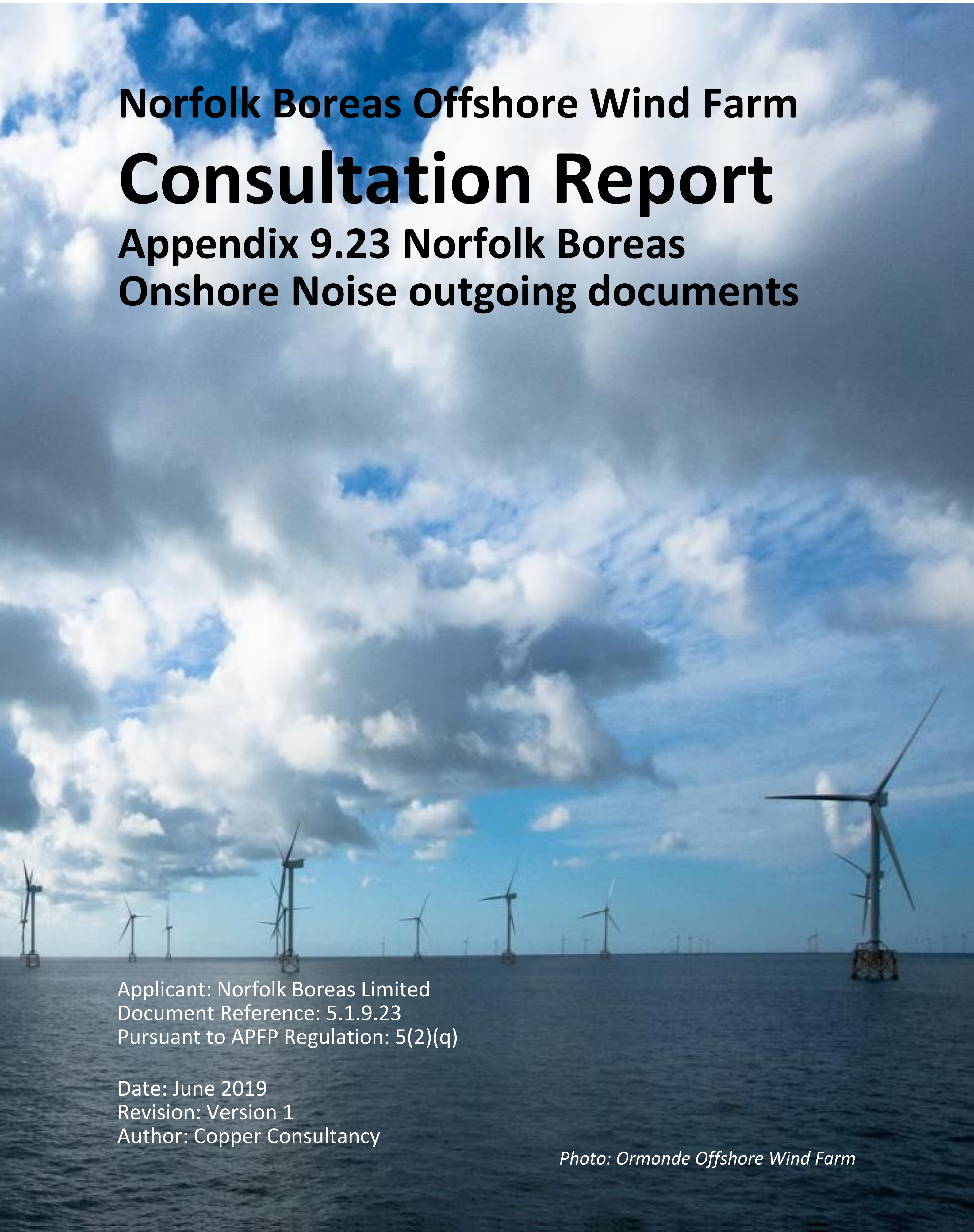
Norfolk Boreas Offshore Wind Farm

Consultation Report

Appendix 9.23 Norfolk Boreas Onshore Noise outgoing documents



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Norfolk Boreas Offshore Wind Farm

Environmental Impact Assessment

Onshore Noise and Vibration Method Statement

Document Reference: PB5640-004-002

Author: Royal HaskoningDHV
Date: January 2018
Client: Norfolk Boreas Ltd

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
30/11/2017	D01	Draft for Review	MS	DC	DT/AD
11/01/2018	D02	Revised following internal review	DC	AB	CD
12/01/2018	D02	Draft submitted for Vattenfall review	DC	CD	AD
29/01/2018	01F	Issue to consultees	DC	CD	JL

This method statement has been prepared by Royal HaskoningDHV on behalf of Norfolk Boreas Limited in order to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report. It has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate. All content and material within this document is draft for stakeholder consultation purposes, within the Evidence Plan Process.

Table of Contents

1 INTRODUCTION

1. The purpose of this method statement is to build upon the information provided within the Norfolk Boreas Environmental Impact Assessment (EIA) Scoping Report, in outlining the proposed approach to be taken and considerations to be made in the assessment of noise and vibration effects of the proposed development.

2. This method statement and the consultation around it form part of the Norfolk Boreas Evidence Plan Process (EPP). The aim is to gain agreement on this method statement from all members of the Noise Expert Topic Group (ETG), all agreements will be recorded on the agreement log.

3. This MS has been produced following a full review of the Scoping Opinion provided by the Planning Inspectorate, response to Norfolk Vanguard PEIR and consultation undertaken through the Norfolk Vanguard EPP.

4. Information provided in this method statement is a draft for stakeholder consultation only and is provided in confidence. It is recognised that Norfolk Vanguard ETG meetings are being held in January 2018 and that agreements will be made during those meetings which are not reflected here. However due to certain project “Mile Stones” which have been set by the Crown Estate Norfolk Boreas must progress on Programme which requires consultation on the Norfolk Boreas Method Statements prior to the conclusion of the Norfolk Vanguard EPP. Therefore, the material provided in this document represents the best available information at the time of writing.

1.1 Assessment Process/Criteria

5. The approach taken to the noise and vibration impact assessment is summarised as:

- Identifying potentially sensitive existing and future noise receptors within the surrounding area of the onshore infrastructure;
- Characterisation of the existing ambient noise at nearby receptor locations through attended and unattended noise surveys;
- Assessment of potential noise and vibration from the construction and operation;
- Assessment of the potential noise effects from changes in traffic on the local road network as a result of the construction;
- Provision of proposals for noise mitigation to protect existing noise sensitive receptors during construction phases;
- Identifying and considering mitigation, where appropriate, to protect existing noise sensitive receptors during operational phases; and
- Assessment of the significance of any residual impacts.

1.2 Background

6. A Scoping Report for the Norfolk Boreas Environmental Impact Assessment (EIA) was submitted to the Planning Inspectorate on the 8th May 2017. Further background information on the project can be found in the Scoping Report which is available at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000015-Scoping%20Report.pdf

7. The Scoping Opinion was received on the 16th June 2017 and can be found at:

https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000013-Scoping%20Opinion.pdf

1.3 Norfolk Boreas Programme

1.3.1 DCO Programme

- EIA Scoping Request submission - 09/05/17 (complete)
- Preliminary Environmental Information (PEI) submission - Q4 2018
- Environmental Statement (ES) and DCO submission - Q2 2019

1.3.2 Evidence Plan Process Programme

8. The Evidence Plan Terms of Reference (Royal HaskoningDHV, 2017a) provides an overview of the EPP and expected logistics, below is a summary of anticipated meetings:

- Agreement of Terms of Reference
- Post-scoping Expert Topic Group meetings / correspondence - Q1 2018
  - Discuss method statements and Project Design Statement
- Expert Topic Group and Steering Group meetings as required - 2018
  - To be determined by the relevant groups based on issues raised
- PEI Report (PEIR) Expert Topic Group and Steering Group meetings - Q4 2018/ - Q1 2019
  - To discuss the findings of the PEI (before or after submission)
- Pre-submission Expert Topic Group and Steering Group - Q1/Q2 2019

meetings

  - To discuss updates to the PEIR prior to submission of the ES

1.3.3 Consultation to Date

9. Norfolk Boreas is the sister project to Norfolk Vanguard (See Section 2 for further details). A programme of consultation has already been undertaken for Norfolk Vanguard which is of relevance to Norfolk Boreas and this is listed below:

- EIA Scoping Request submission - 03/10/16
- Receipt of Scoping Opinion - 11/11/16
- Steering Group meeting -21/03/16
- Steering Group meeting -20/09/16
- Post-scoping Expert Topic Group meetings
  - Agreed method statements and discussed Project Design Statement -25/01/17
- Expert Topic Group meeting to discuss data collected and impact assessment conducted to date 20/07/17
- Expert Topic Group meeting to discuss methodology and impact assessment approach for SS and CRS - 14/09/17
- EIA Preliminary Environmental Information Report (PEIR) Submission - 27/10/17

10. Responses to the Norfolk Vanguard PEIR (Royal HaskoningDHV, 2017b) were received in December 2017. This method statement has been updated to incorporate any key comments made that affect the proposed methodology for the Norfolk Boreas EIA.

1.3.4 Survey Programme

11. Details of the proposed data collection exercise are included under section 3.2.

2 PROJECT DESCRIPTION

2.1 Context and Scenarios

12. Norfolk Boreas is the sister project to Norfolk Vanguard. Vattenfall Wind Power Ltd (VWPL) is developing the two projects in tandem, and is planning to co-locate the transmission infrastructure for both projects in order to minimise overall impacts. This co-location strategy applies to the offshore and onshore parts of the export cable route, the cable landfalls, cable relay stations, and onshore substations.

13. The Norfolk Boreas project is approximately 12 months behind Norfolk Vanguard in the DCO process. As such, the Norfolk Vanguard team is leading on site selection for both projects. Although Norfolk Boreas is the subject of a separate DCO application, the project will adopt these strategic site selection decisions.

14. In order to minimise impacts associated with onshore construction works for the two projects, VWPL is aiming to carry out enabling works for both projects under the Norfolk Vanguard DCO. This covers the installation of buried ducts along the onshore cable route, from the landfall to the onshore substation, modifications at the Necton National Grid substation, visual screening works access road construction, utility connections (water, electricity and phone) and site drainage.

15. However, Norfolk Boreas need to consider the possibility that the Norfolk Vanguard project may not be constructed. In order for Norfolk Boreas to stand up as an independent project, this scenario must be provided for within its DCO. Thus, there are two alternative scenarios to be considered in the context of the EIA and this method statement:

- **Scenario 1:** Norfolk Vanguard consents and constructs transmission infrastructure which would be used by Norfolk Boreas. This includes, cable ducts, access routes to jointing pit locations, extension of the Necton National Grid substation, overhead line modification at the Necton National Grid substation and any site drainage, landscaping and planting schemes around co-located infrastructure. Under Scenario 1 Norfolk Boreas will seek to consent the Horizontal Direction Drill (HDD) at landfall, the creation of the jointing and transition pits, onshore project substation, cable relay station (if required) and the installation of cables in the ducts through a process of cable pulling'.

- **Scenario 2:** Norfolk Vanguard is not constructed and therefore Norfolk Boreas will seek to consent and construct all required project infrastructure including: HDD at landfall, transition and jointing pits, installation of cable ducts, cable installation, cable relay station (if required), onshore project substation, 400kV interface works (between the onshore project substation and the Necton National Grid substation), extension to the Necton National Grid substation, overhead line modification and any site drainage and landscape and planting schemes. For the sake of clarity, the Norfolk Boreas project would, under Scenario 2, involve the construction and installation of all onshore infrastructure necessary for a viable project.

16. **Appendix 1** contains a set of figures showing the current proposed onshore infrastructure locations and **Appendix 2** contains a detailed comparison of what is included in the two different scenarios across all elements of the project. Both these appendices are provided in separate documents.

17. Norfolk Boreas are proposing to employ a construction strategy whereby there are multiple moving work fronts which complete the majority of all construction works in each area before moving on. This reduces overall construction time as most works are completed in one pass and allows flexibility for areas to be avoided at sensitive times and to minimise impact through scheduling of works.

2.2 Site Selection Update

18. A detailed programme of site selection work has been undertaken by VWPL to refine the locations of the onshore infrastructure for both projects. The Norfolk Vanguard Scoping Report presented search areas for the onshore infrastructure which were identified following constraints mapping to avoid or minimise potential impacts (e.g. noise, visual, landscape, traffic, human health and socio-economic impacts). Further data review has been undertaken to understand the engineering and environmental constraints within the search areas identified.

19. This process has been informed by public drop in exhibitions (October 2016, March and April 2017), along with the Scoping Opinion for Norfolk Vanguard and the feedback from the Expert Topic Groups. Details of the site selection process are provided in Chapter 4 of the Norfolk Vanguard Preliminary Environmental Information Report (Royal HaskoningDHV, 2017b). The current locations for infrastructure are shown in **Appendix 1**,with a summary provided below:

2.2.1 Landfall Zone

20. The Norfolk Boreas Scoping report presented three potential landfall locations. Data was reviewed on a broad range of environmental factors, including existing industrialised landscape, the presence of the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ), coastal erosion and archaeology alongside statutory and non-statutory consultation.

21. After publication of the scoping report, VWPL concluded, taking account of all engineering and environmental factors, as well as public feedback, that the most suitable landfall location would be Happisburgh South. The decision to go to

Happisburgh south was presented to the Norfolk Vanguard Evidence Plan Expert Topic groups in June and July 2017 and in the Norfolk Vanguard PEIR (Norfolk Vanguard Limited Royal HaskoingDHV, 2017b).

22. Happisburgh South also has the benefit of being large enough to accommodate landfall works of both Norfolk Vanguard and Norfolk Boreas, therefore reducing the spatial extent of impacts associated with the two projects.

2.2.2 Cable Relay Station Options

23. The Norfolk Boreas Scoping report presented seven potential cable relay station search zones. A single cable relay station would be required for a High Voltage Alternating Current (HVAC). No cable relay station would be required for a High Voltage Direct Current (HVDC) electrical solution. The decision between HVDC and HVAC solutions is not expected to be taken until post consent, therefore for the purposes of the EIA, and under the project envelope approach, assessment would be conducted on the basis of the realistic worst case.

24. Following the scoping opinion further work has been completed and two potential locations are being proposed for the cable relay station (**Appendix 1**). The final siting of the cable relay station on either footprint will have due consideration for of existing watercourses, hedgerows, landscaping, archaeology, ecology, noise, access and other known infrastructure/environmental constraints to minimise impacts, along with feedback from statutory and non-statutory consultation.

25. A Norfolk Boreas cable relay station temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published in Q4 2018.

2.2.3 Onshore Cable Route

26. A 200m wide cable corridor was presented within the Norfolk Boreas scoping report. This corridor, shared with Norfolk Vanguard, is the shortest realistic route between landfall and the Necton National Grid substation (thereby minimising disturbance impacts) whilst also aiming to avoid main residential areas and impacts to landscape, nature conservation designations and other key environmental constraints where possible.

27. The proposed route skirts around the main towns of North Walsham, Aylsham, Reepham and Dereham. Since the Norfolk Boreas scoping report was published further work has been completed (see Norfolk Vanguard Limited Royal HaskoningDHV, 2017b for detail) to refine the cable corridor and an indicative cable route has been established suitable for infrastructure for both the Norfolk Vanguard and Boreas onshore export cables (**Appendix 1**).

2.2.4 Onshore Project Substation

28. The Norfolk Boreas scoping report presented an onshore project substation zone within which the onshore project substation was to be located. Following further site selection work (presented in Norfolk Vanguard Limited Royal HaskoningDHV, 2017b) a preferred onshore project substation location has been identified. Although the onshore project substation location is now well defined there remains the possibility that its exact location may change slightly following consultation on the Norfolk Vanguard PEIR, therefore an onshore project substation search area has been retained (**Appendix 1**).

29. A Norfolk Boreas Onshore project substation temporary construction compound area has not yet been identified, however a location will have been determined prior to the Norfolk Boreas PEIR being published.

2.2.5 Extension to the Existing Necton National Grid substation

30. The Norfolk Boreas Scoping report presented a National Grid substation extension zone. Since the publication of that report further work has been undertaken to define the footprint of these extension works (**Appendix 1**). Further detail on this process is presented in Chapter 4 of the Norfolk Vanguard PEIR (Norfolk Vanguard Limited Royal HaskoningDHV, 2017b).

31. Also presented in the Norfolk Boreas Scoping report was an overhead line modification zone within which the overhead lines leading into the Necton National Grid substation would be realigned (section 2.3.1.5). The area within which this work will be undertaken has since been refined and is presented in the Norfolk Vanguard PEIR and project design statements and shown in **Appendix 1**. Further detail on the process behind this refinement is provided in the Norfolk Vanguard PEIR chapter 5 site selection and alternatives.

2.3 Indicative Worst Case Scenarios

32. The following sections set out the current predicted worst case scenarios for onshore noise and vibration.

33. Each chapter of the PEIR and ES will define the worst case scenario arising from the construction, operation and decommissioning phases of the project for the relevant receptors and impacts. Additionally, each chapter will consider separately the anticipated cumulative impacts of Norfolk Boreas with other relevant projects.

34. The parameters discussed in this section are based on the best available information for Norfolk Boreas at the time of writing and are subject to change as the project

progresses. The Norfolk Boreas ES will provide the final project design envelope for the DCO application.

2.3.1 Infrastructure Parameters

35. HVAC and HVDC electrical solutions are being considered for Norfolk Boreas. Both electrical solutions would have implications for the required onshore infrastructure. Typically the HVAC solution involves a greater area of land take, additional infrastructure and higher noise output, as such the HVAC solution is assumed as the worst case in the remainder of this section.

36. The following key onshore project parameters are considered within this method statement:

- Landfall (Horizontal Directional Drilling (HDD) and associated compounds);
- Cable relay station (required for HVAC only);
- Cable corridor (with associated trenchless crossing technique areas, construction compounds and mobilisation areas and access);
- Onshore project substation;
- Interface cables connecting the onshore project substation and the Necton National Grid substation; and
- Extension to the existing Necton National Grid Substation, including overhead line modification.

37. Each of these project parameters is described in more detail below.

38. Explanation of which parameters are considered for Scenario 1 and for Scenario 2 is provided in the sections below. For full detail of what is considered in each Scenario please see **Appendix 2**.

39. Under Scenario 1, Norfolk Vanguard would be considered within the project operational impact assessment of Norfolk Boreas. Under Scenario 2 Norfolk Vanguard will not be relevant. Other projects which would be considered in the CIA are discussed in section 2.3.5.

2.3.1.1 Landfall

40. The landfall compound zone (**Appendix 1**) denotes the location where up to six offshore export cables (assuming HVAC) would be brought ashore. These would be jointed to the onshore cables in transition pits located within the easternmost “trenchless crossing technique” area shown in **Appendix 1**. Under Scenario 1 Norfolk Boreas would share the landfall area with Norfolk Vanguard at Happisburgh South.

41. Works associated at landfall would be the same under both scenarios. However, under Scenario 1, where Norfolk Boreas cable ducts will be installed concurrently with the Norfolk Vanguard ducts, the Norfolk Boreas ducts would only be installed on the landward (western) side of the transition pits. Ducts on the seaward side of the transition pits would be installed using HDD during Norfolk Boreas construction.

42. The HDD would exit at one of the following two locations:

- On the beach, above the level of mean low water spring (classified as "short HDD"). This would require temporary beach closures during drilling exit and duct installation to maintain public safety. Beach access would be required for an excavator and 4x4 vehicles.
- At an offshore location, seaward the beach (up to 1000m in drill length) (classified as "long HDD").

43. Key parameters of works at landfall:

- Installation of temporary construction compound to accommodate the drilling rig, ducting and associated materials and welfare facilities.
- A total of up to six ducts for the HVAC solution or two ducts for the HVDC solution would be required.
- For a drill length of 500m, it is anticipated that site establishment, drilling of up to six ducts and demobilisation will take approximately 30 weeks when considering 12 hour (7am-7pm), 7 day shifts. 24 hour operation could be employed for drilling activities, subject to planning and environmental restrictions, and could reduce the installation to approximately 20 weeks. Cable pulling would be undertaken subsequent to the duct installation and is covered under the onshore cable corridor assessment.
- Noise from HDD sites is generally associated with generators. The generators are typically containerised units, with the capacity determined by the ground conditions and pulling forces required with a unit in the order of 250kW – 500kW likely to be required.
- The site would be fully reinstated upon completion of the landfall works.

44. A temporary compound would be assembled to provide a controlled environment to be maintained during jointing activities. A small generator could be required to provide the necessary electrical power for the enclosure, any powered jointing equipment and any pumps to manage groundwater.

2.3.1.2 Cable Relay Station

45. A cable relay station would be required for a HVAC electrical solution. No cable relay station would be required for a HVDC solution. Therefore the HVAC solution is the worst case scenario for this element of the onshore infrastructure. The cable relay station would be constructed by Norfolk Boreas under both Scenarios and would be located within one of the sites identified in **Appendix 1**.

46. Under Scenario 1 the Norfolk Boreas cable relay station would occupy some the site which had been used for the Norfolk Vanguard construction compound. Therefore under this scenario a number of enabling works activities would be undertaken by Norfolk Vanguard. These include:

- Landscaping to reduce visual impacts;
- Access roads; and
- Site drainage infrastructure.

47. Under Scenario 2 all enabling works would be undertaken by Norfolk Boreas.

48. Key parameters of works at cable relay station are as follows:

- The cable relay station would consist of a three phase reactor per HVAC circuit (a total of six reactors) with associated outdoor GIS (Gas Insulated Switchgear).
- Cables from the landfall and onwards to the onshore project substation would be laid in concrete troughs within the cable relay station and terminated at the GIS.

49. During construction of the cable relay station the temporary construction compound would be established to support the works. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR being published in Q4 2018. Appropriate access to the B1159 would be provided to permit safe delivery of plant and equipment required for construction.

50. The compound would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators. Under Scenario 2 this compound would also serve as a Primary Mobilisation Area (PMA) for cable installation works. Under Scenario 1 PMAs are not required.

51. The site would be stripped of soil and soil graded as required by the final design. Under Scenario 1 there would be less capacity to do this as landscaping schemes developed to mitigate visual impacts of both Norfolk Vanguard and Norfolk Boreas

would have started to mature by the time Norfolk Boreas construction starts. Any excess material would be disposed of at a licenced disposal site. Excavations and laying of foundations, trenches and drainage would commence after grading is complete.

52. At this stage it is not known whether the foundations would either be ground-bearing or piled. The design would be based on the prevailing ground conditions. Upon completion of the foundations, the specialist electrical equipment would then be delivered to site, installed and commissioned. Due to the size and weight of the reactors, specialist delivery methods would be employed and offloaded at site with the use of a mobile gantry crane.

53. Construction activities would be conducted during working hours of 7am-7pm. Evening or weekend working could be required to maintain programme progress and for specific time critical activities such as transformer oil filling and processing; however these would be kept to a minimum.

2.3.1.3 Onshore cable corridor

54. The onshore cable corridor will contain the final onshore cable route. Currently an indicative cable route has been identified and is displayed in **Appendix 1**.

2.3.1.3.1 Onshore cable route

55. The onshore cable route would contain the export cables housed within High Density Polyethylene (HDPE) ducts and HVAC interface cables connecting the onshore project substation with the Necton National Grid substation. The key elements of the onshore cable route for Scenarios 1 and 2 are detailed in **Appendix 2**, and summarised below.

Scenario 1

56. Norfolk Vanguard would install cable ducts and undertake enabling works (e.g. running track, accesses etc.) for Norfolk Boreas along the entire length of the onshore cable corridor. Therefore, all excavations (except jointing pits and associated temporary construction compounds) and crossings would have already been undertaken. In addition, all ducts will be installed and ground reinstated by Norfolk Vanguard.

Scenario 2

57. Norfolk Boreas would be responsible for installing all onshore cable route infrastructure required for the project, including installing ducts along the entire

cable route and reinstating land (cable pulling would then happen at a later date). Under this scenario the duct installation would also require:

- Trenches for the ducts;
- A running track to deliver equipment to the installation site from mobilisation areas; and
- Storage areas for topsoil and subsoil.

2.3.1.3.2 Trenching and soil storage

Scenario 1

58. No trenching and soil storage would be required under this scenario for Norfolk Boreas as these works would have been completed under Norfolk Vanguard.

Scenario 2

59. Norfolk Boreas would be responsible for duct installation requiring trenching and storage for topsoil and subsoil. The main duct installation method would be through the use of open cut trenching with ducts installed, soil backfilled and land reinstated. Cables would then be pulled though the pre-laid ducts at a later stage.

60. Where the cable route crosses major transport routes or waterways the standard open cut trenching installation technique might not be suitable. The cable burial depth might increase at these crossing locations or an alternative trenchless method may be used. Further details of crossing methodologies are provided below. .

61. The plant required for duct installation (including excavation) would include tracked excavators, dump trucks, pumps and generators.

62. Alternatively, a tracked trenching machine could be used which allows ducting installation to be achieved without excavation. This method will be dependent on soil conditions and other detailed design aspects to be reviewed at the time of construction design.

2.3.1.3.3 Running track

63. A running track would provide safe access for construction vehicles within the onshore cable corridor and could be up to 6m wide.

64. Noise impacts associated with the installation and removal of the running track will be mostly related to fixed and mobile construction plant and associated activities and will therefore be captured as part of the construction phase assessment.

Scenario 1

65. Under Scenario 1 approximately 20% of the Norfolk Vanguard running track would need to be retained or reinstated (reinstated being the worst case scenario) for the cable pulling phases.

Scenario 2

66. Under Scenario 2 running track would be installed along the entire length of the cable route (approximately 60km) to allow safe access from mobilisation areas to the duct installation sites.

2.3.1.3.4 Jointing pits

67. Jointing pits would be required along the onshore cable route to allow cable pulling and jointing of two sections of cable. Under both Scenario 1 and Scenario 2 the jointing pits would be installed by Norfolk Boreas.

68. The jointing pits would typically be located at 800m intervals, the maximum cable length which can be delivered, although site specific constraints may result in shorter intervals where necessary.

2.3.1.3.5 Cable pulling process

69. Under either Scenario the onshore cables would be pulled through the installed ducts later in the construction programme in a staged approach, as offshore generating capacity comes online. This approach allows the major onshore civil engineering works to be completed in advance of cable delivery.

70. Cable pulling would not require the trenches to be reopened, with the cables pulled through the preinstalled ducts between the jointing pits located along the onshore cable route.

71. To facilitate the cable pull and jointing, the jointing pit would be exposed to access the cable ducts and cable drums would be delivered by HGV low loader. The cable drum would be located adjacent to the jointing pit on a temporary hard standing and a winch attached to the cable from the next jointing bay by a pulling wire. The winch would then commence pulling the cable off the drum from one jointing pit to another, through the buried ducts. The cable would be installed in sections, and then joined together to form a single export cable.

72. The cable pulling and jointing process will take approximately six weeks per 1km of cable length, including installing and removing any temporary hard standing and delivering the cables to the joint pits. However any one jointing pit may be open for up to 12 weeks to allow its neighbouring jointing pit to be opened and the cables

pulled from one pit to the next, dependant on the level of parallel work being conducted.

73. Access to and from the jointing pits would be required to facilitate the works during this phase of the project. This would be achieved through access to the onshore cable jointing pits directly from the highways network (at crossing locations) or existing local access routes where possible.

74. Under Scenario 1 in some locations, small sections of the running track would be required to be instated to allow access to more remote jointing bay locations (assuming that the entire running track required for the Norfolk Vanguard Project would have been removed). It is considered as a worst case scenario this would require approximately 20% of the running track to be reinstated to facilitate access to jointing pits**.**

75. Under Scenario 2, approximately 20% of running track presented would be left in place from the duct installation works, or required to be reinstated to allow access to more remote jointing bay locations.

76. During the cable install phase, each retained or reinstated section of running track would be used to bring in plant, cable reels and other materials. This usage would be repeated for each of the Norfolk Boreas cable installation phases (i.e. up to 3 phases in total).

2.3.1.3.6 Crossing installation methods

Scenario 1

77. Under Scenario 1, all necessary crossing installation (such as hedgerows, roads, services, watercourses) would have already been completed and land reinstated by Norfolk Vanguard. No additional works would be required by Norfolk Boreas.

Scenario 2

78. Under Scenario 2, all crossings would be consented and installed by Norfolk Boreas. When crossing some features along the onshore cable route, alternative or amended installation approaches would be required to minimise the impact on the feature or obstacle being crossed as much as reasonably practicable. Further detail on the methods used at each crossing point will be detailed within the PEIR and ES. But crossing methods that might be employed include:

- Culverting;
- Dam an divert;
- Cable bridges;

- Trenchless techniques including:
  - HDD;
  - micro tunnelling; or
  - auger boring

79. Where trenchless drilling activities are to be conducted, a temporary work area would be required to store drilling equipment, welfare facilities, ducting and water for the drilling process.

2.3.1.3.7 Temporary construction compounds

Scenario 1

80. Under Scenario 1 no primary and secondary mobilisation areas would be required as materials will be delivered directly to jointing pits locations.

Scenario 2

81. Primary and secondary mobilisation areas would be required to store equipment and provide welfare facilities. Indicative locations for these are provided in **Appendix 1**. Noise impacts associated with the installation and removal of these compounds will be mostly related to fixed and mobile construction plant and associated activities and will therefore be captured as part of the construction phase assessment. Impacts relating to the construction traffic using the public highways will be incorporated into a specific Construction Traffic Noise Assessment.

2.3.1.3.8 Cable route side access

82. Small temporary access routes would be required to facilitate the safe ingress and egress from the public highways to the construction locations termed side accesses. These current proposed locations for these are displayed in **Appendix 1**.

83. Noise impacts associated with the installation and removal of these cable route side accesses will be mostly related to fixed and mobile construction plant and associated activities and will therefore be captured as part of the construction phase assessment.

Scenario 1

84. Under Scenario 1 some of the side accesses to the cable route would be retained or reinstated from the Norfolk Vanguard project. For the purposes of this Method Statement the worst case scenario would be the reinstatement of these accesses.

Scenario 2

85. Under Scenario 2 side accesses to the cable route would need to be constructed and would be left in place for three years to provide for cable pulling phases before being removed and land reinstated.

2.3.1.4 Onshore Project Substation

86. The onshore project substation would consist of either an HVAC substation or HVDC substation[1], dependant on the electrical solution utilised. One project substation (HVAC or HVDC) would be required for Norfolk Boreas. The proposed onshore project substation location is presented in **Appendix 1**.

87. During construction of the onshore project substation, a temporary construction compound would be established to support the works. The location of the temporary construction compound has not yet been determined but will be presented within the Norfolk Boreas PEIR to be published in Q4 2018.

88. The compound would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services would be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

89. At this stage it is not known whether the foundations would either be ground-bearing or piled based on the prevailing ground conditions.

90. Construction activities would be conducted during working hours of 7am-7pm. Evening or weekend working might be required to maintain programme progress and for specific time critical activities such as transformer oil filling and processing; however, these would be kept to a minimum.

91. The construction programme for the onshore project substation is 18 months. The enabling works for the onshore project substation would differ between scenarios as outlined below:

Scenario 1

92. Under Scenario 1, a number of enabling works activities would be undertaken by Norfolk Vanguard. These include:

- Landscaping to reduce visual impacts;
- Access roads; and

[1] Also referred to as a HVDC converter station. For the purposes of consistency both HVAC and HVDC solutions will be referred to as the onshore project substation.

- Site drainage infrastructure.

93. Under Scenario 1, the access road would be shared with the onshore project substation for Norfolk Vanguard.

Scenario 2

94. Under Scenario 2, all enabling works would be undertaken by Norfolk Boreas.

95. In Scenario 1, this access would be shared with the onshore project substation for Norfolk Vanguard; in Scenario 2, the access would need to be constructed as part of Norfolk Boreas.

2.3.1.5 Necton National Grid Substation Extension

96. The existing Necton National Grid substation would be required to be extended to accommodate the Norfolk Boreas and Norfolk Vanguard connection points. The proposed footprint of this extension is provided in **Appendix 1**.

97. The Necton National Grid substation accommodates the circuit breakers which are the connection points for the Norfolk Boreas and Norfolk Vanguard wind farms with associated busbar structures which allow connection onto the existing 400kV overhead line for generation to be transmitted onto the wider National Grid Electricity Transmission system. In addition to the Necton National Grid substation itself, modifications to the existing overhead lines in parallel to the substation would be required to provide a double turn-in arrangement.

Scenario 1

98. Under Scenario 1 the majority of these works, including modifications to overhead lines, would be undertaken by Norfolk Vanguard for both projects. All extension enabling works would be completed to facilitate both Norfolk Vanguard and Norfolk Boreas including access roads, earthworks, foundations, buildings and civil works. However the electrical busbar extensions and other electrical equipment required for Norfolk Boreas would be installed under Norfolk Boreas consent.

Scenario 2

99. Under Scenario 2 all extension works to Necton National Grid Substation and overhead line modifications to accommodate Norfolk Boreas would be undertaken under Norfolk Boreas DCO. The outdoor busbar would be extended in an east and west direction to an estimated total length of approximately 340m with seven air-insulated switchgear bays installed along the busbar extension for Norfolk Boreas.

100. Two new overhead line towers would be required in close proximity to the existing corner tower (to the north east of the existing Necton Substation) with a maximum height of 67m. The existing corner tower would be demolished and replaced by two new towers, alternatively, the existing corner tower could be modified and one new terminal tower constructed in close proximity. The design approach taken will be confirmed at detailed design phase.

101. The substation extension and overhead line modification works would be conducted within the areas identified within **Appendix 1** as National Grid Overhead Line Works, National Grid substation extension and National Grid temporary works.

102. During construction of the Necton National Grid Substation, two temporary construction compounds would be established to support the works. The compounds would accommodate construction management offices, welfare facilities, car parking, workshops and storage areas. Water, sewerage and electricity services will be required at the site and supplied either via mains connection or mobile supplies such as bowsers, septic tanks and generators.

103. At this stage it is not known whether the Necton National Grid substation foundations would either be ground-bearing or piled based on the prevailing ground conditions.

104. For the overhead line modifications, up to three temporary towers (maximum height 45m) would be constructed in close proximity to the existing towers and the existing circuits transferred over to the temporary towers. The existing towers would be removed and replaced with new towers, each up to 50m in height (or alternatively the existing towers would be modified if possible) and possibly with a slightly larger footprint.

105. The tower foundations could be piled or excavated and cast, dependant on the ground conditions and structural requirements. These works would be undertaken within the National Grid temporary works are displayed in **Appendix 1**.

106. Construction activities would be conducted during working hours of 7am-7pm. Evening or weekend working may be required to maintain programme progress. Cranes, excavators and potentially piling equipment would be the main equipment required to construct the towers and extend the substation with sound levels in the order of 90 dB LAeq at 10m.

107. The construction programme for the Necton National Grid substation extension and overhead line modification works is 18 months and would be conducted primarily during working hours of 7am to 7pm. Further detail on construction programmes is provided below in section 2.3.2.

2.3.2 Construction Programme

108. Currently it is expected that the Norfolk Boreas project would be constructed in one, two or three phases. Error! Reference source not found.**1** summarises the main construction activities and sequence associated with installation of the Norfolk Boreas project onshore infrastructure under a ‘three-phased’ approach (as this represents the worst-case scenario in terms of duration of impact). Separate time lines are discussed for both Scenario 1 and 2.

Table 2.1 Norfolk Boreas Outline Construction Programme

<table>
<tr><th>Date</th><th colspan="2">Scenario 1</th><th colspan="2">Scenario 2</th></tr>
<tr><td>2022</td><td colspan="2" rowspan="2"></td><td rowspan="2">Pre-construction works
Road modifications
Hedge and tree removal (season dependant)
Ecological preparations (e.g. displacement of water voles, fencing of areas for newts, etc.)
Preconstruction drainage (at cable relay station and substation locations)</td><td></td></tr>
<tr><td>2023</td><td></td></tr>
<tr><td>2024</td><td>Pre-construction works
(landfall, cable relay station and onshore project substation only)
Ecological preparations (e.g. displacement of water voles, fencing of areas for newts, etc.)
Preconstruction Drainage at cable relay station and substation locations</td><td rowspan="3">Substation and Cable Relay Station Construction
Main works (drainage, foundations and buildings)</td><td rowspan="2">Main duct installation works
Enabling works
Duct installation
Reinstatement works</td><td rowspan="2">Substation and Cable Relay Station Construction
Main works (drainage, foundations and buildings)</td></tr>
<tr><td>2025</td><td></td></tr>
<tr><td>2026</td><td></td><td rowspan="3">Cable installation
Installed in three phases (2026, 2027 & 2028)</td><td rowspan="3">Substation and Cable Relay Station Construction
Plant installation (to tie in with cable pull)</td></tr>
<tr><td>2027</td><td rowspan="3">Cable pulling
Installed in three phases (2027, 2028 & 2029)</td><td rowspan="3">Substation and Cable Relay Station Construction
Plant installation (to tie in with cable pull)</td></tr>
<tr><td>2028</td></tr>
<tr><td>2029</td><td></td><td></td></tr>
</table>

2.3.3 Operation and Maintenance (O&M) Strategy

109. The cable relay station, onshore project substation and overhead line modification area would not be manned, however access would be required periodically for routine maintenance activities, estimated at an average of one visit per week.

110. There would be no ongoing requirement to maintain the onshore cables following installation. Periodic access to installed link boxes (which may be buried or above ground, may be required for inspection, estimated to be annually.

111. Access to the cable easement would be required to conduct emergency repairs if necessary.

112. Operational noise levels at the National Grid substation extension are not anticipated to change from existing levels due to the nature of the extension works.

113. There would be no operational noise at landfall or along the onshore cable corridor.

2.3.4 Decommissioning

114. No decision has been made regarding the final decommissioning policy for the substation and cable relay station, as it is recognised that industry best practice, rules and legislation change over time. However, the substation and cable relay station equipment will likely be removed and reused or recycled. It is expected that the onshore cables will be removed from ducts and recycled, with the joint pits and ducts left in situ. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. A decommissioning plan will be provided.

2.3.5 Cumulative Impact Scenarios

2.3.5.1 Norfolk Vanguard

115. VWPL are seeking to minimise cumulative impacts between Norfolk Boreas and Norfolk Vanguard through the alignment of onshore cable route and the preference for Norfolk Vanguard to pre-install ducts and undertake other enabling works for Norfolk Boreas.

116. Under Scenario 1 Norfolk Vanguard will be constructed already, therefore operational noise impacts will form part of the baseline for Norfolk Boreas – effectively the project only assessment for Norfolk Boreas will be a cumulative with Norfolk Vanguard. Other projects would then be added for the cumulative assessment.

117. Under Scenario 2 Norfolk Vanguard would not be constructed and therefore not considered.

2.3.5.2 Other projects

118. The assessment would consider the potential for significant cumulative impacts to arise as a result of the construction, operation and decommissioning of Norfolk Boreas in the context of other developments that are existing, consented or at application stage.

119. **Table 2.2** lists the projects considered for the Norfolk Vanguard assessment (as assessed within the PEIR) this would be the starting point for agreement of the list of projects.

Table 2.2 Summary of projects considered for the CIA in relation to the noise and vibration

Project	Status	Development period	[2]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
Hornsea Project Three Offshore Wind Farm.	Pre-Application.	Pre-Application.	0 – cable corridor intersects the project.	Full PEIR available: http://www.dongenergy.co.uk/en/Pages/PEIR-Documents.aspx.	High	Yes	Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during construction where geographical footprints overlap and due to noise emissions from construction traffic.
Dudgeon Offshore Wind Farm.	Construction complete.	Construction completed 2017.	0	Approved PDS available.	Complete/high	Yes	Overlapping proposed project boundaries may result in impacts of a direct and / or indirect nature during operation.
Bacton Gas Terminal Extension	Approved	Approved 20/09/2016. Expires 20/09/2019.	3.1	Approved PDS available	Complete/high	No	The project would not result in an increase in traffic movements and associated noise and

[2] Shortest distance between the considered project and Norfolk Vanguard – unless specified otherwise.

Project	Status	Development period	[2]Distance from Norfolk Vanguard (km)	Project definition	Project data status	Included in CIA	Rationale
							vibration, therefore the noise and vibration impacts are not considered further.
Bacton Gas Terminal coastal protection.	Approved.	Expected construction date 2018.	1.0	Approved PDS available.	Complete/high	No	The project would not result in an increase in traffic movements and associated noise and vibration, therefore the noise and vibration impacts are not considered further.
Bacton Coastal Protection Scheme.	Approved.	Expected construction date 2021.	1.0	Pre-application outline only.	Complete/high	No	The project would not result in an increase in traffic movements and associated noise and vibration, therefore the noise and vibration impacts are not considered further.

3 BASELINE ENVIRONMENT

3.1 Desk Based Review

120. A desk-based assessment will be undertaken to identify and evaluate the potential noise and vibration effects on receptors arising from the construction and operation of the project. The legislative context and relevant guidance for noise and vibration impact assessment are provided in **Appendix 3**.

3.1.1 Data Sources

121. The following information will be used in the baseline review and assessment:

Type	Source
Ordnance Survey mapping	An Ordnance Survey (OS) Vectormap will be used in the assessment.
Aerial Photography	Consideration of the project and surrounding environment will be conducted initially using aerial and satellite photography and mapping data in order to determine the nearest noise sensitive receptors for use in the assessment.
Topographical data	Ordnance Survey topographical data will be used in the assessment and supplemented with Environment Agency Open Data 2.0m resolution LIDAR utilised for the terrain modelling. Open Licence LIDAR data available at: (http://environment.data.gov.uk/ds/survey/#/survey)
On-site noise monitoring data	Data obtained during the baseline noise survey (see section 3.2 below) will be used to inform the noise and vibration assessment.
Traffic Data	Information regarding the off-site anticipated vehicle movements during the construction phase will be provided by Royal HaskoningDHV in the form of 18 hour AAWT flows with HGV percentages.
Construction Data	An indicative list of construction equipment will be provided by VWPL for the various phases of activity expected at the cable landfall, cable relay station, cable route, and onshore substation site. Where this information is unavailable an indicative list of construction equipment will be compiled for the various expected construction phases based on experience of assessing similar schemes. Typical noise emissions used for the noise assessment will be derived from BS5228:2009+A1:2014 Appendix C and Appendix D.
DWG/DXF Drawings	AutoCAD .dwg files, Scaled, geo-referenced proposed site Masterplan, wider site location plan, and elevation drawings will be used in the noise modelling.

3.1.2 Noise Modelling and Propagation Calculations

122. To predict the noise from the various aspects of the proposed development, the assessments will utilise SoundPLAN noise modelling software. The software implements accepted national and international acoustic calculation standards.

123. A three-dimensional model will be created using geo-referenced Ordnance Survey mapping data, topographical data of the local area incorporating buildings, plans and elevations of the project sites.

124. The SoundPLAN model calculates noise levels at a specified receptor 'point'. The construction phase assessment receptor points, which were previously agreed during Norfolk Vanguard ETG meetings, are positioned at a height of 1.5m above local ground level at positions considered to be representative of gardens or at a ground floor (GF) of a building. This is due to the premise that construction operations typically occur during daytime hours and so are likely to impact most significantly upon outdoor residential amenity areas.

125. For the construction phase road traffic assessment receptor points will be placed at first floor (4m high) façade positions in accordance with DMRB guidance and at 1.5m height (ground floor). Façade noise levels will incorporate a +2.5dB correction to account for the reflection of sound energy from the receptor building façade, as required by the CRTN calculation method.

126. For the operational phase BS4142 assessments, receptor points will be placed at 1.5m for the daytime period (07:00 to 23:00hrs) and at first floor (4m high) for the night time period (23:00 to 07:00hrs).

3.2 Data Collection

127. Consultation under the Norfolk Vanguard EPP has been undertaken with relevant stakeholders to agree the baseline survey and appropriate methodology of assessment, specifically:

- Local authorities identified in section 3.2.1; and
- The Environment Agency.

128. The existing baseline noise data obtained for the assessment of noise and vibration in relation to Norfolk Vanguard was deemed sufficient by the relevant stakeholders during the ETG meetings.

129. During the initial appraisal and review of the Norfolk Vanguard and Norfolk Boreas study area, sensitive receptors potentially affected by the schemes were identified and screened. The identification of each receptor was based upon consideration of either scheme being developed in isolation or cumulatively. The receptors were subsequently agreed as part of consultation at the ETG meetings. This covered consideration of landfall, cable relay station, onshore cable route, project substation and the National Grid substation extension. Given this, it is proposed that the survey data collected in support of the Norfolk Vanguard DCO is also suitable for the Norfolk Boreas project.

3.2.1 Study Area

130. The study areas for the cable landfall, cable relay station, cable route, onshore project substation and the extension to the existing Necton 400kV National Grid substation site are located within the administrative region of the following local authorities:

- North Norfolk District Council (NNDC);
- Broadland District Council (BDC);
- Breckland Council (BC); and
- Norwich District Council (NDC).

131. The proposed extent of the Study Area for the construction phase road traffic noise and vibration assessment is based on details provided by the transport team, is the same as that proposed for Norfolk Vanguard and will likely be governed by the outcome of any consultation. The extent is shown on **Figure 1**. The administrative boundaries of the additional local authorities are labelled with RTN denoting Road Traffic Noise.

- South Norfolk District Council (SNDC) (RTN);
- Great Yarmouth District Council (GYDC) (RTN);
- Waveney District Council (WDC) (RTN);
- King's Lynn and West Norfolk District Council KLWNDC (RTN).

132. As part of the Norfolk Vanguard EIA survey programme measurements of the existing ambient noise level have been taken at locations considered representative of nearby Noise Sensitive Receptors (NSRs) that have the potential to be affected by the construction and operation of Norfolk Boreas.

133. The baseline survey quantified the existing noise levels at sensitive receptor locations close to potential noise generating activities associated with Norfolk Boreas, for the following:

- Cable landfall;
- Cable relay station;
- Cable route;
- Onshore substation; and
- Extension to existing Necton 400kV National Grid substation.

3.2.2 Survey Practice

134. The survey methodology for Norfolk Boreas is the same as that previously undertaken for Norfolk Vanguard. A programme of consultation regarding the

baseline survey practice was undertaken for Norfolk Vanguard which is of relevance to Norfolk Boreas. The survey practice was agreed through the production of a project specific Method Statement, subsequent Norfolk Vanguard ETG's, and is further detailed in the Norfolk Vanguard PEIR.

135. Baseline survey measurements were conducted in accordance with current guidance, including BS 4142:2014 Method for Rating and Assessing Industrial and Commercial Sound, and BS 7445:2003, Description and measurement of environmental noise.

136. Sound level meters (SLM) were fully calibrated, traceable to UKAS standards and satisfied the requirements of BS EN 61672-1:20131F for a 'Class 1' Sound Level Meter (SLM).

137. For all measurement locations during the noise survey SLMs were set to record the following:

- L_{Aeq} – the equivalent continuous sound pressure level over the measurement period. This parameter was standardised as pertinent for land use within BS 7445;
- L_{Amax} – the maximum sound pressure level occurring within the defined measurement period;
- L_{A90} – the sound pressure level exceeded for 90% of the measurement period and is indicative of the background noise level;
- L_{A10} - the sound pressure level exceeded for 10% of the measurement period. The L_{A10} index is used within the CRTN as an appropriate descriptor of traffic noise.

138. The equivalent continuous sound pressure level (L_{Aeq}) is the conventional descriptor of environmental noise and is defined below:

$$L_{eq,T} = 10 \times \log\left[\frac{1}{T}\int \frac{\rho^2(t)\partial t}{\rho_0^2}\right] dB$$

139. Noise measurements are normally taken with an A-weighting (denoted by a subscript 'A') to approximate the frequency response of the human ear.

140. Noise measurements were conducted with the SLMs mounted on tripods at a height of between 1.2m and 1.5m above ground level and 3.5m away from any reflecting surface other than the ground, i.e. in free-field conditions. The instruments were calibrated before and after the survey using a portable calibrator. No significant deviation in the calibration level was observed.

141. A record of the meteorological conditions during the survey was made and measurements taken during periods of rain or when average wind speeds exceed 5m/s were screened from the results.

3.2.3 Summary of Existing Baseline

142. In order to characterise the existing noise environment in the vicinity of the project study area a baseline noise survey was undertaken at agreed receptor locations between 27th April and 24th of May 2017.

143. The noise survey was conducted in accordance with the methodologies described within the Norfolk Vanguard method statement. Some adaptations to the methodology where necessary which were subsequently agreed by the relevant stakeholders at the ETG meetings (see section 1.3.3).

144. Baseline noise measurements were conducted within the following study areas:

- Landfall;
- Cable relay station;
- Onshore cable corridor; and
- Onshore project substation / National Grid extension works.

3.2.3.1 Landfall areas

145. Installation compounds and transition joint pits will be sited within the landfall zone at Happisburgh. Measurements were taken at a number of receptor locations presented in **Table 3.1** for each landfall area and were agreed during consultation.

Table 3.1 – Baseline and Assessment Receptors – Landfall zone

Receptor Identifier	Receptor Classification and Sensitivity	X	Y	Nearest Postcode
LFR1H	Residential, Medium	638537	330874	NR12 0PR
LFR2H	Residential, Medium	638416	330635	NR12 0PY
LFR3H	Residential, Medium	638506	329813	NR12 0AJ
LFR4H	Residential, Medium	639337	330246	NR12 0QL

146. Short-term attended measurements were taken at various times throughout the daytime (up to 1 hour) and night time (up to 30 minutes) reference periods. Noise measurements at the landfall were conducted on a fully attended basis.

3.2.3.2 Cable Relay Station

147. The cable relay station search zones are located on the North Norfolk Coast near Happisburgh, a predominantly rural area with small villages and isolated residential properties which experience low ambient noise levels presently. The main noise sources in this area are likely to be local roads and agriculture. There are 2 potential sites being considered, see **Appendix 1.**

148. Measurements have been conducted at a number of receptor locations in the vicinity of the cable relay station site which have been identified and detailed in **Table 3.2**.

Table 3.2 – Baseline and Assessment Receptors – Cable Relay Station areas

Receptor Identifier	Receptor Classification and Sensitivity	X	Y	Nearest Postcode
CRR1E*	Residential, Medium	635949	331285	NR12 0PB
CRR2E	Residential, Medium	636275	330859	NR12 0NU
CRR3E	Residential, Medium	635628	330631	NR12 0PA
CRR4E	Residential, Medium	634739	330870	NR28 9NU
CRR1F*	Residential, Medium	636233	330633	NR12 0NX
CRR2F	Residential, Medium	636378	330155	NR12 0RG
CRR3F	Residential, Medium	637451	330256	NR12 0RA
CRR1G	Residential, Medium	635919	330534	NR12 0PA
CRR2G	Residential, Medium	636313	330189	NR12 0RG
CRR3G*	Residential, Medium	635265	330525	NR28 9NX
CRR4G*	Residential, Medium	635380	329807	NR12 9HZ

Note: CR denotes Cable Relay, R1 denotes a unique Receptor identifier; E, F, G denotes each zone.

*Long term monitoring was conducted at these locations.

149. Samples of L_{A90} were cross referenced against weather data recorded on site during the measurement period. All samples influenced by adverse weather conditions (and therefore unsuitable for noise monitoring due to noise interference) have been removed from the final results. This is evident in the disparity between samples collected against total possible samples within the measurement analysis tables.

150. Statistical analysis methods have been applied to the resulting data sets in order to assess the background noise levels with a greater degree of scrutiny before presenting final levels which will form the basis for the operational assessment.

151. The approach included the use of sound level meters with full octave band analysis capability to enable assessment of the variations in the background sound level at the unattended noise sensitive receptor locations and included for the use of a weather station as recommended in the BS4142:2014 measurement procedure.

3.2.3.3 Cable Route

152. Due to the large geographical area covered by the onshore cable route (60km), the required corridor width (up to 200m), and the temporary nature of the construction works, measurements have not been taken at all locations representing specific sensitive receptors along the route. Instead, locations representative of 'areas' along the cable route were selected, as agreed through Norfolk Vanguard EPP.

153. Measurements were conducted at a number of receptor locations along the cable route as detailed in **Table 3.3**.

Table 3.3 – Baseline and Assessment Receptors – Cable Route

Receptor Identifier	Receptor Classification and Sensitivity	X	Y	Nearest Postcode
CRR1	Residential, Medium	629198	331553	NR28 0RB
CRR2	Residential, Medium	628589	331706	NR28 0RE
CRR3	Residential, Medium	626854	331810	NR28 0NE
CRR4	Residential, Medium	624030	330724	NR11 7EP
CRR5	Residential, Medium	622827	330294	NR11 7EB
CRR6	Residential, Medium	621546	330310	NR11 7ED
CRR7	Residential, Medium	621542	329521	NR11 7DY
CRR8	Residential, Medium	621064	328818	NR11 6LS
CRR9	Residential, Medium	620121	328664	NR11 6LR
CRR10	Residential, Medium	617483	327683	NR11 6NN
CRR11	Residential, Medium	616336	326789	NR11 6UL
CRR12	Residential, Medium	614711	325473	NR10 4HT
CRR13	Residential, Medium	613563	324840	NR10 4HZ

Receptor Identifier	Receptor Classification and Sensitivity	X	Y	Nearest Postcode
CRR14	Residential, Medium	612394	324575	NR10 4EP
CRR15	Residential, Medium	610616	323759	NR10 4FJ
CRR16	Residential, Medium	610373	324059	NR10 4RZ
CRR17	Residential, Medium	607770	323244	NR10 4RS
CRR18	Residential, Medium	606953	322777	NR10 4RJ
CRR19	Residential, Medium	607207	321427	NR10 4RQ
CRR20	Residential, Medium	606512	319757	NR9 5QU
CRR21	Residential, Medium	604276	318184	NR20 4QF
CRR22	Residential, Medium	604088	317164	NR20 3EP
CRR23	Residential, Medium	601847	315633	NR20 4NT
CRR24	Residential, Medium	602288	316063	NR20 4NX
CRR25	Residential, Medium	601167	315515	NR20 4PT
CRR26	Residential, Medium	599455	315130	NR19 2DQ
CRR27	Residential, Medium	598878	314731	NR19 2SU
CRR28	Residential, Medium	596691	315085	NR19 2QD
CRR29	Residential, Medium	595122	313967	NR19 2PA
CRR30	Residential, Medium	594861	312828	NR19 2QN
CRR31	Residential, Medium	594423	312613	NR19 2QN
CRR32	Residential, Medium	594847	312215	NR19 2PF
CRR33	Residential, Medium	593102	311688	NR19 2LU

Note: CR denotes cable route, R1 denotes a unique Receptor identifier.

154. It is anticipated that cable route construction works will generally be conducted over a daytime period only; though under some circumstances construction may occur over a 24-hour period.

155. The onshore cable corridor survey comprised 30-minute daytime measurements and 15-minute night time measurements, in order to capture the range of existing noise levels within the study area and to allow for the flexibility of construction phasing requirements.

3.2.4 Onshore Project Substation / National Grid Extension

156. The onshore project substation search zone is located to the east of the village of Necton to the west of the larger town of Dereham. Noise in this area is likely to be dominated by road traffic on the A47. The area is generally rural in nature with the village of Necton containing the largest concentration of residential properties. Smaller villages and isolated residential properties are also located within the search zone.

157. The location for the onshore project substation is within the vicinity of the existing Necton 400kV National Grid substation, within the substation search zone. Extensive measurements have been conducted at the receptor locations determined during Norfolk Vanguard EPP consultations. The nearest receptors to the proposed Norfolk Boreas substation location are detailed in **Table 3.4**. Note: SS denotes substation, R1 denotes a unique Receptor identifier.

Table 3.4 – Baseline and Assessment Receptors – Norfolk Boreas onshore project substation

Receptor Identifier	Receptor Classification and Sensitivity	X	Y	Nearest Postcode
SSR1*	Residential, Medium	588625	309732	PE37 8HY
SSR2*	Residential, Medium	589597	309670	PE37 8JB
SSR3*	Residential, Medium	592058	310974	NR19 2JY
SSR3 ALT**	Residential, Medium	592331	310051	IP25 7RQ
SSR4*	Residential, Medium	590743	309718	PE37 8JB
SSR5	Residential, Medium	588814	311122	PE37 8DL
SSR6	Residential, Medium	591734	311640	NR19 2JY
SSR7	Residential, Medium	589747	311318	NR19 2RQ
SSR8	Residential, Medium	589971	311705	NR19 2JW
SSR9	Residential, Medium	591059	311817	NR19 2JU
SSR10	Residential, Medium	590756	309364	IP25 7QZ
SSR11	Residential, Medium	588474	310818	PE37 8DL

*Amended due to access rights.

**Additional measurement position added as it was more representative of the identified receptor location within the previously agreed methodology.

158. Where land-access and security constraints allowed, continuous logging equipment was installed for up to 1-week and set to measure 5-minute records of the noise level. At locations where equipment could not be left unmanned, multiple short-term attended measurements were taken at various times throughout the daytime and night time reference periods.

159. Class 1 sound level meters with full octave band analysis and an accompanying weather station, as recommended in the BS4142:2014 measurement procedure, where used throughout the survey.

3.2.5 Construction related vibration

160. Ground-borne vibration can result from construction works and may lead to perceptible levels of vibration within nearby properties, which can at higher levels cause annoyance to residents. In extreme cases, cosmetic or structural building damage can occur, however vibration levels have to be very high and such cases are rare.

161. High vibration levels generally arise from 'heavy' construction works such as piling, deep excavation, or dynamic ground compaction. Construction of the onshore cable route and landfall may generate vibration impacts. The use of piling during the construction of the onshore substation, and cable relay station has not been discounted; however to reduce potential impacts, it is recommended to increase the separation distance between the construction works and receptors or give preference to methods which generate lower levels of vibration.

4 IMPACT ASSESSMENT METHODOLOGY

4.1 Overall Approach

162. This section sets out the overall approach to the assessment and highlights the main potential impacts on noise and vibration sensitive receptors during the construction and operational phases of the project.

4.2 Defining Impact Significance

4.2.1 Sensitivity

163. The closest human receptors to the proposed development have previously been determined during consultation with the relevant stakeholders and are detailed in **Table 3.1** to **Table 3.4** of the previous section.

164. The aims of the National Planning Policy Frameworks (NPPF) and the Noise Policy Statement for England (NPSE) require that a Significant Oberseved Adverse Effect Level (SOAEL) should be "avoided" and that where a noise level which falls between SOAEL and Lowest Observed Adverse Effect Level (LOAEL), then according to the explanatory notes in the statement:

"…reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur."

165. Further guidance can be found in the Planning Practice Guidance (PPG) notes which summarise the noise exposure hierarchy based on the likely average response, as summarised in **Table 4.1**.

Table 4.1 – PPG Noise Exposure Hierarchy

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
		Lowest Observed Adverse Effect Level	

Perception	Examples of Outcomes	Increasing Effect Level	Action
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
		Significant Observed Adverse Effect Level	
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory.	Unacceptable Adverse Effect	Prevent

166. Sensitive receptors, in the context of noise and vibration are typically residential premises but can also include schools, places of worship and noise sensitive commercial premises. **Table 4.2** presents the definitions used relating to the sensitivity of the receptor.

Table 4.2 - Definitions of the different sensitivity levels for a noise and vibration receptor

Sensitivity	Definition	Examples
High	Receptor has very limited tolerance of effect	Noise Receptors have been categorised as high sensitivity where noise may be detrimental to vulnerable receptors . Such receptors include Hospitals (e.g. operating theatres or high dependency units), care homes at night Vibration Receptors have been categorised as high sensitivity where the receptors are listed buildings or Scheduled Ancient Monuments.
Medium	Receptor has limited tolerance of effect	Noise Receptors have been 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 Residential accommodation, private gardens, hospital wards, care homes, schools, universities, research facilities, national parks, during the day; and temporary holiday accommodation at all times Vibration Receptors have been categorised as medium sensitivity where the structural integrity of the structure is limited but the receptor is not a listed building or Scheduled Ancient Monument.
Low	Receptor has some tolerance of effect.	Noise Receptors have been categorised as low sensitivity where noise may cause short duration effects in a recreational setting although particular high noise levels may cause a moderate effect. Such subgroups include Offices, shops, outdoor amenity areas, long distance footpaths, doctors surgeries, sports facilities and places of worship. Vibration Receptors have been categorised as low sensitivity where the structural integrity of the structure is expected to be high. The level of vibration required to cause damage is very high and such levels are not expected to be reached during the Proposed Development.
Negligible	Receptor generally tolerant of effect.	Noise Receptors have been categorised as negligible sensitivity where noise is not expected to be detrimental Such subgroups include Warehouses, light industry, car parks, agricultural land Vibration Receptors have been categorised as negligible sensitivity where vibration is not expected to be detrimental.

167. For each identified receptor details will be provided in a figure and tabulated to allow for ease of comparison for the different assessments. **Table 4.3** provides an example.

Table 4.3 – Receptor Identification, Sensitivity and Classification

Receptor Identifier	Receptor Classification	Receptor Sensitivity	X	Y	Description
R1	Residential	Medium	XXXXXX	XXXXXX	

4.2.2 Magnitude

168. Receptor magnitude has been defined with consideration to the PPG guidance, spatial extent, duration, frequency and severity of the effect. Impact magnitude is defined in **Table 4.4**.

Table 4.4 - Criteria for appraisal of magnitude of effect for a noise and vibration receptor

Magnitude	Definition
High/Major	Fundamental, permanent / irreversible changes, over the whole receptor, and / or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium/Moderate	Considerable, permanent / irreversible changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low/Minor	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 particular receptors character or distinctiveness.
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 particular receptors character or distinctiveness.
No Impact	No discernible, temporary change, or change for any length of time, over a small area of the receptor, and/no alteration to key characteristics or features of the particular receptors character or distinctiveness.

4.2.3 Significance

169. The impact significance matrix presented in **Table 4.5** will be used to determine the potential impact significance based on receptor sensitivity and magnitude of effect.

Table 4.5 Impact Significance Matrix

		Negative magnitude				Beneficial magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*	*Moderate*	*Major*	*Major*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Minor*	*Minor*	*Moderate*	*Major*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*	*Minor*	*Minor*	*Moderate*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Minor*

170. For example, in terms of PPG guidance, an unacceptable adverse effect (UAEL) is considered to align with a Major/High Impact in **Table 4.4** for a medium sensitivity receptor.

171. Assessment of impact significance is qualitative and reliant on professional experience, interpretation and judgement. The matrix should therefore be viewed as a framework to aid understanding of how a judgement has been reached, rather than as a prescriptive, formulaic tool.

172. Effects that result in **Major** or **Moderate** impacts are usually considered to be 'significant' in EIA terms. Significant impacts are those which are likely to influence the outcome of the planning application. Adverse significant impacts may require mitigation that is difficult or expensive to achieve whereas beneficial significant impacts contribute to the case in favour of the Proposed Development.

Table 4.6 Impact Significance Definitions

Impact 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.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

173. Separate assessment guidance, criteria and thresholds exist for construction and operational phases. Specific criteria for each assessment are provided in the following section.

5 POTENTIAL IMPACTS

174. For the assessment, each Scenario will consider each element of the works (landfall, onshore cable route, cable relay station and onshore project substation and National Grid substation extension) in turn and dependent upon the works required as per the respective project descriptions (described in **Appendix 2**).

175. Under Scenario 1 various enabling works will have been undertaken by Norfolk Vanguard as described in section 2.3.1, this will therefore limit the works required, particularly along the onshore cable route. During operation the cable relay station and project substation will operate with Norfolk Vanguard already operational (i.e. Norfolk Vanguard would be considered as part of the project impact not the cumulative impact). Scenario 1 effects are expected to be substantially reduced in temporal and geographical terms.

176. Under Scenario 2 Norfolk Vanguard will not be built. Therefore all the enabling works and full cable installation works will be required as well as construction of the cable relay station and project substation under the Norfolk Boreas DCO. The key factors affected will be plant required, materials required and resultant vehicle movements. During operation, the Norfolk Boreas the cable relay station and project substation will be assessed alone and then cumulatively with other non-VWPL projects.

5.1 Potential Impacts during Construction

177. The potential temporary impacts of construction noise may arise from:

- Activities carried out on the surface along the proposed cable corridor (mainly earth moving and excavation);
- Construction activities at the substation and cable relay station sites including any potential landscaping;
- HDD activities;
- Heavy goods vehicles servicing the proposed cable corridors, cable relay station and substation, delivering or removing materials (including spoil and fill) and plant; and
- Vibration will only be considered as an issue where significant piling works are required i.e. foundations for onshore substation.

5.1.1 Impact: Change in Noise Level at Human Receptors

178. The methodology for the assessment will be the same under both scenarios; the difference in the conclusions will be related to the extent of the works, plant required and duration of effect.

179. Under Scenario 1 various enabling works will have been undertaken by Norfolk Vanguard, this will therefore limit the works required for Norfolk Boreas, particularly along the onshore cable route. Scenario 1 effects are expected to be substantially reduced in temporal and geographical terms.

180. Scenario 2 will require full excavation and this will have the greatest effect in terms of plant required and for duration of impacts. Vehicle movements are considered separately in section 5.1.2.

5.1.1.1 Approach to assessment

181. The same methodology for each construction phase/activity detailed above will be used throughout the assessment and is presented in this section.

182. BS5228:2009+A1:2014 describes several methods for assessing noise impacts during construction projects. The approach to be used in this assessment is the 'ABC' method. BS5228 details the "ABC method" which specifies a construction noise limit based on the existing ambient noise level and for different periods of the day. The predicted construction noise levels were assessed against noise limits derived from advice within Annex E of BS 5228. **Table 5.1**, reproduced from BS 5228:2009+A1:2014 Table E.1, presents the criteria for selection of a noise limit for a specific receptor location.

Table 5.1 – Construction Noise Threshold Levels Based on the ABC Method (BS5228)

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

183. The ‘ABC method’ described in BS 5228 establishes that there is no impact below the three thresholds presented above.

184. BS5228 states:

“If the site noise level exceeds the appropriate category 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.”

185. The model will incorporate noise sources located in the proposed scheme area, nearby residential dwellings and other buildings, intervening ground cover and topographical information.

186. Noise levels for the construction phase will be calculated using the methods and guidance in BS 5228. An appropriate threshold value (using the guidance in Table 5.1) will be assigned to each identified receptor or group of receptors (based on a measured level from the measurement survey).

187. BS5228 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.

188. To predict the noise from the various construction phases of the project, the assessment will utilise SoundPLAN noise modelling software. SoundPLAN calculates noise levels at a specified receptor ‘point’. For the construction phase assessment receptor points will be positioned at a height of 1.5m above local ground level at positions considered to be representative of gardens or at a ground floor (GF) of a building.

189. Details of plant to be used in the construction phase will be provided by Vattenfall; for example, noise from each HDD site is generally associated with generators at the location with a noise emission of 77 dB L_{Aeq} at 10m. At 50m distance from an average HDD site the noise level is 70dB(A) and at 100m is typically 60dB(A).

190. Where this information is not available, an indicative list of construction equipment will be developed for the construction programme and detailed in a tabulated format similar to **Table 5.2**. Construction plant for each assumed phase and typical emissions (source noise levels) for each piece of plant or equipment operating will

be used as the basis for the calculation. Where specific plant information is not provided, noise emission data will be derived from Annex C and Annex D of BS 5228-1:2009+A1:2014.

Table 5.2 – Example Construction Noise Plant Summary Table

Plant / activity	Number of plant per work front	BS 5228-1:2009+A1:2014 Noise Level (dB L_{wA})[3]	On-time (%)
Duct installation (Scenario 2 only) and Landfall			
Bulldozer	1	108	75
Dump Truck	1	107	75
Tracked Excavator	1	107	75
Lorry	3 p/h (per hour)	108	15km/h
Dump Truck	3 p/h	115	15km/h
HDD Rig[4]	1	105[5]	75
Water Pump[2]	1	93	75
Generator[2]	1	105	100
Enabling works (only limited works under Scenario 1)			
Bulldozer	1	108	75
Dump Truck	1	107	75
Tracked Excavator	1	107	75
Onshore project substation, CRS and Necton National Grid substation extension			
Tracked Excavator	2	107	75
Backhoe Loader	2	96	75
Bulldozer	2	108	75
Dumper	2	101	75
Mobile Crane	2	106	75
Cement Mixer Truck (Discharging)	1	103	50
Truck Mounted Concrete Pump and Boom Arm	1	108	50
Piling	1	118[3]	75
Cable pull, joint and commission			
Conveyor Drive Unit	1	95[3]	100
Field Conveyor (Rollers)	2	71[3]	100

[3] Obtained via L_{Aeq} provided in Annex C plus 28 dBA to convert to L_{wA} as noted in Section C2 of the standard
[4] Trenchless Crossing Only
[5] Not referenced in BS 5228-1:2009+A1:2014

Plant / activity	Number of plant per work front	BS 5228-1:2009+A1:2014 Noise Level (dB L_{wA})[3]	On-time (%)
Tracked Excavator	1	107	50
Cement Mixer Truck (Discharging)	1	103	50
Dump Truck	1	107	50
Generator	1	105	100

* An assumed number of hourly movements, expected to exceed actual number during construction.

** For mobile plant using a well-defined route, a speed (in km/h) is required, rather than a percentage on-time.

*** Activity equivalent continuous sound pressure level L_{Aeq} at 10m (one cycle).

191. Predicted construction noise will be assessed using the impact magnitude presented in **Table 5.3** for the daytime period.

Table 5.3 – Daytime Construction Noise Significance Criteria

Construction Noise Level (dB)			Impact Magnitude
A 65dB Threshold	B 70dB Threshold	C 75dB Threshold	
≤ 65	≤70	≤ 75	No Impact
≥65.1 to ≤65.9	≥70.1 to ≤70.9	≥75.1 to ≤75.9	Negligible Adverse
≥66.0 to ≤67.9	≥71.0 to ≤72.9	≥76.0 to ≤77.9	Minor Adverse
≥68.0 to ≤69.9	≥73.0 to ≤74.9	≥78.0 to ≤79.9	Moderate Adverse
≥70	≥75	≥80	Major Adverse

192. Construction noise will be assessed using the impact magnitude presented in **Table 5.4** for the evening and weekend period.

Table 5.4 – Evening and Weekends Construction Noise Significance Criteria

Construction Noise Level (dB)			Impact Magnitude
A 55dB Threshold	B 60dB Threshold	C 65dB Threshold	
≤ 55	≤60	≤ 65	No Impact
≥55.1 to ≤55.9	≥60.1 to ≤60.9	≥65.1 to ≤65.9	Negligible Adverse
≥56.0 to ≤57.9	≥61.0 to ≤62.9	≥66.0 to ≤67.9	Minor Adverse
≥58.0 to ≤59.9	≥63.0 to ≤64.9	≥68.0 to ≤69.9	Moderate Adverse
≥60	≥65	≥70	Major Adverse

193. Construction noise will be assessed using the impact magnitude presented in **Table 5.5** for the Night time period.

Table 5.5 – Night time Construction Noise Significance Criteria

Construction Noise Level (dB)			Impact Magnitude
A 45dB Threshold	B 50dB Threshold	C 55dB Threshold	
≤ 45	≤50	≤ 55	No Impact
≥45.1 to ≤45.9	≥50.1 to ≤50.9	≥55.1 to ≤55.9	Negligible Adverse
≥46.0 to ≤47.9	≥51.0 to ≤52.9	≥56.0 to ≤57.9	Minor Adverse
≥48.0 to ≤49.9	≥53.0 to ≤54.9	≥58.0 to ≤59.9	Moderate Adverse
≥50	≥55	≥60	Major Adverse

5.1.2 Impact: Construction Phase Road Traffic Emissions Assessment

194. Details of the road network study area for the Construction phase traffic assessment will be provided by the traffic consultants as AAWT 18hr flows, % HGVs and Speed data. The methodology for the assessment will be the same under both Scenarios; the difference in the conclusions will be related to the plant required, the resultant vehicle movements and the duration of effect.

195. Scenario 2 will require similar traffic flows as expected for Norfolk Vanguard. Full details of traffic flow changes and composition are detailed in the Traffic and Transport Method Statement.

196. Under Scenario 1 it is anticipated that traffic flows will be significantly reduced as Norfolk Boreas will not require the same level of construction works. Estimates of vehicle movements will be generated for both Scenarios based upon the respective project descriptions and presented in the PEIR.

5.1.2.1 Approach to assessment

197. Following the methodology contained in HD 213/11 Revision 1 within Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7 ‘Noise and Vibration’, 2011, an initial screening assessment will be undertaken to assess whether there would be any significant changes in traffic volumes and composition on surrounding local roads as a result of the proposed scheme.

198. The DMRB methodology explains that the objective of an assessment is to gain an understanding of the noise climate both with and without the project, referred to as the Do-Something and Do-Minimum studies respectively.

199. In order to determine impacts, scenarios need to be assessed for a baseline year and also a future year. For an assessment of temporary construction noise and impacts, the baseline year is taken as that immediately prior to the start of works. The future assessment year would be a year during the period of construction works.

200. Initial screening using the criteria specified in the DMRB guidance document seeks to identify existing roads or possible new routes where traffic flow changes (volume or composition (i.e. HGVs/Light vehicles)) exceeding plus 25% or minus 20%, are expected. It is stated that traffic flow variations below this level would give rise to a maximum change in the noise level of less than 1 dB(A).

201. Where road links are predicted to experience an increase less than 25% or a decrease less than 20%, then the guidance indicates that no further assessment needs to be conducted. Where road links are predicted to experience an increase of greater than 25% or a decrease of 20%, a noise level calculation will be undertaken following the procedure outlined in Calculation of Road Traffic Noise (CRTN).

202. Construction phase road links within the Study Area will be presented in a table similar to the example in **Table 5.6**.

Table 5.6 – Construction Traffic Noise for Assessed Links Example

Link ID and Description	Baseline flows 18hr AAWT		Baseline construction Traffic Development 18hr AAWT		% Change	% Change	Speed (km/h)
	Total Vehicles	% HGVs	Total Vehicles	% HGVs	Total Vehicles	% HGVs	
Road X	10,000	10	13,000	12	30	56	48

203. A comparison will be made between the Baseline year and the Baseline year with construction traffic for the predicted noise levels from the CRTN calculation. Any associated changes in noise level due to a corresponding change in volume and composition which exceed the DMRB criteria outlined above (for example detailed in **Table 5.6**) will be assessed using the construction phase noise impact magnitude criteria detailed in **Table 5.7** which was reproduced from Table 3.1 of DMRB.

204. The sensitivity of the identified receptor will be combined with the predicted impact magnitude to determine the impact significance.

Table 5.7 – Traffic Noise Impact Magnitude Criteria (Short Term)

Increase in Traffic Noise Level (dB $L_{A10,18h}$)	Impact Magnitude
0.0	No change
0.1 – 0.9	Negligible Adverse
1.0 – 2.9	Minor Adverse
3.0 – 4.9	Moderate Adverse
≥ 5.0	Major Adverse

5.1.3 Impact: Construction Vibration

205. The methodology for the assessment will be the same under both scenarios; the difference in the conclusions will be related to the extent of the works, plant required and duration of effect. Scenario 1 effects are expected to be substantially reduced in temporal and geographical terms. For the onshore cable route, Scenario 2 will require full excavation and this will have the greatest effect in terms of plant required and for duration of impacts.

206. 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, however vibration levels have to be very high for this effect to be manifested and such cases are rare.

207. High vibration levels generally arise from 'heavy' construction works such as piling, deep excavation, or dynamic ground compaction. The use of piling during the construction of the project may be required.

208. Section 3.29 of DMRB considers the effect of ground-borne vibration. DMRB states:

"People often express concern that vibrations they feel will cause structural damage to their dwelling. However, it has been shown that vibrations that can be felt indoors and which often cause occupants anxiety are an order of magnitude smaller than would be needed to activate pre-existing strains and cause cracks to propagate. "

209. DMRB provides context of perceived impacts:

"PPVs in the structure of buildings close to heavily trafficked roads rarely exceed 2 mm/s and typically are below 1 mm/s. Normal use of a building such as closing

doors, walking on suspended wooden floors and operating domestic appliances can generate similar levels of vibration to those from road traffic."

5.1.3.1 Approach to assessment

210. Annex E of BS5228-2:2009+A1:2014 contains empirical formulae derived by Hiller and Crabb (2000) from field measurements relating to resultant peak particle velocity (PPV) with a number of other parameters for vibratory compaction, dynamic compaction, percussive and vibratory piling, the vibration of stone columns and tunnel boring operations. These prediction equations are based on the energy approach. Use of these empirical formulae enables resultant PPV to be predicted and for some activities (vibratory compaction, vibratory piling and vibrated stone columns) they can provide an indicator of the probability of these levels of PPV being exceeded.

211. The empirical equations for predicting construction-related vibration provide estimates in terms of PPV and, therefore, the consequences of predicted levels in terms of human perception and disturbance can be established through direct comparison with the BS 5228-2:2009+A1:2014 guidance vibration levels.

212. Ground-borne vibration assessments may be drawn from the empirical methods detailed in BS 5228-2:2009+A1:2014, in the Transport and Road Research Laboratory Research Report (TRRL) 246: Traffic induced vibrations in buildings and within the TRRL 429 (2000): Ground-borne vibration caused by mechanical construction works.

213. These calculation methods rely on detailed information, including the type and number of plant being used, their location and the length of time they are in operation. Given the mobile nature of much of the plant that has the potential to impart sufficient energy into the ground, and the varying ground conditions in the immediate vicinity of the construction works, it is considered that an accurate representation of vibration conditions using these predictive methods is not possible.

214. Consequently, a series of calculations, following the methodologies referred to above is usually carried out based on typical construction activities that have the potential to impart sufficient energy into the ground, applying reasonable worst-case assumptions, in order to determine set-back distances at which critical vibration levels may occur.

215. Humans are very sensitive to vibration, which can result in concern being expressed at energy levels well below the threshold of damage. Guidance on the human response to vibration in buildings is found in BS 6472-1:2008 Guide to evaluation of

human exposure to vibration in buildings, Part 1, Vibration sources other than blasting.

216. BS 6472 describes how to determine the vibration dose value (VDV) from frequency-weighted vibration measurements. The VDV is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

217. BS 6472 states that in homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception.

218. BS 6472 contains a methodology for assessing the human response to vibration in terms of either the VDV, or in terms of the acceleration or the peak velocity of the vibration, which is also referred to as PPV. The VDV is determined over a 16-hour daytime period or 8-hour night-time period.

219. 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. For construction vibration, the vibration level and effects detailed in **Table 5.8** will be adopted, based on guidance from BS5228. Limits for transient vibration, above which cosmetic damage could occur, are given numerically in terms of PPV.

Table 5.8 – Transient Vibration Guide Values for Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	$50mms^{-1}$ at 4Hz and above	
2	Un-reinforced or light framed structures Residential or light commercial type buildings	$15mms^{-1}$ at 4Hz increasing to $20mms^{-1}$ at 15Hz	$20mms^{-1}$ at 15Hz increasing to $50mms^{-1}$ at 40Hz and above

220. **Table 5.9** lists the minimum set-back distances at which vibration levels of reportable significance for other typical construction activities that may occur on a construction site. Where applicable in the relevant calculation methods, a 66.6% certainty factor was included in order to provide a conservative approach.

Table 5.9 – Predicted Distances at which Vibration Levels may Occur

Activity	Set-back Distance at which Vibration Level (PPV) occurs			
	0.3 mm/s	1.0 mm/s	10 mm/s	15 mm/s
Vibratory Compaction (Start-up)	166m	65m	9m	6m
Vibratory Compaction (Steady State)	102m	44m	8m	6m
Percussive Piling+	48m	19m	3m	2m
HGV Movement on uneven Haul Route	277m	60m	3m	2m
Vibratory Compaction (Start-up)	166m	65m	9m	6m

221. For construction vibration from sources other than blasting, the vibration level and effects presented in **Table 5.10** have been adopted based on Table B-1 of BS 5228-2. These levels and effects are based on human perception of vibration in residential environments.

Table 5.10 – Impact Magnitude Construction Vibration

Vibration Limit PPV (mm/s)	Interpreted Significance to Humans	Impact Magnitude
≤0.14	Vibration unlikely to be perceptible	No Impact
0.14 to 0.3	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction	Negligible Adverse
0.3 to 1.0	Vibration might just be perceptible in residential environments	Minor Adverse
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	Moderate Adverse
≥10	Vibration is likely to be intolerable for any more than a brief exposure to this level	Major Adverse

222. At this stage it is therefore considered that there is no requirement for a baseline survey based upon the methodology detailed above.

5.1.4 Impact: Construction Phase - Ecological Receptors

223. The methodology for the assessment will be the same under both scenarios; the difference in the conclusions will be related to the extent of works, plant required

and duration of effect. Scenario 1 effects are expected to be substantially reduced in temporal and geographical terms. For the onshore cable route Scenario 2 will require full excavation and this will have the greatest effect in terms of plant required and spatially as noise impacts will be along the full length of the route rather than at discrete locations (i.e. the jointing pits).

5.1.4.1 Approach to assessment

224. Ecological receptors within the Study Area will be included in the assessment of construction noise where appropriate and through consultation with Onshore Ecology stakeholders and the appointed Ecologist.

225. Noise modelling will be undertaken using SoundPLAN software. A report will be provided containing the results of the quantitative construction noise modelling at areas of ecological interest, along with noise contour isopleths of the study area for interpretation by a qualified Ecologist.

5.2 Potential Impacts during Operation & Maintenance

226. The potential permanent impacts of operational noise from the cable relay station, and onshore substation may arise from:

- The inherent operational noise from the proposed development and its characteristics;
- The proximity of the proposed development to noise sensitive premises (including residential properties) and noise sensitive areas (including PRoW and the Norfolk Broads National Park);
- The proximity of the proposed development to quiet places and other areas that are particularly valued for their acoustic environment or landscape quality; and
- The proximity of the proposed development to designated sites where noise may have an adverse impact on protected species or other wildlife.

227. There are unlikely to be any significant noise and vibration impacts relating to operational and maintenance vehicular traffic. Operational noise impacts may arise from the routine operation of equipment within the substation and cable relay station (e.g. reactors and transformers). In addition, during maintenance, the noise impacts are expected to be of the same magnitude as those determined during routine site operations. An assessment would be undertaken to determine the likely environmental and health impacts due to operational noise emissions on identified sensitive receptors.

228. For both scenarios the assessment will consider the impacts of the proposed onshore elements of the project on noise and vibration, including impacts on

ecological and other sensitive receptors from operational activities. These will be assessed against the existing baseline using data obtained during the 2017 survey period.

229. The potential permanent impacts of operational noise from the onshore project substation and cable relay station for both scenarios may arise from:

- The inherent operational noise from the proposed development, and its characteristics;
- The proximity of the proposed development to noise sensitive premises (including residential properties) and noise sensitive areas (including PRoW and the Norfolk Broads National Park);
- The proximity of the proposed development to quiet places and other areas that are particularly valued for their acoustic environment or landscape quality; and
- The proximity of the proposed development to designated sites where noise may have an adverse impact on protected species or other wildlife.

230. There are unlikely to be any noise and vibration impacts relating to operational or maintenance vehicular traffic but operational noise impacts may arise from the operation of equipment within the substation and cable relay station (e.g. reactors and transformers). An assessment will be undertaken to determine the likely environmental and health impacts due to operational noise emissions on identified sensitive receptors.

231. There are considered to be no significant sources of vibration associated with the operational scheme and operational vibration impacts have therefore been scoped out of further assessment.

5.2.1 Impact: Fixed and Mobile Plant – Cable Relay Station and Onshore Project Substation

232. Under Scenario 1 the cable relay station and project substation will operate with Norfolk Vanguard already operational (i.e. Norfolk Vanguard would be considered as part of the project impact not the cumulative impact).

233. Under Scenario 2 Norfolk Vanguard will not be built, therefore the Norfolk Boreas the cable relay station and project substation will be assessed alone.

234. Where there are noise sources such as fixed plant associated with industrial operations, the most appropriate assessment guidance is BS 4142:2014. The guidance describes a method of determining the level of noise of an industrial noise source and the existing background noise level.

235. Peak noise levels at the cable relay station will be produced by the oil immersed shunt reactors with an unmitigated noise level of approximately 112 dB(A) Sound Power Level (SWL) across a frequency spectrum up to 8 kHz.

236. Peak operational noise levels at the project substation would be produced by autotransformers with an unmitigated noise level of approximately 97dB(A) SWL , static synchronous compensators (STATCOM/ phase reactors) with an unmitigated noise level of approximately 80dB(A) SWL, harmonic filter reactors with an unmitigated noise level of approximately 86dB(A) SWL, and oil immersed shunt reactors with an unmitigated noise level of approximately 112dB(A), all across a frequency spectrum of up to 8kHz.

5.2.1.1 Approach to assessment

237. BS 4142:2014 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident, and combines procedures for assessing the impact in relation to:

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

238. This standard is applicable to the determination of the following levels at outdoor locations:

“a) rating levels for sources of sound of an industrial and/or commercial nature; and

b) ambient, background and residual sound levels, for the purposes of:

1) investigating complaints;

2) assessing sound from proposed, new, modified or additional source(s) of sound of an industrial and/or commercial nature; and

3) assessing sound at proposed new dwellings or premises used for residential purposes."

239. The standard incorporates a requirement for the assessment of uncertainty in environmental noise measurements and introduces the concepts of "significant adverse impact" rather than likelihood of complaints.

240. 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.

241. Assessment is undertaken by subtracting the measured background noise level from the rating level; the greater this difference, the greater the magnitude of the impact.

242. BS 4142 refers to the following:

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

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

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".

243. When assessing the noise from a source, which is classified as the Rated Noise Level, it is necessary to have regard to the acoustic features that may be present in the noise. 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."

244. The methods for assessing whether an acoustic feature is present are:

- Subjective method;
- Objective method for tonality; and
- Reference method.

245. For the subjective method a rating penalty for tones of 2 – 6dB can be added; 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.

246. For impulsive noise a correction of up to 9dB can be applied; 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.

247. For other sound features, where the specific sound features characteristics that are neither tonal nor impulsive, though otherwise are readily distinctive against the residual acoustic environment, a penalty of +3dB can be applied.

248. Where tonal and impulsive characteristics are present in the specific sound within the same reference period then both corrections can be taken into account. If one feature is dominant, then it would be appropriate to apply a single correction. Where both features are likely to affect perception and response, the corrections can be added in a linear manner.

249. When the specific sound has identifiable on/off conditions and the intermittency is readily distinctive against the residual acoustic environment, a penalty of +3dB can be applied.

250. The perception of audibility at the monitoring location determines the value of the penalty to be applied. For the objective and reference methods sections 9.3.2 and 9.3.3 and Annexes C and D of BS4142:2014 should be referred to.

251. The determination of the specific sound level free from sounds influencing the ambient sound at the assessment location is obtained by measurement or a combination of measurement and calculation. This is to be measured in terms of the $L_{Aeq,T}$, where 'T' is a reference period of:

- 1 hour during daytime hours (07:00 hrs to 23:00 hrs); and
- 15 minutes during night-time hours (23:00 to 07:00 hrs).

252. The assessment of noise from proposed fixed and mobile plant associated with the operational elements of the project (cable relay station, onshore project substation and Necton National Grid substation extension) will be considered at the nearest receptors and any penalty corrections will be based on the justification detailed in the operational assessment section.

253. To predict the noise from the operational aspects of the project, SoundPLAN noise modelling software will be utilised. The model will incorporate proposed buildings based on elevation drawings, proposed fixed and mobile plant and additional associated noise sources located at the site. The model will also include nearby residential dwellings and other buildings in the proposed scheme area, intervening ground cover and topographical information.

254. Noise levels for the operational phase will be predicted at the nearest NSR locations identified in the baseline survey and through the consultation process. The calculation algorithm described in International Standard (ISO) 9613 was used in the operational noise propagation modelling exercise.

255. An indicative list of plant and equipment noise levels will be provided by Vattenfall and compiled based on details of the operational activities at the Proposed Development. Where details are not known or available, target noise levels will be recommended based on the measured background/ambient noise level and in accordance with relevant policy.

256. The following assumptions for operational activities will be included in the noise model:

- Operational activities would take place 24 hours a day, 7 days a week;
- All noise sources to be modelled as moving line, area and point sources, as appropriate;
- Residential properties to be modelled as two-storey buildings at a height of 8.5m;
- All ground assumed to have an absorption factor of 0 (acoustically hard and reflective), i.e. concrete/tarmac;
- Roads assumed to be acoustically hard and reflective, i.e. concrete/tarmac and a +5dB adjustment included in the SoundPLAN noise model using the 'create ground effects from roads surfaces' function; and
- Acoustic propagation effects calculated using the ISO9613-2 method.

257. For both scenarios the magnitude of effect will be based on a quantitative assessment of noise impact using BS 4142:2014 for an industrial development.

258. The BS4142:2014 derived magnitudes of effect are summarised in **Table 5.11**.

Table 5.11 – Operational Noise Impact Magnitude Criteria for Industrial/Commercial Sound Sources

BS4142 Assessment	
Rating level dB $L_{Ar,Tr}$	Magnitude of Effect
< Measured L_{A90}	No Impact
= Measured L_{A90}	Low Adverse
L_{A90} + up to 5 dB	Low to Minor Adverse
Measured L_{A90} + >5 dB to <10dB	Minor to Moderate Adverse
Measured L_{A90} + ≥10 dB	Significant (Major) Adverse

5.2.2 Impact: Operational External Noise Levels

259. An assessment of the predicted external daytime and night time noise levels calculated at the identified NSRs from proposed operational activities originating at the site will be undertaken.

260. The World Health Organisation provides the following guidelines on community noise levels with regard to their effects on annoyance with WHO recommended external daytime noise levels detailed in **Table 5.12**.

Table 5.12 – WHO Guidelines for Community Noise - External

Specific Environment	Typical Situation	$L_{Aeq,T}$ (dB)	Time Base (hrs)
External Amenity Areas	Majority of people avoid serious annoyance, daytime evening	55	16
	Majority of people avoid moderate annoyance, daytime evening	50	16

5.2.3 Impact: Operational vibration from the Onshore Project Substation

261. Transformers and other wound power equipment vibrate at twice the power frequency i.e. 100Hz and associated harmonic frequencies e.g. 200Hz, 300Hz. However the effects are negligible and are countered by the use of industry standard mitigation techniques such as the use of vibration isolation pads to prevent transmission of ground borne vibration. Embedded mitigation in the form of anti-vibration mounts will be used at the operational substations, which is likely to result in a negligible source of ground borne vibration. Therefore this can be scoped out of the EIA requirements for the operational phase of the project.

5.2.4 Impact: Operational Phase – Low Frequency Noise (LFN)

262. Operational transformer and shunt reactor noise is typically constant, with a 'low frequency hum' occurring at harmonics of the supply frequency; usually 100Hz and 200Hz components are dominant. Transformers generally run continuously except for occasional maintenance and fault outages.

263. Under Scenario 1 the cable relay station and project substation will operate with Norfolk Vanguard already operational (i.e. Norfolk Vanguard would be considered as part of the project impact not the cumulative impact).

264. Under Scenario 2 Norfolk Vanguard will not be built, therefore the Norfolk Boreas cable relay station and project substation will be assessed in isolation against the measured baseline survey data, acquired in 2017.

5.2.4.1 Approach to assessment

265. EN-1 states that any distinctive tonal and low frequency characteristics of the noise are identified. The Low Frequency Noise element will be considered as part of the operational assessment in accordance with BS4142:2014.

266. To predict the potential low frequency noise impact from the operational aspects of the project, SoundPLAN noise modelling software will be utilised. Data for proposed plant associated with the operational substation will be incorporated into the model for both scenarios. The model will predict external noise levels. These external noise levels can be used to determine the perceptibility of tones within the NSRs; however this will require an assumption of the likely sound reduction index provided by the building elements of the dwelling houses. BS4142:2014 provides guidance for the subjective assessment method of a tonal sound for a given external sound source. The approach considers the subjective prominence of the character of the specific sound at the noise sensitive location and whether this characteristic will attract attention.

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

5.3 Potential Impacts during Decommissioning

Both scenarios

268. No decision has been made regarding the final decommissioning plans for the substation, as it is recognised that industry best practice, rules and legislation change over time.

269. A full EIA will be carried out ahead of any decommissioning works being undertaken. The programme for decommissioning is expected to be similar in duration to the construction phase of 18 months.

5.4 Potential Cumulative Impacts

Scenario 1

270. Cumulative impacts as a result of the proposed Norfolk Vanguard project will be considered as part of the Norfolk Boreas assessment as discussed above.

271. Any other project within the study area with the potential to result in impacts that may act cumulatively with Norfolk Boreas and Norfolk Vanguard will be identified during consultation following a review of available information. These projects will then be included in the CIA and therefore are scoped into the assessment.

Scenario 2

272. The assessment would consider the potential for significant cumulative impacts to arise as a result of the construction, operation and decommissioning of Norfolk Boreas in the context of other developments that are existing, consented or at application stage.

273. Any other project within the study area with the potential to result in impacts that may act cumulatively with Norfolk Boreas will be identified during consultation following a review of available information. These projects will then be included in the CIA and therefore are scoped into the assessment.

Both Scenarios

274. All of the impacts listed above for construction and operation will be considered for potential cumulative effects. **Table 2.2** in section 2.3.5 lists the suggested projects included and rationale for inclusion of either construction, operation or both.

6 REFERENCES

BSI (2003); British Standards Institution BS 7445-1:2003 - Description and measurement of environmental noise. Guide to quantities and procedures. BSI, London.

BSI (2003); British Standards Institution BS EN 61672-1:2003 Electroacoustics. Sound level meters. Specifications. BSI, London.

BSI, (2008); British Standards Institution BS6472-1:2008 Guide to evaluation of human exposure to vibration in buildings. Part 1: Vibration sources other than blasting, BSI, London.

BSI, (2014), British Standards Institution BS4142:2014 Methods for rating and assessing industrial and commercial sound, BSI, London.

BSI, (2014); British Standards Institution [BS] 5228-1:2009+A1:2014 "Code of practice for noise and vibration control on construction and open sites – Part 1: Noise".

BSI, (2014); British Standards Institution [BS] 5228-2: 2009+A1:2014 "Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration".

BSI, (2014); British Standards Institution BS8233: Sound Insulation and Noise Reduction for Buildings. BSI, London.

Department for Communities and Local Government (DCLG), 2014. National Planning Policy Guidance.

Department for Communities and Local Government (DCLG), 2012. National Planning Policy Framework.

Department for Environment, Food and Rural Affairs (DEFRA), 2010. Noise Policy Statement for England.

Department of Energy & Climate Change (2011); National Policy Statement for Renewable Energy Infrastructure (EN-3), The Stationery Office, London.

Department of Energy & Climate Change (2011); National Policy Statement for Electricity Networks Infrastructure (EN-5), The Stationery Office, London.

Department of Energy & Climate Change (2011); Overarching National Policy Statement for Energy (EN-1), The Stationery Office, London.

Department of Transport, Welsh Office (1988); Calculation of Road Traffic Noise HMSO, London.

Environmental Protection Act 1990. HMSO, London.

Highways Agency (2011); Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7: Noise and Vibration. The Highways Agency.

Hiller. DM and Crabb GI, (2000). Ground borne vibrations caused by mechanised construction works. Highways Agency, Transport Research Laboratory, TRL report 429.

International Organization for Standardization, (1996). ISO9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation. ISO, Switzerland.

Royal HaskoningDHV (2017a) Norfolk Boreas Offshore Wind Farm: Evidence Plan Terms of Reference. Document Reference PB5640.004.016. Unpublished – Live Document

Royal HaskoningDHV (2017b) Norfolk Vanguard Offshore Wind Farm Preliminary Environmental Information Report available at: https://corporate.vattenfall.co.uk/projects/wind-energy-projects/vattenfall-in-norfolk/norfolkvanguard/documents/preliminary-environmental-information-report/

Transport Research Laboratory (2000); Hiller D.M and Crabb G.I Groundborne vibration caused by mechanised construction works. TRL Report 429. Wokingham:TRL,2000.

Watts, GR (1990). Traffic induced vibrations in building. Department for Transport, Transport and Road Research Laboratory Research Report (TRRL), Research Report 246.

World Health Organisation (WHO) (1999); Berglund et al. - Guidelines for Community Noise. Geneva.

World Health Organization (2009). Night Noise Guidelines for Europe; available at URL:

http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

APPENDIX 3 – LEGISLATIVE CONTEXT AND RELEVANT GUIDANCE

Legislative Context

275. The following Planning Policy, Legislation and Guidance will be used to inform the assessment.

276. A series of National Policy Statements (NPS) set out national policy for energy infrastructure. Overarching National Policy Statement for Energy (EN-1), in combination with the relevant technology-specific NPSs, has effect on the decisions by the Infrastructure Planning Commission (IPC) on applications for energy developments that fall within the scope of the NPSs.

277. National Policy Statements EN-1, EN-3 and EN-5 provide the primary basis on which the IPC is required to make its decisions. Specific assessment requirements for noise and vibration, as detailed within each relevant NPS are detailed below.

278. EN-1 sets out national policy for energy infrastructure.

In relation to the noise and vibration, Sections 5.11.4 to 5.11.7 of the NPS state that,

"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 area; and
- Measures to be employed in mitigating noise".

279. The NPS also states that:

"The nature and extent of the noise assessment should be proportionate to the likely noise impact" and "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.

"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.

280. Further assessment guidance for specific features of those renewables technology and electricity networks is found in NPS EN-3 and NPS EN-5. 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.

Environmental Protection Act 1990

281. Section 79 of the Act defines statutory nuisance with regard to noise and determines that local planning authorities have a duty to detect such nuisances in their area.

282. The Act also defines the concept of "Best Practicable Means" (BPM):

" 'practicable' means reasonably practicable having regard among other things to local conditions and circumstances, to the current state of technical knowledge and to the financial implications;

the means to be employed include the design, installation, maintenance and manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and structures;

the test is to apply only so far as compatible with any duty imposed by law; and

the test is to apply only so far as compatible with safety and safe working conditions, and with the exigencies of any emergency or unforeseeable circumstances."

Section 80 of the Act provides local planning authorities with powers to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence.

The Control of Pollution Act 1974

283. Section 60 of the Act provides powers to Local Authority Officers to serve an abatement notice in respect of noise nuisance from construction works.

284. Section 61 provides a method by which a contractor can apply for 'prior consent' for construction activities before commencement of works. The 'prior consent' is agreed between the Local Authority and the contractor and may contain a range of agreed working conditions, noise limits and control measures designed to minimise or prevent the occurrence of noise nuisance from construction activities. Application

for a 'prior consent' is a commonly used control measure in respect of potential noise impacts from major construction works.

National Planning Policy

National Planning Policy Framework 2012

285. The National Planning Policy Framework (NPPF) was introduced in March 2012 replacing the former Planning Policy Guidance 24: Planning and Noise. Paragraph 123 of the National Planning Policy Framework states that planning policies and decisions should aim to:

"avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;

mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;

recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and

identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason."

The NPPF also refers to the Noise Policy Statement for England (NPSE) (Defra, 2010).

Noise Policy Statement for England (NPSE) 2010

286. The 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."

The first two points require that significant adverse impact should not occur and that, where a noise level falls between a level which represents the lowest observable adverse effect and a level which represents a significant observed adverse effect:

"…all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life whilst also taking into consideration the guiding principles of sustainable development. This does not mean that such effects cannot occur." (Paragraph 2.24, NPSE, March 2010).

Section 2.20 of the NPSE introduces key phrases including "Significant adverse" and "adverse" and two established concepts from toxicology that are being applied to noise impacts:

"NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected".

Paragraph 2.21 of the NPSE extends the concepts described above and leads to a significant observed adverse effect level – SOAEL, which is defined as the level above which significant effects on health and quality of life occur.

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).

Furthermore, paragraph 2.22 of the NPSE acknowledges that:

"further research is required to increase understanding of what may constitute a significant adverse effect on health and quality of life from noise".

However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

National Planning Practice Guidance for Noise (NPPG) 2014

287. The National Planning Practice Guidance for Noise (NPPG Noise, December 2014), issued under the NPPF, 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 taking decisions about new development, there may also be opportunities to consider improvements to the acoustic environment.

Guidance

288. The following guidance will be referenced and used for the purpose of informing the noise and vibration assessment:

British Standard (BS) 7445: Parts 1 and 2 - Description and Measurement of Environmental Noise

289. This Standard 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 (LAeq). Part 2 of BS 7445 replicates ISO standard 1996-2.

BS8233:2014 – Guidance on Sound Insulation and Noise Reduction for Buildings

290. Provides a methodology to calculate the noise levels entering a building through facades and façade 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, which are based on WHO recommendations.

British Standard (BS) 4142:2014 – Method for Rating and Assessing Industrial and Commercial Sound

291. BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

British Standard (BS) 5228-1:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1: Noise

292. This document 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. The legislative background to noise and vibration control is described and recommendations are given regarding procedures for the establishment of effective liaison between developers, site operators and local authorities. This British Standard provides guidance on methods of predicting and measuring noise and assessing its impact on those exposed to it.

British Standard (BS) 5228-2:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 2: Vibration

293. Part 2 of this Standard gives recommendations for basic methods of vibration control relating to construction and open sites where work activities/operations generate significant vibration levels. The Standard includes tables of vibration levels measured during piling operations throughout the UK. It provides guidance concerning methods of mitigating vibration from construction, particularly with regard to percussive piling.

BS 6472-1:2008 - Guide to Evaluation of Human Exposure to Vibration in Buildings

294. This standard provides general guidance on human exposure to building vibration in the range of 1Hz to 80Hz and includes curves of equal annoyance for humans. It also outlines the measurement methodology to be employed. It introduces the concept of Vibration Dose Value (VDV) and estimated Vibration Dose Value (eVDV) for the basis of assessment of the severity of impulsive and intermittent vibration levels, such as those caused by a series of trains passing a given location.

Calculation of Road Traffic Noise (CRTN) 1988

295. The Calculation of Road Traffic Noise (CRTN) document provides a method for assessing noise from road traffic in the UK and a method of calculating noise levels from the Annual Average Weekday Traffic (AAWT) flows and from measured noise levels. Since published in 1988 this document has been the nationally accepted standard in predicting noise levels from road traffic. The calculation methods provided include correction factors to take account of variables affecting the creation and propagation of road traffic noise, accounting for the percentage of heavy goods vehicles, different road surfacing, inclination, screening by barriers and relative height of source and receiver.

Design Manual for Roads and Bridges (DMRB) 2011

296. Volume 11, Part 3, Section 7 provides guidance on the environmental assessment of noise impacts from road schemes. DMRB contains advice and information relating to transport-related noise and vibration, which has relevance with regard to the construction and operational traffic impacts affecting sensitive receptors adjacent to road networks. It also provides guideline significance criteria for assessing traffic related noise impacts.

World Health Organisation (WHO) (1999) Guidelines for Community Noise

297. 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 LAeq during the day, related to annoyance, and 45dB LAeq or 60dB LAmax at night, related to sleep disturbance.

298. 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 LAeq for continuous noise and 45dB LAmax for single sound events. Lower noise levels may be disturbing depending upon the nature of the noise source."

299. The WHO guidance also highlights that:

"Night-time, outside sound levels about 1 metre from facades of living spaces should not exceed 45dB LAeq, so that people may sleep with bedroom windows open. This value was obtained by assuming that the noise reduction from outside to inside with the window open is 15dB. To enable casual conversation indoors during daytime, the sound level of interfering noise should not exceed 35dB LAeq. To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB LAeq on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB LAeq. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development."

World Health Organisation (2009) Night Noise Guidelines for Europe

300. In 2009, the WHO published the Night Noise Guidelines for Europe, which it describes as an extension to the WHO Guidelines for Community Noise (1999).

301. It concludes that:

"Considering the scientific evidence on the thresholds of night noise exposure indicated by Lnight outside as defined in the Environmental Noise Directive (2002148/EC), an Lnight 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. Lnight 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."

International Standard ISO 9613-2

302. ISO 9613 specifies an engineering method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a noise source.