WAVE DYNAMICS
ACOUSTIC CONSULTANTS

Ballyloo Substation & Grid Connection

Noise Impact Assessment
03 November 2025

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Executive Summary

Wave Dynamics were engaged by Ballyloo Solar Farm Limited to undertake a noise impact assessment for a proposed new substation and underground cable grid connection which is associated with the development of solar farms in County Carlow. The substation and grid connection will be located in the townlands of Ballyloo, Castletown, Graiguenaspiddoge, Kellistown East, Kellistown West, Kilballyhue, Knockbower, Leagh Or Ballybeg, Linkardstown and Moyle Big (townlands), County Carlow.

This report outlines the project criteria, survey results, assessment, and general guidance recommendations for:

- Construction noise from the construction of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.
- Operational noise from operation of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.

Based on the operational hours of the development there is potential for noise impact in both the day and night-time, therefore an assessment for both has been conducted.

The noise impact assessment included attended and unattended noise measurements on the proposed development lands. This included measurements of background noise at the noise sensitive locations. Appendix A outlines a glossary of the acoustic terminology used in this report.

Construction Noise and Vibration

The construction noise and vibration from the development have been predicted to the nearest noise sensitive (NSLs) receptors of the substation and nearby solar farms. The construction predictions were based on the procedures outlined in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise. The construction noise from the development will be of a short-term nature. The works have been assessed on the basis that they will be sequential.

Consideration was given to the construction of the substation, underground cable grid connection and the nearby Ballyloo Solar Farm and the cumulative noise and vibration impact from the construction works. **Based on the assessment outlined in this report it is predicted that the construction noise and vibration from the proposed substation and underground grid connection will comply with the recognised best practice standards typically adopted for such projects in Ireland**

Operational Noise

The noise levels from the substation, grid connection and nearby solar farms were assessed using criteria set out by EPA NG4 and BS4142 2014 A1+ 2019 Methods for rating and assessing industrial and commercial sound, which predicted that there is an unlikely adverse impact at all noise sensitive receptors for the daytime, evening and night-time periods.

Based on the assessment outlined in this report it is predicted that the operational noise levels at the proposed substation and underground grid connection will comply with the project criteria and not produce a negative noise impact.

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1 Introduction

Wave Dynamics were engaged by Ballyloo Solar Farm Limited to undertake a noise impact assessment for a proposed new substation and underground cable grid connection which is associated with the development of solar farms in County Carlow. The substation and grid connection will be located in the townlands of Ballyloo, Castletown, Graiguenaspiddoge, Kellistown East, Kellistown West, Kilballyhue, Knockbower, Leagh Or Ballybeg, Linkardstown and Moyle Big (townlands), County Carlow.

Application Context

The purpose of the proposed development is to transport the electricity generated at the proposed Ballyloo, Park and Ballybannon Solar Farms to the national electricity grid via the existing 220/110kV Kellis substation. The planning status of those solar farms is set out below:

- An application for the Ballyloo Solar Farm was made to Carlow County Council on the 28th February 2024 (Council Reference: 24/60043). The Council issued a Notification of Decision to Refuse Permission on the 25th March 2025 and a First Party Appeal was submitted by to An Coimisiún Pleanála on the 22nd April 2024. Permission was granted by An Coimisiún Pleanála on the 5th September 2025.

- An application for the Park Solar Farm was made to Carlow County Council on the 19th July 2024 (Council Reference: 24/60205). The Council issued a Notification of Decision to Grant Permission on the 24th April 2025.

- An application for the Ballybannon Solar Farm was made to Carlow County Council on the 22nd May 2025 (Council Reference: 25/60137). At the time of reporting, a decision on this application was still pending. Further updates are provided in the Planning and Environmental Statement submitted with the application.

Proposed Development

Overview

The electricity produced from the Ballyloo, Park and Ballybannon Solar Farms will be transported into the proposed substation.

The proposed substation will be either an Air Insulated Switchgear (AIS) or Gas Insulated Switchgear (GIS) tail fed substation with the associated grid connection comprising underground cabling which will connect into the existing 220/110kV Kellis substation.

As set out in the Planning and Environmental Statement, the applicant proposes design flexibility for the following development. The proposed development comprises of:

1. A 220kV Air Insulated Switchgear (AIS) or Gas Insulated Switchgear (GIS) electricity substation or a 110kV AIS electricity substation, including two control buildings, associated electrical structures and apparatus, lightning protection, telecom pole, perimeter security fencing, security lighting, water and drainage infrastructure, temporary construction compound to connect to and serve solar farms;
2. Associated grid connection between the proposed substation and the existing 110/220kV Kellis substation comprising 220kV or 110kV underground electricity cables (reflecting final substation option) of c.8.9 km or c. 8.65 km in length to be provided in an excavated trench including associated fibre cable and ducting, and all associated site development and reinstatement works. Two options are proposed after the first c.8.3 km of underground grid connection and for the final c.0.35 – 0.6 km of the underground cable grid connection route comprising (i) cabling in the L30535 public road, or (ii) cabling in private agricultural land;
3. Temporary construction and permanent operational access to the substation from the L3050, vehicular entrance and access track from this public road;

4. All ancillary site development, excavation, construction, landscaping and reinstatement works;
5. The development subject to this application forms part of grid connection and access arrangements which will facilitate the connection of the permitted Ballyloo Solar Farm (Carlow County Council Reference 24/60043 / An Coimisiún Pleanála Reference ABP-322347-25), permitted Park Solar Farm (Carlow County Council Reference 24/60205), and proposed Ballybannon Solar Farm (Carlow County Council Reference 25/60137) to the national electricity grid via the existing 110/220kV Kellis substation. A Natura Impact Statement (NIS) has been prepared in respect of the proposed development. The NIS includes consideration of the permitted Ballyloo and Park Solar Farms and the proposed Ballybannon Solar Farm which are located in County Carlow.

The operational lifetime of the solar farms is assumed to be 40 years. However, following the decommissioning of the solar farm, it is envisaged that the substation (and underground cable grid connection) will remain in situ as a valuable functioning and operational part of the electricity transmission network managed by the Transmission Systems Operator, EirGrid.

Substation Options

110kV AIS Substation

The operational lifetime of the solar farms is assumed to be 40 years. However, following the decommissioning of the solar farm, it is envisaged that the substation (and underground cable grid connection) will remain in situ as a valuable functioning and operational part of the electricity transmission network managed by the Transmission Systems Operator, EirGrid.

- Cable Sealing End (CSE);
- Surge Arrestor (SA);
- Earth Disconnect (DT);
- Current /Voltage Transformer (CT/VT);
- House Transformer (HT);
- Circuit Breaker (CB);
- Lightning Mast (LM);
- Diesel Generator;
- Security Fencing and Cameras;
- Drainage, access etc.

Earthworks will be undertaken so the compound is level, with a finish compound level of 100.72m. The 110kV AIS substation layout is indicated in Figure 1.

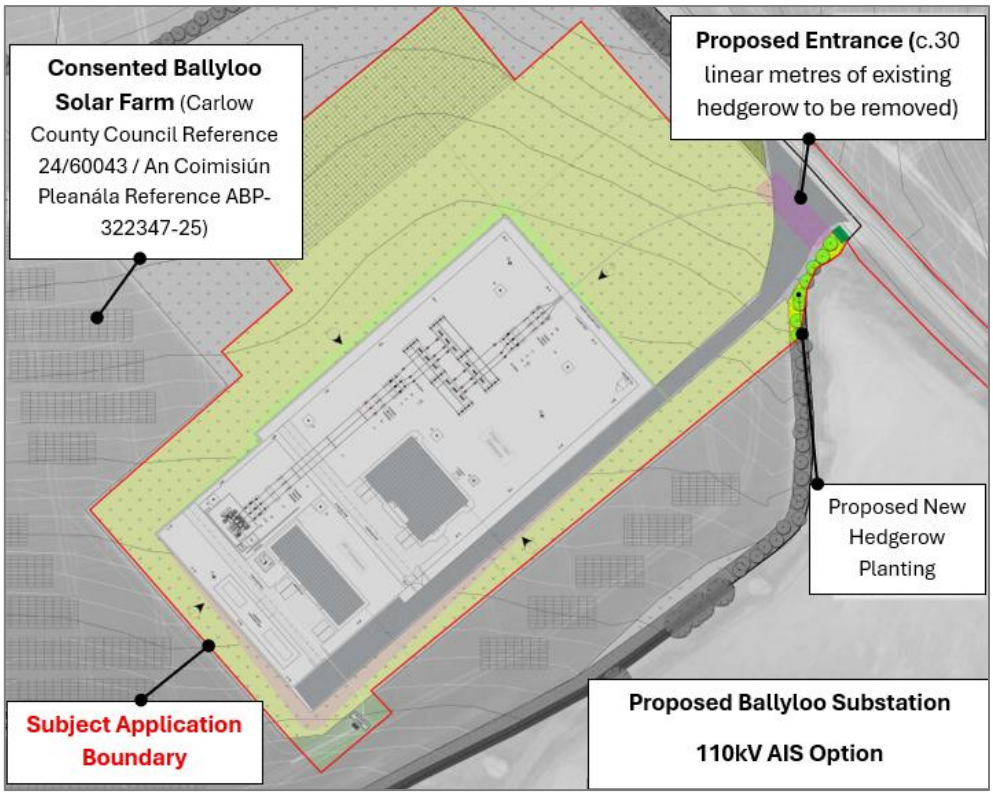

Figure 1: 110kV AIS Substation

220kV AIS Substation

The 220kV AIS substation will comprise the same infrastructure and equipment as the 110kV AIS substation option. The key difference is that the clearance distances required between individual components becomes greater at 220kV and therefore it has a larger footprint.

The 220kV AIS substation layout is indicated in Figure 2.

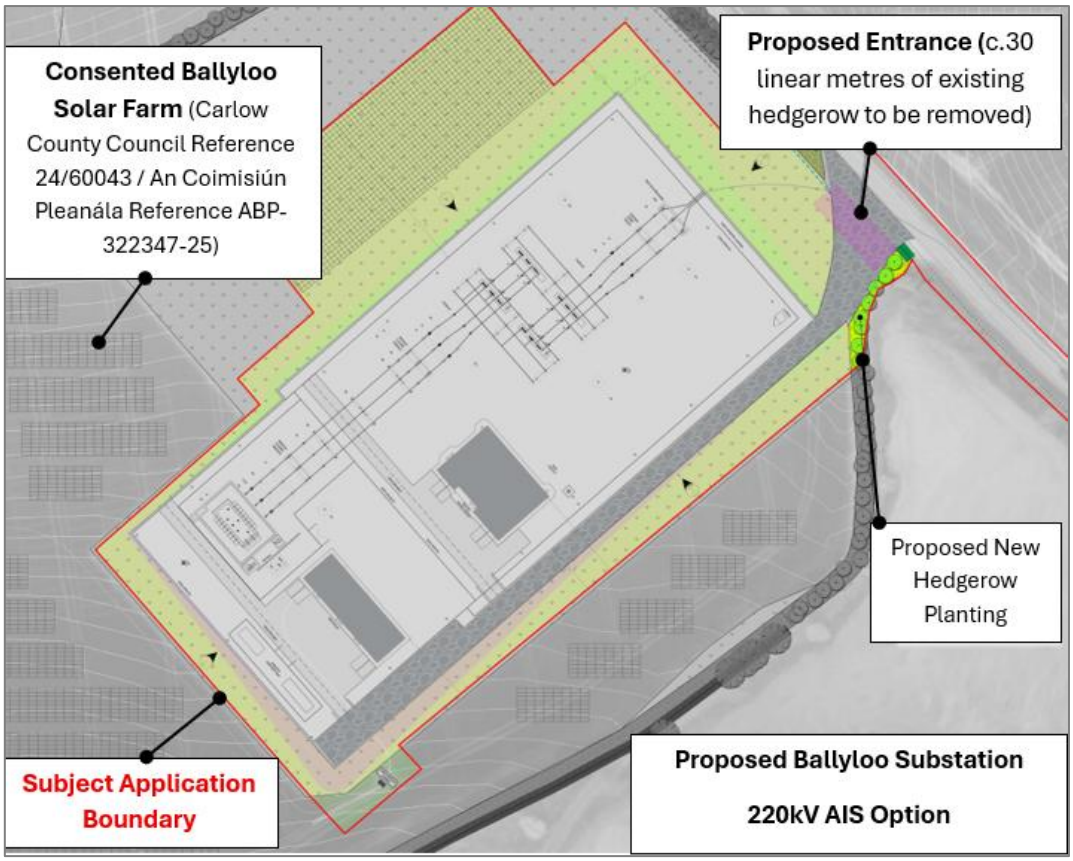

Figure 2: 220kV AIS Substation

220kV GIS Substation

The substation will be based on EirGrid design specifications. The substation compound will consist of a two storey GIS substation building, IPP Control Room building, High Voltage (HV) electrical equipment and associated infrastructure including palisade fences and concrete post and rail fences. The installation of HV electrical equipment will include a transformer with associated equipment along with:

- Lightning Masts (LM);
- Back-Up Diesel Generator;
- Harmonic filters if required by EirGrid;
- Capacitor Bank if required by EirGrid;
- Fire/Blast Wall;
- Telecoms Pole.

The 220kV GIS substation layout is indicated in Figure 3.

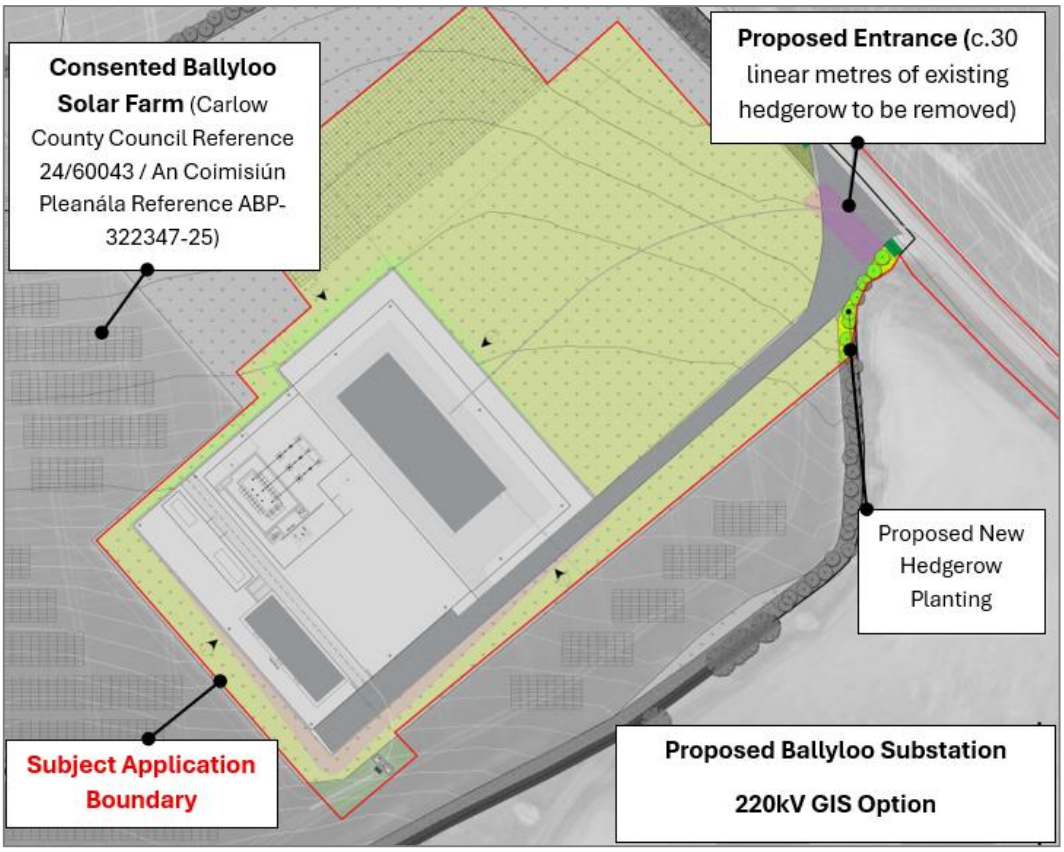

Figure 3: 220kV GIS Substation

Substation Access

It should be noted that the red line development application boundary is identical for all substation options.

Construction access to the substation will be provided by private lands, with a new entrance from the public road L3050. c.30 linear metres of existing hedgerow will be removed to facilitate the entrance. The entrance will be suitably splayed and has been subject to sight line and autotrack analysis, with the latter including modelling of abnormal load delivery for the transformer. The entrance will include a linear drain to ensure there is no potential for runoff to the public road.

A compacted access track will extend from the entrance to the substation compound. The track will include a geotextile base and filter membrane and 200 mm of Clause 804 sub-base. There will be sections of temporary track alongside the permanent track to facilitate delivery of the transformer within the site. The autotrack analysis has demonstrated that delivery of the substation transformer can be safely accommodated.

Temporary Construction Compound

As outlined in the submitted site layout plans, it is proposed to provide a temporary construction compound, accessed from the entrance from the L3050. The temporary compound will include the following facilities at a minimum:

- Adequate canteen space to allow for all workers during the peak period;
- Office space with lighting, heating and internet facilities;
- Toilets and adequate welfare facilities for construction staff in accordance with the relevant statutory Health & Welfare guidelines;
- Parking space for both light and heavy vehicles;
- Designated skips and temporary storage areas.

Surface Water Drainage and Water Services

2110kV & 220kV AIS Substations

It should be noted that the surface water drainage proposals are similar for both the 110kV and 220kV AIS substation options described in this report.

Surface water drainage for the substation compound have been designed to mimic the natural drainage patterns of the site and thereby be in accordance with the Best Management Practices (BMPs) of Sustainable Drainage Systems (SuDS).

This is achieved when the following parameters are considered:

- The compound construction is formed with permeable stone thus mimicking a soakaway scenario. ESB compound stone is single sized for the first 150mm for safety purposes. It then changes to a graded 6F2 material. The area of this permeable surface is circa 8,315m2 for the 110kV AIS substation option and 13,600m2 for the 220kV AIS substation option.
- The main areas to be drained includes the roofs and the compound road. These equate to approximately 1,592m² for the 110kV AIS substation option and 2,023m2 for the 220kV AIS substation option. These areas are modest in themselves and in comparison to the overall compound area. The compound road will be drained via series of road gullies.
- Assuming even the most basic of infiltration rates down through the permeable compound stone, the existing greenfield situation is easily maintained.

The surface water generated in the hardstanding areas and in the bunded areas within the substation compound will discharge to soakaway via Class 1 Full Retention Oil Separators. The electrical transformer in the substation is oil filled equipment and, as such, is protected with impermeable bunds. Surface water generated in this bund will be pumped out by an oil sensitive pump ensuring that only non-contaminated water enters the site drainage network.

220kV GIS Substation

Surface water drainage for the substation compound have been designed to mimic the natural drainage patterns of the site and thereby be in accordance with the Best Management Practices (BMPs) of Sustainable Drainage Systems (SuDS).

This is achieved when the following parameters are considered:

- The compound construction is formed with permeable stone thus mimicking a soakaway scenario. ESB compound stone is single sized for the first 150mm for safety purposes. It then changes to a graded 6F2 material. The area of this permeable surface is circa 7,660m2 for the GIS substation.
- The main areas to be drained includes the roofs and the compound road. These equate to approximately 2,746m². The compound road will be drained via series of road gullies.
- The surface water generated in the hardstanding areas and in the bunded areas within the substation compound will discharge to soakaway via Class 1 Full Retention Oil Separators. The electrical transformer in the substation is oil filled equipment and, as such, is protected with impermeable bunds. Surface water generated in this bund will be pumped out by an oil sensitive pump ensuring that only non-contaminated water enters the site drainage network.

Substation Foul Water Drainage

It should be noted that the foul water drainage proposals are the same for all AIS and GIS substation options described in this report.

There are no existing foul sewer water drains on or near the proposed substation site.

The foul drainage proposal must cater for the wastewater generated in the welfare facilities of the proposed substation. These welfare facilities include a toilet and wash hand basin both the EirGrid and IPP control

buildings. The station will be unmanned in normal operation so demand for facilities which generate foul flows will be low.

Foul holding tanks are normally used in EirGrid and ESB substations. The foul holding tanks will have a capacity of 5m3 which is a multiple of the foul water generated over three months of normal operation of the station. The foul holding tank will also be inspected by a suitably qualified and indemnified person at these intervals and records of inspections will be held on site for inspection by the local authority.

Substation Water Supply
It is proposed to provide the required potable water demand of the station (all options) with a bored well on site. The potable water demand within the site will be low as the proposed station is to be unmanned. To avoid issues like stagnation in the water supply line and problems resulting from this, there will be a continual water demand of 24 litres per week from automatically flushing WCs within the station.

Grid Connection
The substation will connect to the existing 220/110 kV Kellis substation via a proposed 110kV or 220 kV underground grid connection cable.

The overall length of the grid connection is approximately 8.9km at its longest. The route is shown in Figure 4. All works will be carried out in accordance with international best practice and full compliance with health and safety requirements.

Figure 4: Grid Connection Routes into Existing Kellis Substation

It should be noted that the red line development application boundary is identical for both the 110kV and 220kV grid connection cable options. The route travels east from the proposed substation on the L3050 before turning north onto the L30504. It then crosses the N80 at Castletown Cross Roads and continues east on the L7148 before turning south onto the L3053. The cable would then turn east onto the L30535 which is the main road access to the existing 220/110kV Kellis substation. There are two options proposed for the final c.0.35-0.6km section accessing the substation. One option (Option A) is within privately owned agricultural lands and the other option (Option B) is via the L30535 local road. Both options are indicated in Figure 06. In the case of Option A, c. 1m of hedgerow will be temporarily removed for the purposes of laying the cable into the substation lands. This will be reinstated.

Planning permission is being sought from An Coimisiún Pleanála for a proposed grid connection between the proposed Ballyloo Substation and Kellis 110/220kV Substation, and underground cable run of up to c.8.9km metres which terminates at the boundary of the Kellis 110/220kV substation. As set out in the submitted plans

and technical reports, it will be necessary to install a new line bay in the Kellis 220kV substation. This will require an additional short distance of underground cabling into the substation. The connecting line bay will consist of concrete bases, steelwork and electrical equipment similar to the already installed equipment within the station. This additional infrastructure will be subject to a future consenting process and is included for information in this planning application so that a robust assessment can be made of the entire application.

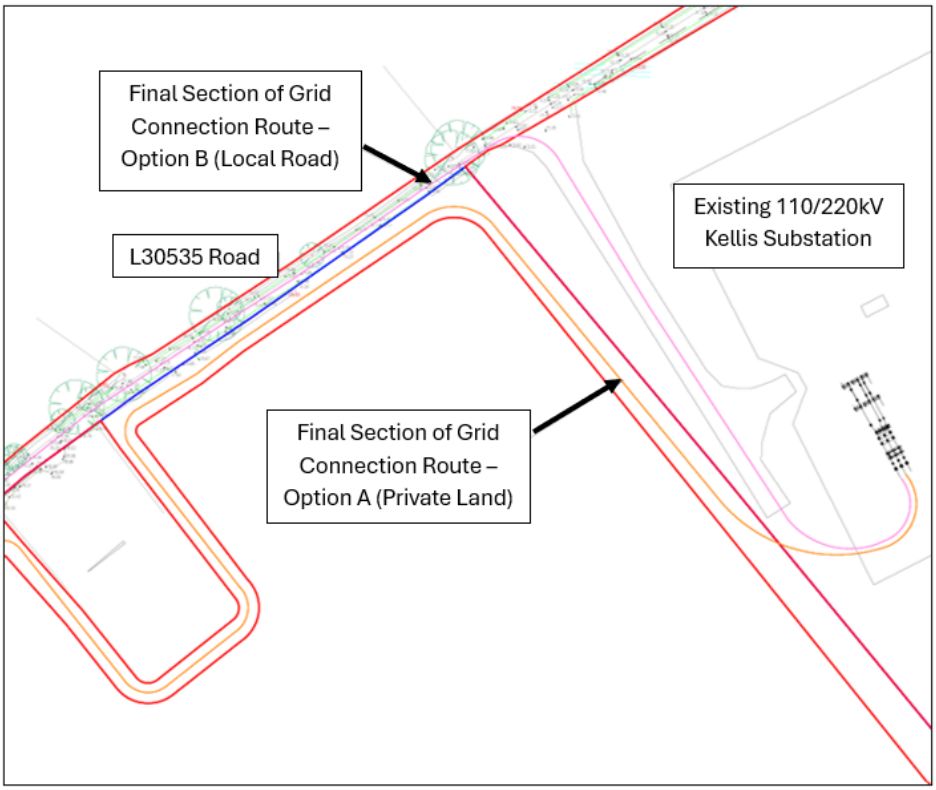

Figure 5: Alternative Grid Connection Routes into Existing Kellis Substation

Site Reprofiling

The subject site is relatively flat in nature but analysis of topographic data confirms that cutting and filling of the existing terrain will be required to establish a level platform for the substation compound.

2110kV & 220kV AIS Substations

For the 110kV substation option, the amount of cut to be transported off site is expected to be ca. 3,443m3. Similarly, the necessary amounts of fill material will be transported onto site. This is expected to be ca. 3,838m3. For the 220kV substation option, the amount of cut to be transported off site is expected to be ca. 7,229m3. Similarly, the necessary amounts of fill material will be transported onto site. This is expected to be ca. 7,868m3.

220kV GIS Substation

The amount of cut to be transported off site is expected to be ca. 3,495m3. Similarly, the necessary amounts of fill material will be transported onto site. This is expected to be ca. 3,472m3.

In all cases, any surplus soil will be disposed of offsite by means of an Article 27 declaration (European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011)) from the EPA or by means of transfer to an appropriate and licensed waste disposal facility.

Site Restoration and Landscaping

This will involve the reinstatement of all other excavated materials and associated landscaping works. It will include the replacement of topsoil in disturbed ground areas such as access tracks and the removal of the construction compound and other temporary work areas. The proposed development provides for the removal

c.30 linear metres of hedgerow at the substation site entrance and c.1 linear metre removed and reinstated under proposed Option A (if advanced) where the cable alignment passes through a field boundary near the Kellis 220kV sub. There is some 32 linear meters of new hedgerow proposed and 15 linear meters of bolstered hedgerow within the project red-line boundary. The application is accompanied by 3 no. landscape mitigation plans by Macro Works, reflecting the three substation options that may be implemented.

Other Planned Works

It is intended that the proposed substation and grid connection will service the permitted Ballyloo and Park Solar Farms, as well as the proposed Ballybannon Solar Farm which is under consideration by Carlow County Council.

Carlow County Council Reference 24/60043 / An Coimisiún Pleanála Reference ABP-322347-25

An application for the Ballyloo Solar Farm was made to Carlow County Council on the 28th February 2024. The solar farm application design as submitted to Carlow County Council comprised of the following:

> *A 10 Year Planning Permission for a solar farm with a total area of circa 192 hectares in the townlands of Ballybar Upper, Ballyloo, Ballyryan, Garryhundon, and Linkardstown, in County Carlow. The solar farm will consist of solar panels on ground mounted frames, 30 no. single storey electrical inverter/transformer stations, 4 no. single storey spare parts containers, 4 no. Ring Main Units, 8 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L3051, L3052 and L3050 public roads to connect solar farm field parcels, security fencing, CCTV, access tracks, 2 no. stream deck crossings and 1 no. horizontal directional drill, temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 4 no. entrances from the L3051, L3052 and L3050. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application.*

The scheme was revised at Request for Further Information stage to include, inter alia, a reduction in the paneled area including omission of c.11.6 ha easternmost field (Parcel 4) of the project. The Council issued a Notification of Decision to Refuse Permission on the 25th March 2025 and a First Party Appeal was submitted by to An Coimisiún Pleanála on the 22nd April 2024. Permission was granted by An Coimisiún Pleanála on the 5th September.

Carlow County Council Reference 24/60205

An application for the Park Solar Farm was made to Carlow County Council on the 19th July 2024. The solar farm application design as submitted to Carlow County Council comprised of the following:

> *A 10 Year Planning Permission for a solar farm with a total area of circa 73 hectares. The solar farm will consist of solar panels on ground mounted frames, 11 no. single storey electrical inverter/transformer stations, 3 no. single storey spare parts containers, 2 no. Ring Main Units, 3 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L1010, L3051, L3052 and L3050 public roads to connect solar farm field parcels, security fencing, CCTV, access tracks, 3 no. watercourse/drain deck crossings and 2 no. horizontal directional drill crossings (under M9 motorway and L3050), temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 2 no. entrances from the L1022 and L1010. Sections of the proposed underground electrical cabling will traverse the solar farm proposed under Carlow County Council Reference 24/60043, but will not alter infrastructure proposed under that application. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application.*

The Council issued a Notification of Decision to Grant Permission on the 24th April 2025. The applied conditions provided for the removal of Parcel 1 from the permitted solar farm.

Carlow County Council Reference 25/60137

An application for the Ballybannon Solar Farm was made to Carlow County Council on the 22nd May 2025 for the following development:

A 10 Year Planning Permission for a solar farm with a total area of circa 57 hectares in the townlands of Ballybannon, Ballybar Lower, Ballybar Upper, Ballycarney, Ballyloo, Cloghna, Linkardstown and Park in County Carlow. The solar farm will consist of solar panels on ground mounted frames, 8 no. single storey electrical inverter/transformer stations, 2 no. single storey spare parts containers, 1 no. Ring Main Unit, 3 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L4038, L8185, R448, L3051, L3052 and L3050 public roads to connect solar farm field parcels, security fencing, CCTV, access tracks, 5 no. watercourse/drain deck crossings and 2 no. horizontal directional drill crossings (under M9 motorway and the Dublin - Waterford railway), temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 2 no. existing entrances from the R448 and L1010. Sections of the proposed underground electrical cabling will traverse the solar farms proposed under Carlow County Council References 24/60043 and 24/60205, but will not alter infrastructure proposed under these applications. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application.

At the time of reporting, a decision on this application was still pending.

1.1 Statement of Competence

The attended and unattended measurements and report were completed by Wave Dynamics, an acoustic consultancy that specialises in noise and vibration. Our consultants have extensive experience in noise impact assessments.

The site survey was conducted by Cathal Reck | Technical Engineer, Cathal has on-site experience of numerous planning stage applications and construction stage sites. Cathal's qualifications include; BSc (Hons) in Music Technology & Production, IOA Certification of Competence in Environmental Acoustics.

This report was completed by James Cousins, Managing Director | Principal Consultant with Wave Dynamics who has extensive experience in assessing noise impacts. James is an experienced acoustic consultant. His qualifications include; BSc (Hons) in Construction Management and Engineering, Pg Cert in Construction Law and Diploma in Acoustics and Noise Control (Institute of Acoustics) and an IOA Competence Cert in Building Acoustic Measurements. James is a member of both Engineers Ireland (MIEI) and the Institute of Acoustics (MIOA) and is the current SITRI Chairman.

The peer review was completed by Sean Rocks, Director | Senior Consultant, Sean has experience of numerous planning stage assessments. Sean's qualifications include; BEng (Hons) in Mechanical and Manufacturing Engineering, Diploma in Acoustics and Noise Control (Institute of Acoustics), IOA Certificate of Competence in Environmental Noise Measurement and SITRI certified sound insulation tester. Sean is a member of both Engineers Ireland and the Institute of Acoustics.

2 Site Description

The substation and grid connection will be located in the townlands of Ballyloo, Castletown, Graiguenaspiddoge, Kellistown East, Kellistown West, Kilballyhue, Knockbower, Leagh Or Ballybeg, Linkardstown and Moyle Big (townlands), County Carlow. There are residential properties located around the lands as shown below in Figure 1. The M9 motorway is in close proximity to the northernmost section of the development. The development is generally surrounded by agricultural farmland.

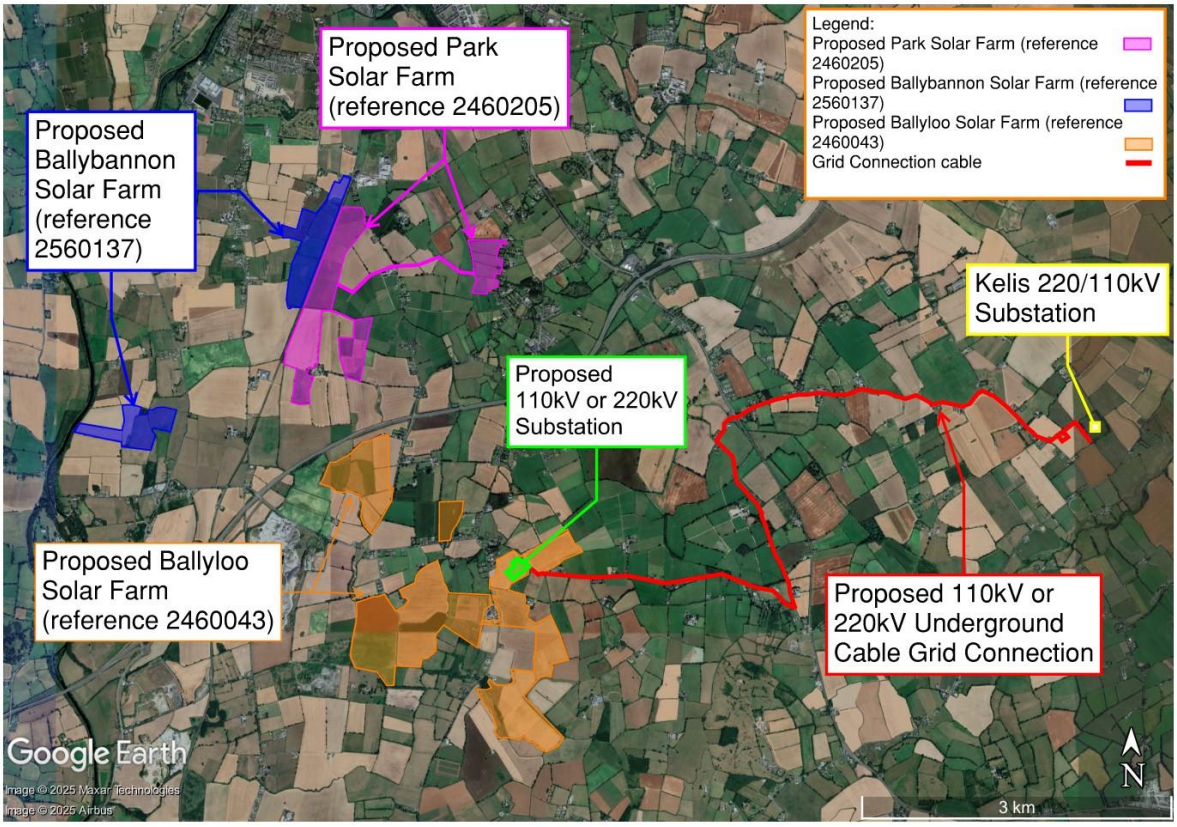

Figure 6: Site Location of solar farms, proposed substation and grid connection cable route.

Table 1 below shows the respective distances between the closest dwelling of each noise sensitive location subgroup and the proposed substation. The noise sensitive locations are shown in Figure 7.

Table 1: Distance between NSLs and proposed substation.

Noise Sensitive Location	Distance from closest façade of the NSL to the proposed substation (m)
NSL1	1409
NSL2	1545
NSL3	1107
NSL4	1245
NSL5	1630
NSL6	1783
NSL7	1095

Noise Sensitive Location	Distance from closest façade of the NSL to the proposed substation (m)
NSL8	1274
NSL9	1509
NSL10	828
NSL11	576
NSL12	1811
NSL13	758
NSL14	381
NSL15	502
NSL16	873
NSL17	1069
NSL18	1573
NSL19	376
NSL20	273
NSL21	172

3 Project Criteria

The acoustic criteria for the project is set out in this section, the purpose of the criteria is to ensure reasonable:

- Construction noise from the construction of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.
- Operational noise from operation of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.

The Ballyloo Solar Farm is located immediately adjacent to the proposed substation and will be constructed and in operation at the same time. For that reason, this solar farm been assessed in this report alongside the substation and grid connection. The Park and Ballybannon solar farms are not predicted to have any impact at the noise sensitive locations near the substation due to their distance from this development site. For that reason, these solar farms are only considered in terms of cumulative impacts.

There will be no predicted noise from the grid connection therefore operational noise from the underground cable has been screened out. Based on our understanding of the project there are no relevant sources of vibration from the operational phase of the development to provide adequate conditions Wave Dynamics have developed the project criteria for:

- Operational noise and construction noise and vibration

Acoustic Standards

The acoustic standards for assessing noise impact for the project have been developed from the following:

- ✓ Environmental Protection Agency NG4: Guidance note for Noise: Licence Applications, Surveys and Assessments in Relation to Scheduled Activities
- ✓ BS4142 2014 A1+ 2019 Methods for rating and assessing industrial and commercial sound
- ✓ ISO 1996-1:2016 Acoustics — Description, measurement and assessment of environmental noise — Part 1: Basic quantities and assessment procedures
- ✓ British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise
- ✓ British Standard BS7385: 1993: Evaluation and measurement for vibration in buildings Part 2: Guide to damage levels from ground borne vibration, and;
- ✓ British Standard BS5228-2: 2009 + A1: 2014: Code of practice for noise and vibration control on construction and open sites – Vibration.
- ✓ Previous experience on similar projects.

3.1 Noise Assessment Criteria

3.1.1 Construction Noise Assessment Criteria

There is currently no statutory Irish guidance for construction noise requirements from noise during the construction phase of a project.

In the absence of specific noise limits, the appropriate criteria for the allowable construction noise levels may be found in British Standard BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise.

The standard (BS5228-1:2009+A1) provides examples of acceptable limits for construction and/or demolition noise in both subjective and objective form. For example, paragraph E.2 of the standard states:

"Noise from construction and demolition sites should not exceed the level at which conversation in the nearest building would be difficult with the windows shut."

Paragraph E.2 goes on to state:

"Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed:

- *70 decibels (dBA) in rural, suburban areas away from main road traffic and industrial noise;*
- *75 decibels (dBA) in urban areas near main roads in heavy industrial areas".*

Typically, the planning authority refer to BS 5228 Part 1 as a method to control construction noise from sites on the local environment. This standard is therefore the de facto appropriate standard in the absence of regulatory guidance.

The criteria for this project will be based on the ABC method, the ABC method takes the background noise measured in the area and sets the appropriate construction noise limits for the project based on the background noise levels.

For the purpose of this assessment buildings other than dwellings which have a residential function will be considered for the lower noise limit, this includes Hotels, B&B's, Student Accommodation, Co Living Developments etc. This is in line with the guidance and definition of noise sensitive residences of EPA NG4. Table 2 below outlines the project criteria in tabular form.

Table 2: BS 5228: 1:2009+A1 threshold levels.

Assessment category and threshold value period	**Threshold value, in decibels (dB) (L_{Aeq})**		
	Category A[1]	**Category B [2]**	**Category C[3]**
Daytime (07:00 – 19:00) and Saturdays (07:00 – 14:00)	65	70	75
Evenings and weekends [4]	55	60	65
Night-time (23:00 to 07:00hrs)	45	50	55

1) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.
2) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.
3) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category B values.
4) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

3.1.2 Construction Vibration Criteria

Best practice guidance is taken from British Standard BS 5228:2009 + A1 2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 2 Vibration.

The standard recommends that for a soundly constructed residential property and similar structures (in good repair), the threshold for minor or cosmetic (i.e. non- structural) damage should be taken as a Peak Particle Velocity (PPV) (in frequency range of predominant pulse) of 15mm/s at 4Hz increasing to 20mm/s at 15Hz and 50mm/s at 40Hz and above. Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of:

Table 3: Likely Construction Noise Impact

Allowable vibration (in terms of peak particle velocity) at the closest part of sensitive property to the source of vibration, at a frequency of:			
Building Type	**Less than 15Hz**	**15 to 40Hz**	**40Hz and above**
Light framed structures/ residential buildings	15 mm/s	20 mm/s	50 mm/s

3.1.3 Operational Noise

Planning authorities can set noise limits from typical substation and solar farm developments pertaining to noise however there is currently no national policy for operational noise limits from either type of development for planning noise assessments. Noise limits for new developments are typically sought from the planning authority's noise action plan, EPA NG4/BS 4142. On review of the Carlow County Council Noise Action Plan no specific guidance has been outlined for noise limits from commercial premises and therefore the criteria from EPA NG4/BS4142 have been adopted for the project.

EPA NG4

EPA NG4 outlines that noise attributable solely to onsite activities from a licenced premises should not exceed the following limits:

- *Daytime (07:00hrs – 19:00hrs) – 55dB $L_{Ar,T}$*
- *Evening (19:00hrs – 23:00hrs) – 50dB $L_{Ar,T}$*
- *Night time (23:00hrs – 07:00hrs) – 45dB $L_{Aeq,T}$*

During daytime and evening periods rigorous efforts should be made to avoid clearly audible tones and impulsive noise at all sensitive locations. A penalty of 5dB for tonal and/or impulsive elements is to be applied to the daytime and evening measured $L_{Aeq,T}$ values to determine the appropriate rating level ($L_{Ar,T}$). In all cases, an assessment by a competent person will be required.

During the night-time period no tonal or impulsive noise from the facility should be clearly audible or measurable at any NSL.

BS 4142:2014+A1:2019

The standard describes a method for the assessment of commercial, industrial and background noise to quantify its impact on persons outside of a residential dwelling. BS 4142 has become the de facto standard for compliance investigation. In addition to the specified broadband noise levels the standards provide objective and subjective methods for the assessment of the impulsivity and tonality of the noise sources. This allows for a penalty/ correction to be applied to the measured noise level of the source (L_{Aeq}) to give the rating level ($L_{Ar,T}$).

It considers the likelihood of complaints by considering the margin by which the noise in source the background noise level.

BS 4142 states that and exceedance of the noise source of the background noise by:

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

BS4142 outlines guidance for penalty corrections to be applied to the noise sources in question should the noise source have one of the following characteristics:

- The noise contains a distinguishable, discreet, continuous tone (whine, or hum);
- The noise contains distinct impulses (i.e. bangs),
- The noise is intermittent or:
- The noise is irregular.

4 Baseline Noise Survey

4.1 Baseline Noise Survey

An attended and unattended baseline noise survey was conducted to assess the background noise levels and the typical noise sources in the area. Multiple locations were chosen to conduct the survey to establish the background noise across the area in which the proposed substation is located and the wider area where the adjacent Ballyloo Solar Farm is proposed. The attended measurements included measurements of background noise during both daytime (07:00-23:00) and night-time hours (23:00-07:00). The purpose of the attended and unattended measurements was to establish the background noise levels in the area, and to use these measurements for predicting the future noise levels from the solar farm and the impact on the area.

4.1.1 Site Description and Measurement Locations

The proposed substation is located adjacent to the Ballyloo Solar Farm lands which spans circa 192 hectares in Ballyloo Co. Carlow. Below in Figure 7 outlines the baseline measurement locations which were chosen to ensure that noise from both the proposed substation and the adjacent Ballyloo Solar Farm were fully considered.

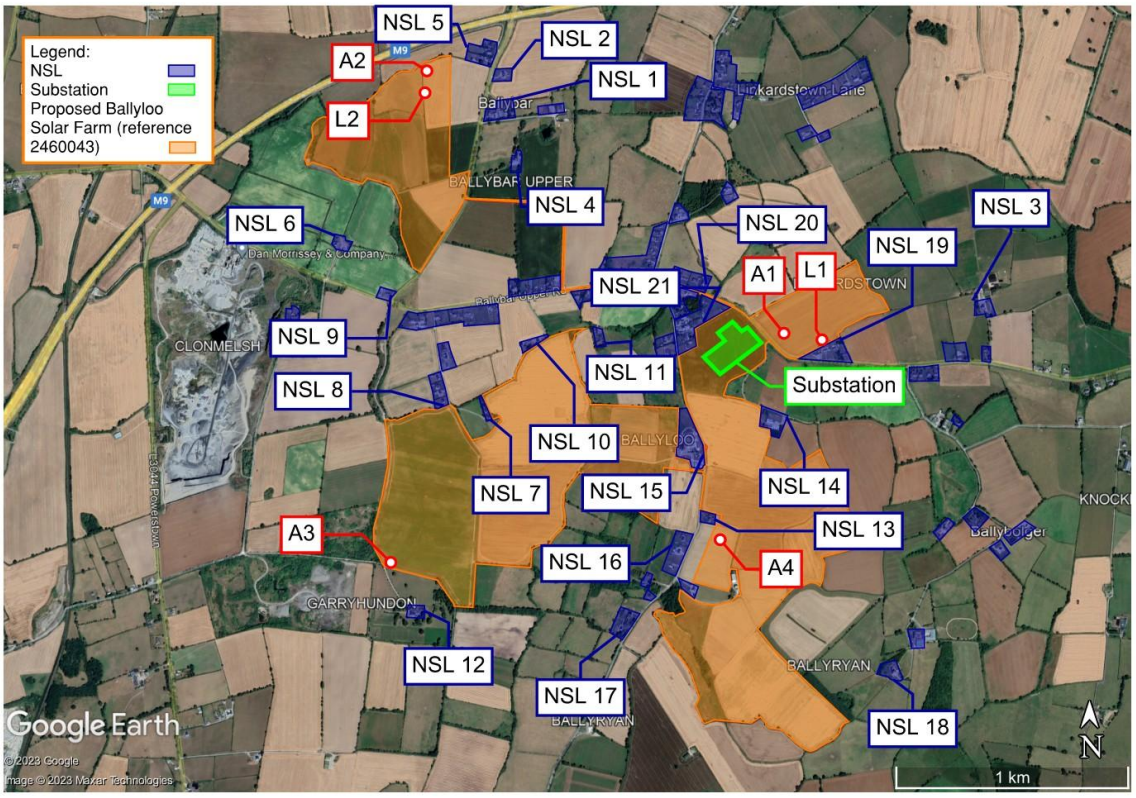

Figure 7: Site location of substation, NSL locations and measurement locations.

The noise monitoring locations undertaken for the survey are shown in Figure 7 above. The purpose of all measurements undertaken at the site was to assess the existing background noise levels in the area of the proposed development.

The background noise levels recorded are used to assess if the noise sensitive locations meet the EPA NG4 criteria for “areas of low background noise”, in order to set the project criteria. The full descriptive details of the monitoring locations are outlined below.

L1: This represents the unattended noise logger at measurement location L1, which was located in a field within the site boundary. This is representative of the residual and background noise levels during the day, evening and

nighttime periods at NSLs 3, 11, 19, 20, 21. The measurements recorded at L1 were dominated by distant road traffic noise. From the measurements it can be determined that these NSLs do not meet the EPA NG4 criteria of "Areas of Low Background Noise" for the operational phase of this project as further detailed in Section 4.2.

A1: This represents attended measurement location A1 which was located in a field within the site boundary and were representative of the day and nighttime noise levels at NSLs 3, 11, 19, 20, 21. These measurements have been used to verify the noise logger measurements across the site. The dominant noise source at this location was distant road traffic noise. Other audible noise sources included birdsong and farm machinery.

A2: This represents attended measurement location A2, which was located in a field within the site boundary. The measurements were representative of the day and nighttime noise levels at NSLs 1, 2, 4, 5 and 6. These measurements have been used to verify the noise logger measurements across the site. The dominant noise source at this location was road traffic noise from the M9 motorway. Other audible noise sources included birdsong and farm machinery.

L2: This represents the unattended noise logger at measurement location L2, which was located in a field within the site boundary. This is representative of the residual and background noise levels during the day, evening and nighttime periods at NSLs 1, 2, 4, 5 and 6. The measurements recorded at L1 were dominated by distant road traffic noise. From the measurements it can be determined that these NSLs do not meet the EPA NG4 criteria of "Areas of Low Background Noise" for the operational phase of this project as further detailed in Section 4.2.

A3: This represents attended measurement location A3, which was located in a field within the site boundary. The measurements were representative of the day and nighttime noise levels at NSLs 7, 8, 9 and 12. These measurements have been used to verify the noise logger measurements across the site. The dominant noise source at this location was distant road traffic noise. Other audible noise sources included birdsong and farm machinery.

A4: This represents attended measurement location A4, which was located in a field within the site boundary. The measurements were representative of the day and nighttime noise levels at NSLs 15, 16, 17 and 18. These measurements have been used to verify the noise logger measurements across the site. The dominant noise source at this location was distant road traffic noise. Other audible noise sources included birdsong and farm machinery.

4.1.2 Survey Methodology and Personnel

The attended and unattended surveys were completed by James Cousins (Principal Consultant) and Cathal Reck (Acoustic Consultant).

Attended Noise Measurements

Noise measurements were undertaken in general accordance with ISO 1996-1:2016 using ISO Class 1 sound analysers. Attended measurements were taken for varying durations based on objective. Background noise measurements were taken over a 60-minute period for the daytime period and over 15 minutes for the night-time period. Care was taken to avoid any effect on the measurements, the sound level meter was positioned at approximately 1.2m above ground level.

Figure 8: Attended noise monitor setup.

Unattended Noise Measurements

Noise measurements were undertaken in general accordance with ISO 1996-1:2016 using ISO Class 1 sound analysers. An unattended noise survey was undertaken from the 10th of November to the 15th of November 2023. Care was taken to avoid any effect on the measurements, the sound level meter was positioned at approximately 1.2m above ground level and securely anchored in place for the duration of the unattended survey. The data from the unattended measurements was filtered for adverse or undesirable weather conditions.

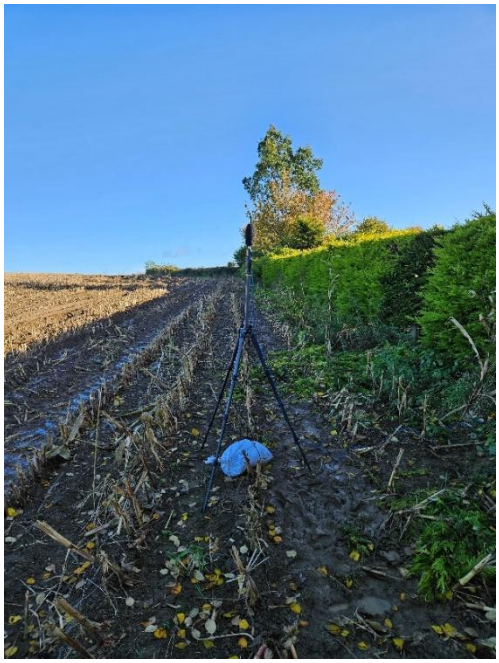

Figure 9: Unattended noise monitor setup.

4.1.3 Survey Period

The attended noise measurements were undertaken on the 14th and 15th of November 2023. The unattended survey was started on the 10th of November 2023 by James Cousins (Principal Consultant) and completed on the 15th of November by Cathal Reck (Technical Engineer).

4.1.4 Noise Measurement Equipment

A Class 1 sound level meter/noise logger in general accordance with IEC 61672-1:2013 was used for the attended measurements. Table 4 below summarises the measurement equipment used. All measurement equipment used had valid calibration data for the duration of the noise surveys.

Table 4: Noise Measurement Equipment

Description	WD Asset Number	Model	Serial No.	Calibration Certificate No.	Calibration Due Date
Calibrator	CAL3	Nor 1251	32096	AC250308	22/07/2026
Sound Level Meter	SLM4	Nti XL2-TA	A2A-23316-E1	UK-23-100	18/09/2027
Calibrator	CAL2	Cirrus CR 515	99866	AC240278	14/11/2025
Sound Level Meter	SLM2	NOR140	1406532	SLM230218	27/09/2025

4.1.5 Subjective Noise Environment

During the attended noise survey following noise sources were identified:

- Traffic noise from the M9 and other localised roads (This was the most dominant source in the area)
- Localised traffic noise to various roads in the area,

- Birds chirping,
- Occasional dog barks.

4.2 Noise Measurement Results

This section outlines the results of the attended noise measurements.

Attended Measurement Results

Table 5 outlines the results of the attended measurement survey.

Table 5: Attended Noise Measurement Results

Measurement				Measured Noise Levels (re 20µPa))		
Location	Date	Time (hrs)	Duration (mins)	L_{Aeq} dB	L_{AFmax} dB	L_{A90} dB
A1	14/11/2023	10:42	60	50	69	40
L1	14/11/2023	10:51	15	49	65	42
A2	14/11/2023	12:09	60	59	79	53
A4	14/11/2023	13:41	60	46	74	39
A1	15/11/2023	04:07	15	37	54	34
A1	15/11/2023	04:22	15	41	59	36
A1	15/11/2023	04:38	15	40	58	36
A4	15/11/2023	05:03	15	41	55	39
A4	15/11/2023	05:18	15	42	54	40
A4	15/11/2023	05:34	15	43	57	40
A3	15/11/2023	06:04	15	43	54	41
A3	15/11/2023	06:20	15	44	52	43
A3	15/11/2023	06:39	15	44	50	42
A3	15/11/2023	07:02	60	46	63	43
A3	15/11/2023	08:04	60	48	78	46
A4	15/11/2023	09:21	60	49	80	42
A1	15/11/2023	10:35	60	47	80	40
A2	15/11/2023	11:56	60	58	81	52
L2	15/11/2023	13:08	15	58	67	54
A5	23/11/2023	12:53	5	45	52	41
A5	23/11/2023	12:59	5	45	56	41
A6	23/11/2023	13:41	60	49	76	44

Unattended Measurement Results

This section contains the measurement results from the unattended measurements. Table 6 displays the measurements taken from the 10th of November 2023 to the 14th of November 2023 at location L1.

Table 6: Unattended measurement results at location L1

Start Date	$L_{Aeq,16hour}$ 07:00 - 23:00 dB	L_{night} ($L_{Aeq,8hour}$ 23:00 - 07:00) dB	L_{den} (00:00 - 00:00) dB	L_{A90} (23:00 - 07:00) dB	L_{A90} (07:00 - 19:00)	L_{A90} (19:00 - 23:00)
10/11/2023	50	43	50	38	45	42
11/11/2023	50	43	51	35	38	32
12/11/2023	48	46	51	40	38	36
13/11/2023	48	39	51	34	42	37
14/11/2023	50	N/A	50	N/A	51	46
15/11/2023	57	N/A	60	N/A	53	N/A

Table 7 below displays the measurements taken from the 14th of November 2023 to the 15th of November 2023 at location L2.

Table 7: Unattended measurement results at Location L2

Start Date	Lday ($L_{Aeq,16hour}$ 07:00 - 23:00) dB	Lnight ($L_{Aeq,8hour}$ 23:00 - 07:00) dB	Lden (00:00 - 00:00) dB	10th highest night-time L_{AFmax}	L_{A90} (23:00 - 07:00) dB
14/11/2023	58	52	58	65	37
15/11/2023	57	N/A	60	N/A	N/A

Discussion of Measurement Results

The attended background measurements were taken on a weekday to establish the existing background noise levels. Additionally, two logger positions were chosen to collect large amounts of data to help establish the background noise levels across the large site. Attended measurements were taken during both daytime (07:00-23:00) and night-time (23:00-07:00) hours. From the measurements it can be determined that this is not an area of low background noise as defined in EPA NG4.

EPA Quiet Area Screening

The development location does not meet the EPA definition of a “Quiet Area” as it is located < 5km from the M9 National Motorway Route. The EPA NG4 criteria for the development has been set in accordance with the “Areas of Low Background Noise” criteria.

EPA Areas of Low Background Noise

For all areas not identified as Quiet Areas, the existing background noise levels measured during the environmental noise survey should be examined to determine if they are located an area of low background noise, which would mean satisfying each of the following criteria:

- Average Daytime Background Noise Level ≤40dB L_{AF90}, and;
- Average Evening Background Noise Level ≤35dB L_{AF90}, and;
- Average Night-time Background Noise Level ≤30dB L_{AF90}.

If all three of the above criteria are satisfied for any of the measurement locations, then those locations are deemed to be in areas of low background noise, and reduced noise limit criteria would apply.

Unattended noise monitoring results from location L1 are considered to be representative of the existing background noise levels at the NSLs surrounding the proposed substation site and therefore have been used to

assess against the “Area of Low Background Noise” criteria. Table 7 outlines the average daytime, evening and night-time noise levels at monitoring location L1.

Table 8: Average Daytime, Evening and Night-time Noise Levels at Monitoring Location L1

Noise Monitoring Location	**Average Daytime L_{AF90} (07:00 - 19:00)**	**Average Evening L_{AF90} (19:00 – 23:00)**	**Average Night-time L_{AF90} (23:00 - 07:00) dB**
L1	41	37	37

Based on the noise measurement results from L1, it can be determined that the background noise levels do not meet the classification of “Area of Low Background Noise” according to EPA NG4 for daytime, evening and nighttime L_{AF90} measurements undertaken at the site. Therefore, the NG4 noise limit criteria for “All Other Areas” are applicable to the proposed development.

4.3 Weather Conditions for Monitoring Period

In general, good weather conditions were noted during the attended survey, with winds typically less than 5 m/s and no rain and clear skies. A storm impacted the measurements on the night of the 14th of November and subsequently the noise measurements from the night-time period were filtered.

5 Noise Impact Assessment

5.1 Construction Noise Assessment

Based on the location of the site, the construction works the following noise sensitive receptors have been identified. These noise sensitive receptors were chosen as they are the closest NSL's to the proposed development.

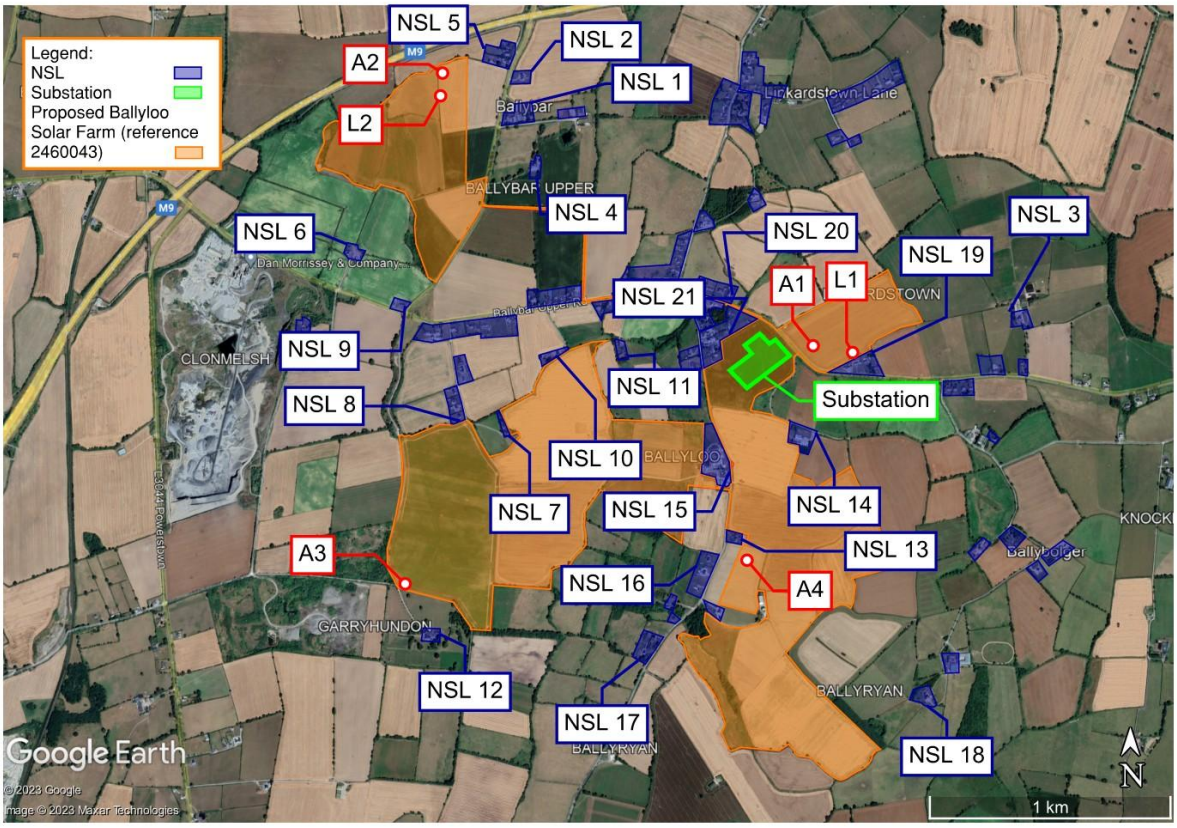

Figure 10: Site location of substation, measurement location, noise sensitive locations.

Noise Limits

The criteria for the project based on the criteria outlined in section 3 and the background noise in the area the project criteria for construction noise is outlined below in Table 9. Reference to the baseline survey results and guidance contained in BS 5228 Part 1 for construction noise levels threshold for significance affect from construction activities is set as follows for the closest noise sensitive locations:

Table 9: Threshold of significant impact at dwellings

Assessment category and threshold Value Period (Laeq)	Threshold value in decibels (dB)		
	Category A	Category B	Category C
Night-time (23:00-07:00)	45	50	55
Evening and Weekends	55	60	65
Daytime (07:00-19:00) and Saturdays (07:00-13:00)	65	70	75

1) A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.

2) If the ambient noise level exceeds the threshold values given in the table (i.e, the ambient noise level is higher that the above values), then a significant effect is deemed to occur if the total L_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.
3) Applied to residential receptors only.

For the appropriate assessment period (i.e. daytime in this instance) the ambient noise level is determined and rounded to the nearest 5dB. If the noise generated by construction activities exceeds the appropriate category value, then a significant effect is deemed to occur. The appropriate category value for this project has been determined as Category A with a 65dBA threshold.

5.1.1 Construction Noise Predictions

Construction noise for the site has been predicted based on the information provided by HW Planning. A summary of the expected equipment, durations and operating times are provided for both the proposed substation and the Ballyloo Solar Farm. The assessment has taken into consideration that the works are dynamic and will be conducted at different locations across the wider development study area. The prediction methodology in BS5228 has been used to calculate the noise level over a typical day for each of the main construction stages.

These predictions include the construction traffic from the site. Table 10 below outlines the plant used for the construction noise impact from works on the proposed substation and the adjacent Ballyloo solar farm. It should be noted that construction noise is considered for both the substation (encompassing the AIS and GIS options) and the Ballyloo Solar Farm as it is envisaged that construction activities for both developments will occur at the same time.

Table 10: Construction noise assessment for solar farm including substation.

Construction Phase	Item of Plant (BS 5228-1:2009+A1:2014 Ref)	Noise Level (L_{Aeq} at 10m dB(A))	On Time of 10 hr day
Enabling Works	Digger	77	3 hours
	Dump Truck	79	3 hours
	Power Tools	70	0.5 hours
	Road Lorry	76	1 hour
Substructure	Excavators	77	3 hours
	Power Tools	70	1 hour
	Tracked Mobile Crane	67	0.5 hour
	Road Lorry	76	1 hour
	Dumper	81	1 hour
	Cement Mixer (Discharging)	75	1 hour
	Telescopic Handler	71	3 hours
	Concrete Pump	78	1 hours
	Piling	63	2 Hours
Civil & Electrical	Road Lorry	76	1 Hour
	Power Tools	70	4 Hours
	Impact Steel	69	2 Hours
	Hammer	69	1 Hour
	Dumper	81	2 Hours
	Telescopic Handler	71	6 Hours

Construction Phase	Item of Plant (BS 5228-1:2009+A1:2014 Ref)	Noise Level (L_{Aeq} at 10m dB(A))	On Time of 10 hr day
Superstructure	Tracked Mobile Crane	67	0.5 Hour
	Power Tools	70	4 Hours
	Impact Steel	69	2 Hours
	Hammer	69	0.5 Hour
	Cement Mixer	75	1 Hour
	Telescopic Handler	71	5 Hours
	Road Lorry	76	1 Hour
External Finishes	Hand Tools	70	5 Hours
	Power Tools	70	2 Hours
	Road Lorry	76	1 Hour

Predicted Construction Noise

Table 11 summarises the predicted construction noise level at the noise sensitive locations. Examination of the results indicate the construction noise without mitigation is predicted to be within the noise limits set out by BS 5228-1 for all stages of the development.

The calculations set out below are based on assumed site construction works and a combination of the plant operating at the same time i.e. worst-case scenario associated with both the construction of the proposed substation and the Ballyloo Solar Farm.

The substructure works and superstructure works were applied to the substation works only as these works are not applicable to the general solar farm works. Many of the noise sensitive locations are a significant distance (>500m) from the substation as shown in Table 1 previously in this report, therefore the construction noise levels at the substation site will be negligible at these NSLs. All substation options (i.e. AIS and GIS) are considered in this assessment. The construction noise levels at the proposed substation are shown for receptors within 500m in Table 11 below.

*Table 11: Predicted noise levels **without** mitigation for each stage.*

NSL	Criteria L_{Aeq}, dB	Predicted noise level (construction noise + ambient) with no mitigation L_{Aeq}, dB				
		Enabling Works	Substructure	Civil & Electrical	Superstructure	External finishes
NSL1	65	65	-	65	-	63
NSL2	65	64	-	65	-	63
NSL3	65	59	-	62	-	59
NSL4	65	64	-	65	-	62
NSL5	65	63	-	65	-	62
NSL6	65	64	-	64	-	63
NSL7	65	61	-	64	-	58
NSL8	65	60	-	58	-	55
NSL9	65	60	-	59	-	56
NSL10	65	60	-	58	-	56

NSL	Criteria L_{Aeq}, dB	Predicted noise level (construction noise + ambient) with no mitigation L_{Aeq}, dB				
		Enabling Works	Substructure	Civil & Electrical	Superstructure	External finishes
NSL11	65	59	-	58	-	56
NSL12	65	59	-	58	-	55
NSL13	65	62	-	61	-	58
NSL14	65	62	63	63	61	62
NSL15	65	61	63	59	61	57
NSL16	65	60	-	59	-	56
NSL17	65	60	-	59	-	57
NSL18	65	60	-	59	-	57
NSL19	65	62	63	64	61	58
NSL20	65	62	63	63	61	62
NSL21	65	63	64	65	62	64

1) Where no noise level has been predicted in the table is because there will be no measurable noise impact from the substation construction.

5.1.2 Predicted Cumulative Noise Impact

The predicted cumulative construction noise impact from other developments in the area as well as the underground cabling and grid connection works has been considered.

The underground cable installation works will be of short duration, transient with approximately 100m of trenching will be completed per day and will largely be within the existing road network. The proposed grid route has been considered as part of the review, and it is not expected based on the information provided to us that the underground cable installation works or the underground grid connection to the existing Kellis substation will exceed the BS 5228-1 criteria for the project.

Based on the information available and provided to us and given the location of these developments in relation to the NSLs for the proposed substation the cumulative noise impact is not expected to exceed the values outlined in Table 11.

Table 12 below outlines the developments with planning in the area.

Table 12: Developments with existing planning within the wider area.

Ref Number	Distance from Subject Site	Status	Description
24/60205	0km	Granted Permission – 24/04/2025	A 10 Year planning permission for a solar farm with a total area of circa 73 hectares in the townlands of Ballybar Lower, Ballybar Upper, Ballycarney, Ballyloo, Linkardstown, Park and Tinryland in County Carlow. The solar farm will consist of solar panels on ground mounted frames, 11 no. single storey electrical inverter/transformer stations, 3 no. single storey spare parts containers, 2 no. Ring Main Units, 3 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L1010, L3051, L3052 and L3050 public roads to connect solar

Ref Number	Distance from Subject Site	Status	Description
			farm field parcels, security fencing, CCTV, access tracks, 3 no. watercourse/drain deck crossings and 2 no. horizontal directional drill crossings (under M9 motorway and L3050), temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 2 no. entrances from the L1022 and L1010. Sections of the proposed underground electrical cabling will traverse the solar farm proposed under Carlow County Council Reference 24/60043, but will not alter infrastructure proposed under that application. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application
24/60043	0km	Granted Permission – 05/09/2025	A 10 Year Planning Permission for a solar farm with a total area of circa 192 hectares. The solar farm will consist of solar panels on ground mounted frames, 30 no. single storey electrical inverter/transformer stations, 4 no. single storey spare parts containers, 4 no. Ring Main Units, 8 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L3051, L3052 and L3050 public roads to connect solar farm field parcels, security fencing, CCTV, access tracks, 2 no. stream deck crossings and 1 no. horizontal directional drill, temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 4 no. entrances from the L3051, L3052 and L3050. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application
25/60137	0km	Notification to grant – 31/10/25	A 10 Year Planning Permission for a solar farm with a total area of circa 57 hectares. The solar farm will consist of solar panels on ground mounted frames, 8 no. single storey electrical inverter/transformer stations, 2 no. single storey spare parts containers, 1 no. Ring Main Unit, 3 no. weather stations, underground electrical ducting and cabling within the development site, private lands and within the L4038, L8185, R448, L3051, L3052 and L3050 public roads to connect solar farm

Ref Number	Distance from Subject Site	Status	Description
			field parcels, security fencing, CCTV, access tracks, 5 no. watercourse/drain deck crossings and 2 no. horizontal directional drill crossings (under M9 motorway and the Dublin - Waterford railway), temporary construction compounds, landscaping and all associated ancillary development and drainage works. Construction and operational access will be via 2 no. existing entrances from the R448 and L1010. Sections of the proposed underground electrical cabling will traverse the solar farms proposed under Carlow County Council References 24/60043 and 24/60205, but will not alter infrastructure proposed under these applications. The operational lifespan of the solar farm will be 40 years and planning permission is requested for this duration. A Natura Impact Statement (NIS) has been prepared and will be submitted to the Planning Authority with the application.
24/60410	0.1km	Granted Permission – 06/06/25	The replacement ("restringing") of the existing overhead line circuit conductor wires with a new higher capacity conductor • the strengthening of foundations at 7no. locations • shear block remedial works at 77no. locations • the strengthening of towers (i.e., member replacement) at 34no. locations • the replacement of 5.1km of earthwire • the painting of all structures • the replacement of insulating and ancillary hardware at structures • all associated works within the existing Kellis 220kV substation to accommodate the uprated 220kV OHL including uprating of the Great Island bay in Kellis 220kV substation
24/60223	0.1km	Granted Permission – 20/09/2024	110kV underground electricity cabling and all associated ancillary site development works. The cabling will extend from and connect with permitted 110kV underground electricity cabling (under An Bord Pleanála reference ABP-313139-22) on the L30535 public road to a line bay in the Kellis 220kV substation.
313139-22	0.1km	Granted Permission – 03/11/2022	Proposed 110kV substation and underground grid connection.
20143	0.1km	Granted Permission – 2/09/2021	A 10 year Planning Permission for a solar farm.
24/60295	2.0km	Live Application, Decision Due – 07/01/2026	Ten year planning permission for renewable energy development comprising of the construction of a solar farm.
ABP-303821	0.2km	Granted Permission – 23/09/2019	10 year permission for an up to 100MW Battery Energy Storage Facility providing energy services to the National Grid consisting of construction and operation of up to 34 metal containers.

Ref Number	Distance from Subject Site	Status	Description
ABP-320354	c. 5.5km	Live Application, Decision Due – 04/12/2024 (Decision delayed at Board)	Permission for the construction of 7 wind turbines and all associated works. A 10 year planning permission and 35 year operational life of the wind farm from the date of commissioning is sought. Environmental Impact Assessment Report and Natura Impact Statement submitted with application.
24/60295	c.2.4km	Live Application, Decision Due – 7/01/2026	Ten-year planning permission for renewable energy development comprising of the construction of a solar farm.
24/60332	c. 1.8km	Granted Permission – 12/12/2024	the demolition of all existing structures within the Tinryland Wastewater Treatment Plant and the construction on an extended site (0.09 ha in total) which will consist of a new pumping station (17m2), new below-ground storm tank (total storage of 123m³), replacement welfare facility (33m2), ground-mounted photovoltaic array (83 m2), new palisade perimeter fencing (2.4m high) and associated works; the construction of a new rising main and gravity main (3.7km in length) along the Nurney Road, L1023 and N80, connecting to the existing wastewater sewer at Ballinacarrig; and all ancillary and associated temporary works. A Natura Impact Statement (NIS) will be submitted to the Planning Authority with the application
ABP-318295	c. 3.7km	Granted Permission – 21/11/2024	Construction of five wind turbines, meteorological mast, electricity sub station and associated site works. The application is accompanied by a Planning Report, Environmental Impact Assessment Report and a Natura Impact Statement.
24/60149	c. 1.4km	Granted Permission – 27/09/2024	The expansion of the existing commercial store into the adjoining agricultural use buildings including raised roof height to the unit to the east and the provision of a retention pond and all associated ancillary works, the buildings will be repurposed as whiskey maturation warehouses
ABP-318475	c. 8km	Granted Permission – 04/06/2024	A ten year planning permission for a solar energy development with a total site area of 77 hectares and all associated site works.
ABP-315063	c. 0.1km	Granted Permission – 02/05/2024	Development of a synchronous condenser grid support facility and all associated works
ABP-315365	c. 5.5km	Granted Permission – 21/11/2023	Wind energy development consisting of 7 no. wind turbines and all associated works.
ABP-322690	c.0km	Live Application - due to be decided by 01/12/2025	Proposed 110kV electrical substation and grid connection.

Ref Number	Distance from Subject Site	Status	Description
ABP-321416	c.3km	Live Application - due to be decided by 05/06/2025	Proposed development along a section of the N80 Road known as the N80 Leagh Bends Scheme.
21/23	c.3.75km	Granted 26/10/21	Construction of a Solar PV development and all associated site works.
23/92	c.3.85km	Granted 04/06/2024	A ten-year planning permission for a solar energy development with a total site area of 77 hectares and all associated site works.
22/142	c.3km	Granted Permission – 22/03/2023	Clonmacshane Solar Farm
ABP-314421	c. 460m	Granted Permission – 26/07/2022	To construct a 30m multi-user lattice telecommunications support structure, carrying antenna and dishes enclosed within a 2.4 metre high palisade fence compound together with associated ground equipment cabinets and associated site works including new access track and to replace existing gated access. The installation will form part of eir mobile telecommunications network. A Natura Impact Statement (N.I.S.) will accompany the planning application.

There is no predicted negative cumulative noise impact predicted from the development and other committed developments in the area.

Other Considerations

Additional traffic noise from the construction works is not expected to increase the traffic noise from the roads to any significant impact. The Design Manual for Roads and Bridges (DMRB) states that a 25% increase in traffic flows leads to a 1dBA increase in traffic noise levels. Construction traffic flow increases associated with the proposed development will be significantly less than 25% and therefore the noise levels from construction traffic will not increase the existing noise levels at the noise sensitive locations by more than 1dBA.

It is generally accepted that it takes an approximate 3dBA increase in noise levels to be perceptible to the average person (Ref: Planning Policy Guidance Note 24 [PPG24 - Planning & Noise]). Construction traffic noise levels associated with the Proposed Development will not have a negative impact on nearby noise sensitive locations (NSLs).

5.1.3 General Recommendations

This section of the report sets out general recommendations for the control of noise from construction works. As stated in Section 5.1 no construction mitigation is required as all noise from construction works falls within the criteria set out by BS 5228-1. Notwithstanding, the following standard noise commitments will be adhered to.

Selection of Plant and Equipment

The noise impact of all plant and equipment should be assessed prior to selection of the plant for the project. Where an item of plant is identified as noisy with the potential to cause a negative noise impact it should be reviewed to check if there is an alternative quieter version of the same plant to undertake the same construction task.

Noise Control at Source

Where replacing a noisy item of plant is not viable or practical, consideration should be given to control that noise at source. This includes modifying the piece of plant or equipment to generate less noise, using dampening to

control vibration induced noise or rattling. Example best practice mitigation measures to be considered are as follows:

- All plant and equipment to be switched off when idling.
- The use of white noise reversing alarms.
- Restriction on the dropping and loading of materials to less sensitive hours.
- The use of local screening for noisy activities or works with hand tools
- Not dropping materials onto hard surfaces and using rubber mats etc for the dropping of materials.
- Ensure all plant and equipment is well maintained and cleaned, all lubrication should be in line with manufacturers guidelines.

Screening

Screening when used correctly can be an effective method of reducing the construction noise impact on the NSL's. The use of site hoarding and careful selection of areas for noise works, using buildings on the site, site offices and the building being constructed to screen noise from the works.

Local screening of noisy works with the use of temporary acoustic barriers, examples are provided below:

- https://ventac.com/acoustic-products/noisebreak-acoustic-barrier/
- https://echobarrier.com/

Figure 11: Temporary Construction Noise Barrier © Ventac

Construction Noise Monitoring

Construction noise monitoring will be undertaken at periodic sample periods on the boundary with the nearest noise sensitive receptors.

Noise monitoring will be conducted in accordance with the International Standard ISO 1996: 2017: Acoustics – Description, measurement and assessment of environmental noise.

5.2 Construction Vibration

Prediction of vibration levels at receptors is complex and dependent on several variables including the nature of the used equipment, the properties of the subsoil, the heterogeneity of the soil deposit, the distance to the receptor and the dynamic characteristic of the adjacent structures. Therefore, limits or threshold criteria as set out in BS5228-2 are applied for buildings and humans.

Based on our understanding of the project and the distances to the receptors it is not anticipated that there will be any negative vibration impact from the construction works.

5.3 Operational Phase

Following the survey, a model of the proposed development using SoundPLAN 9.1 modelling software was developed to establish the noise levels from the proposed development in operation in a worst-case scenario. The software implements the algorithms contained in ISO 9613-1 and ISO 9613-2. The noise model considers:

- Distance attenuation,
- Source and receptor locations,
- Barrier effects (buildings, walls etc)
- Topographical elevations,
- Ground effects and absorption,
- Source sound power levels,
- Directivity and orientation of the source,
- Atmospheric attenuation and meteorological effects.

The SoundPLAN 9.1 predictive model uses methodology via a ray tracing method, in principle the modelling follows the general principles of the following formula outlined in ISO 9613 Part 1 and Part 2: *Acoustics - Attenuation of sound during propagation outdoors*:

$$Lp = Lw - 20\log_{10}(R) - 11 - A - B - G$$

Where:

- Lp is the sound pressure level at a particular point.
- Lw is the sound power level of the plant and equipment.
- R is the distance from the noise source at which the sound pressure level is predicted.
- 11 is a constant based on a noise source with omnidirectional directivity.
- A considers the correction reduction in noise levels via atmospheric conditions.
- B considers the correction reduction in noise levels due to noise barriers.
- G considers the correction reduction in noise levels due to ground absorption and topography.

The acoustic model for the proposed substation and adjacent solar farm developments has been developed based on attended and unattended noise survey and the proposed site location and predicted noise sources. As the site has potential to create noise impact at both day and nighttime, a worst-case scenario has been developed for both predicting the noise impact at the nearest noise sensitive locations.

5.3.1 Operational Noise from Substation and adjacent Solar Farms

From discussions with the design team, it has been confirmed that the external plant and equipment for the proposed substation and the adjacent solar farms with the potential to generate operational phase noise consists of the substation itself (AIS or GIS) and inverter/transformer stations within the solar farm. The noise levels from the substation have been assumed based on data from the WDA library.

Noise levels at the NSLs were assessed to the height of the worst-case façades (4m for two-storey NSLs), to predict the noise levels at the first-floor bedrooms of the nearest noise sensitive receptors. Noise levels were also checked at 2m to assess the external amenity noise levels on the NSLs, and grid noise contours have been provided in Figure 12 and Figure 13 at this height.

The sound power levels from the noise sources are based on the information from our library and previous planning applications for similar developments as outlined in Table 13. Equal or approved plant is suitable for the development.

Table 13: Assumed noise levels for plant and equipment proposed.

Item	Assumed Noise Level (L_{wA})	Reference Source
Substation Assumed (Equal or approved)	92 dB	WDA Library
1 x Inverter/Transformer	94 dB	WDA library
2 x Inverter/Transformers	97 dB	WDA library

Substation Noise

The SID application outlines three potential options for the substation including:

- 110kV AIS Substation,
- 220kV AIS Substation,
- 220kV GIS Substation.

The 110kV and 220kV AIS substations will consist of the same infrastructure and equipment for both, with the only difference being the clearance distances between specific equipment. The noise levels from either AIS substation will be the same, with the main transformer typically having sound power level of 92dBA L_w.

The 220kV GIS substation consists of a two-storey building which will house the GIS substation. As the equipment is housed internally within the building, the operational noise levels from the GIS substation are lower than the AIS.

As a worst case scenario, the operational noise model outlined in this report is based on the AIS substation noise levels.

Cumulative Noise Impact Assessment

Ballyloo Solar Farm Limited have also applied for planning permission for three Solar Farms located nearby the proposed substation including:

- Ballyloo Solar Farm (reference number 24/60043) which has been granted by An Coimisiún Pleanála. The proposed substation outlined in this report will be located on the lands of the solar farm application, with the solar farm surrounding as shown in Figure 7.

The Park Solar Farm and the Ballybannon Solar Farm proposed by Ballyloo Solar Farm Limited are predicted to have no impact at the noise sensitive locations near the substation due to their distance from the site (>2km). See Section 5.3.6 for details of the cumulative noise impact assessment.

5.3.2 Daytime Operations

As the substation, grid connection and permitted solar farm have the potential to generate noise with different characteristics for both the day and night-time, a model has been undertaken for both the day and nighttime operations of the proposed development. This section outlines the operational noise assessment for the daytime scenario.

The daytime situation assumes the following noise sources:

- Substation operating at full capacity as per Table 13 continuously.
- Inverters/transformers operating for daytime daylight hours (7am-10pm).
- Assumed noise level in (L_{wA}) for inverters and AC condenser used in model as per Ballyloo Solar Farm noise impact assessment (reference number 24/60043),
- Model calibrated using on-site measurements.

The nearest noise sensitive receivers in each direction were taken as part of the assessment as identified in Figure 10. This allows for a worst-case scenario assessment, NSLs further away from the solar farm are expected to experience lower noise levels with typical conditions due to distance attenuation.

NG4 recommends a daytime criterion (07:00hrs – 19:00hrs) of 55dB $L_{Ar,T}$. The predicted noise emissions from the solar farm at each NSL for a height of 4m (worst-case i.e first floor bedrooms) have been outlined in Table 14. All values refer to the free field façade noise levels.

Table 14: Model results for the noise impact from the substation, grid connection and solar farm for daytime at 4m height.

NSL	Criteria dB L_{ArT}	Daytime Predicted Noise dB L_{ArT} (7:00hrs to 19:00hrs)	Compliant/Non-Compliant
NSL1	55	40	Compliant
NSL2	55	37	Compliant
NSL3	55	31	Compliant
NSL4	55	37	Compliant
NSL5	55	37	Compliant
NSL6	55	38	Compliant
NSL7	55	43	Compliant
NSL8	55	40	Compliant
NSL9	55	37	Compliant
NSL10	55	40	Compliant
NSL11	55	38	Compliant
NSL12	55	35	Compliant
NSL13	55	39	Compliant
NSL14	55	40	Compliant
NSL15	55	40	Compliant
NSL16	55	38	Compliant
NSL17	55	37	Compliant
NSL18	55	34	Compliant
NSL19	55	34	Compliant
NSL20	55	38	Compliant
NSL21	55	39	Compliant

Figure 12 on the next page outlines the daytime predicted noise emissions from the proposed substation and Ballyloo Solar Farm in operation for the daytime period at 2m height in the external amenity spaces. As noted from the grid noise map all residential receptors are outside of the 55 dBA contour for daytime and therefore compliant with the NG4 project criteria.

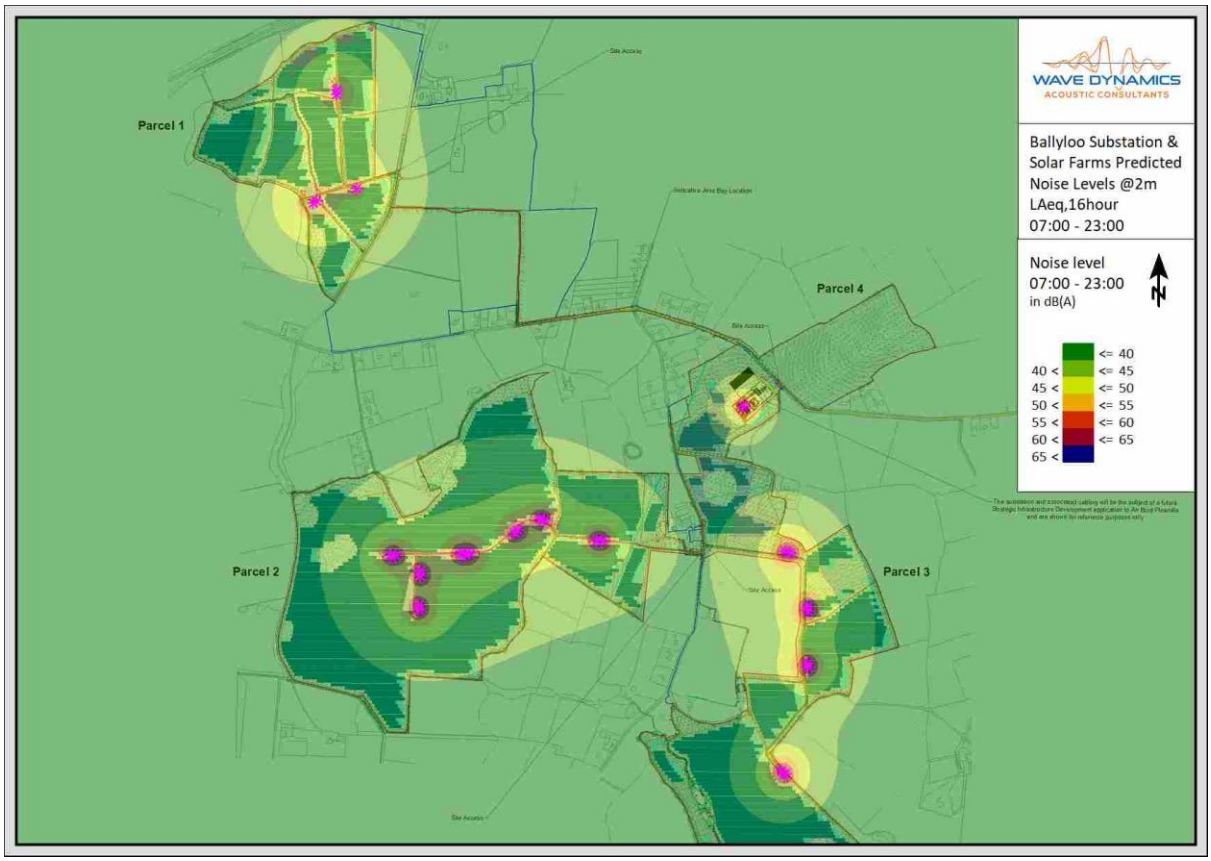

Figure 12: Noise contours for the daytime noise impact

All predicted noise the levels are below the NG4 project criteria and therefore within the project requirements.

Evening Time Scenario

The noise levels for the evening time are predicted to be the same as the daytime noise levels however as per EPA NG4 criteria, a lower noise criteria of 50dB $L_{Ar,T}$ is applicable. Based on the predicted noise levels outlined in Table 14 and shown in Figure 12, the evening time criteria is predicted to be achieved. As the predicted specific sound is below the background noise therefore no perceptible noise impact from the proposed substation and Ballyloo Solar Farm operations is predicted for both the day and evening time periods.

Consideration was also given to the BS4142 requirements, as the specific sound is below the background noise in the area no negative noise impact is predicted in accordance with BS 4142.

5.3.3 Night-time Operations

The proposed substation is understood to be operational continuously throughout the night time. As solar panels produce power only when the sun is shining, inverters will be virtually silent for the hours of darkness at night. However, this assessment is based on a worst-case scenario to include summer months where the sunrise may happen pre 7am where inverters and transformers may begin noise generating activities.

The night-time situation assumes the following noise sources:

- Substation operating at full capacity as per Table 13 continuously.
- Two hours of inverter use during nighttime daylight hours (5am-7am).
- Assumed noise level in (L_{wA}) for inverters and AC condenser used in model as per Ballyloo Solar Farm noise impact assessment (reference number 24/60043),
- Model calibrated using on-site measurements.

NG4

NG4 recommends a night time criteria of 45dB $L_{Aeq,T}$. The predicted noise levels from the proposed substation and adjacent solar farms are compliant at all noise sensitive locations. All predicted values refer to the free field façade noise levels.

Table 15: Model results for night-time at the NSLs at a height of 4m.

NSL	Criteria dB L_{Aeq}	Nighttime Predicted Noise dB L_{Aeq} ((23:00hrs to 07:00hrs	Compliant/Non-Compliant
NSL1	45	35	Compliant
NSL2	45	32	Compliant
NSL3	45	27	Compliant
NSL4	45	32	Compliant
NSL5	45	32	Compliant
NSL6	45	33	Compliant
NSL7	45	38	Compliant
NSL8	45	34	Compliant
NSL9	45	32	Compliant
NSL10	45	35	Compliant
NSL11	45	33	Compliant
NSL12	45	30	Compliant
NSL13	45	34	Compliant
NSL14	45	35	Compliant
NSL15	45	35	Compliant
NSL16	45	33	Compliant
NSL17	45	31	Compliant
NSL18	45	29	Compliant
NSL19	45	30	Compliant
NSL20	45	37	Compliant
NSL21	45	37	Compliant

Figure 13 on the next page outlines the nighttime predicted noise emissions from the proposed substation and Ballyloo Solar Farm in operation for the daytime period at 2m height.

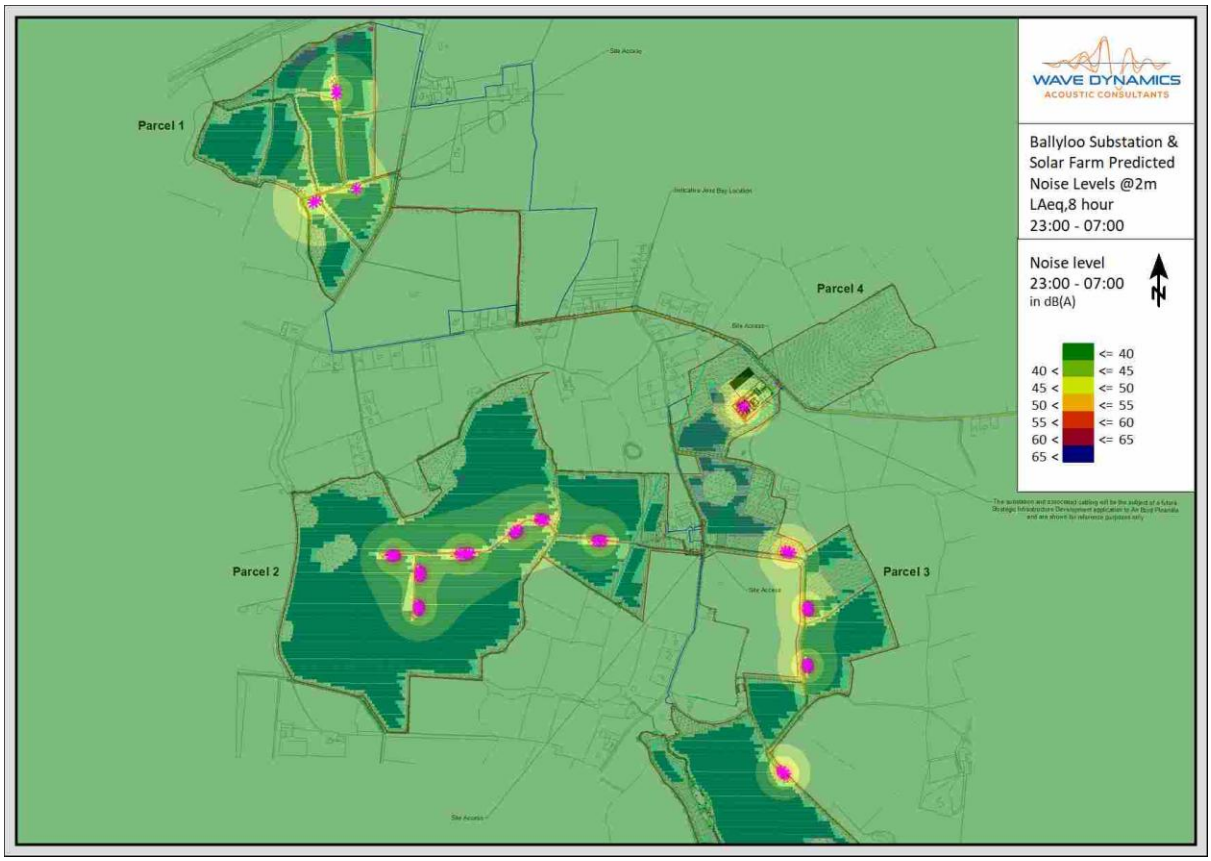

Figure 13: Noise contours for the night-time noise impact.

As noted from the grid noise map and Table 15 all residential receptors are outside of the 45 dBA contour for night-time and therefore compliant with the NG4 project criteria. As the predicted specific sound is below the background noise therefore no perceptible noise impact from the proposed substation or solar farm is predicted. Consideration was also given to the BS4142 requirements, as the specific sound is below the background noise in the area no negative noise impact is predicted in accordance with BS 4142.

Modelling Assumptions

The following assumptions were made throughout the modelling and assessment:

- Assessment based on the noise measurements undertaken onsite outlined in Section 4.
- Noise source data for the assessment was based on the noise sources, information provided by the design team and previous planning applications for the nearby solar farms.
- Model assumes a worst-case operating scenario as outlined in Section 5 above.
- Modelling based on the drawings, layouts and information provided.
- Assessment based on proposed substation and adjacent solar farms.
- Modelling tolerances apply +/- 3dB.

5.3.4 BS4142 Operational Noise Assessment

In addition to the assessment outlined above in line with EPA NG4 criteria, the solar farm and substation have been assessed using BS4142 criteria. The operational noise levels from the full development are predicted to be in general below the background noise levels in the area and therefore it is likely there will be no adverse noise impact. Based on the information provided and the assumptions in this report it is predicted that the noise levels in general will not increase the background noise at the NSLs,

5.3.5 Tonality & Impulsivity

Based on the noise levels at all of the noise sensitive locations, it is predicted there will be no audible tonal or impulsive characteristics to the noise levels. The operational noise of the proposed substation will consist of mechanical plant and equipment noise from continuous operation of the transformers in addition to the operation of the solar farm inverter / transformer units in operation during sunlight hours. The operation of the substation does not include activity that could create impulsive noise. It will be ensured that the selected equipment will not have any impulsive characteristics. Plant and equipment shall be maintained to ensure it operates in its normal capacity.

A prediction of the one third octave band noise levels from the inverter / transformer units and the substation has been undertaken based on the proposed development which indicated no tonal characteristics of the noise. The predicted noise levels from the development were generally lower than the existing daytime background noise levels (L_{A90}) measured at the site. The predicted nighttime noise levels from the development are lower than the background noise levels (L_{A90}) measured across the site.

5.3.6 Cumulative Noise Impact Assessment

The predictions outlined in this report are inclusive of the Ballyloo Solar Farm Limited proposed developments surrounding the site and to the northwest of the proposed substation site. As the nearby Park Solar Farm and Ballybannon Solar Farm and grid connection are over 2km from the proposed development at the closest point to the substation, there will be no audible noise levels from the other committed developments at the noise sensitive locations outlined in this report.

5.3.7 Operational Phase Conclusion

Based on the information provided, the site survey and the worst-case scenario predictions **it is predicted that noise emanating from the development will achieve the NG4 and BS4142 project criteria without any additional mitigation works. In general, the predicted noise levels are well below the project criteria.**

6 Conclusion

Wave Dynamics were engaged by Ballyloo Solar Farm Limited to undertake a noise impact assessment for a proposed new substation and underground cable grid connection which is associated with the development of solar farms in County Carlow. The substation and grid connection will be located in the townlands of Ballyloo, Castletown, Graiguenaspiddoge, Kellistown East, Kellistown West, Kilballyhue, Knockbower, Leagh Or Ballybeg, Linkardstown and Moyle Big (townlands), County Carlow.

This report outlines the project criteria, survey results, assessment, and general guidance recommendations for:

- Construction noise from the construction of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.
- Operational noise from operation of the proposed substation, underground cable grid connection and nearby Ballyloo Solar Farm.

Based on the operational hours of the development there is potential for noise impact in both the day and night-time, therefore an assessment for both has been conducted.

The noise impact assessment included attended and unattended noise measurements on the proposed development lands. This included measurements of background noise at the noise sensitive locations. Appendix A outlines a glossary of the acoustic terminology used in this report.

Construction Noise and Vibration

The construction noise and vibration from the development have been predicted to the nearest noise sensitive (NSLs) receptors of the substation and nearby solar farms. The construction predictions were based on the procedures outlined in BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites – Noise. The construction noise from the development will be of a short-term nature. The works have been assessed on the basis that they will be sequential.

Consideration was given to the construction of the substation, underground cable grid connection and the nearby Ballyloo Solar Farm and the cumulative noise and vibration impact from the construction works. **Based on the assessment outlined in this report it is predicted that the construction noise and vibration from the proposed substation and underground grid connection will comply with the recognised best practice standards typically adopted for such projects in Ireland**

Operational Noise

The noise levels from the substation, grid connection and nearby solar farms were assessed using criteria set out by EPA NG4 and BS4142 2014 A1+ 2019 Methods for rating and assessing industrial and commercial sound, which predicted that there is an unlikely adverse impact at all noise sensitive receptors for the daytime, evening and night-time periods.

Based on the assessment outlined in this report it is predicted that the operational noise levels at the proposed substation and underground grid connection will comply with the project criteria and not produce a negative noise impact.

Appendix A- Glossary of Terms

Ambient Noise	The totally encompassing sound in a given situation at a given time, usually composed of sound from all the noise sources in the area.
Background Noise	The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T ($L_{AF90,T}$).
dB	Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 μPa).
dB(A)	An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Hertz	The unit of sound frequency in cycles per second.
L_{A90}	A-weighted, sound level just exceeded for 90% of the measurement period and calculated by statistical analysis. See also the background noise level.
L_{Aeq}	A-weighted, equivalent continuous sound level.
L_{AFmax}	A-weighted, maximum, sound level measured with a fast time-constant - maximum is not peak
R_W	Weighted sound reduction index - a single number quantity which characterises the airborne sound insulation of a material or building element over a range of frequencies, based on laboratory measurements