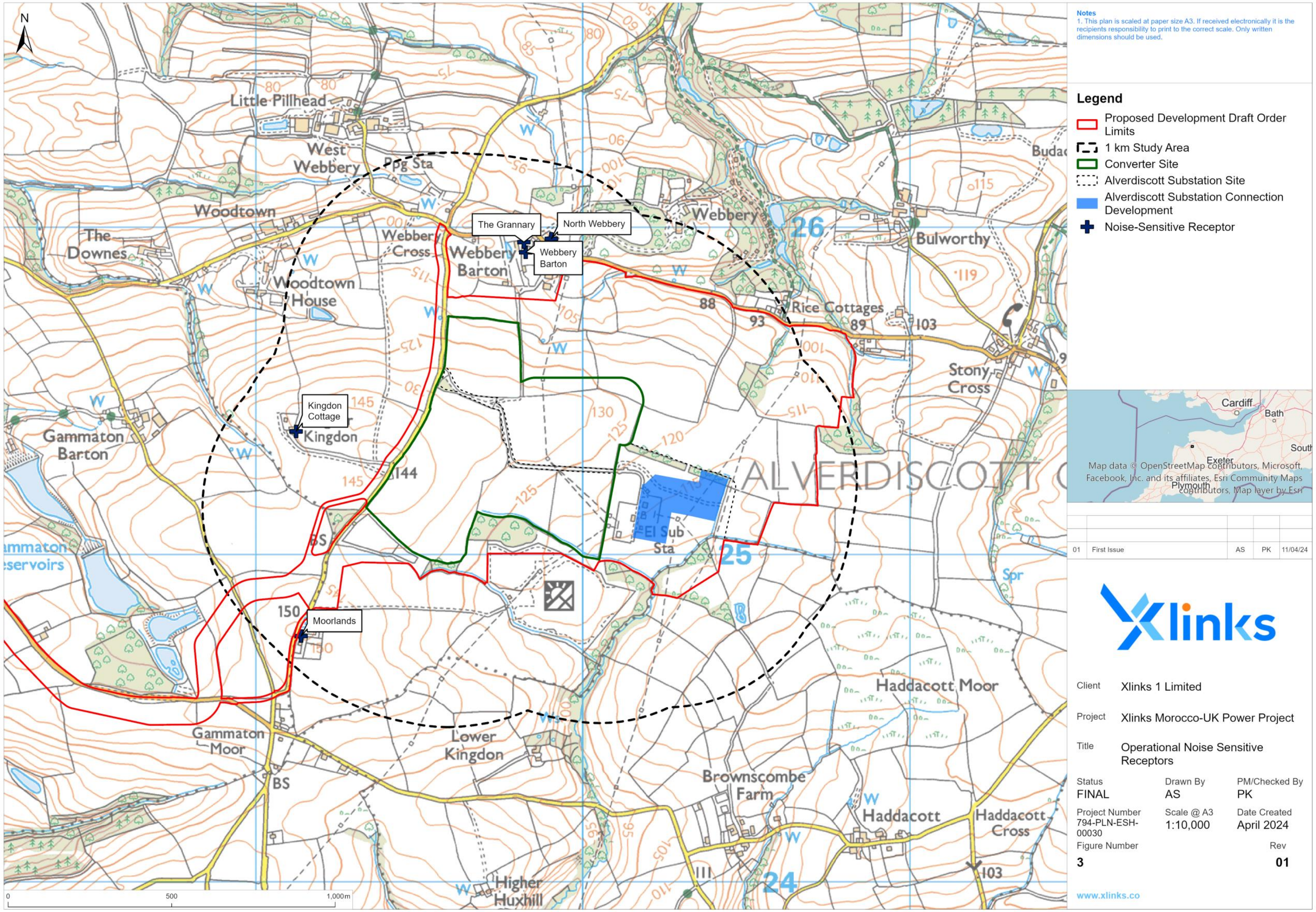

Figure 3: Operational Noise Sensitive Receptors

1.5 Assessment Methodology

1.5.1 Noise levels during the operation of the converter stations at the nearest receptors have been predicted from a 3D acoustic model. The predicted noise levels have been assessed with reference to the guidance in British Standard (BS) 4142:2014+A1:2019 – 'Methods for rating and assessing industrial and commercial sound'.

1.5.2 The nearest receptors to the are presented graphically in **Figure 3** above.

British Standard 4142:2014+A1:2019

1.5.3 British Standard (BS) 4142:2014+A1:2019 – 'Methods for rating and assessing industrial and commercial sound' provides a method for rating industrial and commercial sound and method for assessing resulting impacts upon people. The method is applicable to fixed plant installations, sound from industrial and manufacturing process and other associated activities.

1.5.4 In summary, this standard provides guidance on determining 'rating sound levels' by correcting the 'specific sound level' from the site or operations under consideration for acoustic character corrections such as tonality, impulsivity, and intermittency. The standard provides the following corrections to be applied where each is appropriate:

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

Impulsivity - 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

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

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

1.5.5 An initial estimate of the impact of the source is obtained by subtracting the measured background sound level from the rating sound level of the proposed plant. Background sound levels at the receptors were identified from the baseline sound survey data (see Volume 2, Appendix 6.1: Baseline Sound Survey, of the PEIR).

1.5.6 Acoustic character corrections are applied to the specific sound level at the receptor as presented in **Table 5** below.

1.5.7 Typically, the greater the difference between the measured background sound level and the rating sound level, the greater the magnitude of the impact. The operational noise criteria adopted for the Proposed Development are presented in **Table 4** below.

Table 4: Operational noise criteria.

Magnitude of Impact	BS 4142:2014+A1:2019 Semantic Description	Difference Δ between rating sound level $L_{Ar,Tr}$ and background sound level $L_{A90,T}$ (dB)
High	A difference of around +10 dB or more is likely to be an indication of a significant adverse impact, depending on the context.	$\Delta \geq 10$
Medium	A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.	$5 \leq \Delta < 10$
Low	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.	$0 \leq \Delta < 5$
Negligible		$-10 \leq \Delta \leq 0$

1.6 Operational Noise Assessment

1.6.1 The results of the baseline (unmitigated) scenario and mitigated scenario for the converter stations' operation are presented in **Table 5** and **Table 6** below, with the noise contours the night-time scenarios presented in **Figure 4** and **Figure 5**, respectively.

Table 5: Operational noise assessment (baseline scenario)

Receptor	Background Sound Level, $L_{A90,T}$ (dB)		Specific Sound Level, $L_{Aeq,T}$ (dB)		Acoustic Character Correction (dB)		Rating Level, $L_{Ar,T}$ (dB)		Difference Between Rating Level and Background Level (dB)		Magnitude of Impact	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Kingdon Cottage	33	31	26	27	4	4	30	31	-3	0	**Negligible**	**Low**
Moorlands	33	31	22	29	4	4	26	33	-7	+2	**Negligible**	**Low**
North Webbery	36	30	35	36	4	4	39	40	3	+10	**Low**	**High**
The Grannary	36	30	28	31	4	4	32	35	-4	+5	**Negligible**	**Medium**
Webbery Barton	36	30	34	35	4	4	38	39	+2	+9	**Low**	**Medium**

Table 6: Operational noise assessment (mitigated scenario)

Receptor	Background Sound Level, $L_{A90,T}$ (dB)		Specific Sound Level, $L_{Aeq,T}$ (dB)		Acoustic Character Correction (dB)		Rating Level, $L_{Ar,T}$ (dB)		Difference Between Rating Level and Background Level (dB)		Magnitude of Impact	
	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
Kingdon Cottage	33	31	23	25	0	0	23	25	-10	-6	**Negligible**	**Negligible**
Moorlands	33	31	20	28	0	0	20	28	-13	-3	**Negligible**	**Negligible**
North Webbery	36	30	32	32	0	0	32	32	-4	+2	**Negligible**	**Low**
The Grannary	36	30	23	28	0	0	23	28	-13	-2	**Negligible**	**Negligible**
Webbery Barton	36	30	30	31	0	0	30	31	-6	1	**Negligible**	**Low**

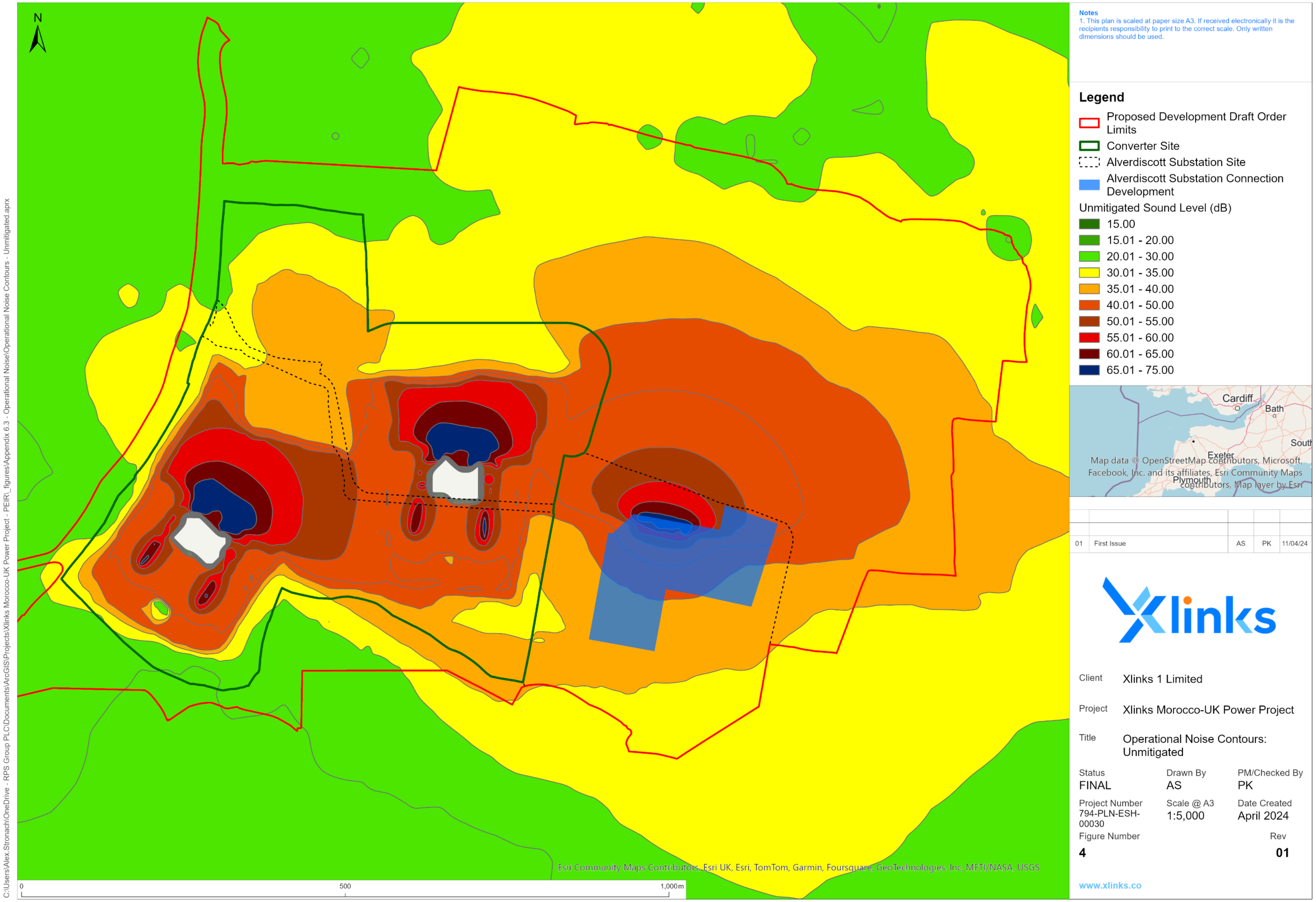

Figure 4: Operational Noise Contours: Unmitigated

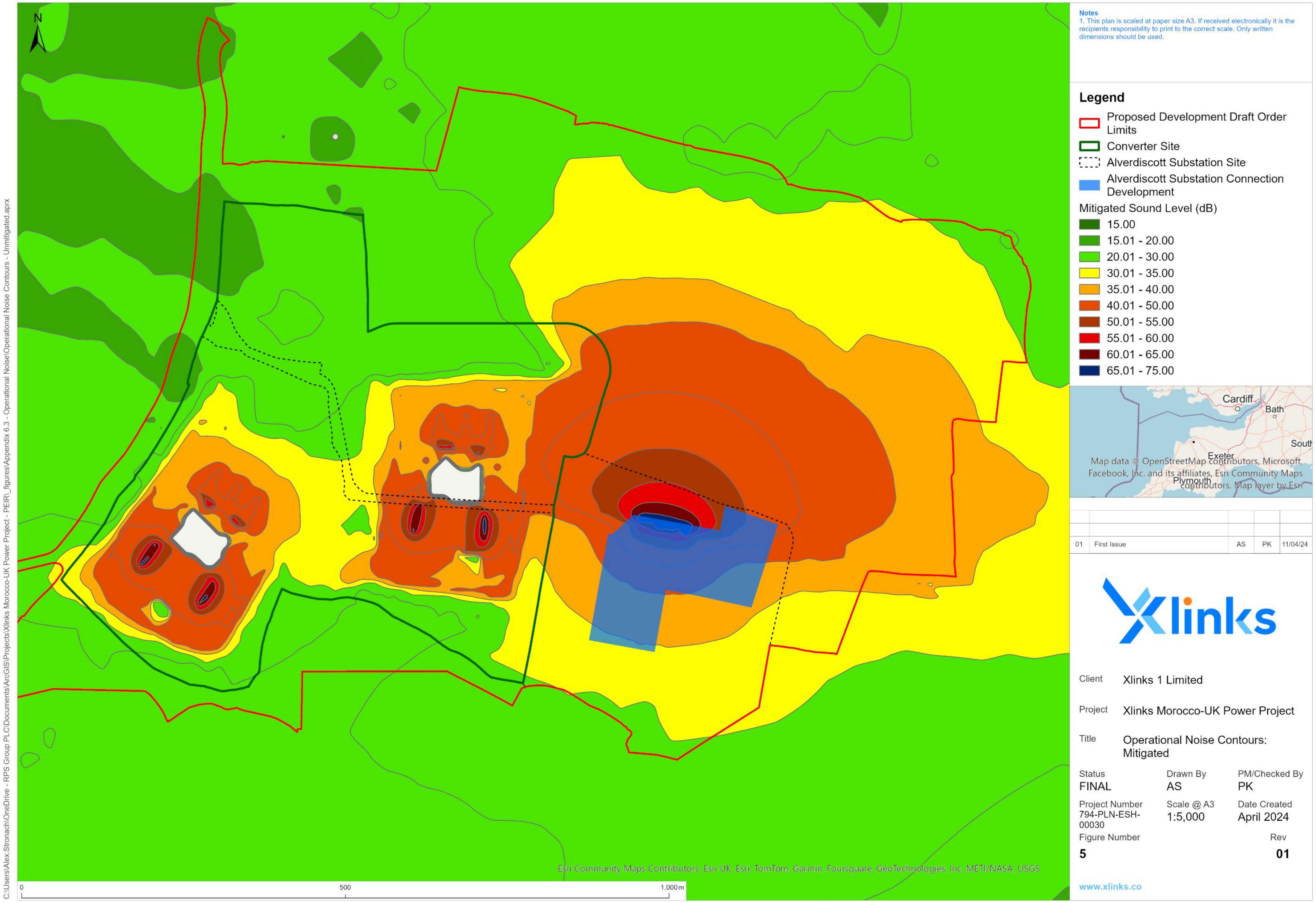

Figure 5: Operational Noise Contours: Mitigated

1.7 Operational Traffic Noise

1.7.1 As outlined in Volume 1, Chapter 3: Project Description of the PEIR, the Proposed Development includes proposed improvements to the local highway network to facilitate access during both the construction and operation and maintenance phases.

1.7.2 These works are understood to comprise:

- Road improvement works at Gammaton Moor, including the following potential options:
  - Widening of Gammaton Road in selective locations to enable future electricity transformer vehicle movements as well as full two-way movement of vehicles.
  - A new junction west of Gammaton Moor Crossroads and a new section of public highway connecting Gammaton Road with the unnamed road to Converter Site.
  - Potential relocation of the unnamed road to the Converter Site further to the west to facilitate utility diversions (gas and water) within and adjacent to the Converter Site. This will be confirmed during the detailed design.
  - Asymmetric widening either online or offline of the unnamed road to the Converter Site to enable full future electricity transformer vehicle movements as well as full two-way running for light vehicles.

1.7.3 These improvements to the highway network may result in changes to the baseline traffic flows and may move traffic closer to receptors in certain areas.

1.7.4 The exact works required, and their locations, are not yet known. A full assessment of any changes in operational traffic noise as a result of the Proposed Development will be undertaken as part of the Environmental Statement once the relevant design information becomes available.

1.8 References

British Standards Institution (2019) 'British Standard 4142:2014+A1:2019 – 'Methods for rating and assessing industrial and commercial sound'.

Gange. M (2011), 'Low-frequency and Tonal Characteristics of Transformer Noise', Proceedings of ACOUSTICS 2011, Gold Coast, Australia

International Organisation for Standards (1996) 'ISO 9613-2:1996 – Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation'.

National Grid (2021), Operational Noise Assessment for the Proposed Little Horsted 400 kV Substation, Available: https://planning.wealden.gov.uk/plandisp.aspx?recno=153380. Accessed November 2023

ANNEX A: NOISE EMISSION SPECTRA

Table A. 1: Converter station transformer spectrum

Plant Item	Sound Power Level (dB) at 1/3-Octave Centre Frequency (Hz)																							dB(A)
	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	
Converter Station Transformer	72	76	76	96	76	71	92	78	89	90	85	81	74	74	73	67	65	63	60	57	58	59	58	58	**90**
NGET Transformer	70	74	74	94	74	69	90	76	87	88	83	79	72	72	71	65	63	61	58	55	56	57	56	56	**88**

Table A. 2: Operational noise model input spectra (excluding transformers)

Plant Item	Sound Power Level (dB) at 1/1-Octave Centre Frequency (Hz)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Converter Transformer Fans	96	92	89	89	84	82	72	62	**90**
Valve Cooling Fan Bank	96	91	88	88	84	81	72	62	**89**
AC Filter Capacitor	68	85	82	81	63	58	62	54	**80**
AC Filter Reactor	68	85	82	81	63	58	62	54	**80**
Air Handling Unit	82	76	83	80	77	74	66	60	**82**
NGET Cooling Fans	90	86	83	83	78	76	66	56	**84**