Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 1

Chapter 23 - Noise and Vibration

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Glossary of Acronyms

AAWT	Annual Average Weekday Traffic
ACR	Air Core Reactor
AIS	Air Insulated Switchgear
BDC	Broadland District Council
BEIS	Department for Business Energy and Industrial Strategy
BNL	Basic Noise Level
BPM	Best Practicable Means
BS	British Standard
BSI	British Standards Institution
CBS	Cement Bound Sand
CCW	Countryside Council for Wales
CFA	Continuous Flight Auger
CIA	Cumulative Impact Assessment
CNMP	Construction Noise Management Plan
CoCP	Code of Construction Practice
CPC	Cawston Parish Council
CRTN	Construction of Road Traffic Noise
CTMP	Construction Traffic Management Plan
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DEFRA	Department for the Environment and Rural Affairs
DEP	Dudgeon Offshore Wind Farm Extension Project
DMRB	Design Manual for Roads and Bridges
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
HDD	Horizontal Directional Drilling
HGV	Heavy Goods Vehicle
HVAC	High-Voltage Alternating Current
IEMA	Institute of Environmental Management and Assessment

IPMP	In-principle Monitoring Plan
ISO	International Standards Organisation
km	Kilometre
LFR	Landfall Receptor
LOAEL	Lowest Observed Adverse Effect Level
MW	Megawatts
NAC	Noise Advisory Council
NE	Natural England
NNC	North Norfolk Council
NNDC	North Norfolk District Council
NNG	Night Noise Guideline
NOEL	No Observed Effect Level
NorCC	Norwich City Council
NPPF	National Planning Policy Framework
NPPG	National Planning Practice Guidance
NPS	National Policy Statement
NPSE	Noise Policy Statement for England
NSIP	Nationally Significant Infrastructure Project
NSR	Noise Sensitive Receptor
OAE	Observed Adverse Effect
OCoCP	Outline Code of Construction Practice
OPC	Oulton Parish Council
PEIR	Preliminary Environmental Information Report
PPG	Planning Practice Guidance
PPV	Peak Particle Velocity
PRoW	Public Right of Way
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SGT	Super Grid Transformer
SHR	Shunt Reactor
SNC	South Norfolk Council
SNDC	South Norfolk District Council
SOAEL	Significant Observed Adverse Effect Level
SPC	Swainsthorpe Parish Council

SSR	Substation Receptor
TRRL	Transport and Road Research Laboratory
UK	United Kingdom
WHO	World Health Organisation

Glossary of Terms

Order Limits	The area subject to the application for development consent, including all permanent and temporary works for SEP and DEP.
Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas, and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the EIA and HRA for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable corridor which would house HDD entry or exit points.
Jointing bays	Underground structures constructed at regular intervals along the onshore cable corridor to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water
Onshore cable corridor	The area between the landfall and the onshore substation sites, within which the onshore cable circuits will be installed along with other temporary works for construction.
Onshore export cables	The cables which would bring electricity from the landfall to the onshore substation. 220 – 230kV.
Onshore Substation	Compound containing electrical equipment to enable connection to the National Grid.

PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
Study area	Area where potential impacts from the project could occur, as defined for each individual Environmental Impact Assessment (EIA) topic.
The Applicant	Equinor New Energy Limited

23 NOISE AND VIBRATION

23.1 Introduction

1. This chapter of the Environmental Statement (ES) describes the potential noise and vibration impacts of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP). The chapter provides an overview of the existing environment for the proposed onshore development area, followed by an assessment of the potential impacts and associated mitigation for the construction, operation, and decommissioning phases of SEP and DEP.
2. This assessment has been undertaken with specific reference to the relevant legislation and guidance, of which the primary source is the National Policy Statements (NPS). Details of these and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) are presented in **Chapter 5 EIA Methodology** and **Section 23.4**.
3. The assessment should be read in conjunction with the following linked chapters:
   - **Chapter 20 Onshore Ecology and Ornithology;**
   - **Chapter 21 Onshore Archaeology and Cultural Heritage;**
   - **Chapter 24 Traffic and Transport;**
   - **Chapter 27 Socio-Economics and Tourism;** and
   - **Chapter 28 Health**.
4. Additional information to support the Noise and Vibration assessment includes:
   - **Appendix 23.1 Baseline Noise Survey and Acoustic Terminology;**
   - **Appendix 23.2 Road Traffic Noise Assessment;**
   - **Appendix 23.3 Construction Noise and Vibration Assessments;** and
   - **Appendix 23.4 Onshore Substation Operational Noise Assessment.**

23.2 Consultation

5. Consultation has been undertaken in line with the general process described in **Chapter 5 EIA Methodology** and the **Consultation Report** (document reference 5.1). The key elements to date have included scoping and consultation with Broadland District Council (BDC), South Norfolk Council (SNC) and Norwich City Council (NorCC) to discuss the approach for determining the existing noise environment, detailed in **Section 23.5**. The feedback received has been considered in preparing this chapter. **Table 23-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

6. The feedback received throughout this process has been considered in undertaking the noise and vibration assessment. This chapter incorporates the comments received on the Preliminary Environmental Information Report (PEIR) following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Table 23-1** provides a summary of the consultation responses received to date relevant to this topic and how these have been addressed.

Table 23-1: Consultation Responses

Consultee	Date/ Document	Comment	Project Response
Scoping Responses - The following comments were received prior to consultation on the PEIR and were in response to the Scoping Report or direct consultation with stakeholders. These comments were taken into account in the production of the PEIR.			
Scoping Opinion	Scoping Opinion Response 19/11/19	Paragraphs 744 and 745 of the Scoping Report state that there will be no significant sources of vibration associated with the operational substation due to use of vibration isolation pads/mounts to prevent transmission of ground borne vibration according to industry standards. The Scoping Report states that there will be negligible levels of ground-borne vibration, but no details of industry standards have been provided and at this stage the exact location of onshore infrastructure and proximity to receptors has not yet been determined. The Inspectorate therefore does not agree this can be scoped out at this stage.	Refer to **Section 23.4.3.7** for discussion on operational phase vibration assessment methodology, which provides a justification for scoping out these effects.
Scoping Opinion	Scoping Opinion Response 19/11/19	Table 3-19 proposes to scope out transboundary impacts from increased noise and vibration, although no justification is provided within the aspect chapter. Nevertheless, given the nature of the Proposed Development the Inspectorate agrees that significant transboundary effects of this type are unlikely and therefore this matter can be scoped out of the ES.	Transboundary impacts scoped out of assessment.
Scoping Opinion	Scoping Opinion Response 19/11/19	The Inspectorate agrees that given the distance between the proposed offshore wind farm arrays and the coast, construction activities in the array area are unlikely to result in significant effects to onshore receptors and that this matter can be scoped out of the ES. With regards to the installation of the export cable, no evidence has been provided to back up the assertion that “noise generated by cable laying vessels is generally low and is unlikely to be significantly elevated above background levels”. In the absence of a defined cable corridor, it is not possible to determine what receptors could be potentially affected from near-shore. The Inspectorate considers that	Noise impacts from construction of the offshore wind farm arrays on onshore receptors are scoped out of the assessment. Offshore cable laying vessels will be operating further than 1km from the shore, refer to **Chapter 4 Project Description**, **Section 4.5.** Given that distance of separation no noise impacts would be experienced by noise sensitive

Consultee	Date/ Document	Comment	Project Response
		any likely significant effects should be assessed.	receptors onshore. As such, potential noise impacts from cable laying vessels to onshore receptors has not been considered in the assessment.
Scoping Opinion	Scoping Opinion Response 19/11/19	The Inspectorate agrees that given the distance between the proposed offshore wind farm arrays and the coast, operational turbine noise is unlikely to result in significant effects to onshore receptors and that this matter can be scoped out of the ES.	Operational noise impacts from the offshore wind farm arrays scoped out of the assessment.
Scoping Opinion	Scoping Opinion Response 19/11/19	The ES should provide a description of the noise generation aspects of the Proposed Development for both the construction and operation stage. Any distinctive tonal, impulsive or low frequency characteristics of the noise should be described.	Potential construction noise is presented in **Section 23.6.1.1** Operational noise associated with the onshore substation is described in **Section 23.6.2.1** and supplemented by **Appendix 23.4 Onshore Substation Operational Noise Assessment**.
Scoping Opinion	Scoping Opinion Response 19/11/19	The Scoping Report acknowledges the potential for piling of foundations for the substation and infrastructure (including National Grid infrastructure, drilling rigs at the landfall, and along the onshore cable corridor). The ES should identify the locations of any necessary piling and assess the impacts. Where uncertainty exists, the assessment should be undertaken on the basis of the worst-case scenario for noise.	Consideration of noise associated with piling is presented in **Section 23.6.1.3**.
Scoping Opinion	Scoping Opinion Response 19/11/19	The ES should provide details of any noise modelling undertaken to inform the assessment, including the relevant input parameters.	Details of noise modelling for the onshore substation options are provided in **Appendix 23.4 Onshore Substation Operational Noise Assessment**.
Scoping Opinion	Scoping Opinion Response 19/11/19	The Scoping Report has not provided a justification for scoping these matters out of the assessment. The Inspectorate considers that significant effects to any recreation/tourism assets along the onshore cable corridor are unlikely to be significant during the operational	As discussed above, operational turbine noise is scoped out of the ES. Operational noise impacts associated with the cable corridor are also not anticipated and scoped out. Hence, the

Consultee	Date/ Document	Comment	Project Response
		phase. However, the exact location of the onshore substation has not yet been determined and Figure 4.4.1 shows a number of tourist attractions within the search area for the substation. As such, the Inspectorate considers it would be premature to scope out the potential for loss of, disturbance to and visual impacts to tourism and recreation assets. However, the Inspectorate agrees that significant effects to these receptors from noise and dust during operation are unlikely and that these matters can be scoped out of the assessment.	only anticipated operational impacts are associated with the substation noise. There are no recreation/tourism receptors with the potential to be impacted by substation operational noise. Hence, as per the scoping response, operational noise impacts associated with disturbance to recreation and tourism are scoped out of this assessment. Tourism and recreation effects are considered in **Chapter 27 Socio-Economics and Tourism**
BDC detailed in the Scoping Response	Email attached to Scoping Response 01/12/20	On behalf of the District Council I would like to request that the Environmental Statement includes the impacts of the proposals on the following topics: Historic environment (including cultural heritage, listed building and archaeology); Landscape (including important views, trees, historic hedgerows) and have regard to the District Council's Landscape Character Assessment SPD; Biodiversity; Geology & Soils; Noise, Vibration and Air Quality; People and Communities.	Potential noise and vibration impacts are considered in **Section 23.6**. Impacts of the proposals on the other requested topics are addressed in **Chapter 17 Ground Conditions and Contamination**; **Chapter 19 Land Use, Agriculture and Recreation**; **Chapter 20 Onshore Ecology and Ornithology**; and **Chapter 26 Landscape and Visual Impact Assessment**.
Cawston Parish Council (CPC) detailed in the Scoping Response	Email attached to Scoping Response 01/12/20	A full assessment of the cumulative impact of Dudgeon Sheringham shoal extensions with the three other wind farm cable corridor schemes which affect North Norfolk including the Cawston area. All assessments of items affecting public health and well-being, including noise and vibration, air quality and traffic impacts, should include the cumulative impacts with the other schemes noted above.	Cumulative noise impacts are assessed in **Section 23.7**. It should be noted that the Applicant has committed to avoid routing SEP and DEP construction traffic through Cawston. This is detailed in **Chapter 24 Traffic and Transport, Table 24.3**.
Natural England	Email attached to	Schedule 4 of the Town & Country Planning (Environmental Impact	Potential noise impacts are discussed in

Consultee	Date/ Document	Comment	Project Response
(NE) detailed in the Scoping Response	Scoping Response 01/12/20	Assessment) Regulations 2017 sets out the necessary information to assess impacts on the natural environment to be included in an ES, specifically: Expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed development.	**Section 23.6**. Other relevant referenced residues and emissions are assessed in the following chapters: **Chapter 17 Ground Conditions and Contamination**; **Chapter 18 Water Resources and Flood Risk**; **Chapter 22 Air Quality**; and **Chapter 26 Landscape and Visual Impact Assessment**.
Oulton Parish Council (OPC) detailed in the Scoping Response	Email attached to Scoping Response 01/12/20	Oulton Parish Council wish to highlight these main concerns… Traffic and transport (project in isolation and cumulative with other projects) Noise from traffic and construction (project in isolation and cumulative with other projects) Night time working (noise and light pollution)	Potential noise impacts associated with construction works (including the potential for evening and night time working) are considered in **Section 23.6.1.1.1**, impacts associated with noise related to construction traffic are considered in **Section 23.6.1.4**.
Environmental Topic Group (ETG) Meetings			
BDC/South Norfolk District Council (SNDC)	ETG Meeting 1 and Evidence Plan Agreement Log, November 2020	Proposed noise survey approach and a review of questions raised by BDC relating to the baseline survey methodology document via email (14th October 2020) were discussed.	Proposed noise survey approach was discussed and agreed and is set out in **Section 23.5**. It was agreed that the construction phase assessment noise thresholds should be based around the BS 5228:2009+A1:2014 'ABC method'. It was also agreed that a conservative approach would be to use the lowest threshold (for the BS 5228:2009+A1:2014 'ABC method') at all identified noise sensitive receptors for the assessment of construction noise. Refer to **Section 23.6**.
BDC/SNDC	ETG Meeting 1 and	Additional and/or amended survey locations.	No survey was undertaken at SSR10

Consultee	Date/ Document	Comment	Project Response
	Evidence Plan Agreement Log, November 2020		(previously SSR9) due to access constraints. Refer to **Section 23.5**.
BDC/SNDC	ETG Meeting 1 and Evidence Plan Agreement Log, November 2020	Potential effects of Covid-19 and the recent countrywide lockdown on the current soundscape around the proposed onshore infrastructure location	Use of publicly available data to inform the existing baseline environment for PEIR agreed with BDC.
BDC/SNDC/NNC	ETG Meeting 2 and Project update meeting, 24th February 2022	Baseline survey and Assessment updates and cumulative impacts.	Refer to **Section 23.6** and **Section 23.7**.
Section 42 Responses - The following comments were made in response to the PEIR and were taken into account in the production of this ES.			
Highways England	Section 42 Response Letter, 2021	National Highways identified critical road links for consideration in the DCO application.	The traffic data supplied to inform this noise assessment included the links identified by National Highways. Refer to **Section 23.6**.
North Norfolk District Council (NNDC)	Section 42 Response Letter, 2021	NNDC request to be included in developing the OCoCP and OTMP to minimise noise.	Due to timing constraints it was not possible to engage with NNDC on the development of an **Outline Code of Construction Practice (OCoCP)** or **Outline Construction Traffic Management Plan (OCTMP)**. However, copies are included with the application (document reference 9.17 and 9.16 respectively) and sets out the noise mitigation measures which are also detailed within this chapter.
Swainsthorpe Parish Council (SPC)	Section 42 Response Letter, 2021	SPC would like to be kept informed and work alongside Equinor to ensure impacts are minimised, especially from Pylons and OnSS infrastructure.	No new pylons, or alterations to existing pylons, are proposed as part of SEP and DEP. Potential construction and operation noise impacts are discussed in **Section 23.6**.

23.3 Scope

23.3.1 Study Area

7. The study area for noise and vibration comprises the nearest noise and vibration sensitive receptors to the onshore order limits including the landfall location, onshore cable corridor and onshore substation, (labelled as Order limits) as detailed on **Figure 23.1**.

8. The nearest noise and vibration sensitive receptors to the Order Limit accounting for the landfall, onshore cable corridor and onshore substation are shown on **Figure 23.1**. The noise and vibration study area also includes road traffic links with the potential to be affected by the proposed scheme during the construction phase, as defined in **Chapter 24 Traffic and Transport**.

23.3.2 Realistic Worst-Case Scenario

23.3.2.1 General Approach

9. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach to EIA, referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine: Rochdale Envelope (v3, 2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 5 EIA Methodology**.

10. The realistic worst-case scenarios for the noise and vibration assessment are summarised in **Table 23-2**. These scenarios are based on the project parameters described in **Chapter 4 Project Description**, which provides further details regarding specific activities and their durations.

11. In addition to the design parameters set out in **Table 23-2**, consideration is also given to how SEP and DEP could be constructed, as described in **Section 23.3.2.2** to **Section 23.3.2.4**. This accounts for the fact that, whilst SEP and DEP are the subject of one DCO application, either one or both projects could be developed, and if both are developed, that construction may be undertaken either concurrently or sequentially. Further details are provided in **Chapter 4 Project Description**.

23.3.2.2 Construction Scenarios

12. In the event that both SEP and DEP are built, the following principles set out the framework for how SEP and DEP may be constructed:

- SEP and DEP may be constructed at the same time, or at different times;
- If built at the same time both SEP and DEP could be constructed in four years;
- If built at different times, either Project could be built first;

- If built at different times, each Project would require a four year period of construction;
- If built at different times, the offset between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
- Taking the above into account, the total maximum period during which construction could take place is eight years for both Projects; and
- The earliest construction start date is 2025.

13. The impact assessment for noise and vibration considers the following development scenarios in determining the worst-case scenario for each topic:
    - Build SEP or build DEP in isolation;
    - Build SEP and DEP sequentially with a gap of up to four years between the start of construction of each Project – reflecting the maximum duration of effects; and
    - Build SEP and DEP concurrently – reflecting the maximum peak effects.
14. Any differences between SEP and DEP, or differences that could result from the manner in which the first and the second projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in the impact assessment section of this chapter (**Section 23.6**). For each potential impact, where necessary, only the worst-case construction scenario for two Projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst-case is provided, where necessary, in **Section 23.6**.
15. The onshore construction of SEP and DEP will require trenchless crossings. These are referred to as horizontal directional drilling (HDD) in this chapter. Reference to HDD should be taken as including other trenchless crossing techniques.

23.3.2.3 Operation Scenarios

16. Operation scenarios are described in detail in **Chapter 4 Project Description**. Where necessary, the assessment considers the following three scenarios:
    - Only SEP in operation;
    - Only DEP in operation; and
    - The two Projects operating at the same time, with a gap of two to four years between each Project commencing operation.
17. The operational lifetime of each Project is expected to be 40 years.

23.3.2.4 Decommissioning Scenarios

18. Decommissioning scenarios are described in detail in **Chapter 4 Project Description**. Decommissioning arrangements for the onshore elements of SEP and DEP will be agreed through the submission of an onshore decommissioning programme to the relevant planning authority for approval within six months of the permanent cessation of commercial operation (unless otherwise agreed in writing by the relevant planning authority), however, for the purpose of this assessment it is assumed that decommissioning of SEP and DEP could be conducted separately, or at the same time.

Table 23-2: Realistic Worst-Case Scenarios

Impact	Parameter	SEP or DEP in Isolation	SEP and DEP Concurrently	SEP and DEP Sequentially	Notes and Rationale
Construction					
Impact 1: Construction works relating to the Landfall	Construction noise at sensitive receptors	**Landfall:** Temporary HDD works: Temporary access route from the existing road system. Duration: 4 months HDD rigs in operation at any one time: 1 HDD Equipment: • Drilling Rig • Drill Cabin • 20kVa Generator • 375kVa Generator • Fuel store • Office and Welfare Units • Stores • Site Vehicle Parking • Water Storage Tanks • Drilling Fluid Mixing Tanks • Drilling Fluid Active Tank • Mud Pumps • Recycling Unit	**Landfall:** Temporary HDD works: Temporary access route from the existing road system. Duration: 5 months HDD rigs in operation at any one time: 1 HDD Equipment: • Drilling Rig • Drill Cabin • 20kVa Generator • 375kVa Generator • Fuel store • Office and Welfare Units • Stores • Site Vehicle Parking • Water Storage Tanks • Drilling Fluid Mixing Tanks • Drilling Fluid Active Tank • Mud Pumps • Recycling Unit	**Landfall:** Temporary HDD works: Temporary access route from the existing road system. Duration: 4 months per project, 8 months total HDD rigs in operation at any one time: 1 HDD Equipment: • Drilling Rig • Drill Cabin • 20kVa Generator • 375kVa Generator • Fuel store • Office and Welfare Units • Stores • Site Vehicle Parking • Water Storage Tanks • Drilling Fluid Mixing Tanks • Drilling Fluid Active Tank • Mud Pumps • Recycling Unit	The magnitude of a construction noise effect depends on the noise level and duration of exposure. Consideration should be given to both the spatial impacts (proximity to receptors) and temporal (duration) aspect of each of the workfronts, per scheme, whether construction is in isolation, concurrent or sequential. Construction HDD noise at noise sensitive receptors (NSRs) at the landfall has been calculated assuming all construction plant is operating simultaneously. The Sequential scenario results in the longest duration of (temporal) landfall HDD impacts. However for each construction scheme (in isolation, concurrent or sequential) the proposed workfront plant is expected to be of the same separation distance from noise and vibration sensitive receptors. Additionally, the same equipment and numbers per workfront; i.e. enabling works, civils works, cable installation works, HDD/trenchless crossings, reinstatement/ demobilisation, main compound, secondary compounds; per scenario is expected to be used even if SEP and DEP are constructed in isolation, concurrently or undertaken sequentially. The worst-case scenario for assessment of onshore cable corridor noise and vibration impacts at sensitive receptors is considered to be SEP and DEP sequentially as this represents the longest duration (temporal impact) and requires the same number of workfronts and plant as SEP or DEP constructed in isolation or SEP and DEP constructed concurrently. Construction noise at NSRs along the cable corridor has been calculated assuming all construction plant is operating simultaneously at the edge of the Order limits for each activity, with the exception of trenchless crossing works, which are limited to specific locations. The worst-case scenario for assessment of onshore substation and 400kV connection noise and vibration impacts at sensitive receptors is
Impact 2: Construction works relating to the Onshore Cable Corridor		**Onshore Cable Corridor:** Distance: Rounded to 60km from 58.35km, Corridor Width: 45m, (100m at trenchless crossings). Overall Construction Duration: 24 months in total Maximum number of workfronts at any one time: 10 Workfronts include: • Enabling works • Civils works • Cable installation works • HDD/Trenchless Crossings • Reinstatement/Demobilisation • Main Compound	**Onshore Cable Corridor:** Distance: Rounded to 60km from 58.35km, Corridor Width: 60m, (100m at trenchless crossings). Overall Construction Duration: 26 months in total Maximum number of workfronts at any one time: 10 Workfronts include: • Enabling works • Civils works • Cable installation works • HDD/Trenchless Crossings • Reinstatement/Demobilisation • Main Compound	**Onshore Cable Corridor:** Distance: Rounded to 60km from 58.35km, Corridor Width: 60m, (100m at trenchless crossings). Overall Construction Duration: 24 months per project. Maximum number of workfronts at any one time: 10 Workfronts include: • Enabling works • Civils works • Cable installation works • HDD/Trenchless Crossings • Reinstatement/Demobilisation • Main Compound	

Impact	Parameter	SEP or DEP in Isolation	SEP and DEP Concurrently	SEP and DEP Sequentially	Notes and Rationale
		• Secondary Compounds Working Hours: 07.00 to 19.00 Monday to Friday 07.00 to 13.00 Saturdays No work on Sundays or bank holidays. Potential for 24 hour working at trenchless crossings No. main construction compounds: 1 Duration: 48 months. No. secondary construction compounds: 6, No. Cement Bound Sand (CBS) batching compounds: 2 Duration: 12 - 18 months No. cable trenches: 1 No. haul roads within corridor: 1 Typical approximate jointing bay frequency: 60 per 1000m, Typical approximate link box frequency: 60 per 1000m Trenchless crossing compound duration: Max trenchless installation time per location i.e. 7 weeks.	• Secondary Compounds Working Hours: 07.00 to 19.00 Monday to Friday 07.00 to 13.00 Saturdays No work on Sundays or bank holidays. Potential for 24 hour working at trenchless crossings No. main construction compounds: 1 Duration: 48 months. No. secondary construction compounds: 6, No. CBS batching compounds: 2 Duration: 12 – 18 months No. cable trenches: 2 No. haul roads within corridor: 1 Typical approximate jointing bay frequency: 120 per 1000m, Typical approximate link box frequency: 120 per 1000m Trenchless crossing compounds duration: Max trenchless installation time per location i.e. 12 weeks.	• Secondary Compounds Working Hours: 07.00 to 19.00 Monday to Friday 07.00 to 13.00 Saturdays No work on Sundays or bank holidays. Potential for 24 hour working at trenchless crossings No. main construction compounds: 1 per project Duration: 48 months per project. Note - compound assumed to be removed following completion of the first project and reinstated for the second project. No. secondary construction compounds: 6 per project, No. CBS batching compounds: 2 per project Duration: 12 - 18 months per project Note - compound assumed to be removed following completion of the first project and reinstated for the second project. No. cable trenches: 2 No. haul roads within corridor: 1 (for each project) Typical approximate jointing bay frequency: 120 per 1000m, Typical approximate link box frequency: 120 per 1000m Trenchless crossing compounds duration: Max trenchless installation time per location i.e. 7 weeks per project	considered to be SEP and DEP sequentially as this represents the longest duration (temporal impact) and requires the same number of workfronts and plant as SEP or DEP constructed in isolation or SEP and DEP constructed concurrently. Construction noise at NSRs at the onshore substation has been calculated assuming all construction plant is operating simultaneously at the edge of the Order limits for each activity. Noise levels associated with Landfall HDD plant, onshore cable corridor workfront plant, onshore substation and 400kV connection plant are detailed in **Appendix 23.3 Construction Noise and Vibration Assessments**.
Impact 3: Construction works relating to the Onshore Substation and 400kv connection.		**Onshore Substation and 400kv connection:** Substation footprint Permanent area = 3.25ha. Substation platform level (mAOD): 28.23m Duration: 28 months in total Piling works at the onshore substation were assessed based on a single percussive piling rig for daytime works	**Onshore Substation and 400kv connection:** Substation footprint Permanent area = 6.0ha Substation platform level (mAOD): 28.23m Duration: 30 months in total Piling works at the onshore substation were assessed based on a single percussive piling rig for daytime works	**Onshore Substation and 400kv connection:** Substation footprint Permanent area = 6.0ha Substation platform level (mAOD): 28.23m Duration: 28 months in total for each project Piling works at the onshore substation were assessed based on a single	

Impact	Parameter	SEP or DEP in Isolation	SEP and DEP Concurrently	SEP and DEP Sequentially	Notes and Rationale
		only.	only.	percussive piling rig for daytime works only.	
Impact 4: Construction phase off-site vehicular movements relating to the Landfall, Onshore Cable Corridor and Onshore Substation	Temporary road traffic noise level increases at sensitive receptors due to construction traffic	Increase in traffic flows (18hr AAWT) and % HGV across the study area for a Peak and Average construction activity.	Increase in traffic flows (18hr AAWT) and % HGV across the study area for a Peak and Average construction activity.	A SEP and DEP sequential scenario would have the same activity schedule and in turn daily traffic demand, as a SEP or DEP in isolation scenario. The daily traffic demand would be replicated for each project. In the event that there is an overlap between SEP and DEP in the sequential built out scenario, the potential impacts are assessed within the worst-case parameters identified for SEP and DEP concurrently built out scenario.	Increased number of vehicles during proposed working hours across the project study area and associated traffic noise. SEP and DEP constructed concurrently is the worst-case scenario from a construction traffic relative change in noise level impact due to the higher total vehicles and percentage HGVs on any of the network links. Spatially all scenarios present the same potential effect as the same highways links are relevant for all schemes (in isolation, concurrent or sequential).
Impact 5: Construction phase vibration from works relating to the Landfall, Onshore Cable Corridor and Onshore Substation at sensitive receptors	Construction Vibration impacts at sensitive receptors from plant during temporary works	**Landfall/Onshore Cable Corridor/Onshore Substation:** Works include: • Enabling works • Civils works • Cable installation works • HDD/Trenchless Crossings • Reinstatement/Demobilisation • Main Compound • Secondary Compounds **Piling/Trenchless Crossings:** Piling works at the onshore substation were assessed based on a single Continuous Flight Auger (CFA) piling rig for daytime works only. Low vibration piling methods will be adopted. Durations are as per the construction noise impacts for each of the Landfall/Onshore Cable Corridor/Onshore Substation.			The Sequential scheme is the worst scenario due to the longer duration. Spatially all projects present the same potential effect due to the defined Order limits limiting proximity to sensitive receptors. Equipment and plant are detailed in **Table 23-26**.
		Construction durations Landfall: 4 months in total Onshore cable corridor: 24 months in total. Onshore substation: 28 months in total	**Construction durations** Landfall: 5 months in total Onshore cable corridor: 26 months in total. Onshore substation: 30 months in total	**Construction durations** Landfall: 4 months in total per project Onshore cable corridor: 24 months in total per project. Onshore substation: 28 months in total per project	
Operation					
Impact 1: Onshore substation and 400kv connection	Operational noise from substation infrastructure with the potential to impact sensitive human	**Onshore Substation and 400kv connection:** Substation footprint Maximum operational area = 3.25ha. Air Insulated Switchgear (AIS) Maximum dimensions of main buildings:	**Onshore Substation and 400kv connection:** Substation footprint Maximum operational area = 6.0ha. AIS Maximum dimensions of main buildings:	**Onshore Substation and 400kv connection:** Substation footprint Maximum operational area = 6.0ha. AIS Maximum dimensions of main buildings: 30m long x 14m wide x 15m high for each	SEP and DEP concurrently and sequentially represent the worst-case scenario for operational noise as these require more items of substation plant than SEP or DEP in isolation. The concurrent and sequential scenarios require the same amount of substation plant at similar locations; hence impacts from these scenarios are unlikely to be distinguishable from each other.

Impact	Parameter	SEP or DEP in Isolation	SEP and DEP Concurrently	SEP and DEP Sequentially	Notes and Rationale
	receptors	30m long x 14m wide x 15m high Number of main buildings: 2 Substation platform level (mAOD): 28.23 Substation structure (open/indoor) and main equipment: Mix. Indoor: Control buildings and SVC building Outdoor: AIS, Harmonic Filters, Transformers, Shunt Reactors, Shelters if required. SEP in isolation has a different substation footprint location to DEP in isolation.	50m long x 25m wide x 15m high Number of main buildings: 2 Substation platform level (mAOD): 28.23 Substation structure (open/indoor) and main equipment: Mix. Indoor: Control buildings and SVC building Outdoor: AIS, Harmonic Filters, Transformers, Shunt Reactors, Shelters if required	project Number of main buildings: 4 Substation platform level (mAOD): 28.23 Substation structure (open/indoor) and main equipment: Mix. Indoor: Control buildings and SVC building Outdoor: AIS, Harmonic Filters, Transformers, Shunt Reactors, Shelters if required	Refer to **Appendix 25.4 Onshore Substation Operational Noise Assessment** for further details regarding sound power levels from various elements of onshore substation infrastructure.
	Routine maintenance at the onshore substation.	Operational Period: 40 years Annual O&M: Un-manned. Only visits for maintenance staff and visitors. Approximately 1 visit per week.	Operational Period: 40 years Annual O&M: Un-manned. Only visits for maintenance staff and visitors. Approximately 1 visit per week.	Operational Period: 40 years Annual O&M: Un-manned. Only visits for maintenance staff and visitors. Approximately 1 visit per week.	SEP and DEP concurrently or sequentially represent the worst-case scenarios for maintenance related noise as there are a higher number of operational plant items requiring checks. Maintenance may require plant to be temporarily switched off, reducing the number of plant operating simultaneously. Number of visits is the same whether SEP or DEP is operational in Isolation or Concurrent.
Decommissioning					
No final decision has yet been made regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable corridor and onshore substation. It is also recognised that legislation and industry best practice change over time. However, it is likely that the onshore project equipment, including the cable, will be removed, reused or recycled where possible and the transition bays and cable ducts being left in place. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the purposes of a worst-case scenario, the impacts will be no greater than those identified for the construction phase.					

23.3.3 Summary of Mitigation Embedded in the Design

19. This section outlines the embedded mitigation relevant to the noise and vibration assessment, which has been incorporated into the design of SEP and DEP (**Table 23-3**). Where other mitigation measures are proposed, these are detailed in the impact assessment (**Section 23.6**).

Table 23-3: Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Construction phase works	Commitment to Best Practice Measures (BPM) implemented during the construction phase, detailed in the Construction Environmental Management Plan.
Operational substation location	Site selection has identified a single onshore substation site option in proximity to the existing Norwich Main substation which is at least 500m from the nearest residential properties.
Operational substation noise	Each main source of sound at the proposed onshore substation, which are capable of generating tones, can be fully enclosed where regard is given to other environmental impacts (e.g. landscape and visual effects). Certain equipment, such as the transformers and the shunt reactors, can be fully enclosed for operational and engineering reasons and, as such, a high degree of noise control can be applied to this equipment. Using these embedded measures, the substation will be designed to achieve the operational noise limits included in the relevant DCO condition.
Operational vibration	The substation plant would be designed and installed as to minimise vibration transmission from any plant items which might generate vibration. This control of vibration at source is necessary to maximise life of the plant and minimise maintenance. Typically, placing vibration isolation mounts into concrete pads would ensure that groundborne vibration is not perceptible beyond the immediate area of the substation.
HDD at landfall location	Long HDD (up to 1.25km) avoiding trenching works within the intertidal area. Offshore cable laying vessels would be no closer than 1km from the shore.

23.4 Impact Assessment Methodology

23.4.1 Policy, Legislation and Guidance

20. This section describes the applicable policy, legislation and guidance to this assessment. All of the identified policies and guidance have been followed in this assessment.

23.4.1.1 National Policy Statements

21. The assessment of potential noise and vibration impacts has been made with reference to the relevant NPS. These are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to SEP and DEP are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5) (DECC 2011c).

22. The above documents are in the process of being revised. A draft version of each NPS was published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS), (2021a), BEIS, (2021b) and BEIS (2021c) respectively). The specific assessment requirements for noise and vibration, as detailed in the extant and draft versions of each NPS, are summarised in **Table 23-4** together with an indication of the section of the ES chapter where each is addressed.

23. Where there is no change to the wording, or where only minor wording changes are included within the draft versions which do not materially influence the NPS (EN-1, EN-3, EN-5) requirements, these have not been reflected in **Table 23-4**.

Table 23-4: NPS Assessment Requirements

NPS Requirement	NPS Reference	Section Reference
NPS for Energy (EN-1)		
• Where noise impacts are likely to arise, the applicant should include: • A description of the noise generating aspects of the development proposal leading to noise impacts including the identification of any distinctive tonal, impulsive or low frequency characteristics of the noise; • Identification of noise sensitive premises and noise sensitive areas that may be affected; • The characteristics of the existing noise environment; • A prediction of how the noise environment will change with the proposed development; • In the shorter term such as during the construction period; • In the longer term during the operating life of the infrastructure; • At particular times of the day, evening and night as appropriate; • An assessment of the effect of predicted changes in the noise environment on any noise sensitive premises and noise sensitive areas; and • Measures to be employed in mitigating noise. • The nature and extent of the noise assessment should be proportionate to the likely noise impact.	EN-1, paragraph 5.11.4 (materially the same as draft EN-1, paragraph 5.12.4)	Refer to **Section 23.4.3** for the assessment methodology for assessing potential noise and vibration impacts, **Section 23.5** for details on the existing noise environment including the identification of NSRs and **Section 23.6** where any changes in noise levels as a result of SEP and DEP are assessed, and any potential impacts and potential mitigation measures are identified.
The noise impact of ancillary activities associated with the development, such as increased road and rail traffic movements, or other forms of transportation, should also be considered.	EN-1, paragraph 5.11.5 (materially the same as draft EN-1, paragraph 5.12.6)	Refer to **Section 23.6.1.2** where any changes in noise levels as a result of SEP and DEP from ancillary works, for example vehicle movements, are assessed and any potential impacts and potential mitigation measures are identified.

NPS Requirement	NPS Reference	Section Reference
Operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. Further information on assessment of particular noise sources may be contained in the technology-specific NPSs. In particular, for renewables (EN-3) and electricity networks (EN-5) there are assessment guidance for specific features of those technologies. For the prediction, assessment and management of construction noise, reference should be made to any relevant British Standards and other guidance which also give examples of mitigation strategies.	EN-1, paragraph 5.11.6 (materially the same as draft EN-1, paragraph 5.12.7)	Any changes in noise levels as a result of SEP and DEP are assessed in **Section 23.6**, and any potential impacts and potential mitigation measures are identified. The current relevant British Standards (BS) have been used within this assessment detailed within **Section 23.4**.
The applicant should consult EA and NE, or the Countryside Council for Wales (CCW), as necessary and in particular with regard to assessment of noise on protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account.	EN-1, paragraph 5.11.7 (materially the same as draft EN-1, paragraph 5.12.8)	Noise impacts on terrestrial protected species is considered within **Chapter 20 Onshore Ecology and Ornithology**.
The project should demonstrate good design through selection of the quietest cost-effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission.	EN-1, paragraph 5.11.8	The key mechanism by which of good design has been taken into account is the site selection exercise. A key consideration was to position the substation as far from residential properties as possible. The preferred substation location is approximately 500m from the nearest residential receptor. Refer to **Chapter 3 Site Selection and Alternatives**. In addition, the embedded mitigation measures described in **Section 23.3.3** and proposed mitigation measures described in **Section 23.6** demonstrate good design has been adopted.
A development must be undertaken in accordance with statutory requirements for noise. Due regard must be given to the relevant sections of the Noise Policy Statement for England, the NPPF, and the government's associated planning guidance on noise.	Draft EN-1 paragraph 5.12.9 duplicates EN-1 paragraph 5.11.8 but	Due regard is given to statutory requirements and the quoted policy, as described in **Section 23.6**

NPS Requirement	NPS Reference	Section Reference
	incorporates this additional text	
The IPC should not grant development consent unless it is satisfied that the proposals will meet the following aims: ● avoid significant adverse impacts on health and quality of life from noise; ● mitigate and minimise other adverse impacts on health and quality of life from noise; and ● where possible, contribute to improvements to health and quality of life through the effective management and control of noise.	EN-1, paragraph 5.11.9 (materially the same as draft EN-1, paragraph 5.12.10)	These aims are met by adoption of the proposed mitigation as shown in **Section 23.6** which concludes that significant residual impacts are not anticipated.
When preparing the development consent order, the IPC [Infrastructure Planning Commission] should consider including measurable requirements or specifying the mitigation measures to be put in place to ensure that noise levels do not exceed any limits specified in the development consent.	EN-1, paragraph 5.11.10	Where relevant, requirements and mitigation measures to ensure that limits are not exceeded are proposed in **Section 23.6**
These requirements or mitigation measures may apply to the construction, operation, and decommissioning of the energy infrastructure development.	Draft EN-1 paragraph 5.12.11 duplicates EN-1 paragraph 5.11.10 but incorporates this additional text	All phases of the development are considered within this assessment.
NPS for Electricity Networks Infrastructure (EN-5)		
While standard methods of assessment and interpretation using the principles of the relevant British Standards are satisfactory for dry weather conditions, they are not appropriate for assessing noise during rain. This is when overhead line noise mostly occurs, and when the background noise itself will vary according to the intensity of the rain. Therefore, an alternative noise assessment method to deal with rain-induced noise is needed, such as the one developed by National Grid as described in report TR (T) 94,199319. This follows recommendations broadly outlined in ISO 1996 (BS 7445:1991) and in that respect, is consistent with BS 4142:1997. The IPC [now the Planning Inspectorate and the Secretary of State] is likely to be able to regard it as acceptable for the applicant to use this or another methodology that appropriately addresses these particular issues.	EN-5, paragraph 2.9.8 and paragraph 2.9.9	SEP and DEP do not include any requirement for additional overhead lines. As such, further operational assessment of rain-induced noise is not considered necessary.

23.4.1.2 Other

23.4.1.2.1 National Planning Policy Framework

24. The National Planning Policy Framework (NPPF) (as revised in 2021) forms the basis of the Government's planning policies for England and how these should be applied. Section 15, Paragraph 174 of the NPPF states planning policies and decisions should contribute to and enhance the natural and local environment by:

"*e)……preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution……*"

25. Furthermore, Section 15, Paragraph 185 states:

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

- *a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;*
- *b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason…..”*

23.4.1.2.2 Noise Policy Statement for England, 2010

26. The Noise Policy Statement for England (NPSE) document was published by Defra in 2010 and paragraph 1.7 states three policy aims:

"*Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development*:

- *Avoid significant adverse impacts on health and quality of life;*
- *Mitigate and minimise adverse impacts on health and quality of life; and*
- *Where possible, contribute to the improvement of health and quality of life.”*

27. The Explanatory Note contained within the NPSE introduces the following concepts to aid in the establishment of significant effects:

- No Observed Effect Level (NOEL): the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established.
- Lowest Observable Adverse Effect Level (LOAEL): the level above which adverse effects on health and quality of life can be detected.
- Significant Observed Adverse Effect Level (SOAEL): the level above which significant adverse effects on health and quality of life occur.

28. The aims of the NPSE can therefore be interpreted as follows (within the context of Government policy on sustainable development):

- The first aim is to avoid noise levels above the SOAEL.
- To consider situations where noise levels are between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and minimise the effects. However, this does not mean that such adverse effects cannot occur.

29. The NPSE states:

"*It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations*". (Paragraph 2.22, NPSE, March 2010).

30. Furthermore, paragraph 2.22 of the NPSE acknowledges that:

"*Further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise*".

23.4.1.2.3 National Planning Practice Guidance (NPPG) 2019

31. The National Planning Practice Guidance (NPPG, July 2019), states that noise needs to be considered when new developments may create additional noise and when new developments would be sensitive to the prevailing acoustic environment. When preparing local or neighbourhood plans, or making decisions about new development, there may also be opportunities to consider improvements to the acoustic environment. No material changes were made to the 2021 NPPF for noise and no update to the NPPG is expected.

23.4.1.3 Local Planning Policy

23.4.1.3.1 North Norfolk Local Development Framework Core Strategy (September 2008)

32. Policy EN7 Renewable energy states:

"*Proposals for renewable energy technology, associated infrastructure and integration of renewable technology on existing or proposed structures will be permitted where individually, or cumulatively, there are no significant adverse effects on…residential amenity (noise)*"

33. Policy EN13 Pollution and Hazard Prevention and Minimisation states:

"*All development proposals should minimise, and where possible reduce, all emissions and other forms of pollution, including light and noise pollution…*

… Proposals will only be permitted where, individually or cumulatively, there are no unacceptable impacts on;

The natural environment and generally amenity…"

23.4.1.3.2 Broadland District Council Development Management Development Plan Document (2015)

34. Policy EN4 - Pollution states:

"*Development proposals will be expected to include an assessment of the extent of potential pollution. Where pollution may be an issue, adequate mitigation measures will be required. Development will only be permitted where there will be no significant adverse impact upon amenity, human health or the natural environment*."

23.4.1.4 Guidance Documents

23.4.1.4.1 BS 4142:2014+A1:2019 – Method for Rating and Assessing Industrial and Commercial Sound

35. This standard describes a method for rating and assessing sound of an industrial and/or commercial nature. This method uses a Rating level to assess the likely effects from sound of an industrial or commercial nature on people using amenity space outside a dwelling or premises used for residential purposes upon which the sound is incident.

23.4.1.4.2 BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise

36. Part 1 of BS 5228 provides recommendations for basic methods of noise and vibration control relating to construction and open sites where work activities/operations generate significant noise and/or vibration levels. It also provides guidance on methods of predicting and measuring noise and assessing its impact on those exposed to it.

23.4.1.4.3 BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration

37. Part 2 of BS 5228 gives recommendations for basic methods of vibration control on construction and open sites, where work activities generate significant vibration levels. It also provides guidance on predicting and assessing vibration levels from construction and a database of measured vibration levels during piling activities.

23.4.1.4.4 BS 7385-2: 1993 'Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground Borne Vibration'

38. This standard provides guidance regarding the potential for vibration to result in building damage, including basic principles for carrying out vibration measurements and processing the data. It includes guide values for transient and continuous vibration, above which there is a likelihood of cosmetic damage.

23.4.1.4.5 BS 7445:2003 Part 1 and BS 7445:1991 Part 2 – Description and Measurement of Environmental Noise

39. Provides details of the instrumentation and measurement techniques to be used when assessing environmental noise and defines the basic noise quantity as the continuous A-weighted sound pressure level (L_{Aeq}). Part 2 of BS 7445 replicates International Standards Organisation (ISO) 1996-2.

23.4.1.4.6 BS 8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

40. Provides a methodology to calculate the noise levels entering a building through facades and facade elements and provides details of appropriate measures for sound insulation between dwellings. It includes recommended internal noise levels which are provided for a variety of situations and are based on World Health Organisation (WHO) recommendations.

23.4.1.4.7 Calculation of Road Traffic Noise (CRTN) 1988

41. Provides a method for calculating noise levels from the Annual Average Weekday Traffic (AAWT) flows and from measured noise levels. Since publication in 1988 this document has been the accepted standard for predicting noise levels from road traffic in the UK. The calculation methods take account of variables including percentage of heavy goods vehicles (HGVs), road surfacing, gradient, screening by barriers and relative height of source and receiver.

23.4.1.4.8 Design Manual for Roads and Bridges (DMRB), LA 111 Noise and Vibration, Revision 2

42. LA111 Noise and Vibration provides detailed methodologies for the assessment of construction and operational noise and vibration impacts from road schemes. It provides guideline significance criteria in terms of both absolute noise and vibration levels (LOAELs and SOAELS for use in relation to the NPSE) and the change in noise levels due to a scheme.

23.4.1.4.9 A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}, Report by a Working Party for the Technical Sub-committee of the Noise Advisory Council' (NAC)

43. Provides a method for the prediction of road traffic noise levels at 10m from the nearside carriageway edge which is similar to the CRTN methodology. In brief, the methodology requires separate calculations to be undertaken for Light Vehicles/Cars and HGVs. The calculated noise levels are added together to establish the overall noise level for a given link. This method can be used when traffic flows are below the minimum at which CRTN is validated.

23.4.1.4.10 ISO 9613-2:1996 Acoustics - Attenuation of Sound during Propagation Outdoors - Part 2: General Method of Calculation

44. Specifies an engineering method for calculating the attenuation of sound due to propagation outdoors, enabling prediction of sound levels at a specified distance from a source.

23.4.1.4.11 WHO (1999) Guidelines for Community Noise

45. These guidelines present health-based noise limits intended to protect the population from exposure to excess noise. They present guideline limit values at which the likelihood of particular effects, such as sleep disturbance or annoyance, may increase. The guideline values are 50 or 55dB L_{Aeq} during the day, related to annoyance, and 45dB L_{Aeq} or 60dB L_{Amax} at night, related to sleep disturbance.

46. The Guidance states:

“*The effects of noise in dwellings, typically, are sleep disturbance, annoyance and speech interference. For bedrooms the critical effect is sleep disturbance. Indoor guideline values for bedrooms are 30dB L_{Aeq} for continuous noise and 45dB L_{Amax} for single sound events. Lower noise levels may be disturbing depending on the nature of the source*.”

23.4.1.4.12 WHO (2009) Night Noise Guidelines for Europe

47. These guidelines an extension to the WHO Guidelines for Community Noise (1999). Based on evidential review, they conclude that:

“*Below the level of 30dB $L_{night,outside}$, no effects on sleep are observed except for a slight increase in the frequency of body movements during sleep due to night noise. There is no sufficient evidence that the biological effects observed at the level below 40dB $L_{night,outside}$ are harmful to health. However, adverse health effects are observed at the level above 40dB $L_{night,outside}$.*

Therefore, 40dB $L_{night,outside}$ is equivalent to the LOAEL for night noise.”

48. In addition to the above, the following is also stated,

"*Considering the scientific evidence on the thresholds of night noise exposure indicated by $L_{night,outside}$ as defined in the Environmental Noise Directive (2002148/EC), an $L_{night,outside}$ of 40dB should be the target of the night noise guideline (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly. $L_{night,outside}$ value of 55dB is recommended as an interim target for those countries where the NNG cannot be achieved in the short term for various reasons, and where policy-makers choose to adopt a stepwise approach*."

23.4.1.4.13 WHO (2018) Environmental Noise Guidelines for the European Region

49. The guidance states:

“*The main purpose of these guidelines is to provide recommendations for protecting human health from exposure to environmental noise originating from various sources: transportation (road traffic, railway and aircraft) noise, wind turbine noise and leisure noise. They provide robust public health advice underpinned by evidence, which is essential to drive policy action that will protect communities from the adverse effects of no*ise.”

50. Further detail where relevant is provided in **Chapter 2 Policy and Legislative Context**.

23.4.2 Data and Information Sources

23.4.2.1 Site Specific Surveys

51. In order to provide site specific and up to date information on which to base the impact assessment, a baseline sound survey within the vicinity of the landfall and onshore substation was conducted during October 2021, as described in **Section 23.5.1**. The scope and extent of the baseline survey was agreed with BDC.

23.4.2.2 Other Available Sources

52. Other sources that have been used to inform the assessment are listed in **Table 23-5**.

Table 23-5: Other Available Data and Information Sources

Data set	Spatial coverage	Year	Notes
Google Maps aerial photography	Onshore Noise and Vibration Study Area	2021	n/a
Environment Agency Lidar topographical data	Onshore Noise and Vibration Study Area	2020	Open License Data
Local Authority Local Plans	Onshore Noise and Vibration Study Area	2008 and 2015	
Ordnance Survey mapping	Onshore Noise and Vibration Study Area	2022	n/a
The Hornsea Project Three Environmental Statement	Onshore Noise and Vibration Study Area	2017	Available at: https://infrastructure.planninginspectorate.gov.uk
Norfolk Vanguard ES (Norfolk Vanguard Offshore Wind Farm 2018) Chapter 25 Noise and Vibration Environmental Statement Volume 1	Onshore Noise and Vibration Study Area	2018	Available at: https://infrastructure.planninginspectorate.gov.uk
Norfolk Boreas ES (Norfolk Boreas Offshore Wind Farm (2019) Chapter 25 Noise and Vibration Environmental Statement Volume 1	Onshore Noise and Vibration Study Area	2019	Available at: https://infrastructure.planninginspectorate.gov.uk

23.4.3 Impact Assessment Methodology

53. **Chapter 5 EIA Methodology** provides a summary of the general impact assessment methodology applied to SEP and DEP. The following sections confirm the methodology used to assess the potential impacts on noise and vibration.

23.4.3.1 Definitions of Sensitivity and Magnitude

54. For each effect, the assessment identifies receptors sensitive to that effect and implements a systematic approach to understanding the impact pathways and the level of impacts on given receptors. The definitions of sensitivity and magnitude for the purpose of the noise and vibration assessment are provided in **Table 23-6** and **Table 23-7**.

Table 23-6: Definition of Sensitivity for Noise and Vibration Receptors

Sensitivity	Definition	Examples
High	Receptor has very limited tolerance of effect	Noise receptors are categorised as high sensitivity where noise may be detrimental to vulnerable receptors. Such receptors include certain hospital wards (e.g. operating theatres or high dependency units) or care homes at night. Vibration receptors are categorised as high sensitivity where the structural integrity of the building is unsound, in accordance with BS 5228.
Medium	Receptor has limited tolerance of effect	Noise receptors are categorised as medium sensitivity where noise may cause disturbance and a level of protection is required but a level of tolerance is expected. Such subgroups include, at all times of day, residential accommodation, private gardens, hospital wards, care homes, schools, universities, research facilities, and temporary holiday accommodation. National parks (during the day only). Vibration receptors are categorised as medium sensitivity where the structural integrity of the structure is limited.
Low	Receptor has some tolerance of effect	Noise receptors are categorised as low sensitivity where noise may cause short duration effects in a recreational setting although particularly high noise levels may cause a moderate effect. Such subgroups include offices, shops (including cafes), outdoor amenity areas during the day (including recreation, public amenity space/play areas), long distance footpaths (including Public rights of Way (PRoW), dog walking routes, bird watching areas, footpaths and other walking routes, visitor attractions, cycling routes including rural roads), doctor's surgeries, sports facilities and places of worship. Vibration receptors are categorised as low sensitivity where the structural integrity of the structure is expected to be high.
Negligible	Receptor generally tolerant of effect	Noise receptors are categorised as negligible sensitivity where noise is not expected to be detrimental. Such subgroups include warehouses, light industry, car parks, and agricultural land. Vibration receptors are categorised as negligible sensitivity where vibration is not expected to be detrimental.

Table 23-7: Definition of Magnitude for Noise and Vibration Receptors

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the receptor's character or distinctiveness. The impact gives rise to serious concern; it should be considered as

Magnitude	Definition
	unacceptable.
Medium	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the receptor's character or distinctiveness. The impact gives rise to some concern, but it is likely to be tolerable (depending on its scale and/or duration).
Low	Discernible, temporary (throughout project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the receptor's character or distinctiveness. The impact is undesirable, but of limited concern.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the receptor's character or distinctiveness. The impact is at a threshold of predictive quantification and is not of concern.

23.4.3.2 Impact Significance

55. In basic terms, the potential significance of an impact is a function of the sensitivity of the receptor and the magnitude of the effect (see **Chapter 5 EIA Methodology** for further details). The determination of significance is guided by the use of an impact significance matrix, as shown in **Table 23-8**. Definitions of each level of significance are provided in **Table 23-9**.

56. Potential impacts identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations.

Table 23-8: Impact Significance Matrix

		Magnitude of effect			
		High	**Medium**	**Low**	**Negligible**
Sensitivity	**High**	*Major*	*Major*	*Moderate*	*Minor*
	Medium	*Major*	*Moderate*	*Minor*	*Negligible*
	Low	*Moderate*	*Minor*	*Negligible*	*Negligible*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*

Table 23-9: Definition of Impact Significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision-making process.

Significance	Definition
Negligible	No discernible change in receptor condition.

23.4.3.3 Construction Phase Noise Assessment Methodology

57. Annex E of BS 5228:2009+A1:2014 describes several methods for assessing construction phase noise impacts. The approach utilised in this assessment is the ‘ABC’ method, which specifies a construction noise ‘Threshold Value’, based on the existing ambient noise level at different time periods at the NSR, as shown in **Table 23-10**.

Table 23-10: Construction Noise Threshold Values Based on The ABC Method (BS 5228)

Assessment category and Threshold Value period ($L_{Aeq,T}$)	Threshold Value, in decibels (dB)		
	Category A A)	**Category B** B)	**Category C** C)
Night time (23.00 – 07.00)	45	50	55
Evenings and weekends D)	55	60	65
Daytime (07.00 – 19.00) and Saturdays (07.00 – 13.00)	65	70	75
A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than these values.			
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values.			
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values.			
D) 19.00–23.00 weekdays, 13.00–23.00 Saturdays and 07.00–23.00 Sundays.			

58. BS 5228-1 states that: “*If the site noise level exceeds the appropriate category value* [Threshold Value]*, then a potential significant effect is indicated. The assessor then needs to consider other project-specific factors, such as the number of receptors affected and the duration and character of the impact, to determine if there is a significant effect*.”

59. Given the length of the onshore cable corridor, it was not practical to measure baseline sound levels at receptors along the entire corridor potentially affected by noise from construction of these elements of the projects. In the absence of these baseline noise data, the existing noise levels at residential receptors have been assumed to be low, so the Category A Threshold Values presented in **Table 23-10** are deemed applicable. This approach was agreed with the ETG.

60. Construction noise impacts are assessed using the criteria presented in **Table 23-11** for the daytime, evening and weekend, and night-time. The SOAEL values in the table are the levels identified in BS 5228-1 that, if exceeded for a "significant period of time (either continuously or sporadically)”, could result in "widespread community disturbance or interference with activities or sleep”.

Table 23-11: Construction Noise Magnitude of Effect Criteria

Magnitude of effect	Construction noise level (dB $L_{Aeq,T}$)			NPSE/PPG category
	Daytime	**Evenings and weekends**	**Night-time**	
High	≥75	≥65	≥55	Lower end of range is equivalent to SOAEL
Medium	≥70 to <75	≥60 to <65	≥50 to <55	-
Low	≥65 to <70	≥55 to <60	≥45 to <50	Lower end of range is equivalent to LOAEL
Negligible	<65	<55	<45	-

61. In accordance with BS 5228-1, there are other project-specific factors which can be considered, any or all of which may be relevant depending on the specific situation. The following demonstrates how these other factors can be considered to determine the magnitude of effect, receptor sensitivity and impact significance:

- the duration of the effect. Based on the guidance in BS 5228-1, construction noise levels above the Threshold Value for less than 10-days (or 10-evenings/weekends or nights) in any 15, or 40-days or less (or 40 evenings/weekends or nights) in any 6-month period would not normally be considered significant;
- the timing of the effect, night time impacts being more likely to be considered significant than daytime impacts;
- the location of the effect at the NSR, for example, a receptor may contain areas which are more or less sensitive than others, for example in a school, office spaces or kitchens would be considered less sensitive than classrooms;
- the nature, times of use and design of the receptor, for example a NSR which is not used at night would not be considered sensitive to night-time construction works; and
- NSRs exposed to combined noise and vibration effects are more likely to experience significant impacts than those which are only exposed to one effect.

62. Noise levels for the construction phase have been calculated using the methods and guidance in BS 5228. The standard provides methods for predicting receptor noise levels from construction works based on the number and type of construction plant and activities operating on site, with corrections to account for:

- The 'on-time' of the plant, as a percentage of the assessment period;
- Distance from source to receptor;
- Acoustic screening by barriers, buildings or topography; and
- Ground type.

63. The predictions undertaken are indicative only, as they are based on a preliminary understanding of the likely construction schedule, activities and plant to be used. This information may change once a construction contractor is appointed.

23.4.3.4 Construction Phase Road Traffic Noise Assessment Methodology

64. Construction road traffic noise impacts were determined by assessing the change in Basic Noise Level (BNL) in accordance with the methodology provided in CRTN. CRTN requires a ‘low-flow correction’ to be applied to total vehicular 18hr flows between ≥1000 to ≤4000 vehicles; otherwise, no correction to the BNL is applied outside of this range. Separate calculations were undertaken for all speed limits on any given link, provided in the traffic dataset.

65. Initially the CRTN methodology was used for all road links within the study area for the ‘with development construction phase flows’ and ‘without development construction phase flows.’

66. Following this first stage, a further stage of screening determined compliance with speed criteria and the traffic flow data of the validated CRTN range. Where the 18hr AAWT (Total Vehicles) movements is less than 1000, the alternative calculation method detailed in ‘A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level L_{eq}, Report by a Working Party for the Technical Sub-committee of the Noise Advisory Council’ (NAC) was used. This is detailed in **Appendix 23.2 Road Traffic Assessment (Annex 23.2.1)**.

67. This alternative methodology predicts the noise level at 10m from the nearside carriageway edge, similar to CRTN methodology. In brief, the methodology requires separate calculations to be undertaken for Light Vehicles/Cars and HGVs. The calculated noise levels are added together to establish the overall noise level for a given link, and for each of the scenarios being considered.

68. The NAC alternative methodology was applied for both with development construction phase flows’ and ‘without development construction phase flows’ noise level predictions, where the flow in either case falls outside the range of validity for CRTN (for each of the scenarios being assessed).

69. Following this approach ensures that the resulting noise level change is determined based on following the same calculation approach i.e. CRTN without development and CRTN with development, NAC without development and NAC with development.

70. The NAC calculation method determines the resulting road traffic noise levels in terms of the $L_{Aeq,T}$ noise index; the time base (T) being 18hrs. CRTN uses the $L_{A10,18hr}$ noise index; however, it is considered valid that the noise level changes determined can also be assessed based on the scale detailed within **Table 23-12**.

71. Construction road traffic noise effects are determined by assessing the change in BNL. Effect magnitude criteria for construction traffic, as detailed in Table 3.17 of the DMRB, are displayed in **Table 23-12**.

Table 23-12: Magnitude Criteria for Relative Change Due to Construction Road Traffic

Magnitude of effect	Increase in BNL of closest public road used for construction traffic (dB)
High	≥5.0

Magnitude of effect	Increase in BNL of closest public road used for construction traffic (dB)
Medium	≥3.0 to <5.0
Low	≥1.0 to <3.0
Negligible	<1.0

72. The LOAEL and SOAEL for construction traffic noise during the daytime period are defined in DMRB as an $L_{A10,18hr}$ façade level. These thresholds are detailed in **Table 23-13**.

Table 23-13: LOAELs and SOAELS at NSRs for Road Traffic

Time Period	LOAEL	SOAEL
Day (06:00 - 24:00)	55dB $L_{A10,18hr}$ facade	68dB $L_{A10,18hr}$ facade
	50dB $L_{Aeq,16hr}$ free-field	63dB $L_{Aeq,16hr}$ free-field

73. The conversion detailed in **Table 23-13** is derived through applying a correction of -3dB for façade level to free-field as per standard acoustic theory. As per Section 6.2.2 of BS 8233, a -2dB correction has been applied to convert $L_{A10,18hr}$ to $L_{Aeq,16hr}$. For temporary effects due to construction traffic noise, predicted 'with scheme' road traffic noise levels which are less than the LOAEL are considered to represent an effect of no worse than minor magnitude (i.e. not significant), irrespective of the change in BNL. For effects between the LOAEL and SOAEL, the duration of the effect must be considered, in addition to the magnitude of the change, when determining whether an impact is significant.

74. The calculated BNLs used to determine the change in road traffic noise levels are the noise level at 10m from the carriageway edge, depending on traffic flow parameters only i.e. total flow, vehicle speed and %HGV. They do not account for actual distance to the receptor, the presence of screening, angle of view or road gradient. Therefore, these BNLs cannot be compared directly with the LOAELs and SOAELs in **Table 23-13**. A simplified calculation has been undertaken to determine a potential L_{Aeq} road traffic noise level, based on the distance to closest identified NSR to each link. Whist a correction for road gradient could be up to +5dB, screening and angle of view corrections would only reduce the calculated noise level. Hence, to account for the fact that these parameters are not included, in the calculations, a +3dB correction for uncertainty has been applied to the calculated values. This ensures that the assessment considers a significant potential worst-case.

23.4.3.5 Construction Phase Vibration Assessment Methodology

75. Ground-borne vibration can result from construction works and may lead to perceptible levels of vibration at nearby receptors, which at higher levels can cause annoyance to residents. In extreme cases, cosmetic or structural building damage can occur, but only at extremely high vibration levels and such cases are rare.

76. Typically, perceptible ground-borne vibration is only emitted by ‘heavy’ construction works such as piling, deep excavation, or dynamic ground compaction.

77. The response of a building to ground-borne vibration is affected by the type of foundation, ground conditions, the building construction and the condition of the building. BS 7385-2 provides guidance on vibration levels likely to result in cosmetic damage and is referenced in BS 5228-2. Guide values for transient vibration in terms of peak particle velocity (PPV), above which cosmetic damage could occur, are given in **Table 23-14.**

Table 23-14: Transient Vibration Guide Values for Cosmetic Damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 $mm.s^{-1}$ at 4 Hz and above	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	15 $mm.s^{-1}$ at 4 Hz increasing to 20 $mm.s^{-1}$ at 15 Hz	20 $mm.s^{-1}$ at 15 Hz increasing to 50 $mm.s^{-1}$ at 40 Hz and above

78. BS 7385-2 states that the probability of building damage tends to zero for transient vibration levels less than 12.5 $mm.s^{-1}$ PPV. For continuous vibration, such as from vibratory rollers, the threshold is around half this value.

79. BS 7385-2 states that minor damage occurs at a vibration level twice that of cosmetic damage and major damage occurs at a vibration twice that of minor damage. The values in **Table 23-14** refer to the likelihood of cosmetic damage. ISO 4866:2010 defines three different categories of building damage:

- Cosmetic – formation of hairline cracks in plaster or drywall surfaces and in mortar joints of brick/concrete block constructions;
- Minor – formation of large cracks or loosening and falling of plaster or drywall surfaces or cracks through brick/block; and
- Major – damage to structural elements, cracks in support columns, loosening of joints, splaying of masonry cracks.

80. **Table 23-15** reproduced from research (Rockhill *et al*, 2014) details minimum safe separation distance for piling activities from sensitive receptors to reduce the likelihood of cosmetic damage occurrence.

Table 23-15: Receptor Proximity for Indicated Piling Methods

Building type (limits on vibrations from Eurocode 3)	Piling method		
	Press-in	25 kJ drop hammer	170 kW 27 Hz vibrohammer
Architectural merit	2.6 m	29.6 m	27.7 m
Residential	0.5 m	11.8 m	13.8 m

Building type (limits on vibrations from Eurocode 3)	Piling method		
	Press-in	25 kJ drop hammer	170 kW 27 Hz vibrohammer
Light commercial	0.14 m	5.9 m	5.5 m
Heavy industrial	0.06 m	3.9 m	3.7 m
Buried services	0.03 m	2.9 m	2.2 m

81. The vibration level and effects presented in **Table 23-16** are taken from Table B-1 of BS 5228-2. These levels and effects are based on human perception of vibration in residential environments.

Table 23-16: Construction Vibration – Example of Human Perception in Buildings

Vibration limit PPV (mms^{-1})	Interpreted significance to humans	Magnitude of effect	NPSE/PPG Category
<0.14	Vibration unlikely to be perceptible	Negligible	NOEL
0.14 to 0.3	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction		LOAEL
0.3 to 1.0	Vibration might just be perceptible in residential environments	Low	
1.0 to <10.0	It is likely that vibration at this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents	Medium	SOAEL
>10.0	Vibration is likely to be intolerable for any more than a brief exposure to this level	High	

82. Predicted construction vibration levels at receptors which exceed a value of 1 $mm.s^1$ have the potential to result in a significant effect. However, the same additional project-specific factors which can influence the construction noise effect significance (as discussed in **Section 23.4.3.3**) are considered relevant to vibration impacts. Hence, the same process for considering these other factors should be used to determine the vibration effect significance.

83. Comparison of the criteria in **Table 23-14** and **Table 23-16** shows that the levels at which building damage may occur are significantly above those which are considered tolerable by the occupants. The assessment therefore applies the criteria for human annoyance. Assuming that the vibration impacts will be controlled to avoid significant annoyance effects, then building damage is not anticipated

84. Annex E of BS 5228-2:2009+A1:2014 contains empirical formulae derived by Hiller and Crabb (2000) from field measurements relating to resultant PPV with several other parameters for vibratory compaction, dynamic compaction, percussive and vibratory piling, the vibration of stone columns and tunnel boring operations. Use of these empirical formulae enables resultant PPV to be predicted and for some activities (vibratory compaction, vibratory piling and vibrated stone columns) they provide an indicator of the probability of these levels of PPV being exceeded.

85. Consequently, calculations following these methodologies were carried out for the anticipated construction activities with the potential to result in perceptible vibration at receptors. Reasonable worst-case assumptions were applied regarding ground conditions and energy levels to determine set-back distances at which critical vibration levels may occur, as detailed in **Appendix 23.3 Construction Noise and Vibration Assessments**.

86. The DMRB LA111 states that "*A study area of 100m from the closest construction activity with the potential to generate vibration is normally sufficient to encompass vibration sensitive receptors*". On this basis, and as agreed in consultation, the assessment of vibration impacts only extends to NSRs which are no further than 100m from the Order limits. The closest identified NSRs to the proposed landfall and substation locations are further than 100m away; hence, assessment of vibration impacts due to construction of the landfall and substation has been excluded from the assessment scope.

87. The DMRB LA111 states that "*a maintained road surface will be free of irregularities as part of project design and under general maintenance, so operational vibration will not have the potential to lead to significant adverse effects*." On this basis, and as agreed in consultation, the assessment of vibration impacts due to construction traffic using public roads has been excluded from the assessment scope.

23.4.3.6 Operational Phase Noise Assessment Methodology

88. An operational noise impact assessment in accordance with BS 4142 has been undertaken for the SEP and DEP projects, in-combination and isolation i.e. SEP or DEP on their own at the NSRs.

89. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature and is referred to in NPS EN-1. The standard applies to industrial/commercial and background noise levels outside residential buildings and for assessing whether existing and new industrial/commercial noise sources are likely to give rise to significant adverse impacts on the occupants living in the vicinity.

90. The basis of BS 4142 is a comparison between the *background sound level* in the vicinity of residential locations and the *rating level* of the noise source under consideration. The relevant parameters in this instance are as follows:

- *Background sound level* – $L_{A90,T}$ – defined in the Standard as the ‘A’ weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90% of a given time interval, T, measured using time weighting F (Fast) and quoted to the nearest whole number of decibels;
- *Specific sound level* – $L_{Aeq,Tr}$ – the equivalent continuous ‘A’ weighted sound pressure level produced by the specific sound source at the assessment location over a reference time interval, T_r (1 hour during the daytime hours (07:00 to 23:00 hours) and 15 minutes during night-time hours (23:00 to 07:00 hours));
- *Residual Sound Level* - $L_{Aeq,T}$ - the equivalent continuous ‘A’ weighted sound pressure level at the assessment location in the absence of the specific sound source under consideration, over a given time interval, T; and
- *Rating level* – $L_{Ar,Tr}$ – the *specific sound level* plus a “character correction” if required for the acoustic features of the noise such as tonality, impulsivity and intermittency.

91. When comparing the *background* and the *rating sound* levels, the standard states that:

“*a) Typically, the greater the difference, the greater the magnitude of impact.*

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

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

d) The lower the rating level 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”.

92. When assessing the noise from a source, it is necessary to have regard to the acoustic features that may be present. Section 9.1 of BS 4142 states:

“*Certain acoustic features can increase the significance of impact over that expected from a basic comparison between the specific sound level and the background sound level. Where such features are present at the assessment location, add a character correction to the specific sound level to obtain the rating level*.”

93. For clarity, an explanation of each character correction type (taken from BS 4142:2014+A1:2019, page 13 and 14) is provided here:

- Tonality - For sound ranging from not tonal to prominently tonal a correction of between 0dB and +6dB for tonality can be applied. Subjectively, this can be converted to a penalty of 2dB for a tone which is just perceptible at the noise receptor, 4dB where it is clearly perceptible, and 6dB where it is highly perceptible.
- Impulsivity - A correction of up to +9dB can be applied for sound that is impulsive. Subjectively, this can be converted to a penalty of 3dB for impulsivity which is just perceptible at the noise receptor, 6dB where it is clearly perceptible, and 9dB where it is highly perceptible.
- Intermittency - When the specific sound has identifiable on/off conditions, the specific sound level ought to be representative of the time period of length equal to the reference time interval which contains the greatest total amount of on time. If intermittency is readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied.
- Other sound characteristics - Where the specific sound feature characteristics that are neither tonal nor impulsive, nor intermittent, though otherwise are readily distinctive against the residual acoustic environment, a penalty of 3dB can be applied.

94. To predict the noise from the operation of the SEP and DEP substation, SoundPLAN 3D noise modelling software was utilised. The model incorporated proposed buildings based on elevation drawings and proposed fixed plant associated with the SEP and DEP layout. The model also included residential dwellings and other buildings in the onshore Study Area, intervening ground cover and topographical information.

95. Noise levels for the operational phase were predicted at NSR locations detailed in **Table 23-20**. The calculation algorithm described in ISO 9613-2 was used in the operational noise propagation modelling.

96. In accordance with BS 4142, a suitable operational noise level limit is 5dB above background, as this is the threshold at which adverse impacts are anticipated. However, it is also necessary to consider the context; of particular relevance to this assessment are the absolute sound levels. Regarding absolute sound levels, BS 4142 states that "*Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night.*" The standard offers no guidance about what *background* and *rating levels* are considered low; however, the 1997 version of the standard stated that *background sound levels* below around 30dB L_{A90}, and *rating levels* below around 35dB L_{ArTr}, were considered very low and therefore outside the scope of the assessment method. The Association of Noise Consultants produced guidance on the application of BS 4142 (BS 4142:2014+A1:2019 Technical Note, Association of Noise Consultants, March 2020) which states that "*similar values* [i.e. *background sound levels* below around 30dB L_{A90}, and *rating levels* below around 35dB L_{ArTr}] *would not be unreasonable in the context of BS 4142, but that the assessor should make a judgement and justify it where appropriate.*"

97. The WHO Night Noise Guidance for Europe (NNG) found that below the level of 30dB $L_{night,outside}$ there are no observed effects on sleep. Furthermore, there is no evidence that biological effects observed at levels below 40dB $L_{night,outside}$ are harmful to health. At levels above 55dB $L_{night,outside}$, the NNG detailed that adverse health effects occur frequently and there is limited evidence that the cardio-vascular system is coming under stress.

98. The magnitude of impact based on a predicted level of operational noise sources above the prevailing background sound environment, in accordance with BS 4142, are summarised in **Table 23-17**. Section 11 of BS 4142 states that:

"*Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night*."

99. The WHO NNG for Europe was published to complement the WHO Guidelines for Community Noise and introduced additional research on the effects of night-time noise exposure.

100. In summary, the NNG found that below the level of 30dB $L_{night,outside}$ there are no observed effects on sleep. Furthermore, there is no evidence that biological effects observed at levels below 40dB $L_{night,outside}$ are harmful to health. At levels above 55dB $L_{night,outside}$, the NNG detailed that adverse health effects occur frequently and there is limited evidence that the cardio-vascular system is coming under stress.

101. Therefore, based on the NNG, the following effect levels for assessing against the NPSE categories are also relevant as detailed in **Table 23-17**:

- 30dB $L_{night,outside}$ - NOEL;
- 40dB $L_{night,outside}$ - LOAEL; and
- 55dB $L_{night,outside}$ - SOAEL.

Table 23-17: Operational Noise Magnitude of Effect Criteria for Industrial/Commercial Noise Sources

Magnitude of effect	**Excess of *rating level* over *background sound level* (dB)**	**NPSE/PPG category using BS 4142 criteria**	**WHO NNG threshold**	**NPSE/PPG category using WHO NNG threshold**
High	≥ 10	SOAEL	>55dB $L_{night,outside}$	SOAEL
Medium	5 to <10	LOAEL to < SOAEL	40 to ≤55dB $L_{night,outside}$	LOAEL to < SOAEL
Low	> 0 to < 5dB	LOAEL	30 to ≤40dB $L_{night,outside}$	LOAEL
Negligible	≤ 0	NOEL	≤30dB $L_{night,outside}$	NOEL

102. Table 7-14 of the IEMA 2014 guidance refers to impacts from change in sound levels (sourcing HS2 Phase 1 ES as its origin). This table introduces the concept of long-term impact classification and short-term impact classification, with a daytime and night time timebase of $L_{pAeq,16h}$ and $L_{pAeq,8h}$ and associated thresholds. **Table 23-18** outlines these sound level change criteria for short term and long term classification.

Table 23-18: IEMA Sound Level Change Criteria

Long Term Impact Classification	Short Term Impact Classification	Sound level change dB L_{pAEqT} (positive or negative) T = either 16hr day and 8hr night
High	High	≥10 dB
Medium		≥5 dB and < 10dB
Low	Medium	≥3 dB and <5 dB
Negligible	Low	≥1 dB and <3 dB
	Negligible	≥ 0 dB and < 1 dB

23.4.3.7 Operational Phase Vibration Assessment

103. Some of the substation electrical plant is vibration sensitive; hence, to prevent damage, the proposed onshore substation will be designed to achieve very low levels of ground-borne vibration within the substation itself. This will be achieved using industry standard mitigation measures applied to items of plant with the potential to generate significant levels of vibration, such as vibration isolation pads/mounts for proposed super grid transformers.

104. In terms of the potential for impacts at receptors, these very low levels of vibration within the substation will be further attenuated due to propagation with distance. On this basis, the operation of the substation is not anticipated to result in perceptible levels of vibration at receptors and no further assessment of operational phase vibration impacts is required, as agreed in consultation.

23.4.4 Cumulative Impact Assessment Methodology

105. The CIA considers other plans, projects and activities that may impact cumulatively with SEP and DEP. As part of this process, the assessment considers which of the residual impacts assessed for SEP and/or DEP on their own have the potential to contribute to a cumulative impact. It also considers the availability of required data and the resulting confidence in the assessment. **Chapter 5 EIA Methodology** provides further details of the general framework and approach to the CIA.

106. For noise and vibration, these activities include on-site construction noise, noise associated with construction road traffic and operational phase noise associated with the onshore substation.

23.4.5 Transboundary Impact Assessment Methodology

107. There are no transboundary impacts with regard to onshore noise and vibration as the onshore project area would not be sited in proximity to any international boundaries. Transboundary impacts are therefore scoped out of this assessment and are not considered further, as agreed in consultation.

23.4.6 Assumptions and Limitations

108. In the absence of detailed information from a construction contractor, assumptions have been made about the types of plant and equipment which are likely to be used for the construction works. These assumptions are considered representative of a reasonably foreseeable worst-case.

109. Any measurement of existing ambient or background sound levels will be subject to a degree of uncertainty. Environmental sound levels vary between days, weeks, and throughout the year due to variations in source levels and conditions, meteorological effects on sound propagation and other factors. Hence, any measurement survey can only provide a sample of the ambient levels. Every effort is made to ensure that measurements are undertaken in such a way to provide a representative sample of conditions, such as avoiding periods of adverse weather conditions, and school holiday periods (which are often considered to result in atypical sound levels). However, a small degree of uncertainty will always remain in the values taken from such a measurement survey.

110. For the assessment of construction noise associated with the onshore cable corridor, noise predictions were undertaken assuming all construction plant is concurrently operating at the Order limits for each activity. Similarly, all substation construction plant was assumed to be concurrently operating at the substation site option boundaries. These assumptions ensure that a worst-case assessment is presented, as in reality most of the works will be undertaken further away from the NSRs.

111. Calculations of likely construction vibration levels have been undertaken. In some instances, it has been necessary to calculate vibration levels at distances beyond their stated validated range; hence, the result should only be treated as an estimate. This is noted where relevant in **Section 23.6.1.5**.

23.5 Existing Environment

23.5.1 Baseline Noise Environment

112. An understanding of the baseline noise environment is required to determine the significance of potential impacts during both construction and operational phases.

113. A total of 10 NSR locations at the onshore substation were agreed as part of consultation with BDC and SNC for SEP and DEP; these are presented in **Table 23-19**.

114. The NSR locations at the landfall are labelled either with the prefix LFR (denoting an NSR near the landfall), or SSR (denoting that it is near the proposed substation). Each receptor was given an accompanying individual number.

Table 23-19: Onshore Noise Sensitive Receptors Included in Assessment

NSR identifier	Coordinates		Classification	Sensitivity
	X	Y		
Landfall				
LFR1	610977	343450	Residential	Medium
Substation				
SSR1	620863	302329	Residential	Medium
SSR2	621180	301320	Residential	Medium
SSR3	621610	301271	Residential	Medium
SSR4	620339	301806	Residential	Medium
SSR5	622499	302482	Residential	Medium
SSR6	622529	302038	Residential	Medium
SSR7	621575	302924	Residential	Medium
SSR8	621319	303086	Residential	Medium
SSR9	620982	301753	Residential	Medium
SSR10	620997	301476	Residential	Medium

115. The baseline sound survey comprised of attended measurements at the landfall location and unattended measurements at the onshore substation. Measurements were conducted in accordance with current guidance including BS 4142 and BS7445.

116. Measurement locations (representative of individual or groups of NSRs) were identified and agreed with BDC and SNC, as provided in **Table 23-20** and displayed in **Figure 23.1**.

117. Note the X and Y coordinates in **Table 23-19** (NSR locations) are slightly different to the coordinates provided in **Table 23-20** (baseline sound survey locations). All measurement locations are considered representative of individual or groups of receptors and measurements were undertaken within the curtilage of the identified receptor land.

118. No measurements were obtained at receptor SSR3 and SSR10 due to access constraints. Baseline sound survey measurements from location SSR2 are considered representative for SSR3, and SSR9 is comparable with location SSR10.

Table 23-20: Baseline Sound Survey Measurement Locations

NSR identifier	Coordinates	
	X	Y
Landfall location		
LFR1	610986	343479
LFR2	611574	343619
Onshore substation		
SSR1	620864	302308
SSR2	621153	301333
SSR3	620344	301827
SSR4	622480	302516
SSR5	622514	302184
SSR6	621564	302907
SSR7	621353	303104
SSR8	620969	301772
SSR9	620864	302308
SSR10	620997	301476

119. Details of the baseline survey sound procedures are provided in **Appendix 23.1 Baseline Noise Survey and Acoustic Terminology**.

23.5.1.1 Onshore Cable Corridor and Landfall Location Baseline

120. The results of the attended baseline noise measurement survey are summarised in **Table 23-21** and **Table 23-22** for LFR1 and LFR2 respectively.

Table 23-21: Measured Baseline Sound Levels – Measurement Location LFR1

Period and Start Date and Time	Duration (mm:ss)	L_{Aeq} (dB)	L_{A10} (dB)	L_{A90} (dB)	L_{AFmax} (dB)
Daytime 13/10/21 16:48	36:14	51	52	35	70
Evening 13/10/21 19:49	16:38	39	41	35	55
Night time 13/10/21 23:24	15:31	40	41	37	65

Table 23-22: Measured Baseline Sound Levels – Measurement Location LFR2

Period and Start Date and Time	Duration (mm:ss)	L_{Aeq} (dB)	L_{A10} (dB)	L_{A90} (dB)	L_{AFmax} (dB)
Daytime 13/10/21 15:57	30:05	42	45	38	56
Evening 13/10/21 19:22	15:38	43	45	41	52
Night time 13/10/21 22:59	15:22	50	53	47	57

23.5.1.2 Onshore Substation Location Baseline

121. A summary of the unattended baseline sound survey results, representative of the NSRs around the proposed onshore substation site, is provided in **Table 23-23**.

Table 23-23: Measured Baseline Sound Levels, Onshore Substation Site

NSR identifier	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	L_{A10} (dB)	L_{A90} (dB)
Daytime (07:00 - 23:00)				
SSR1	51	34 to 96	44	37
SSR2	50	38 to 89	47	38
SSR3*	50	38 to 89	47	38
SSR4	51	37 to 92	44	37
SSR5	52	48 to 91	50	45
SSR6	51	46 to 94	49	43
SSR7	53	43 to 98	48	43
SSR8	52	40 to 93	47	42
SSR9	52	38 to 95	45	37
SSR10**	52	38 to 95	45	37
Night-time (23:00 - 07:00)				
SSR1	39	29 to 73	36	30
SSR2	40	34 to 76	43	31
SSR3*	40	34 to 76	43	31
SSR4	37	31 to 71	35	29
SSR5	43	42 to 70	44	35

NSR identifier	$L_{Aeq,T}$ (dB)	L_{AFmax} (dB)	L_{A10} (dB)	L_{A90} (dB)
SSR6	42	38 to 70	42	35
SSR7	47	39 to 75	42	36
SSR8	44	37 to 96	41	34
SSR9	38	31 to 68	36	29
SSR10**	38	31 to 68	36	29

* Access denied to SSR3: hence, baseline sound levels assumed to be as measured at SS2.
** Access denied to SSR10; hence, baseline sound levels assumed to be as measured at SSR9

122. No baseline noise measurements were obtained along the cable corridor to inform the construction phase noise assessment. It was agreed with BDC that a conservative approach would be to use the lowest threshold (for the BS 5228:2009+A1:2014 'ABC method') at all identified NSRs for the assessment of construction noise.

23.5.2 Baseline Road Traffic Noise

123. The road links required for SEP and DEP construction traffic are presented in **Appendix 23.2 Road Traffic Noise Assessment**. A BNL was calculated for each link likely to be used during the construction phase, these are also presented in **Appendix 23.2 Road Traffic Noise Assessment**.

23.5.3 Climate Change and Natural Trends

124. As discussed in **Section 23.4.1.2.1**, UK planning policy such as the NPPF (para. 185) requires that new development incorporates mitigation measures to reduce potential adverse noise impacts to a minimum; hence, in general, developments which significantly increase noise in the study area would not be expected to be granted consent. In addition to planning controls there is a clear trend for noise from vehicle, commercial and industrial sources to be driven down in compliance with stricter legislation and guidance as well as consumer expectations.

125. The baseline noise monitoring survey identifies the existing soundscape within the study area and the sources which are contributing to it. In the absence of evidence to the contrary, it is reasonable to assume that the contributing noise sources will not change over time. Hence, changes in future baseline noise levels will depend on the change in noise emissions from the identified sources.

126. In general, the dominant sources contributing to the baseline sound climate were aircraft, road traffic and sounds typical of a rural environment, such as bird call and farm machinery. Road traffic and aircraft noise levels depend on road traffic flows and individual vehicle noise levels. Traffic flows and aircraft movements are generally expected to increase in line with expectations for macro-economic expansion; however, as discussed above, vehicle and aircraft noise levels are expected to reduce over time. Farm machinery noise levels would also be expected to reduce as old equipment is replaced with newer, quieter versions.

127. It is reasonable to anticipate that the trend for increased economic activity to increase baseline noise levels would be balanced out by the effect of planning controls and reductions in source noise emissions. This would result in no change in overall baseline conditions in the study area.

23.6 Potential Impacts

23.6.1 Potential Impacts During Construction

128. The worst-case scenario construction assessment (**Table 23-2 Road Traffic Noise Assessment**) has been undertaken, with assumptions regarding construction plant for each activity and the expected construction noise levels at the nearest NSRs, are provided in **Appendix 23.3 Construction Noise and Vibration Assessments**.

23.6.1.1 Impact 1: On-site Construction Noise at Landfall Location

23.6.1.1.1 Magnitude of Effect - All Scenarios

129. For all construction scenarios it is proposed that there will be one active HDD rig operating at the landfall which will operate 24 hours a day over the works duration.

130. For the SEP and DEP sequentially scenario, the magnitude of effect associated with construction works at the landfall location is considered to be the same as for SEP and DEP in isolation and SEP and DEP concurrently scenarios but for a longer duration.

131. The predicted noise level at the nearest NSR during landfall construction activities is 50dB $L_{Aeq,T}$. This level represents an effect of negligible magnitude during the daytime, evening and weekend reference periods, in accordance with the criteria outlined in **Section 23.4.3.3**.

132. During the night-time reference period, the predicted noise level (50dB $L_{Aeq,T}$) would represent an effect of low magnitude.

23.6.1.1.2 Impact Significance – All Scenarios

133. NSRs surrounding the landfall location are identified to be of medium sensitivity; this results in impacts of negligible significance, i.e. not significant, during the daytime and evenings and weekends reference periods, for all construction scenarios.

134. During the night-time reference period, without mitigation, a minor adverse impact is predicted i.e. not significant.

23.6.1.1.3 Mitigation Measures – All Scenarios

135. Where night-time working is required at the landfall, additional mitigation would be provided.

136. Prior to construction, a Construction Noise Management Plan (CNMP) (as part of the CoCP) would be prepared, outlining BPM for noise mitigation including, but not limited to:

- Ensuring plant and machinery is turned off when not in use;
- Using modern, quiet equipment and ensuring such equipment is properly maintained and regularly inspected;
- Informing local residents about the construction works, including the timing and duration of any particularly noisy elements; and
- Implement a grievance mechanism (e.g. complaint procedure) for local residents to report nuisance and other issues, including 24-hour contact details for a site representative.

137. The CNMP would detail the measures required to mitigate noise associated with the landfall works, including temporary screening around the work area or construction compound to ensure that no part of the noise source is visible at the NSR. BS 5228-1 indicates that screening provides 5 to 10dB of attenuation, but the effectiveness is dependent on the distance to the noise source, and the extent to which line-of-sight is obstructed.

23.6.1.1.4 Residual Impacts – All Scenarios

138. After implementation of the specific noise control measures, and on the basis that a 5 to 10dB noise reduction is achievable with screening, the magnitude of the effect would be reduced to negligible, representing a residual impact of negligible significance at NSRs near the landfall location i.e. not significant.

23.6.1.2 Impact 2: On-site Construction Noise Along Onshore Cable Corridor

23.6.1.2.1 Magnitude of Effect – All Scenarios

139. Potential construction noise along the onshore cable corridor is assumed to be equal for the SEP and DEP concurrent or sequential construction scenarios, as there would be the same number of active work-fronts at any one time.

140. To assess the potential impacts from construction noise, 78 NSR locations were identified along the cable corridor and 5 NSR locations near to the proposed main compound. NSR locations were chosen to represent the worst-case for each group of residential dwellings along the onshore cable corridor, i.e. closest to the proposed works and with minimal existing screening.

141. Construction noise impacts along the onshore cable corridor would be temporary in nature and linked to the following activities:

- Installation of temporary access tracks;
- Establishing temporary work areas;

- Installation, ducting and pulling of cables along the onshore cable corridor;
- Main compound site works; and
- Trenchless crossing works along the onshore cable corridor.

142. It is assumed that all construction works along the cable corridor would be undertaken during the BS 5228-1 daytime reference period only, with the exception of concrete pouring activities at the onshore substation, and trenchless crossings, which are all considered to be continuous activities which may extend into the evening/weekend and night time reference periods.

143. Construction noise at NSRs along the cable corridor has been calculated assuming all construction plant is concurrently operating at the closest point on the Order limits for each activity, except for trenchless crossing works, which are limited to specific locations.

144. This approach is considered to represent the worst-case scenario for potential construction noise along the cable corridor and assumes all plant is operating at the nearest location to NSRs. It should be noted that the Order limits represent an approximately 60m wide study corridor.

145. Trenchless crossing works assume all plant associated with that activity to be in simultaneous operation at each proposed crossing location.

146. Assumptions regarding plant for each construction activity are provided in **Appendix 23.3 Construction Noise and Vibration Assessments** in addition to the predicted construction noise level at each NSR.

147. **Table 23-24** presents the predicted number of NSRs per magnitude of effect level for each unmitigated construction activity.

Table 23-24: Magnitude of Effect Predicted or Construction Noise at Identified NSRs Along the Cable Corridor for Each Construction Activity Type – Unmitigated (Number Represents the Number of NSRs Affected)

Negligible	Low	Medium	High
Installation of temporary access tracks – daytime			
44	9	12	13
Establishing temporary work areas – daytime			
63	4	3	8
Cable duct and installation – daytime			
59	4	7	8
Cable pull – daytime			
60	4	6	8
Main Compound works - daytime			
3	2	0	0
Main Compound works - evening and weekends			
2	3	0	0
Main Compound works - night-time			

Negligible	Low	Medium	High
0	1	1	3
Trenchless crossing works (HDD) - daytime			
69	2	2	5
Trenchless crossing works (HDD) - evening and weekends			
46	13	10	9
Trenchless crossing works (HDD) - night-time			
9	18	19	32

23.6.1.2.2 Impact Significance All Scenarios

148. **Table 23-24** shows that, without mitigation, a magnitude of effect of medium or high is predicted at a maximum of 51 of the 78 assessed NSRs (during night-time trenchless crossing works).

149. All NSRs along the onshore cable corridor are of medium sensitivity. For those NSRs which are relatively far from the construction works the magnitude of effect is low to negligible; hence, impacts are of minor adverse significance. Without mitigation, the NSRs closer to the works would potentially experience adverse impacts of moderate or major adverse significance.

150. To determine whether the identified moderate and major adverse impacts are significant, the likely impact durations have been identified for each construction activity. This is to allow comparison with the guidance in BS 5228-1 that indicates construction noise levels above the Threshold Value for fewer than 10 days (or 10 evenings/weekends or nights) in any 15 consecutive days, or 40 days or fewer (or 40 evenings/weekends or nights) in any 6-month period, would not normally be considered significant.

151. The main compound is likely to be used for the full duration of the onshore construction works and is expected to be in use, to some extent, if there are any night time works taking place anywhere along the route. Therefore, as a worst-case assumption, the night-time compound works could last for 40 days in any 6-month period and/or 10 days in any 15; hence, these identified moderate and major adverse impacts are considered significant.

152. The trenchless crossing works are expected to last a maximum of 7 weeks (SEP or DEP in isolation), 12 weeks (SEP/DEP concurrent) or 7 weeks per project (SEP/DEP sequential). As a worst-case assumption, the resultant noise impacts at an NSR could therefore also last for 40 days in any 6-month period and/or 10 days in any 15; hence, the identified moderate and major adverse impacts due to trenchless crossing works are considered significant.

153. The construction works on the cable corridor (i.e. installation of temporary access tracks and work areas, cable duct and installation) are linear in nature and for all scenarios, SEP or DEP in isolation, SEP/DEP concurrent or sequential, they are expected to be undertaken in 1km sections, requiring a construction presence for up to 4 weeks per section. For such linear activities, to identify the impact duration, it is necessary to calculate the maximum distance from the activity to the NSR at which it could cause an exceedance of the Threshold Value. This minimum distance has been calculated as follows:

- installation of temporary access tracks – 116m
- establishing temporary work areas – 84m
- cable duct and installation – 119m
- cable pull – 112m

154. To identify whether a significant effect is likely to occur, it is necessary to establish the length of time the works will be less than the above distance from each NSR.

155. The cable duct and installation works are likely to result in the longest duration exceedances of the Threshold Value. As a worst-case, it is assumed that these works last for the entire month i.e. progressing at 250m per week. On this basis, the exceedance of the Threshold Value at an NSR would only last for one week. It is therefore considered highly unlikely that any exceedance of the Threshold Value would last for more than 40 days in any 6-month period or 10 days in any 15; hence, the identified moderate and major adverse impacts due to construction works along the cable corridor route are considered not significant.

23.6.1.2.3 Mitigation Measures All Scenarios

156. Before the construction works start, a CNMP will be prepared detailing site specific noise control measures for construction activities. These measures will minimise the impact of increases in noise due to construction of SEP and DEP.

157. The final mitigation measures to be applied will be based on a detailed understanding of the potential scheme impacts, considering factors not known at the time of writing this ES, such as micrositing the final cable corridor alignment within the corridor, plant on-time and location relative to the NSRs, duration of specific activities and other relevant factors.

158. Where significant impacts remain, the following further mitigation measures would be considered and included in the CNMP, where applicable:

- Temporary screening around the work area or construction compound;
- Use of silencers and/or enclosures around noisy equipment;
- Reduced numbers of plant during sensitive periods where practicable;
- Reduced on-time of plant during sensitive periods where practicable;
- Increased separation distance between works and NSRs where practicable;
- Choosing alternative, lower impact equipment or methods where practicable;
- Where practicable, noisy works should be interspersed between quieter works to provide periods of respite;

- Where practicable, the works should be phased to ensure that the noisiest operations are performed during the least sensitive times; and
- Review the construction programme to minimise the duration of the works in proximity to NSRs where feasible. Minimising the duration of work is generally beneficial, if higher noise levels may result in a significant reduction in the overall duration of the works this should be considered.

23.6.1.2.4 Residual Impacts All Scenarios

159. The assessment of onshore cable corridor construction noise impacts identified that impacts are not likely to be significant. After implementation of the specific noise control measures agreed through the CNMP, residual construction noise impacts will be further minimised and are considered not significant.

23.6.1.3 Impact 3: On-site Construction Noise at the Onshore Substation

23.6.1.3.1 Magnitude of Effect – All Scenarios

160. Potential construction noise sources at the onshore substation are assumed to be the same for all of the construction scenarios: SEP or DEP in Isolation, or SEP and DEP either sequentially or concurrently.

161. Noise predictions were undertaken assuming all construction plant is concurrently operating at the closest approach of the onshore substation site to the NSR. This approach considers the worst-case scenario for noise levels associated with construction of the onshore substation and assumes all plant is operating at the nearest location to each NSR.

162. Assumptions regarding construction plant for each activity are provided in **Appendix 23.3 Construction Noise and Vibration Assessments** in addition to the predicted noise level at each NSR.

163. The nearest NSRs are all in excess of 500m from the substation site boundary. **Appendix 23.3 Construction Noise and Vibration Assessments** shows a negligible magnitude of effect is predicted at all NSRs during all the construction time periods.

23.6.1.3.2 Impact Significance All Scenarios

164. The substation is at a fixed location; hence, the duration of the effect is simply the duration of the works. All NSRs in proximity to the onshore substation construction works are of medium sensitivity, and the negligible magnitude of effect represents impacts of negligible significance i.e. not significant at all NSRs. No requirement for additional mitigation has been identified.

23.6.1.4 Impact 4: Noise from Off-Site Construction Traffic

165. Two potential worst-case construction traffic noise scenarios for SEP and DEP have been identified:

- Construct SEP and DEP sequentially; and
- Construct SEP and DEP concurrent.

166. The SEP or DEP in-isolation scenario would have peak construction traffic identical to the SEP and DEP sequential scenario. In keeping with the assessment format presented in **Chapter 24 Traffic and Transport**, impacts are presented of the SEP or DEP in-isolation scenario and the impact of the SEP and DEP sequential scenario is not presented separately. The only anticipated difference in the impacts between the SEP and DEP sequential and SEP or DEP in-isolation scenarios is in the overall duration.

167. Road links required for SEP and DEP construction traffic are presented in **Figure 24.1** of **Chapter 24 Traffic and Transport**.

168. The data were provided for a baseline year plus growth (‘without SEP and DEP scenario) and baseline year plus growth plus development (‘with SEP and DEP scenario) and details for the total traffic flow per link, the composition of the flow with percentage heavy goods vehicle (HGVs) and speed data.

169. The earliest realistic year that construction works will start is 2025; therefore, considered the worst-case year for assessment. It is anticipated that later years would have higher baseline traffic flows and therefore a lesser magnitude of effect.

170. All data are provided encapsulating the cumulative traffic for SEP and DEP in combination and an assessment of both SEP and DEP in isolation.

171. The traffic noise assessment comprises the following situations:

- 2025 Factored Base versus 2025 Factored Base + Peak Construction Isolation (SEP or DEP in isolation)
- 2025 Factored Base versus 2025 Factored Base + Average Construction Isolation (SEP or DEP in isolation).
- 2025 Factored Base versus 2025 Factored Base + Peak Construction Concurrent (SEP/DEP concurrent)
- 2025 Factored Base versus 2025 Factored Base + Average Construction Concurrent (SEP/DEP concurrent)

172. The peak construction concurrent SEP/DEP traffic against the 2025 baseline is considered the worst-case year for assessment purposes as it represents the earliest year for the start of construction works. Later years would have higher baseline traffic flows and therefore the introduction of SEP and DEP construction traffic would represent a lesser impact magnitude.

173. For each situation (detailed above) and road link (182 Total which includes some links with different speeds), a BNL was calculated using the CRTN or NAC methodology to determine the short-term relative change from construction traffic associated with the SEP and DEP schemes. The road links assessed are provided in full detail in **Appendix 23.2 Road Traffic Noise Assessment**.

23.6.1.4.1 Magnitude of Effect (SEP or DEP in Isolation or SEP and DEP Sequential)

174. The construction road traffic noise assessment predicts changes in $L_{A10,18hr}$ (CRTN) and $L_{Aeq,18hr}$ (NAC). From the SEP or DEP in isolation traffic noise level calculations, a <1dB change in BNL (a negligible magnitude of effect) is predicted at 142 of the road links during peak construction traffic flows. Changes of 1 to 2.9dB (low effect according to **Table 23-12**) are predicted on 29 road links, 3 to 4.9dB (medium) at five links (links 58, 64, 90, 102 and 137), and ≥ 5dB (high) at six links (links 61, 84, 128, 147, 148 and 149). These are detailed in full in **Appendix 23.2 Road Traffic Noise Assessment**. In

23.6.1.4.2 Impact Significance (SEP or DEP in Isolation or SEP and DEP Sequential)

175. No highly sensitive receptors have been identified along any of the identified road links. Traffic link 128 was predicted to experience a high magnitude of effect; however, this link will allow access from the highway to the onshore substation, routed from the A140 (link 127). There are no sensitive receptors between the A140 and the onshore substation; therefore, the predicted impact on this link is negligible i.e. not significant.

176. To assess a potential worst-case, there are assumed to be residential NSRs along all the identified remaining road links i.e. receptors of medium sensitivity. Hence, the worst-case impact on NSRs due to the identified negligible and low magnitude effects will be of negligible and minor significance respectively i.e. not significant.

177. The impact on medium sensitivity NSRs due to the predicted medium and high magnitude effects are moderate and major significance respectively i.e. potentially significant. However, these impacts relate to the peak (i.e. worst-case week) construction traffic flow across the entire construction schedule which is a very short duration; hence, on their own, these changes do not indicate a significant impact. To provide further context on the duration of the impacts, an analysis of the predicted average change in traffic flow on these links has been undertaken. The construction traffic flows have been averaged across the periods of the construction schedule when any construction traffic is forecast to use the identified link. Note that in most instances, there are long periods of the construction schedule when no traffic flows will use a particular link. These periods have been excluded from the calculation of the average flows to assess a potential worst-case.

178. The analysis of average SEP or DEP in isolation traffic indicates a negligible impact on 169 links and impacts of minor adverse significance on seven links. Noise impacts due to peak traffic flows on links 58, 64, 90, 102 and 137 were identified as potentially significant, but average traffic flows result in minor adverse impacts (not significant).

179. Using the average traffic flow data, an impact of moderate adverse significance is predicted on three of the identified links (147, 148 and 149) and major adverse significance on a further two of the identified links (61 and 84). Without mitigation, impacts on these links are predicted to be potentially significant.

180. To further analyse the potential impacts, the closest NSR has been identified to the links on which medium and high road traffic noise magnitude effects are predicted, due to the peak SEP or DEP in isolation traffic flows. Road traffic noise levels at these NSRs, with the peak SEP or DEP in isolation traffic flows, have been calculated for comparison with the LOAEL and SOAEL criteria in **Table 23-13**, as shown in **Appendix 23.2 Road Traffic Noise Assessment**. The calculated road traffic noise levels at receptors are between the LOAEL and SOAEL for links 61, 64, 84, 102, 147, 148 and 149. On that basis, impacts on these links are no greater than minor adverse significance i.e. not significant. However, on links 58, 90 and 137, calculated road traffic noise levels exceed the SOAEL.

181. For those links on which the calculated road traffic noise levels exceed the SOAEL, further analysis has been undertaken. The maximum HGV flows which could be introduced onto these links, without causing a change in the road traffic noise level of 3dB, has been identified, as shown in **Appendix 23.2 Road Traffic Noise Assessment**. If this change is less than 3dB, the impact is no worse than minor adverse significance, as shown in **Table 23-12**.

182. To inform this assessment, data showing likely HGVs movements over time for those links on which a potentially significant impact has been identified are presented in **Appendix 23.2 Road Traffic Noise Assessment**. Analysis of the weekly flow data on link 58 shows that the number of construction-related HGVs associated with SEP or DEP in isolation will be more than 110 for two weeks in the entire construction schedule. Similarly, for link 90, SEP or DEP in isolation construction HGV flows are only anticipated to exceed the maximum (120) for one week. Using the criteria for impact duration in BS 5228-1 (40 days in any 6-month period), the periods of exceedance of the 3dB change criterion on these links are considered too short to cause a significant impact. On that basis, the significance of impacts on these links are considered no worse than moderate adverse i.e. not significant.

183. On link 137, SEP or DEP in isolation HGV flows are anticipated to exceed the maximum (24) for 19 weeks. Without further mitigation, this further analysis does not change the conclusion regarding the identified medium magnitude of effect on this link, which, at a medium sensitivity receptor, equates to an impact of moderate adverse significance i.e. significant.

23.6.1.4.3 Mitigation Measures (SEP or DEP in Isolation or SEP and DEP Sequential)

184. A CTMP would be developed to reduce peak SEP or DEP in isolation traffic flows causing significant impacts along the identified links, this will also serve to reduce the associated construction traffic noise impacts. Traffic management measures are provided in **Chapter 24 Traffic and Transport** - **Section 24.6, and** will minimise construction traffic noise impacts. Additionally, the **outline CTMP** provided with this application (document reference: 9.16) proposes mitigation measures for the links as detailed in **Table 23-25**. For justification of the identified measures, please see **Chapter 24 Traffic and Transport**.

Table 23-25: CTMP Mitigation Proposed Peak Isolation SEP or DEP Traffic

Link	Mitigation Proposed
58	No mitigation proposed
61	Peak LV hour demand to not exceed the forecast average peak hour demand.
64	Peak LV hour demand to not exceed the forecast average peak hour demand and peak daily HGV demand to not exceed the forecast average daily HGV demand.
84	Peak LV hour demand to not exceed the forecast average peak hour demand and peak daily HGV demand to not exceed the forecast average daily HGV demand.
90	No mitigation proposed
102	Peak LV hour demand to not exceed the forecast average peak hour demand and peak daily HGV demand to not exceed the forecast average daily HGV demand.
128	No mitigation proposed
137	No mitigation proposed
147	Peak LV hour demand to not exceed the forecast average peak hour demand and peak daily HGV demand to not exceed the forecast average daily HGV demand.
148	No mitigation proposed
149	Peak LV hour demand to not exceed the forecast average peak hour demand and peak daily HGV demand to not exceed the forecast average daily HGV demand.

185. Incorporating the mitigation shown in **Table 23-25**, on links 64, 84, 102, 147 and 149, peak daily HGV demand will not exceed the forecast average; hence, this provides further evidence that noise impacts due to construction traffic on these links will be not significant.

186. The calculations of maximum allowable construction traffic flows, to avoid a 3dB change in road traffic noise level, are shown in **Appendix 23.2 Road Traffic Noise Assessment**. This provides two options for an allowable maximum construction traffic flow on link 137, as follows:

- 24 HGVs and 138 LCVs
- 37 HGVs and 70 LCVs

187. The final construction traffic flows will be determined by the appointed construction contractor. A further mitigation measure is that the construction traffic flows on link 137 will be controlled to make sure that the additional traffic does not result in a change in the basic noise level of 3dB or more for a period of 40 or more days in any 6-month period. This is secured through the OCoCP (document ref: 9.17).

23.6.1.4.4 Residual Impact (SEP or DEP in Isolation or SEP and DEP Sequential)

188. Prior to mitigation, the identified traffic noise impacts due to construction of SEP or DEP in isolation, or SEP and DEP sequential, are no worse than minor adverse (not significant) on all links except link 137. With the proposed mitigation to control traffic flows on link 137, the significance of the residual impacts on all links is no worse than minor adverse i.e. not significant.

23.6.1.4.5 Magnitude of Effect (SEP/DEP Concurrent)

189. From the peak concurrent SEP/DEP traffic calculations (considered as the worst-case scenario), a <1dB change in BNL (i.e. a negligible magnitude of effect according to the criteria in **Table 23-12**) is predicted at 134 of the road links. Changes of 1 to 2.9dB (effect of low magnitude) are predicted on 38 road links, 3 to 4.9dB (medium) at three links (links 58, 64 and 102), and ≥ 5dB (high) at seven links (links 61, 84, 90, 128, 147, 148 and 149). These are detailed in full in **Appendix 23.2 Road Traffic Noise Assessment**.

23.6.1.4.6 Impact Significance (SEP/DEP Concurrent)

190. As per the SEP or DEP in isolation scenario, there are no NSRs to experience the change in traffic noise levels on link 128; hence, the predicted impact on this link is negligible i.e. not significant.

191. The sensitivity of the properties alongside road links is medium; hence, the worst-case impact on NSRs due to the identified negligible and low magnitude effects will be of negligible and minor adverse significance respectively i.e. not significant.

192. The predicted medium and high magnitude effects represent impacts of moderate and major adverse significance, respectively i.e. potentially significant. However, these peak traffic flow magnitude effects are potentially of short duration; hence, on their own, do not necessarily indicate a significant impact. The predicted average change in traffic flow on these links has been analysed to consider the potential impacts further.

193. The analysis of average concurrent SEP/DEP traffic indicates a negligible impact on 164 links and minor adverse on 12 links. Noise impacts due to peak traffic flows on links 58, 64, 90 and 102 were identified as potentially significant, but average traffic flows result in minor adverse impacts (not significant).

194. Using the average traffic flow data, an impact of moderate adverse significance is predicted on three of the identified links (147, 148 and 149) and major adverse significance on a further three of the identified links (61, 84 and 128). Without mitigation, impacts on these links are predicted to be significant.

195. The closest NSR has been identified to the links on which medium and high road traffic noise magnitude effects are predicted. Road traffic noise levels at these NSRs, with the peak SEP and DEP concurrent traffic flows, have been calculated for comparison with the LOAEL and SOAEL criteria in **Table 23-13**, as shown in **Appendix 23.2 Road Traffic Noise Assessment**. The calculated road traffic noise levels at receptors are between the LOAEL and SOAEL for links 61, 64, 84, 102, 147, 148 and 149. On that basis, impacts on these links are no greater than minor adverse significance i.e. not significant. However, on links 58 and 90, calculated road traffic noise levels exceed the SOAEL.

196. The maximum HGV flows which could be introduced onto these links, without increasing road traffic noise levels by 3dB (effect no worse than low magnitude), are identified for the SEP or DEP in isolation scenario. These are also applicable to the SEP and DEP in combination scenario.

197. Analysis of the weekly flow data on link 58 shows that the number of construction-related HGVs associated with SEP and DEP concurrent will be more than 110 for two weeks in the entire construction schedule. Similarly, for link 90, SEP and DEP construction HGV flows are only anticipated to exceed the maximum (120) for one week. Using the criteria for impact duration in BS 5228-1 (40 days in any 6-month period), the periods of exceedance of the 3dB change criterion on these links are considered too short to cause a significant impact. On that basis, the significance of impacts on these links are considered no worse than moderate adverse significance i.e. not significant.

23.6.1.4.7 Mitigation Measures (SEP/DEP Concurrent)

198. The same measures to be included in the CTMP, as described in relation to the impact of SEP or DEP in isolation, are relevant to the impacts of SEP and DEP concurrent, and specifically those mitigation measures for each road links as detailed in **Table 23-13**.

23.6.1.4.8 Residual Impact (SEP/DEP Concurrent)

199. With the proposed mitigation, the significance of the residual impacts on all links is no worse than minor adverse i.e. not significant.

23.6.1.5 Impact 5: Construction Vibration Along Cable Corridor

200. As discussed in **Section 23.4.3.5**, the assessment of construction vibration impacts is confined to the onshore cable corridor. No vibration impacts are anticipated due to construction of the landfall or substation.

201. The construction actvities with the potential to emit significant vibration have been identified. **Table 23-26** lists the minimum set-back distances at which the vibration level criteria relevant to the potential for human annoyance and cosmetic building damage (for transient vibration at a frequency of 4 Hz) may occur for these activities. Set back distances were derived using the calculation methods provided in BS 5228-2.

202. The operation of HDD rigs is likely to generate similar levels of vibration to rotary bored piling due to the similar mechanisms involved. Table D.6 of BS 5228-2:2009+A1:2014 suggests that vibration from rotary bored piling activities would generally fall below $1.0mm.s^{-1}$ at a distance of approximately 10m.

203. The calculations for impacts upon humans (i.e. PPV levels 0.3 to 10 $mm.s^{-1}$) assume a frequency independent vibration transfer function (level multiplied by 1.8) between outdoors and indoors, based upon measurements by D.J Martin (1980) described in the TRRL report 'Ground vibrations from impact pile driving during road construction'[1]. There is a 5% probability that the predicted vibration levels are exceeded. Further detail on the assumptions made to undertake these calculations are provided in **Appendix 23.3 Construction Noise and Vibration Assessments**.

Table 23-26: Predicted Distances at Which Vibration Levels May Occur

Activity	Set-back distance at which vibration level (PPV) occurs			
	0.3 $mm.s^{-1}$	**1.0 $mm.s^{-1}$**	**10 $mm.s^{-1}$**	**15 $mm.s^{-1}$**
Rotary Piling (HDD) based on Ref.106 Table D.6 BS 5228	15.1m	4.5m	0.45m	0.3m
Vibratory compaction (start-up)	123m*	48m	7.2m	2.8m
Vibratory compaction (steady state)	87m	38m	7.3m	3.2m
* equation only validated to a set-back distance of 2 to 110m; hence, these values are only estimates				

23.6.1.5.1 Magnitude of Effect

204. The closest NSR to the proposed trenchless crossing works is CCR2C at a minimum distance of 6.5m from the Order limits. Assuming that equipment is positioned at the closest point to CCR2C within the Order limits, the predicted PPV levels are between 0.3 and 1.0$mm.s^{-1}$ at CCR2C. For human receptors, the criteria in **Table 23-16** shows that these predicted vibration levels have the potential to cause an effect of low magnitude.

205. The closest NSR to the proposed cable duct installation works is CCR9 at a minimum distance of 7m from the Order limits. Assuming the equipment was positioned at the closest point of the Order limits, the predicted PPV levels are between 10 and 15 $mm.s^{-1}$ at receptor CCR9 during start-up and steady state operation of the compaction plant. For human receptors, the criteria **Table 23-16** shows that these predicted vibration levels have the potential to cause an effect of high magnitude.

206. As detailed in **Table 23-16**, the set-back distances for the use of vibratory compactors/rollers of >48m for start-up and approximately >38m for steady state operation would represent a low magnitude of effect on residential properties.

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[1] Martin D.J. (1980). Ground vibrations from impact pile driving during road construction. Transport and Road Research Laboratory, TRL Supplementary Report 544.

207. Limits for transient vibration at residential buildings from vibration sources are presented in **Table 23-14**. BS 5228-2 states that for continuous vibration (such as that induced by vibratory compaction), the thresholds might need to be reduced by up to 50%.

208. TRL Report 429 ‘*Groundborne vibration caused by mechanised construction works’* shows that the frequency of vibration generated by compaction using rollers exceeds 15 Hz. Hence, the threshold for the potential for vibration-induced cosmetic damage to occur from vibratory compaction is 10 $mm.s^{-1}$. Based on the separation distances in **Table 23-26**, to control the risk of vibration-induced cosmetic damage to no greater than 5%, any vibratory compaction should be at least 8m from a residential property. Assuming this set back distance is complied with, vibration on buildings would represent a magnitude of effect no greater than low.

23.6.1.5.2 Impact Significance

209. The identified NSRs are of medium sensitivity; hence, the predicted low magnitude effects on human receptors due to the trenchless crossing works are anticipated to result in impacts of minor adverse significance i.e. not significant.

210. The worst-case vibratory compaction works are predicted to cause effects on human receptors of medium magnitude (when the compactor is within 48m of the NSR) and high magnitude (when the compactor is within 7.2m). However, the duration of vibratory compaction works within 48m of a NSR is likely to be very short; hence, an exceedance of the 1$mm.s^{-1}$ threshold does not necessarily imply a significant adverse impact. As discussed in **Section 23.6.1.2.2**, the cable corridor works are anticipated to progress at a rate of 250 m per week. The cable corridor works include activities other than ground compaction; hence, the rate of progression of ground compaction will be even quicker. On that basis, ground compaction is only likely to be within 48 m of any NSR for less than one day. Such a short duration of exposure means that vibration impacts on human NSRs due to ground compaction will be no greater than minor adverse significance i.e. not significant.

211. Building damage effects due to vibration from ground compaction are predicted to be of no worse than low magnitude; hence, worst-case impacts will be of minor adverse significance i.e. not significant.

23.6.1.5.3 Mitigation Measures

212. A CNMP will be provided as part of the COCP (an **Outline CoCP** is provided with the application – document reference: 9.17), which will outline BPM for vibration mitigation including, but not limited to:

- using non-vibratory ground compaction methods at distances of 8m or less from a receptor;
- choosing alternative, lower impact equipment or methods wherever possible;
- scheduling the use of vibration-causing equipment, at the least sensitive time of day;

- routing, operating or locating high vibration sources as far away from sensitive areas as possible;
- sequencing operations so that vibration-causing activities do not occur simultaneously;
- isolating the equipment causing the vibration on resilient mounts; and
- keeping equipment well maintained.

23.6.1.5.4 Residual Impact

213. Following the implementation of best practice measures, the construction vibration impacts are expected to be no greater than minor adverse significance i.e. not significant.

23.6.2 Potential Impacts During Operation

23.6.2.1 Impact 1: Operation of the Onshore Substation Noise Impacts

23.6.2.1.1 SEP or DEP in Isolation

214. The assessment of operational noise was based on the unmitigated fixed plant details for SEP or DEP operating in isolation provided in **Appendix 23.4 Onshore Substation Operational Noise Assessment**.

215. Full details regarding assumptions and operational noise sources included in the assessments and the predicted *specific sound levels* at each NSR are provided in **Appendix 23.4 Onshore Substation Operational Noise Assessment**.

216. As discussed in **Section 23.4.3.6**, the following analysis considered whether any character corrections (for tonality, intermittency, impulsivity or other sound characteristics) should be applied to the predicted *specific sound levels* to determine the *rating levels* for comparison with the measured *background sound levels*.

217. Whilst the sound emitted by some of the substation plant is likely to include tonal components, the embedded mitigation measures within the detailed design phase will minimise the eventual tonality of the overall substation sound emissions. With these measures installed, tonality is unlikely to be audible outside the substation boundary. Any remaining tonality will be further attenuated by propagation with distance to receptors (at least 500m). It is therefore highly unlikely that tonality will be perceptible at the NSRs. Nevertheless, a +2dB acoustic character correction (BS 4142 subjective method – 'just perceptible') has been applied to the *specific sound level* to determine the *rating level*.

218. The sound emissions from the onshore substation plant and equipment will be present 24/7 and are very steady; hence, no penalty corrections for intermittency or impulsivity are required. As a penalty is applied for tonality, it would not be appropriate to apply a penalty for other sound characteristics.

23.6.2.1.2 Magnitude of effect – Onshore Substation SEP in isolation

219. Using the BS 4142 criteria, the predicted unmitigated noise levels indicate a negligible magnitude of effect at all NSRs during the daytime as the predicted rating level, $L_{Ar,T}$, is below the background sound level, L_{A90}.

220. During the night-time reference period, a negligible magnitude of effect is predicted at SSR4, SSR5, SSR6, SSR7, SSR8; and a low magnitude of effect is predicted at SSR1, SSR2, SSR3, SSR9 and SSR10 using the BS 4142 criteria.

221. During the night-time, the highest predicted *rating level* is +3dB above the existing *background sound level* at SSR3; indicating a low magnitude of effect when using the BS 4142 criteria. According to the IEMA Guidelines criteria for the impact of sound level changes (shown in **Table 23-18**) and the WHO NNG criteria (shown in **Table 23-17**), the predicted effects are of negligible magnitude and below the LOAEL, respectively.

23.6.2.1.3 Impact Significance – Onshore Substation SEP in isolation

222. All NSRs are of medium sensitivity; therefore, during the daytime reference period the significance of impact will be negligible i.e. not significant.

223. During the night-time reference period the assessment indicates an impact of negligible significance at SSR4, SSR5, SSR6, SSR7, SSR8, and minor adverse significance at SSR1, SSR2, SSR3, SSR9 and SSR10 using the BS 4142 criteria.

224. According to the assessment against the WHO NNG criteria and the IEMA change in sound level guidance, the impact is of negligible significance i.e. not significant.

23.6.2.1.4 Magnitude of effect – Onshore Substation DEP in isolation

225. Using the BS 4142 criteria, the predicted unmitigated noise levels indicate effects of negligible magnitude at all NSRs during the daytime as the predicted rating level, $L_{Ar,T}$, is below the background sound level, L_{A90}.

226. During the night-time reference period, effects of negligible magnitude are predicted at SSR1, SSR4, SSR5, SSR7, SSR8; and low at SSR2, SSR3, SSR6, SSR9 and SSR10, using the BS 4142 criteria.

227. During the night-time the highest predicted rating level is +4dB above the existing background sound level at SSR3; indicating a low magnitude of effect when using the BS 4142 criteria. According to the IEMA Guidelines and WHO NNG criteria, the predicted effects are of negligible magnitude and below the LOAEL, respectively.

23.6.2.1.5 Impact Significance – Onshore Substation DEP in Isolation

228. All NSRs are of medium sensitivity; therefore, during the daytime reference period the significance of impact will be negligible i.e. not significant.

229. During the night-time reference period the assessment indicates an impact of negligible significance at SSR1, SSR4, SSR5, SSR7, SSR8; and at SSR2, SSR3, SSR6, SSR9 and SSR10 a minor adverse significance using the BS 4142 criteria.

230. According to the assessment against the WHO NNG criteria and the IEMA change in sound level guidance, the impact is of negligible significance i.e. not significant.

 [redacted]

23.6.2.1.6 SEP and DEP Concurrent

231. This operational noise assessment only considers the potential impacts for SEP and DEP operating concurrently, which represents the worst-case operational noise scenario. As discussed in **Table 23-2**, impacts from the SEP and SEP sequential and SEP and DEP concurrent scenarios are likely to be indistinguishable, as the plant requirements are identical.

232. The assessments were undertaken using the unmitigated worst-case scenario for the potential components that could be in operation at the onshore substation; based on the fixed plant details provided in **Appendix 25.3 Construction Noise and Vibration Assessments**.

233. Full details regarding assumptions and operational noise sources included in the assessments and the predicted noise levels at each NSR are provided in **Appendix 25.3 Construction Noise and Vibration Assessments**.

23.6.2.1.7 Magnitude of effect – Onshore Substation SEP and DEP Concurrent

234. Using the BS 4142 criteria, the predicted unmitigated noise levels indicate effects of negligible magnitude at all NSRs during the daytime as the predicted rating level, $L_{Ar,T}$, is below the background sound level, L_{A90}.

235. During the night-time reference period, effects of negligible magnitude are predicted at SSR5, SSR7 and SSR8; and effects of low magnitude are predicted at SSR1, SSR4, SSR6 and SSR10 using the BS 4142 criteria.

236. A medium magnitude of effect is predicted at SSR2, SSR3 and SSR9 during the night-time in accordance with the BS 4142 criteria.

237. During the night-time the worst-case impact is predicted at R3, where the *rating level* is 7dB above the existing *background sound level*; indicating a magnitude of effect of medium when using the BS 4142 criteria. According to the WHO NNG criteria shown in **Table 23-17** the predicted effects are below the LOAEL at all identified NSRs. According to the IEMA sound level change criteria shown in **Table 23-18**, the predicted effects are of negligible magnitude at all NSRs except for SSR2, SSR3, SSR9 and SSR10, where the effect is low.

23.6.2.1.8 Impact Significance – Onshore Substation SEP and DEP Concurrent

238. All NSRs are of medium sensitivity; therefore, during the daytime reference period the significance of impact will be negligible i.e. not significant.

239. During the night-time reference period the assessment indicates an impact of negligible significance at SSR1, SSR4, SSR5, SSR6, SSR7, SSR8 and SSR10.

240. At SSR1, SSR4, SSR6 and SSR10, an impact of moderate adverse significance is predicted based on the BS 4142 criteria i.e. a significant impact.

241. According to the WHO NNG criteria the predicted impacts are negligible, i.e. not significant, at all identified NSRs. According to the IEMA sound level change criteria, the worst-case predicted impacts are of minor adverse significance i.e. not significant.

23.6.2.1.9 Mitigation Measures - Onshore Substation SEP and DEP Concurrent

242. Detailed analysis of the predicted noise levels at NSRs in proximity to the onshore substation indicate that noise associated with SGT, 220kV SHR, 220kV Air Core Reactor and 440kV Filter Reactor components are the dominant contributors of noise from the onshore substation. Mitigation measures would therefore focus on introducing noise attenuation at these items of substation equipment.

243. The operational noise predictions and recommended mitigation measures are reliant on the currently available substation plant sound power level data. The sound emissions from the equipment the original equipment manufacturer (OEM) installs may be different to those utilised in the predictions, this would alter the substation sound emissions and mitigation requirements. It is therefore necessary to define operational noise level limits which will need to be complied with by the OEM, based on predictive noise modelling and assessment to be undertaken during the detailed design phase.

244. Compliance with these limits is secured by DCO Requirement 21 *Control of Noise During Operational Phase*.

23.6.2.1.10 Residual Impact - Onshore Substation SEP and DEP Concurrent

245. The predicted noise levels after implementation of the mitigation measures (noise enclosures for selected substation equipment) are provided in **Appendix 25.3 Construction Noise and Vibration Assessments**.

246. The incorporation of noise mitigation measures at the SGTs, SHRs, Air Core Reactor (ACRs) and Filter Reactors would reduce the magnitude of effect at all substation NSRs to no greater than negligible in accordance with the BS 4142 criteria during the night-time reference period, representing a residual impact of negligible significance at all NSRs.

23.6.3 Potential Impacts During Decommissioning

247. No decision has been made regarding the final decommissioning policy for the onshore infrastructure as it is recognised that industry best practice, rules and legislation change over time. It is likely the cables would be pulled through the ducts and recycled, with the transition pits and ducts capped and sealed then left *in situ*.

248. A full EIA will be carried out ahead of any decommissioning works. The programme for onshore decommissioning is expected to be similar in duration to the construction phase of SEP and DEP consecutively i.e. 36 months. The detailed activities and methodology for decommissioning will be determined later within the SEP and DEP lifetime, in line with relevant policies at that time, but would be expected to include:

- Dismantling and removal of electrical equipment;
- Removal of cabling from site;
- Removal of any building services equipment;
- Demolition of the buildings and removal of fences; and

- Landscaping and reinstatement of the sites.

249. Whilst details regarding the decommissioning are currently unknown, it is anticipated that the impacts would be no greater than those during construction.

250. The decommissioning methodology cannot be finalised until closer to the time of decommissioning but would be in line with relevant policy at that time.

23.7 Cumulative Impacts

23.7.1 Identification of Potential Cumulative Impacts

251. The first step in the cumulative assessment is the identification of which residual impacts assessed for SEP and/or DEP on their own have the potential for a cumulative impact with other plans, projects and activities (described as 'impact screening'). This information is set out in **Table 23-27**.

252. Only potential impacts assessed in **Section 23.6** as minor or above are included in the CIA (i.e. those assessed as 'negligible' are not taken forward as SEP and/or DEP would not be responsible for any cumulative impact).

253. **Table 23-27** concludes that potential cumulative noise and vibration impacts could occur during the construction phase due to spatial overlap with other projects within the DCO study area. Temporal overlap with other projects could also occur due to the extended period for the consecutive SEP and DEP scenario.

254. Construction Traffic impacts for a Peak and Average scenario, SEP and DEP in isolation and SEP and DEP Concurrent were assessed in **Section 23.6**. Consideration of overlap with other Onshore infrastructure projects (HOW03 and Norfolk Vanguard Project) has been assessed for the Peak period of project overlap on the shared links where additional project specific vehicles will be routed.

Table 23-27: Potential Cumulative Impacts (Impact Screening)

Impact	Potential for Cumulative Impact	Rationale
Construction Impact 1: On-site construction noise at landfall location	Yes	Potential for night-time construction noise impacts associated with the landfall location to act cumulatively with construction noise associated with other nearby projects where there is a temporal overlap. The likelihood of a temporal overlap with other nearby projects may increase for sequential scenario where construction works at the landfall location will take place over a longer period of time. Negligible impact significance is predicted during the daytime and evenings and weekends periods at landfall location NSRs; therefore, it is considered that there is no potential pathway for cumulative construction noise impacts. Consecutive projects would increase the likelihood of temporal impacts due to the longer duration.
Construction Impact 2 On-site construction noise along onshore cable	Yes	Potential for construction noise impacts associated with the onshore cable corridor to act cumulatively with construction noise associated with other nearby projects where there is a temporal overlap. The likelihood of a temporal overlap with other nearby projects may increase for sequential scenario where

Impact	Potential for Cumulative Impact	Rationale
corridor		construction works at along the onshore cable corridor will take place over a longer period of time. Consecutive projects would increase the likelihood of temporal impacts due to the longer duration.
Construction Impact 3 On-site construction noise at the onshore substation	No	Impact significance of negligible predicted at all NSRs surrounding the onshore substation site; therefore, it is considered that there is no potential pathway for cumulative construction noise impacts.
Construction Impact 4 Noise from off-site construction traffic	Yes	Potential for construction road traffic noise impacts associated with the Projects to act cumulatively with construction traffic on the local road network associated with other nearby projects where there is a temporal overlap. The likelihood of a temporal overlap with other nearby projects may increase for sequential scenario where construction works will take place over a longer period of time. Consecutive projects would increase the likelihood of temporal impacts due to the longer duration.
Construction Impact 5 Construction vibration	Yes	Potential for cumulative construction vibration impacts with other nearby potential sources of vibration at locations where trenchless crossing works are being undertaken. Due to separation distance between the onshore substation site and NSRs (500m) vibration impacts were not considered in the CIA.
Operational Impact 1 Operation of the onshore substation	Yes	Potential for operational phase noise impacts associated with the onshore substation site options to act cumulatively with other nearby industrial / commercial premises. The likelihood for cumulative effects associated with the onshore substation site options may be greater for concurrent and sequential scenarios when both Projects are operating due to the larger number of potential noise sources.

23.7.2 Other Plans, Projects and Activities

255. The second step in the cumulative assessment is the identification of the other plans, projects and activities that may result in cumulative impacts for inclusion in the CIA (described as 'project screening'). This information is set out in **Table 23-28** below, together with a consideration of the relevant details of each, including current status (e.g. under construction), planned construction period, closest distance to SEP and DEP, status of available data and rationale for including or excluding from the assessment.

256. The project screening has been informed by the development of a CIA Project List which forms an exhaustive list of plans, projects and activities in a very large study area relevant to SEP and DEP. The list has been appraised, based on the confidence in being able to undertake an assessment from the information and data available, enabling individual plans, projects and activities to be screened in or out.

257. In summary, the following projects will be assessed for potential direct cumulative impacts:

- Hornsea Project Three Offshore Wind farm;
- Norfolk Vanguard Offshore Wind farm;
- Norfolk Boreas Offshore Wind farm; and
- Norwich Western Link (highway improvement scheme).

Table 23-28: Summary of Projects Considered for the CIA in Relation to Noise and Vibration (Project Screening)

Project	Status	Construction Period	Closest Distance from the Project (km)	Confidence in Data	Included in the CIA (Y/N)	Rationale
Hornsea Project Three Offshore Wind farm	DCO consented	2023-2025 (single phase) 2023-2031 (two phase)	0km (Export cable corridor - ECC)	High	Y	Construction impacts at the landfall (Impact 1), onshore cable corridor (Impact 2) considered in the CIA.
Norfolk Vanguard Offshore Wind farm	DCO consented	2023-2029	0km, (ECC)	High	Y	Construction impacts along onshore cable corridor (Impact 2) considered in the CIA.
Norfolk Boreas Offshore Wind farm	DCO consented	2023-2029	0km, (ECC)	High	Y	Construction impacts along onshore cable corridor (Impact 2) considered in the CIA.
Norwich Western Link (highway improvement scheme)	Pre-application	2023	0km, (ECC)	N/A	N	As detailed in **Chapter 24 Traffic and Transport**, it has been agreed with NCC and National Highways that potential cumulative impacts between the construction phases of the highway scheme could be managed through the respective CTMP rather than in the DCO application. Therefore, these schemes have been screened out of the CIA.
East Anglia GREEN	Site selection / pre-scoping	2027-2031	NA	Low	N	Screened out as insufficient details available about this proposal to undertake any meaningful cumulative impact assessment.

23.7.3 Assessment of Cumulative Impacts

258. Having established the residual impacts from SEP and/or DEP with the potential for a cumulative impact, along with the other relevant plans, projects and activities, the following sections provide an assessment of the level of impact that may arise.

23.7.3.1 Cumulative Impact 1 Construction Noise at Landfall Location

259. There is the potential for cumulative construction noise impacts should night-time works be required by both SEP/DEP and Hornsea Project Three Offshore Wind farm, and these occur at the same time.

260. The current construction programme for SEP and DEP indicates that HDD works at the landfall location would be undertaken in year two (2026) for SEP or DEP in isolation and SEP and DEP concurrent scenarios and in years two (2026) and four (2028) for the SEP and DEP sequentially scenario, depending on the gap between projects.

261. Hornsea Project Three is reported to complete construction in 2025 (single phase build out) or 2031 (two phase build out). Landfall works for Hornsea Project Three are reported to take place in Year 2 (2023), Year 4 (2025) and potentially Year 6 (2027).

262. Although it is considered unlikely that construction works would be undertaken simultaneously for DEP/SEP and Hornsea Project Three during the night-time for both projects, there is potential for these works to overlap temporally and they are spatially very close to each other.

263. The Hornsea Project Three Environmental Statement (Hornsea Project Three Offshore Wind PINS Document Reference: A6.3.8) commits that mitigation measures will be incorporate to ensure that residual landfall construction noise impacts are not significant in EIA terms. Therefore, after implementation of the proposed mitigation measures for the SEP and DEP (described in **Section 23.6.1**) significant cumulative construction noise impacts at the landfall location are not considered likely.

23.7.3.2 Cumulative Impact 2 Construction Noise and Vibration along Onshore Cable Corridor

264. The onshore cable corridor construction phases of SEP/DEP, Hornsea Project Three Offshore Wind farm, Norfolk Vanguard and Norfolk Boreas Offshore Wind farms, could all overlap at various times and, therefore, there is the potential for cumulative noise and vibration impacts during construction where the proposed cable corridors intersect or in locations where concurrent cable corridor construction works associated are being undertaken nearby.

265. The current construction programme for SEP and DEP assumes onshore cable corridor works would be undertaken in years 1-3 (2025 - 2027) for SEP or DEP in isolation and SEP and DEP concurrent scenarios.

266. The current construction programme for SEP and DEP assumes onshore cable corridor works would be undertaken in Years 1-3 (2025 – 2027) and 5-6 (2029 - 2030) for the SEP and DEP constructed sequentially scenario, depending on the gap between the projects' construction.

267. Hornsea Project Three is reported to undertake onshore cable works between 2023-2025 (single phase built out) and additional in 2028 (for the two phase build out). Norfolk Vanguard and Boreas are reported to have onshore cable works occurring between 2023-2024. Based on these timings it is considered unlikely that construction works would be undertaken simultaneously for SEP/DEP and these projects. However, Hornsea Project Three, Norfolk Vanguard and Norfolk Boreas have all been subject to delays to consenting decisions.

268. This uncertainty in the timings of these similar projects suggests that the potential for these works to overlap should be assumed as a precaution.

269. The proposed onshore cable corridor associated with SEP and DEP directly intersects Norfolk Vanguard and Norfolk Boreas cable corridors south of Oulton Airfield. CCR17 is a common NSR considered within the construction noise assessments for both those projects (as reported in the Norfolk Vanguard ES (Norfolk Vanguard Offshore Wind Farm 2018) and Norfolk Boreas ES (Norfolk Vanguard Offshore Wind Farm 2019). Construction noise predictions at this NSR for Norfolk Vanguard and Norfolk Boreas indicate a negligible impact for all associated works as they are below the BS 5228 thresholds; therefore, it is considered that there is no mechanism for cumulative construction noise impacts at this intersection of the onshore cable corridor with SEP and DEP.

270. The potential for cumulative construction noise impacts along the onshore cable corridor with Hornsea Project Three construction activities were identified at NSRs in Attlebridge, Ringland and Swardeston; displayed in **Table 23-29**.

Table 23-29: Cumulative Construction Noise NSR Locations Along the Onshore Cable Corridor

SEP/DEP project NSR identifier	Coordinates		Classification	Sensitivity
	X	Y		
CCR22B	612760	316742	Residential	Medium
CCR24	612211	314071	Residential	Medium
CCR22C	613092	316787	Residential	Medium

271. An effect of negligible magnitude is predicted at CCR22B during the daytime and evenings and weekends reference periods for all associated works. On this basis, significant cumulative impacts are considered unlikely.

272. During the night-time reference period, a worst-case impact of moderate adverse significance (i.e. significant) is predicted at CCR22B during HDD works without mitigation. Hence, trenchless crossings may give rise to significant cumulative impacts should night-time construction works associated with Hornsea Project Three be required simultaneously with those for SEP and/or DEP. However, after employing the mitigation measures provided for Impact 2, (detailed in **Appendix 23.3 Construction Noise and Vibration Assessments**) the residual impact for SEP and DEP is reduced to negligible; hence, significant cumulative impacts are considered unlikely.

273. The Hornsea Project Three Environmental Statement includes predicted construction noise levels at locations CCR24 and CCR22C. The maximum predicted daytime construction noise levels at CCR24 are 62dB $L_{Aeq,T}$ (Cable duct and installation) and 60dB $L_{Aeq,T}$ (HDD works), respectively. During the evenings/weekends and at night, the worst-case predicted unmitigated magnitude of effect during trenchless crossing works are medium and high, respectively at CCR24. The Hornsea Project Three Environmental Statement concludes that, following mitigation, the magnitude of effect at CCR24 is lowered to negligible during the evening/weekends and low at night time; hence, significant cumulative impacts are considered unlikely.

274. The maximum predicted unmitigated daytime construction noise levels at CCR22C are 51dB $L_{Aeq,T}$ (cable duct and installation) and 50dB $L_{Aeq,T}$ (trenchless crossing works), respectively. The predicted SEP/DEP construction noise magnitude of effect is negligible (daytime), negligible (evening and weekends) and low (night time); hence, significant cumulative impacts are considered unlikely.

275. Although the mixed-use scheme at land North East Wymondham, Norwich Common, Wymondham, Norfolk is only at EIA scoping opinion stage, the construction of the mixed use scheme has the potential to overlap with cable corridor works for SEP and DEP. The implementation of BPM for both SEP and DEP and the mixed use scheme is expected to minimise the cumulative impacts.

23.7.3.3 Cumulative Impact 3: Construction Phase Road Traffic Noise

276. As detailed in Cumulative Impact 2 there is uncertainty with the timings of Hornsea Project Three, Norfolk Vanguard and Norfolk Boreas due to delayed consenting. However, there are shared road links between these projects along with SEP and DEP that are required for the respective construction phases.

277. The uncertainty in the timings of these similar projects suggests that as a precaution the potential for these works to overlap should be assumed. The potential for cumulative construction traffic noise impacts on shared road links is assessed and presented here to accompany the DCO application.

278. A BNL was calculated for the cumulative traffic noise impact assessment, taking into account the SEP and DEP concurrent flows utilising the same links proposed to carry the construction traffic of the Hornsea Project Three (HOW03) scheme and Norfolk Vanguard scheme.

279. The scenarios assessed are:

- 2025 Factored Base versus 2025 Factored Base + Peak Construction SEP/DEP concurrent plus NV and HOW03.
- 2025 Factored Base + Peak Construction SEP/DEP concurrent versus 2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) plus NV and HOW03.

23.7.3.3.1 Magnitude of effect – 2025 Factored Base versus 2025 Factored Base + Peak Construction SEP/DEP Concurrent plus NV and HOW03

280. Road links required for SEP and DEP Peak Concurrent construction traffic scenario, cumulative with HOW03 and NV are presented in **Chapter 24 Traffic and Transport**.

281. For this scenario 91 out of a 182 in total number of road links were overlapping with HOW03 and NV. All links were included regardless of overlap which includes some links with different speeds. A BNL was calculated using the CRTN or NAC methodology to determine the short-term relative change from construction traffic associated with the SEP and DEP schemes. The road links assessed are provided in full detail in **Appendix 23.2 Road Traffic Noise Assessment**.

282. The construction road traffic noise assessment predicts changes in $L_{A10,18hr}$ (CRTN) and $L_{Aeq,18hr}$ (NAC).

283. From the 2025 Factored Base versus 2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) plus NV and HOW03 scenario, a magnitude of effect of negligible at 93 of the road links, a magnitude of effect of low at 78 of the road links, a magnitude of effect of medium at four of the road links, and a magnitude of effect of high at seven of the identified road links. These are detailed in full in **Appendix 23.2 Road Traffic Noise Assessment**.

23.7.3.3.2 Impact Significance (Peak Concurrent Scenario SEP/DEP Cumulative with HOW03 and NV)

284. All NSRs along the identified road links are considered to be of medium sensitivity.

285. Therefore, the assessment indicates that the impact significance from peak construction traffic will be negligible at 136 road links and minor across 36 road links. On this basis there is no requirement for additional mitigation measures along the 172 of the 182 assessed road links.

286. The Peak Concurrent Scenario SEP/DEP assessment indicates an impact of moderate adverse significance along three of the identified road links and major adverse across seven of the identified road links.

287. Due to the low traffic flow along 9 out of the 10 links with an adverse effect (considered as significant in EIA terms) the NAC calculation procedure was used to determine impacts along these links. The impacts are largely attributed to the number of additional HGVs required during the Peak scenario.

23.7.3.3.3 Mitigation Measures

288. A CTMP would be developed to reduce peak construction traffic flows causing significant traffic and transport impacts along the identified links; this will also serve to reduce the associated construction traffic noise impacts. The CTMP will also address cumulative impacts. Traffic management measures are provided in **Chapter 24 Traffic and Transport** - **Section 24.6**. An Outline CTMP is included with the application (document refence 9.16).

23.7.3.3.4 Residual Impact

289. Following the implementation of agreed traffic measures within the CTMP, the impact magnitude would be expected to reduce to minor during the peak construction traffic scenario for some of the 18hr reference period. Construction traffic flows are representative over a typical 12hr daytime period.

290. The Peak Concurrent Scenario SEP/DEP Cumulative with HOW03 and NV scenario represents a relatively short period in the project duration. The ten road links would result in a residual impact of minor adverse significance.

23.7.3.3.5 Magnitude of effect – 2025 Factored Base + Peak Construction Tandem (SEP/DEP Concurrent) versus 2025 Factored Base + Peak Construction Tandem (SEP/DEP Concurrent) Plus NV and HOW03

291. For this scenario 91 out of a 182 in total number of road links were overlapping with HOW03 and NV. All links were included regardless of overlap which includes some links with different speeds.

292. From the 2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) versus 2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) plus NV and HOW03 scenario, a magnitude of effect of negligible at 162 of the road links, a magnitude of effect of low at 20 of the identified road links. These are detailed in full in **Appendix 23.2 Road Traffic Noise Assessment**.

23.7.3.3.6 Impact Significance (2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) versus 2025 Factored Base + Peak Construction Tandem (SEP/DEP concurrent) plus NV and HOW03)

293. All NSRs along the identified road links are considered to be of medium sensitivity.

294. Therefore, the assessment indicates that the impact significance from peak construction traffic will be negligible at 162 road links and minor across 20 road links.

295. No additional mitigation is required, beyond the CTMP being developed. Traffic management measures are provided in **Chapter 24 Traffic and Transport** - **Section 24.6**.

23.7.3.4 Cumulative Impact 4: Operational Phase Noise at the Onshore Substation

296. There is potential for cumulative noise impacts between the onshore substation for SEP and DEP and Hornsea Project Three Offshore Wind farm during the operational phase.

297. Two common operational phase NSR locations are shared between the projects; SSR7 and SSR8. At these locations the predicted BS 4142 *rating level* before mitigation for SEP and DEP in operation is below the existing *background sound level* for the daytime and night-time reference periods; indicating a negligible impact associated with SEP and DEP projects.

298. Assessing the impact using the IEMA noise level change criteria, a negligible impact magnitude is predicted at each receptor. The predicted noise level is also below the NNG LOAEL criteria.

299. Therefore, a cumulative impact is not expected at these receptors.

23.8 Transboundary Impacts

300. Transboundary impacts associated with noise and vibration were scoped out of the assessment, as detailed in **Table 23-1**.

23.9 Inter-relationships

301. The ES chapters outlined in **Section 23.1** were identified as having inter-relationships with noise and vibration and are shown in **Table 23-30**.

Table 23-30: Noise and Vibration Inter-Relationships

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Construction			
Impact 1: Construction Noise at Landfall Location **Impact 2:** Construction Noise along Onshore Cable Corridor **Impact 3:** Construction Noise at Onshore Substation **Impact 5:** Construction Vibration	**Chapter 20 Onshore Ecology and Ornithology**	NA	Potential noise impacts at ecological receptors addressed separately in **Chapter 20 Onshore Ecology and Ornithology**.
	Chapter 21 Onshore Archaeology and Cultural Heritage	NA	Potential noise impacts at archaeological receptors addressed separately in **Chapter 21 Onshore Archaeology and Cultural Heritage**.
	Chapter 27 Socio-Economics and Tourism	NA	Potential noise impacts addressed separately in **Chapter 27 Socio-Economics and Tourism**.
	Chapter 28 Health	**Section 28.6**	Potential human health impacts related to increase in noise at NSRs.
Impact 4: Construction Road Traffic Noise	**Chapter 24 Traffic and Transport**	**Section 24.6**	Influence of noise associated with construction traffic on local amenity.
	Chapter 28 Health	**Section 28.6**	Potential human health

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
			impacts related to increase in noise at NSRs.
Operation			
Impact 1: Operation of Onshore Substation	**Chapter 20 Onshore Ecology and Ornithology**	NA	Potential noise impacts at ecological receptors addressed separately in **Chapter 20 Onshore Ecology and Ornithology**.
	Chapter 21 Onshore Archaeology and Cultural Heritage	NA	Potential noise impacts at archaeological receptors addressed separately in **Chapter 21 Onshore Archaeology and Cultural Heritage**.
	Chapter 24 Traffic and Transport	**Section 24.6**	Influence of noise associated with construction traffic on local amenity.
	Chapter 27 Socio-Economics and Tourism	NA	Potential noise impacts addressed separately in **Chapter 27 Socio-Economics and Tourism**.
	Chapter 28 Health	**Section 28.6**	Potential human health impacts related to increase in noise at NSRs.
Decommissioning			
Inter-relationships and the identified impacts associated with the decommissioning phase would be no greater than those identified for the construction phase.			

23.10 Interactions

302. The impacts identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between impacts are presented in **Table 23-31**. This provides a screening tool for which impacts have the potential to interact. **Table 23-32** provides an assessment for each receptor (or receptor group) as related to these impacts.

303. Within **Table 23-32** the impacts are assessed relative to each development phase (Phase assessment, i.e. construction, operation or decommissioning) to see if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor. Following this, a lifetime assessment is undertaken which considers the potential for impacts to affect receptors across all development phases.

Table 23-31: Interaction between Impacts - Screening

Potential Interaction between Impacts					
Construction					
	Impact 1: Construction Noise at Landfall Location	**Impact 2:** Construction Noise along Onshore Cable Corridor	**Impact 3:** Construction Noise at Onshore Substation	**Impact 4:** Construction Road Traffic Noise	**Impact 5:** Construction Vibration
Impact 1: Construction Noise at Landfall Location	-	Yes	No	Yes	Yes
Impact 2: Construction Noise along Onshore Cable Corridor	Yes	-	Yes	Yes	Yes
Impact 3: Construction Noise at Onshore Substation	No	Yes	-	Yes	Yes
Impact 4: Construction Road Traffic Noise	Yes	Yes	Yes	-	Yes
Impact 5: Construction Vibration	Yes	Yes	Yes	Yes	-
Operation					
	Impact 1: Operation of Onshore Substation	Impact 2	Impact 3	Impact 4	Impact 5
Impact 1: Operation of Onshore Substation	-	-	-	-	-
Decommissioning					
	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5

Potential Interaction between Impacts					
Impact 1	It is anticipated that the decommissioning impacts would be no greater than those of construction.	-	-	-	-

Table 23-32: Interaction between Impacts – Phase and Lifetime Assessment

	Highest Significance Level				
Receptor	**Construction**	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Residential	Minor adverse	Minor adverse	Minor adverse	**No greater than individually assessed impact** Impacts 1-6 range from no impact to major adverse impact significance at residential receptors before mitigation measures. With the inclusion of mitigation the impacts (Impacts 1-6) are considered to range from negligible to minor adverse impact significance at residential receptors. Given the predicated impact significance and that each impact will be managed with standard and best practice methodologies it is considered that there would either be no interactions or that these would not result in greater impact than assessed individually.	**No greater than individually assessed impact** There will only be potential noise impacts during construction and decommissioning phases at the landfall location and onshore cable corridor; therefore, it is considered that over the lifetime of the project these impacts would not combine to increase the significance level of any impacts identified in this assessment. At the onshore substation, the assessment indicates minor adverse impacts throughout the operational phase. Such impacts are not significant in EIA terms; therefore, it is considered that these impacts would not combine to increase the significance level of any impacts identified in this assessment.

23.11 Potential Monitoring Requirements

304. DCO Requirement 21 sets out that a scheme for monitoring operational noise at the onshore substation will be produced. This will monitor operational noise levels at the nearest NSRs and monitor the effectiveness of noise attenuation measures included within the design.

23.12 Assessment Summary

305. The existing noise and vibration environment at NSRs has been characterised using a site-specific baseline noise survey and following current best practice and guidance.

306. Construction phase noise and vibration assessments were undertaken based on a preliminary understanding of the mobile/fixed construction plant and machinery required to build the projects at the landfall, cable corridor and onshore substation Order limits.

307. The worst-case construction noise impacts are associated with the SEP and DEP sequential scenario. The assessment has established that there will be some minor residual impacts on the landfall and cable corridor receptors during construction and decommissioning phases of SEP and DEP through construction work activities.

308. The worst-case construction traffic noise impacts are associated with the SEP and DEP concurrent scenario, except for link 137, where the worst-case impacts are due to SEP or DEP sequential. This assessment considered the impact of the change in road traffic noise levels during construction and the potential impact of the with-construction road traffic noise levels using absolute sound level criteria. The assessment of these potential noise impacts concluded that residual impacts will be no greater than minor adverse i.e. not significant.

309. The worst-case construction vibration impacts are associated with the SEP and DEP sequential scenario. The assessment of these potential vibration impacts concluded that residual impacts will be no greater than minor adverse i.e. not significant.

310. The operational phase assessment utilised 3D modelling to predict noise levels from the indicative onshore substation infrastructure, along with the baseline noise data to establish any potential impacts.

311. The worst-case operational phase scenario is SEP and DEP concurrent. The assessment established there will be low impacts at some NSRs for the SEP and DEP concurrent scenario using the BS 4142 assessment criteria.

312. The operational phase assessment also considered the context by comparing predicted substation sound levels at NSRs with absolute sound level criteria based on the WHO NNG and using the IEMA change in noise level guidance. This identified that impacts would be of negligible significance.

313. An assessment summary is provided in **Table 23-33**.

Table 23-33: Summary of Potential Impacts on Noise and Vibration Topic

Potential impact	Project	Receptor	Sensitivity	Magnitude	Pre-Mitigation Impact	Mitigation Measures Proposed	Residual Impact	Cumulative Residual Impact
Construction								
Impact 1: Construction Noise at Landfall Location	SEP or DEP in isolation SEP & DEP	Residential	Medium	Daytime - negligible Evenings and weekends - negligible Night-time - low	Daytime - **negligible** Evenings and weekends - **negligible** Night-time - **minor adverse**	Prior to construction, a Code of Construction Practice (CoCP) and Construction Noise Management Plan (CNMP) will be submitted to the Local Planning Authority for approval to discharge the requirements of the draft DCO outlining specific noise control measures per construction activity. Construction information is currently indicative and has been assessed as a worst-case of where plant may be located within the cable corridor or Order limits. As this information is likely to be fully known at detailed design stage; therefore, mitigation measures may include: Temporary screening to be installed around the work area or construction compound so that no part of the noise source is visible at the NSR. Increased separation distance between the source and receptor. Reduced numbers of equipment and reduced on-times i.e. night-time.	Daytime - **negligible** Evenings and weekends - **negligible** Night-time – **negligible**	None predicted
Impact 2: Construction Noise along Onshore Cable Corridor	SEP or DEP in isolation SEP & DEP	Residential	Medium	Negligible to high, depending on distance from receptor to construction works	**Negligible** to **major adverse**		**Negligible** to **minor adverse**	None predicted
Impact 3: Construction Noise at Onshore Substation	SEP or DEP in isolation SEP & DEP	Residential	Medium	Negligible	**Negligible**		**Negligible**	None predicted
Impact 4: Construction Road Traffic Noise	SEP or DEP in isolation	Residential	Medium	Negligible to major based on BNL relative noise level change	**Negligible** to **minor adverse** based on the duration of the identified effects due to relative noise level change and the comparison of predicted absolute sound levels with LOAEL and SOAEL values	Development of a Construction Traffic Management Plan to reduce the peak construction traffic flows as far as possible. Avoid change in road traffic noise level of 3 dB or greater for a duration of 40 days or more in a 6-month period.	**Minor adverse**	**Minor adverse**
	SEP & DEP			Negligible to major based on BNL relative noise level change	**Negligible** to **moderate adverse** based on the duration of the identified effects due to relative noise level change and the comparison of predicted absolute sound levels with LOAEL and SOAEL values			
Impact 5: Construction Vibration	SEP or DEP in isolation SEP & DEP	Residential	Medium	Negligible to minor during HDD Negligible to major during ground compaction	**Negligible** to **minor adverse** during ground compaction	Prior to construction, a CoCP and CNMP which will include any vibration mitigation measures will be submitted to the Local Planning Authority for approval to discharge the requirements of the draft DCO outlining specific noise control measures per construction activity.	**Negligible** to **Minor adverse**	None predicted
Operation								
Impact 1 Operation of Onshore Substation	SEP or DEP in isolation	Residential	Medium	Negligible to Low	**Minor adverse**	SGT to reduce source noise levels from 95dB L_{WA} to 85dB L_{WA}, 220kv SHR ACR to reduce noise levels from 89dB L_{WA} to 84dB L_{WA}.	**Negligible**	None predicted

Potential impact	Project	Receptor	Sensitivity	Magnitude	Pre-Mitigation Impact	Mitigation Measures Proposed	Residual Impact	Cumulative Residual Impact
	SEP & DEP	Residential	Medium	Medium	**Moderate adverse**	SGT reduce source noise levels from 95dB L_{WA} to 80dB L_{WA}, SHRs to reduce noise levels from 89dB L_{WA} to 80dB L_{WA}, 220kV Air Core Reactor and 440kV Filter Reactor components from 87dB L_{WA} to 82dB L_{WA}.	**Negligible**	None predicted
Decommissioning								
As per construction.								

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