NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Chapter 5 Project Description

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Glossary of Acronyms

AIL	Abnormal Indivisible Load
AIS	Air Insulated Switchgear
bgl	Below Ground Level
CAA	Civil Aviation Authority
CBS	Cement Bound Sand
Cd	Candela
CEA	Cumulative Effects Assessment
CL:AIRE	Contaminated Land: Applications in Real Environments
CoSHH	Control of Substances Hazardous to Health
CTMP	Construction Traffic Management Plan
CTV	Crew Transfer Vessel
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
DNO	Distribution Network Operation
DP	Dynamic Positioning
DTS	Distributed Temperature Sensing
EACN	East Anglia Connection Node
EIA	Environmental Impact Assessment
ES	Environmental Statement
GBS	Gravity Base System
GGOW	Greater Gabbard Offshore Wind Farm
GIS	Gas Insulated Switchgear
GWF	Galloper Wind Farm
HDD	Horizontal Directional Drill
HDPE	High-density polyethylene
HGV	Heavy Goods Vehicle
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
JUV	Jack-up Installation Vessel
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MV	Medium Voltage
NFOW	North Falls Offshore Wind Farm Limited
NGET	National Grid Electricity Transmission

NPPF	National Planning Policy Framework
NPS	National Policy Statement
NVIS	Night Vision Imaging Systems
OCoCP	Outline Code of Construction Practice
OCP	Offshore Converter Platform
OCSS	Offshore Coordination Support Scheme
OCTMP	Outline Construction Traffic Management Plan
Ofgem	Office of Gas and Electricity Markets
O&M	Operation and Maintenance
OSP	Offshore Substation Platforms
OTNR	Offshore Transmission Network Review
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PRoW	Public Rights of Way
RIAA	Report to Inform Appropriate Assessment
ROV	Remotely Operated Vehicle
RPM	Rotations Per Minute
RWE	RWE Renewables UK Swindon Limited
SAC	Special Area of Conservation
SCADA	Supervisory Control and Data Acquisition
SPA	Special Protection Area
SSER	SSE Renewables Offshore Windfarm Holdings Limited
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
TCC	Temporary Construction Compound
THLS	Trinity House Lighthouse Service
TP	Transition Piece
UKPN	UK Power Networks
UXO	Unexploded Ordnance
VEOWL	Five Estuaries Offshore Wind Farm Limited
WTG	Wind Turbine Generators

Glossary of Terminology

400kV onshore cable route	Onshore route within which the onshore substation to National Grid connection point onshore export cables and associated infrastructure would be located.
400kV onshore cables	The cable circuits which take the electricity from the onshore substation on to the National Grid connection point. These also comprise High Voltage Alternative Current (HVAC) cables, buried underground.
Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cables, offshore substation platform(s) and/or offshore converter platform will be located.
Array cables	Cables which link the wind turbine generators with each other, the offshore substation platform(s) and/or the offshore converter platform.
Bentley Road improvement works	Works involving the widening and improvement of the carriageway along Bentley Road, required to facilitate heavy goods vehicle and abnormal indivisible load access to the onshore cable route and the onshore substation.
Cable circuit (onshore)	The onshore export cables are comprised of cable 'circuits'. Each cable circuit is typically comprised of three power cables, as well as fibre cables and earth cables. It is expected that each circuit would compromise up to seven cables in total.
Cable ducts	Housing for the onshore export cables, typically comprising plastic high-density polyethylene (HDPE) pipes buried underground. Each cable circuit will potentially comprise up to seven individual ducts (i.e. one per cable).
Crosswind	Perpendicular to the prevailing wind.
Downwind	In the orientation of the prevailing wind.
Haul road	The track along the onshore cable route used by construction traffic to access different sections of the onshore cable route.
Horizontal directional drill (HDD)	Trenchless technique to bring the offshore export cables ashore at landfall. The technique will also be the primary trenchless technique used for installation of the onshore export cables at sensitive areas of the onshore cable route.
Jointing bay	Underground structures, constructed at regular intervals along the onshore cable route to connect the sections of cable together so that each cable is a continuous length, as well as facilitating the installation of the cables into the buried cable ducts.
Landfall	The location where the offshore export cables come ashore at Kirby Brook.
Landfall compound	Compound at landfall within which HDD or other trenchless technique would take place.
Link boxes	Underground chambers or above ground cabinets next to the onshore export cables housing low voltage electrical earthing links.
National Grid connection point	The grid connection location for the Project. National Grid are proposing to construct new electrical infrastructure (a new substation) to allow the Project to connect to the grid, and this new infrastructure will be located at the National Grid connection point.
National Grid substation connection works	Infrastructure required to connect the Project to the National Grid connection point.
Offshore cable corridor	The corridor of seabed from array area to the landfall within which the offshore export cables will be located.
Offshore converter platform	Should an offshore connection to a third party High Voltage Direct Current (HVDC) cable be selected, an offshore converter platform would be required. This is a fixed structure located within the array area, containing

	HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via a third party HVDC interconnector cable.
Offshore export cables	The cables which bring electricity from the offshore substation platform(s) to the landfall, as well as auxiliary cables.
Offshore project area	The overall area of the array area and the offshore cable corridor.
Offshore substation platform(s)	Fixed structure(s) located within the array area, containing HVAC electrical equipment to aggregate the power from the wind turbine generators and increase the voltage to a more suitable level for export to shore via offshore export cables.
Onshore cable route	Onshore route within which the onshore export cables and associated infrastructure would be located.
Onshore export cables	The cables which take the electricity from landfall to the onshore substation. These comprise HVAC cables, buried underground.
Onshore project area	The boundary within which all onshore infrastructure required for the Project will be located (i.e. landfall; onshore cable route, accesses, construction compounds; onshore substation and cables to the National Grid substation).
Onshore scoping area	The boundary in which all onshore infrastructure required for the Project will be located, as considered within the North Falls Environment Impact Assessment (EIA) Scoping Report.
Onshore substation	A compound containing electrical equipment required to transform and stabilise electricity generated by the Project so that it can be connected to the National Grid.
Onshore substation construction compound	Area set aside to facilitate construction of the onshore substation. Will be located adjacent to the onshore substation.
Onshore substation works area	Area within which all temporary and permanent works associated within the onshore substation are located, including onshore substation, construction compound, access, landscaping, drainage and earthworks.
Onshore substation zone	The area considered at Preliminary Environmental Information Report (PEIR), within which the onshore substation will be located.
Platform interconnector cable	Cable connecting the offshore substation platforms (OSP); or the OSP and offshore converter platform (OCP).
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the wind turbine generator foundations and offshore substation platform(s) foundations as a result of the flow of water.
Temporary construction compound	Area set aside to facilitate construction of the onshore cable route. Will be located adjacent to the onshore cable route, with access to the highway where required.
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.
Transition joint bay	Underground structures that house the joints between the offshore export cables and the onshore export cables.
Trenchless crossing	Use of a technique to install limited lengths of cable below ground without the need to excavate a trench from the surface, used in sensitive areas of the onshore cable route to prevent surface disturbance. Includes techniques such as HDD.

Trenchless crossing compound	Areas within the onshore cable route which will house trenchless crossing (e.g. HDD) entry or exit points.
Wind turbine generator (WTG)	Power generating device that is driven by the kinetic energy of the wind.

5 Project Description

5.1 Introduction

1. This chapter of the Environmental Statement (ES) provides a full description of the physical components of the North Falls Offshore Wind Farm (OWF) project (herein 'North Falls' or 'the Project').

2. As discussed in Chapter 1 Introduction (Document Reference: 3.1.3), North Falls is an extension to the existing Greater Gabbard Offshore Wind Farm (GGOW), in the southern North Sea. The Project would make an important contribution to UK climate change policies and Net Zero targets through the generation of clean, low carbon, renewable electricity (see Chapter 2 Need for the Project, Document Reference: 3.1.5).

3. This chapter describes the necessary construction, operation and maintenance, and the decommissioning of both onshore and offshore components of the Project. The Project has an indicative design life of approximately 30 years.

4. At this stage of the Project's development, some optionality is required in order to future proof the Development Consent Order (DCO). This is a standard approach and is discussed further in Section 5.3.

5. Refinements to the Project design have been incorporated following consultation on the Preliminary Environmental Information Report (PEIR), these are reported on and assessed in this ES which has been prepared to support the DCO application.

5.2 Consultation

6. Consultation regarding North Falls has been undertaken through a number of forums, as discussed in Chapter 7 Technical Consultation (Document Reference: 3.1.9). Table 5.1 outlines North Falls Offshore Wind Farm Limited (NFOW)'s response to key points raised in relation to the Project description. Where appropriate, this chapter has been updated following the consultation on the PEIR.

7. In addition, stakeholder feedback on specific topic constraints is discussed in the relevant technical chapters (Chapters 8 to 33, Document Reference: 3.1.10 to 3.1.35) and this has also been considered during the development of the Project design envelope.

8. Refinement of the offshore and onshore project areas, as a result of stakeholder feedback is described in Chapter 4 Site selection and assessment of alternatives (Document Reference: 3.1.6).

Table 5.1 Consultation responses specific to the Project description

Consultee	Date / Document	Comment	Response / where addressed in the ES
Essex County Council	August 2021 Scoping Opinion	It is noted that for on shore infrastructure, the development is not fixed at this time and relies on the as quoted "Rochdale Envelope" as set out in Advice Note 9. However, and for the purpose of this Scoping Submission, the area to be covered by this envelope is set at over 150 square kilometres (ref Scoping Report para 43, and figure 1.4, Volume II). It is firstly questioned as to whether this can correctly be considered as falling within this so-called envelope due to its significant size, and secondly makes the effects of the development hugely difficult to predict in anything other than general terms. ECC is told this will focus down to a proposed landfall and connection point early in 2021 however, and dependant on the same, it may be necessary to re- Scope the development and consider its true impacts relevant to specific proposals again. Alternatively it is considered reasonable to say that as the impact of the development are not known it is impossible to scope out any topic at this particular time. This is the view of the Joint Councils at this time.	The onshore scoping area approach has been used successfully on consented offshore wind farms, such as Norfolk Vanguard, East Anglia TWO and East Anglia ONE North, where there is uncertainty from National Grid on the precise connection point at the time of scoping. Consulting on options through the scoping process, enables consultee responses to be considered during the site selection process. The scoping process aims to identify likely significant effects that require further assessment through the EIA and where doubt remains, the effect is scoped in. The PEIR represented the next step in refining the Project envelope and enabling consultation on the likely significant effects of the Project prior to production of the final ES. Refinement of the onshore project area between scoping and PEIR is discussed in Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6). Following PEIR, the onshore and offshore project areas have been refined. This is discussed in ES Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6).
Natural England	August 2021 Scoping Opinion	**Section 1.5 Point 26** The scoping report notes that the export cable corridor passes through a number of designated sites. However, it is also important to note that both the northern and southern arrays are situated in the Southern North Sea Special Area of Conservation (SAC) and the southern array is partially located within the Kentish Knock East Marine Conservation Zone (MCZ). The location of the site within these sites should be noted in the ES. It would also be useful to provide a separate overview or section of the statutory protected sites within the study area and/or Zone of Influence that are designated under European Directives and/or implemented through national legislation by a statutory body, thereby having recognised legal protection.	Section 5.5.1 describes the location of the offshore project area, including in relation to designated sites. Each technical chapter describes the relevant study area or zone of influence in relation to the specific receptors. A Report to Inform Appropriate Assessment (RIAA) and MCZ Assessment report are provided alongside the ES. Following PEIR, the offshore project area has been refined and no longer overlaps with the Kentish Knock East MCZ.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Natural England	August 2021 Scoping Opinion	**Section 1.5.3** Natural England note the large onshore scoping area and reserve the right to make future detailed comments once the onshore transmission substation location has been confirmed but will endeavour to provide the best advice available with the information currently provided. For information only.	Noted
Natural England	August 2021 Scoping Opinion	**Section 1.5.3 Points 40 - 42** At present, there is no confirmed Grid Connection point from National Grid, and no definitive location of any onshore substation. This presents the risk that the onshore search area may change when the connection point is secured and thus, any studies, surveys and baseline understanding of the onshore aspects of the Project may need to be revised. Should the grid connection point be out with the areas considered within the scoping report it may be necessary to rescope the Project. The decision to scope is one the applicant has undertaken at their own risk, and Natural England reserves the right to amend or update our opinion based on the final grid location, once it is known.	The refined onshore project area assessed in this ES remains within the onshore scoping area, including the anticipated location of the Project's connection to the National Grid at National Grid Electricity Transmission (NGET)'s new proposed East Anglia Connection Node (EACN) substation west of Little Bromley.
Natural England	August 2021 Scoping Opinion	**Section 1.5.3 Point 42** The list of open matters includes repowering. Repowering is likely to occur near the end of the Project life. As this is likely to be in excess of thirty years from the current scoping we would advise that any repowering should be subject to updated scoping and a full new application.	No repowering works are included within the DCO application. Should repowering be proposed, further consents would be sought and would be supported by the required environmental information.
Natural England	August 2021 Scoping Opinion	Natural England notes that there remain issues with securing an onshore grid connection and that within the current area of search for landfall, onshore cable route and substation there are likely to be significant nature conservation and landscape challenges. Therefore, we strongly advise that the Project seriously considers utilising National Grid Ventures Nautilus Interconnector as means to address these issues.	NFOW has engaged with other developers, including National Grid Ventures to explore connection options. As discussed in Section 5.3.1, NFOW has applied to the Offshore Coordination Support Scheme (OCSS) in consortium with NGET and Five Estuaries Offshore Wind Farm Limited (VEOWL) for an offshore connection to Sea Link, a marine cable between Suffolk and Kent proposed by NGET as part of their Great Grid Upgrade.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Public Health England	13/08/2021 Scoping Opinion	**Policy Measures for the Electricity Industry** A voluntary code of practice is published which sets out key principles for complying with the [International Commission on Non-Ionizing Radiation Protection] ICNIRP guidelines. Companion codes of practice dealing with optimum phasing of high voltage power lines and aspects of the guidelines that relate to indirect effects are also available	The Project intends to comply with *Power Lines: Demonstrating compliance with EMF public exposure guidelines A voluntary Code of Practice* (DECC, 2012). Further details are provided in Chapter 28 Human Health (Document Reference: 3.1.30).
Planning Inspectorate	26/08/2021 Scoping Opinion	The ES should include the following: • a description of the Proposed Development comprising at least the information on the site, design, size and other relevant features of the development; and • a description of the location of the development and description of the physical characteristics of the whole development, including any requisite demolition works and the land-use requirements during construction and operation phases	Information on the site and a description of the location of the development is provided in Sections 5.5.1 (offshore), 5.6.1 (landfall) and 5.7.1 (onshore). A description of the physical characteristics of the whole development, including the design and size is provided throughout Sections 5.4 to 5.7. A description of anticipated decommissioning works is provided in Sections 5.5.16, 5.7.3.6 and 5.7.4.10. The final scope of the decommissioning works would be determined by the relevant legislation and guidance at the time of decommissioning.
Planning Inspectorate	26/08/2021 Scoping Opinion	The Scoping Report presents an indicative construction programme for the Proposed Development at Section 1.5.5. This indicates that there is potential for a phased approach to construction, with onshore activity commencing in 2026 prior to offshore activity in 2028. The ES should describe the construction programme, and any phasing in delivery, including the expected duration and overlap of different components to enable an assessment of the effects on the basis of a worst case scenario.	The construction programme is discussed in Sections 5.5.13 and 5.7.7.
Planning Inspectorate	26/08/2021 Scoping Opinion	The anticipated generating capacity of the Proposed Development is not stated in the Scoping Report, although paragraph 5 explains that the expected capacity is greater than 100 MW. The maximum technical capacity (i.e., electrical output) of the individual WGTs and of the Proposed Development as a whole should be confirmed within the ES.	Where relevant to the assessment (e.g. ES Chapter 31 Socio-economics Document Reference: 3.1.33) an indicative capacity has been considered. However, for the majority of the EIA, the physical parameters of the infrastructure and associated works, as described in this chapter, are relevant to the assessments. The capacity of the Project will be subject to the turbine technology available at the time of construction, within the design envelope parameters.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Planning Inspectorate	26/08/2021 Scoping Opinion	The Scoping Report provides limited information about the operational and maintenance activities for the operational phase of the Proposed Development. The ES should provide a full description of the nature and scope of these activities, including types of activity, frequency, and how works will be carried out for both offshore and onshore components. This should include consideration for the potential overlapping of activities with those required for the continuing operation of GGOW and GOWF.	The North Falls operation and maintenance activities are discussed in Sections 5.5.14, 5.7.3.5 and 5.7.4.9. The likely significant effects associated with these works are assessed in the relevant technical chapters (Chapters 8 to 33, Document Reference: 3.1.10 to 3.1.35). Where relevant, the cumulative effects of ongoing operation and maintenance of GGOW and Galloper Wind Farm (GWF) with North Falls are considered in the offshore technical chapters (Chapters 8 to 18, Document Reference: 3.1.10 to 3.1.35).
Planning Inspectorate	26/08/2021 Scoping Opinion	Paragraph 90 of the Scoping Report confirms that the ES will consider the potential for impacts during decommissioning of the Proposed Development, but limited information is provided about the physical characteristics associated with this activity. Most of the subsequent aspect sections of the Scoping Report also address decommissioning in respect of the Proposed Development, noting that activities would be similar to those during the construction phase without describing the activities in detail. The ES should include a description of the anticipated decommissioning activities and their likely duration. Where there is uncertainty of impacts during decommissioning, this should be clearly explained along with the implications for the assessment of significant effects (including assumptions and mitigation on which reliance is placed).	A description of decommissioning activities is provided in Sections 5.5.16, 5.7.3.6 and 5.7.4.10.
Planning Inspectorate	26/08/2021 Scoping Opinion	Section 1.5.4 of the Scoping Report states that port facilities will be required to support the construction and operation of the Proposed Development, and it is likely that the port will be located on the east coast of England. The ES should make effort to identify the location of the port(s), where possible, and assess any likely significant effects associated. In the event that the port(s) have not been confirmed, the ES should make effort to assess the likely significant effects associated with relevant assumptions and a worst case scenario. The worst case parameters applied in relation to port location(s) should be clearly defined and consistently applied across the relevant assessments in the ES.	The port location(s) will be identified post consent. This approach is standard for offshore wind farms, due to commercial and procurement constraints. Where port assumptions are required to inform the assessment, the worst case scenario is described in the relevant technical chapters.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Planning Inspectorate	26/08/2021 Scoping Opinion	The ES should include a description of the nature and quantity of materials and natural resources used in the Proposed Development, including water, land, soil and biodiversity.	Information regarding the quantity of materials and natural resources (e.g. scour protection and rock protection) is provided in this ES.
Planning Inspectorate	26/08/2021 Scoping Opinion	The layout of Wind Turbine Generators (WTGs), including the division of WTGs between the two proposed array areas, has not yet been ascertained and it is stated that this will be determined following site investigation post consent (paragraph 28 of the Scoping Report). Table 1.1 states that there will be a maximum of 71 WTGs. In addition, paragraph 27 of the Scoping Report identifies a possibility that more than one model of WTG may be used. The ES should include a full and detailed description of the potential WTG models and the parameters associated with their design (including distance between WTG), as well as establishing and assessing the layout(s) that result in the worst case adverse effects.	The design envelope of WTGs is provided in Section 5.5.3.1. Indicative layouts are included in the assessments where applicable, namely Chapter 15 Shipping and Navigation (Document Reference: 3.1.17); and Chapter 29 Seascape, landscape and visual impact assessment (SLVIA) (Document Reference: 3.1.31).
Planning Inspectorate	26/08/2021 Scoping Opinion	The Scoping Report explains that the array cables used to connect the WTGs to the offshore substation will be between 33kV and 132kV but not the process by which the final voltage would be chosen. The ES should describe these options, any differences in the physical infrastructure requirements and provide an assessment of environmental effects that may result from the selected options.	The final voltage will be selected based on technical feasibility, regulatory issues and environmental impact at the time of selection. The voltage options for the array cables have now been refined to 66-132kV.
Planning Inspectorate	26/08/2021 Scoping Opinion	Paragraph 29 of the Scoping Report states that the design of foundations for the WTGs and platforms will be informed by site investigation post consent, and that it is possible that more than one type of foundation will be used. The following foundation design options are being considered: monopiles, jackets on pins or suction caissons, and gravity base structures (GBS). Table 1.2 of the Scoping Report sets out indicative dimensions and construction materials for the range of options. The ES should include a full and detailed description of foundation options and any scour protection for which development consent is sought, including the location, maximum diameter and depth, and the maximum diameter of piles should they be used.	A description of the range of foundation options is provided in Section 5.5.3.3.
Planning Inspectorate	26/08/2021	The Inspectorate notes that the preferred options for landfall location of the export cables, location of the onshore substation and routeing	A description of the landfall and onshore components is provided in Sections 5.6 and 5.7.

Consultee	Date / Document	Comment	Response / where addressed in the ES
	Scoping Opinion	of the underground cables will be refined and selected during the assessment process (paragraphs 37 and 51 of the Scoping Report). The Inspectorate understands that the onshore location and routeing will in part be determined based on the selected location of the East Anglia Coastal transmission substation, which is the subject of a separate consenting process by National Grid. The ES should describe the preferred options for landfall and onshore components of the Proposed Development, including the location and maximum design parameters of each component (footprint, height, width, depth and volume as relevant). It should explain the relationship between the preferred options and the East Anglia Coastal transmission substation, the status of the separate project, any uncertainty remaining if it is not yet finalised and how that has been addressed in the assessment presented in the ES.	
Planning Inspectorate	26/08/2021 Scoping Opinion	As the landfall and onshore components are still subject to areas of search, the Inspectorate notes that it is not yet clear whether any temporary or permanent crossings of watercourses, major roadways and / or railways will be required as part of the Proposed Development, nor is any information presented as to the proposed methodology that would be used for such crossings. The ES should identify the locations and types of all such crossings. Where reliance is placed in the ES on the use of a specific method as mitigation, the Applicant should ensure that such commitments are appropriately defined and secured.	A Crossing Schedule is provided as an Appendix to this chapter (Appendix 5.1, Document Reference: 3.3.2). This schedule lists all the obstacle crossings currently understood to be required to facilitate construction of the Projects landfall and onshore infrastructure and sets out the range of techniques being proposed at each at this stage in the Project’s design.
Planning Inspectorate	26/08/2021 Scoping Opinion	The EIA Regulations require an estimate, by type and quantity, of expected residues and emissions. Specific reference should be made to water, air, soil and subsoil pollution, noise, vibration, light, heat, radiation and quantities and types of waste produced during the construction and operation phases, where relevant. This information should be provided in a clear and consistent fashion and may be integrated into the relevant aspect assessments.	Expected emissions predicted to arise during the construction and operational phases of the Project are detailed in this chapter (Sections 5.5 - 5.7) the relevant technical chapters (Volume 3.1), including: • Chapter 19 Ground Conditions and Contamination (Document Reference: 3.1.21) • Chapter 20 Air Quality (Document Reference: 3.1.22) • Chapter 21 Water Resources and Flood Risk (Document Reference: 3.1.23) • Chapter 26 Noise and Vibration (Document Reference: 3.1.28) • Chapter 33 Climate Change (Document Reference: 3.1.35).

Consultee	Date / Document	Comment	Response / where addressed in the ES
Planning Inspectorate	26/08/2021 Scoping Opinion	The Inspectorate notes that the Scoping Report does not make reference to the potential for any emissions in respect of radiation during the construction, operational or decommissioning phases of the Proposed Development. Given the nature of the Proposed Development as an offshore wind farm and associated infrastructure, the Inspectorate considers that significant effects from radiation would not be likely and the ES does not need to reference this matter.	Noted. The Applicant also notes that electromagnetic forces and their potential to be generated during the Project's operation are discussed in Chapter 28 Human Health (Document Reference: 3.1.30).
Natural England	14/07/2023 PEIR Section 42 Response	Section 5.6.3.2/Point 40 Methodology It is stated that the 'minimum separation between wind turbines would be approximately of 5 x the rotor diameter (i.e., 820m for the smallest turbines with 164m rotor diameter or 1,685m for the largest turbines with 337m diameter'. However, the minimum separation distance has been calculated using minimum rotor diameter for the smallest turbines, but maximum rotor diameter for the largest turbines. Please can this be clarified?	A single rotor diameter for each wind turbine generator size class is now defined and the spacing updated accordingly in Section 5.5.3.2.
Trinity House	13/07/2023 PEIR Response	We would welcome your earliest possible consultation regarding proposed turbine layouts, as well as the locations of any other infrastructure, as this matter may well require significant work to reach agreement.	Consultation with shipping stakeholders, including Trinity House has been undertaken throughout the pre-application stage. A hazard workshop was held in October 2023.
Anglian Water	13/07/2023 PEIR Response	Anglian Water notes that this section states that a surface water drainage system would be required for the operational substation. Anglian Water would welcome a design that follows the drainage hierarchy in seeking to manage surface water through sustainable drainage systems, and only seek a connection to a public sewer when all other options are demonstrated to be impracticable. The PEIR states that the full specification for water attenuation and drainage system, plus any foul drainage connection to a public sewer system (if available) would be addressed as part of detailed design post consent. If a connection to a public sewer is therefore a possibility, Anglian Water would wish to be included as a consultee in the Schedule of Requirements that specifically concern surface water and foul water drainage.	An Outline Operational Drainage Strategy has been developed for the Project, which includes Sustainable Drainage Systems (SuDS) to manage runoff from the Project (Document Reference 7.19). The Outline Operational Drainage Strategy (Document Reference: 7.19) identifies that there are no public sewers in the vicinity of the onshore substation (according to the Anglian Water sewer records), so it will not be possible to make a foul connection to a public sewer. A septic tank is therefore proposed for the onshore substation site. The size of the septic tank will be confirmed during the post-DCO design stage.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Anglian Water	13/07/2023 PEIR Response	We would also seek clarification whether a connection to our wastewater network will be required for any of the temporary construction compounds (TCC) and advise that early discussions should take place with our pre-development team regarding capacity of our network and assets to accept wastewater flows from the proposed TCC sites.	There is no intention to connect to the wastewater network at any of the temporary construction compounds (TCC) at this stage, with all wastewater generated from welfare facilities proposed to be removed from site and treated at a permitted waste treatment facility.
Ardleigh Parish Council	13/07/2023 PEIR Response	We urge you to work with Government and others to connect offshore thus avoiding all of the above negative impacts on the Tendring peninsular in general and Ardleigh in particular.	NFOW co-operated with the Department of Energy Security and Net Zero (DESNZ) to explore grid connection options, as part of the Offshore Transmission Network Review (OTNR). In addition, NFOW has applied to the OCSS in consortium with NGET and VEOWL for an offshore connection to Sea Link, a marine cable between Suffolk and Kent proposed by NGET as part of their Great Grid Upgrade. NFOW continues to engage with Government, Office of Gas and Electricity Markets (Ofgem) and other developers to explore the potential options.
Environment Agency	14/07/2023 PEIR Response	All three landfall site locations shown in drawing PB9244-RHD-ZZ-LN-DR-GS-0239 would require passing under an existing tidal defence. Jaywick and Holland On Sea defences are currently maintained by the Environment Agency and depending on the micro siting of the proposed Dovercourt location it may also be maintained by the Environment Agency. At the detailed design stage the Applicant must provide evidence/data to prove the design will not affect the stability of the existing defence.	Noted. Protective provisions for the benefit of the Environment Agency have been included within the draft DCO.
Five Estuaries Offshore Windfarm	14/07/2023 PEIR Response	Thank you for the opportunity to review the Preliminary Environmental Information Report and associated documents for the North Falls Offshore Wind Farm Project. The detail provided has been helpful for the Five Estuaries Offshore Wind Farm Project team to be able to assess the potential cumulative environmental effects and benefits of both projects. The Five Estuaries Project team look forward to continuing to cooperate with the North Falls team in order to consider ways to minimise impacts on the local community and on the onshore and offshore environment where possible. This will be a positive factor as the Five Estuaries team progresses its project, to support the	Noted. NFOW has worked with VEOWL throughout the pre-application stage to develop co-ordinated proposals as discussed in Section 5.3.1 and Section 5.7.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		government's target to achieve 50 gigawatts of offshore wind capacity in the UK by 2030 in line with the revised draft National Policy Statements, which are expected to be designated this year.	
East Suffolk Council (ESC)	06/07/2023 PEIR Response	Need case and coordination ESC acknowledges that renewable energy will play a central role in tackling climate change and in meeting Government targets in the lead up to net-zero by 2050. A significant amount of new offshore wind generation and associated infrastructure is required to connect 50GW by 2030. However, the shift towards the delivery of low carbon and renewable sources of energy must consider the potential impacts it may have on the landscape, natural environment and local communities set to host or neighbour such development. Developers must also explore opportunities for greater levels of coordination between projects in relation to the objectives set out in the OTNR. ESC supports North Falls' submission into the Government's Offshore Coordination Support Scheme (OCSS), noting that this seeks to provide grants to offshore energy projects to develop coordinated options for offshore transmission infrastructure. North Falls is also engaging with the OTNR as is the developer of the Five Estuaries project, and whilst it is welcomed that the North Falls project, alongside other developers, has committed to exploring options within the Early Opportunities workstream3, ESC remains disappointed that the project has not been put forward as a Pathfinder. Every opportunity should be undertaken by the two developers, given it is likely that they will have the same connection location, to seek maximum coordination between the projects in order to minimise impacts on local communities and the environment. The Sheringham Shoal and Dudgeon extension projects located in Norfolk are demonstrating that greater coordination is possible, and this should be replicated. ESC would welcome the opportunity to engage in future pathfinder discussions should these options be pursued within East Suffolk. ESC welcomes the intention for coordination between the North Falls and Five Estuaries offshore wind farm projects, noting that an opportunity to coordinate more closely has been identified by the developers. We understand that coordination will seek to reduce the	NFOW has worked with VEOWL throughout the pre-application stage to develop co-ordinated proposals as discussed in Section 5.3.1 and Section 5.7.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		potential impact of building the onshore connection to the national electricity transmission network for the two projects, however, note that the viability of any coordinated connection is dependent on the progress made by the OTNR process, associated regulatory and commercial policy changes and the individual offshore connector projects involved. Whilst the proposed onshore connections for both North Falls and Five Estuaries projects are not within the East Suffolk District, offshore options for connection should continue to be fully explored, minimising the need for onshore infrastructure. It is therefore encouraging to see the intention of this project's DCO to include a third option for connection as stated earlier (an offshore electrical connection supplied by a third-party electricity network provider), which will be for the Secretary of State to decide which is to be pursued as part of the DCO decision making process at the appropriate time. ESC supports the proposed coordination effort between the two projects regarding key elements such as cable corridor selection (to optimise both onshore routes), environmental surveys and by sharing consultation feedback. It is encouraging to read that coordination and cooperation will continue between the projects throughout their development and may enable elements of joint delivery should the technical and commercial conditions allow for this, reducing the potential impact of building the onshore connection to the national electricity transmission network for the two projects. ESC is being consulted on and is aware of a number of energy related projects that may have an impact on our District, and we welcome and support collaborative working between all Applicants and the National Grid to ensure that the optimal solution is delivered. We expect this to involve coordination and the sharing of infrastructure where feasible to reduce the amount required onshore.	
Essex Fire and Rescue Service	07/2023 PEIR Response	Having reviewed the consultation document, at this time Essex County Fire and Rescue Service would ask that the following are considered during the continued development of the North Falls Offshore Wind Farm:	All buildings constructed for the Project will comply with the relevant buildings fire safety regulations.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		Adherence to the requirements of the Fire Safety Order and relevant building regulations, especially approved document B.	Fire suppression systems will be provided where required for safety reasons. The type of suppression system will be based on the equipment present within the room. The design proposes limited changes to the road network. There will be temporary restrictions whilst construction is ongoing, but these will be discussed and communicated with the relevant stakeholders. Further details on construction access are provided in Chapter 27 Traffic and Transport (Document Reference: 3.1.29). Measures to mitigate effects upon water resources are detailed in Chapter 21 Water Resources and Flood Risk (Document Reference: 3.1.23). A Design Vision (Document Reference: 2.3) has been prepared which sets out the principles to be adhered during development of the Project's design, including in relation to operational safety. All construction works will be carried out by a competent contractor, in adherence with the construction management measures set out in the Outline Code of Construction Practice (OCoCP) (Document Reference: 7.13).
Essex Fire and Rescue Service	07/2023 PEIR Response	Installation of smoke alarms and/or sprinkler systems at suitably spaced locations throughout each building.	
Essex Fire and Rescue Service	07/2023 PEIR Response	Implementation of vision zero principles where there are introductions of or changes to the road network.	
Essex Fire and Rescue Service	07/2023 PEIR Response	Appropriate planning and mitigations to reduce risks around outdoor water sources.	
Essex Fire and Rescue Service	07/2023 PEIR Response	Suitable principles in design to avoid deliberate fire setting.	
Essex Fire and Rescue Service	07/2023 PEIR Response	A risk reduction strategy to cover the construction and completion phases of the project.	
Essex Fire and Rescue Service	07/2023 PEIR Response	Implementation of a land management strategy to minimise the potential spread of fire either from or towards the development site.	Noted.
Health & Safety Executive	23/05/2023 PEIR Response	Based on the Preliminary Environmental Information Report (PEIR), it is unlikely that hazardous substance consent (HSC) will be required. Hazardous substances planning consent is required to store or use any of the Categories of Substances or Named Hazardous Substances set out in Schedule 1 of The Planning (Hazardous Substances) Regulations 2015 as amended, if those hazardous substances will be present on, over or under the land at or above the controlled quantities. There is an addition rule in the Schedule for below-threshold substances. Further information on HSC should be sought from the relevant Hazardous Substances Authority, if required or if changes to the scheme are made	Hazardous substances above set threshold quantities are not expected to be part of the Project design, and therefore hazardous substances consent is not anticipated.

Consultee	Date / Document	Comment	Response / where addressed in the ES
Health & Safety Executive	23/05/2023 PEIR Response	Explosives sites HSE has no comment to make as there are no licensed explosives sites in the vicinity.	Noted
Health & Safety Executive	23/05/2023 PEIR Response	Electrical Safety No comment from a planning perspective	Noted
Suffolk & North East Essex ICB	14/07/2023 PEIR Response	With regard to impacts from major accidents and disasters, it is noted that there are no specific references to major accidents or disasters in relation to their likely impact on healthcare and services, in particular within Chapter 31 (Socio-Economics) of the PEIR. Given that people affected by a major accident or disaster associated with the project are likely to be transferred to either Colchester or Ipswich Hospital, the impacts of such an event(s) on these facilities should be fully addressed. Therefore, it is requested that the PEIR is updated accordingly, and that major accidents and disasters are included in the HIA.	
National Grid	13/07/2023 PEIR Response	Norwich to Tilbury The Norwich to Tilbury project is required to achieve the UK Government's ambition of achieving net zero emissions by 2050 by upgrading the existing transmission network to allow communities across the country to benefit from this clean energy, the proposed project by National Grid Electricity Transmission (National Grid) is to reinforce the high voltage power network in East Anglia between the existing substations at Norwich Main in Norfolk, Bramford in Suffolk and Tilbury in Essex, as well as connect new offshore wind generation. The project as a whole and as one DCO application would comprise the construction of c.158km new overhead line and c. 25km of underground cabling over a total route of 183km between the existing National Grid Norwich Main and Bramford substations in the North East Anglia (NEA) region, continuing from Bramford down to Tilbury substation in the South East Anglia (SEA) region, via a New East Anglia Connection Node Substation located in the Tendring District,	Noted. As the Project's National Grid connection point, North Falls has engaged with NGET to identify the infrastructure required to interface with the EACN substation in order to connect with the national grid. This infrastructure is outlined in Section 5.7.4.7.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		east of Ardleigh. The East Anglia Connection Node (EACN) Substation will be the point of operational interface where the connection between the North Falls Onshore Substation and the National Grid Electricity Transmission System will be established. As such National Grid recognise the importance of early and continued collaboration between National Grid and the North Falls project teams across the aspects of: • Engineering • Property & Lands • Consents and Environment • External Affairs The purpose of such is to ensure all interfaces between the projects are aligned and impacts minimised throughout the project lifecycle stages: • Design/Development • Construction • Operation & Maintenance. Furthermore, National Grid shall consider further interfacing projects who plan to connect at the same EACN Substation and work collaboratively. I confirm that NGET has no existing apparatus within or in close proximity to the proposed site boundary. I hope the above information is useful. If you require any further information, please do not hesitate to contact me. In the meantime, we look forward to receipt of further information and consultation relating to potential impacts on our assets. The information in this letter is provided not withstanding any discussions taking place in relation to connections with electricity customer services.	
NFU	14/07/2023 PEIR Response	The NFU represents 55,000 members across England and Wales. In addition, we have 20,000 NFU Countryside members with an interest in farming and rural life. The NFU would like to make the following	See responses below.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		points in regard to the North Falls Offshore Wind Farm on behalf of NFU members affected by the project.	
NFU	14/07/2023 PEIR Response	The NFU understands that the proposal is for a maximum of four electrical circuits along an approximately 24km corridor.	This was correct at the PEIR stage but the maximum number of electrical circuits has now been reduced to two.
NFU	14/07/2023 PEIR Response	Substation Locations – It is noted in chapter 5, paragraph 56 of the PIER (Project Description) that the precise location of the onshore substation and grid connection is subject to ongoing consultation, however will be located within the onshore substation zone. The NFU would like to be kept informed in regard to the development of the substation.	Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6) sets out the ongoing site selection process and consultation activities in relation to the identification of the onshore substation location.
NFU	14/07/2023 PEIR Response	Easement – The PEIR (Chapter 5, Project Description) outlines that the North Falls Offshore Wind Farm Project has an indicative operational life of 30 years. The NFU would therefore like confirmation of the length of easement being sought from landowners through voluntary agreements. The NFU strongly feels that the easement term should not exceed the operational lifetime of the scheme.	Noted.
NFU	14/07/2023 PEIR option Response	Cable Depth – The NFU understands from the PIER (Chapter 5: Project Description – Table 5.21 Onshore export cables characteristics) that the minimum depth of burial for the cables will be 0.90m and the approximate depth of trench to the top of the protection tile is 0.85m-1.2m. The NFU would like clarity on the depth the cables will be laid through agricultural land. It is imperative that the cables are laid at a minimum depth of 1.2m to the top of the tile to ensure there is sufficient distance between the cables and farming operations i.e. field drainage is generally laid at 0.9m and mole drainage at 0.65m.	NFOW will aim to lay cables at a depth not shallower than 1.2m to top of duct. This is in line with UK Power Networks (UKPN) requirements which are stated in ECS 02-0019. This is designed to take into consideration the requirements for drainage and deep ploughing. Where there are issues with the ground conditions, NFOW will still aim to bury the cable as deep as is reasonably practicable. NFOW will ensure that no infrastructure is shallower than 0.9m, including marker tape.
NFU	14/07/2023 PEIR Response	Surface Apparatus – It is noted in the PIER (Chapter 5: Project Description – Table 5.21 Onshore export cables characteristics) that joint bays will be located approximately every 500m with dimensions being 13mx5m. There will also be up to 196 link boxes. It is noted that where possible, the link boxes will be located adjacent to field boundaries. Section 22.6.3.2 states that the final design of the link	The location of the link boxes is dictated by detailed design, which will seek to locate these close to field boundaries and in accessible locations where possible. However, it may not be practicable to locate them in a location that is preferred by a landowner or occupier. Where link boxes are located below ground, these will be marked appropriately.

Consultee	Date / Document	Comment	Response / where addressed in the ES
		boxes is yet to be completed, however they could be above ground structures up to 1.5m tall, 0.6m deep and 1m wide or they could be below ground and accessed via manhole covers at ground level. The NFU would like to see that landowners are consulted on the location of any surface apparatus to minimise the impact on agricultural operations. It is essential that any link boxes located within agricultural fields are at ground level and marked appropriately in consultation with the landowner/occupier to avoid further disruption to agricultural operations.	
NFU	14/07/2023 PEIR Response	Cable Corridor – The NFU understands from the PIER that the working corridor is to be 60m wide and may be where trenchless techniques are used up to 122m wide. The NFU would like to understand further how construction for this will take place if there is co-ordination between the construction of the Five Estuaries project and the North Falls project including whether the circuits will be laid sequentially or in parallel to understand the impact on farming businesses.	NFOW has worked with VEOWL throughout the pre-application stage to develop co-ordinated proposals as discussed in Section 5.3.1 and Section 5.7.
NFU	14/07/2023 PEIR Response	Biodiversity Net Gain – The NFU would like to understand further how RWE are intending to deliver Biodiversity Net Gain on the project. Chapter 5 of the PIER (Project Description), section 5.8.4.6 states that the project is exploring opportunities to deliver a minimum of 10% biodiversity net gain for the onshore elements of the project. The NFU does not support any agricultural land being acquired compulsorily for the purposes of delivering biodiversity net gain. If the project needs to acquire additional land to deliver such gain then this should be acquired through negotiation only.	NFOW has provided an initial Biodiversity Net Gain Assessment (provided as part of the Project's Biodiversity Net Gain Strategy (Document Reference: 7.22)) which describes potential opportunities for enhancement of terrestrial habitats. Areas identified as suitable for enhancement will be focussed within the Project's onshore project area (on-site) in the first instance. Off-site (areas outside of the onshore project area) habitat creation / enhancement as compensation will only be used if there is no suitable alternative on-site, in order to adhere to the mitigation hierarchy.

5.3 Project design envelope

9. The North Falls Environmental Impact Assessment (EIA), reported in this ES, is based on a design envelope approach in accordance with National Policy Statement for renewable energy infrastructure (National Policy Statement (NPS) EN-3; paragraph 2.8.74 in DESNZ, 2023b) which recognises that: "*Owing to the complex nature of offshore wind farm development, many of the details of a proposed scheme may be unknown to the applicant at the time of the application to the Secretary of State. Such aspects may include:*

- *the precise location and configuration of turbines and associated development;*
- *the foundation type and size;*
- *the installation technique or hammer energy;*
- *the exact turbine blade tip height and rotor swept area;*
- *the cable type and precise cable or offshore transmission route;*
- *the exact locations of offshore and/or onshore substations."*

10. The design envelope is therefore based on maximum and minimum parameters, where appropriate, to ensure the worst case scenario can be quantified and is assessed in the EIA. The final design of North Falls will lie within the range of parameters assessed in the EIA and detailed in this chapter. Each technical chapter (Chapters 8 to 33, Document Reference: 3.1.10 to 3.1.35) of this ES outlines the relevant worst case scenario, noting that this will vary depending on the receptor and impact being considered. For example, with regards to duration of foundation construction (see Section 5.5.3.3), the worst case scenario for underwater noise would be based on foundations installed using pile driving, whereas the worst case scenario for habitat loss would be based on gravity base foundations with the largest seabed footprint.

11. This approach has been widely successful in the consenting of OWFs and is consistent with the Planning Inspectorate Advice Note Nine: Rochdale Envelope (Planning Inspectorate, 2018) which states that: "*The Rochdale Envelope assessment approach is an acknowledged way of assessing a Proposed Development comprising EIA development where uncertainty exists and necessary flexibility is sought*".

5.3.1 Grid connection optionality

12. As noted in Section 5.1, at this stage of the Project's development, some optionality is required in order to future-proof the DCO.

13. One area of optionality is in relation to the National Grid connection point. As discussed in Chapter 1, NFOW is committed to working with the Department for Energy Security and Net Zero (DESNZ) to explore grid connection options and as such, NFOW has co-operated with the Offshore Transmission Network Review (OTNR) process. In addition, NFOW has applied to the OCSS in consortium with NGET and VEOWL for an offshore connection to Sea Link, a marine cable between Suffolk and Kent proposed by NGET as part of their Great Grid Upgrade. The following grid connection options are therefore included in the Project design envelope:

- Option 1: Onshore electrical connection at a National Grid connection point within the Tendring peninsula of Essex (discussed in Section 5.7), with a project alone onshore cable route and onshore substation infrastructure;
- Option 2: Onshore electrical connection at a National Grid connection point within the Tendring peninsula of Essex, sharing an onshore cable route and onshore cable duct installation (but with separate onshore export cables) and co-locating separate project onshore substation infrastructure with Five Estuaries Offshore Wind Farm ('Five Estuaries'); or
- Option 3: Offshore electrical connection, supplied by a third party.

14. The relevant worst case scenario of these options is assessed throughout the technical chapters (Chapters 8 to 33, Document Reference: 3.1.10 to 3.1.35). Where there are key differences between the options which are relevant to different technical chapters, these are highlighted in Sections 5.5 - 5.7.

15. Note that for the onshore and project wide technical chapters, in most cases the parameters associated with Option 2 represent the worst case assessment, as the option includes additional construction activity required to facilitate installation of ducts for Five Estuaries.

16. For offshore works, there is little difference between Option 1 and Option 2. The potential for optimising construction between two projects would primarily take place during onshore construction.

17. For Option 3, the onshore works and offshore cable corridor would no longer be required, therefore the impacts would relate to the offshore array area only.

18. It should be noted that Options 1 and 2, with a connection point within the Tendring peninsula of Essex, are currently the only grid options provided by National Grid and therefore available to North Falls.

5.3.2 Co-ordination with Five Estuaries and cumulative assessment

19. Following a commitment by NFOW and VEOWL to seek to co-ordinate and collaborate where practicable in order to minimise both projects' environmental and social effects, the onshore electrical connection options set out under Option 1 and 2 have been designed in co-ordination with the Five Estuaries project. The onshore cable routes of the two projects will run immediately adjacent, with the footprint required for both covered by the onshore project area. This is to allow either project to install cable ducting for both projects to realise efficiencies in construction. In addition, the onshore substations have been co-located in the same location to the west of Little Bromley. Due to electrical requirements, separate cables and onshore substations are required for each project, and therefore construction of the Five Estuaries' cabling and onshore substation is not included within the North Falls DCO application.

20. When developing a co-ordinated design onshore, North Falls and Five Estuaries have developed three possible build-out scenarios for both projects. These are:

- **Scenario 1** – North Falls proceeds to construction and undertakes the additional onshore cable trenching and ducting works for Five Estuaries as part of a single construction activity (i.e. ducting for four electrical circuits). North Falls would undertake the cable installation and onshore substation construction for its project only (i.e. two electrical circuits). The two projects would share accesses from the public highway for onshore cable installation and substation construction. The projects would utilise and share the same TCCs for the cable installation works.

Note that alternatively, under this scenario, Five Estuaries may instead proceed to construction and undertake the additional onshore cable trenching and ducting works for North Falls, in which instance the only infrastructure built out under the North Falls consent would be the cable installation and onshore substation construction for the North Falls project (i.e. two electrical circuits). As this build-out is not the 'worst case' under this scenario, it is not considered further.

- **Scenario 2** – Both North Falls and Five Estuaries projects proceed to construction on different but overlapping timescales (between 1 and 3 years apart), with onshore cable trenching and ducting works undertaken independently but opportunities for reuse of enabling infrastructure e.g. haul roads / site accesses etc., with the other project then reinstating once complete.
- **Scenario 3** – Five Estuaries does not proceed to construction; or both Five Estuaries and North Falls projects proceed to construction on significantly different programmes (over 3 years apart). In the latter case the significantly different programmes would mean that haul roads and TCCs are reinstated prior to the second project proceeding. In such case cumulative impacts are for a potential construction period of 6 years+. This scenario presents no reduction in overall impacts for the projects from the sharing of infrastructure.

21. These potential build out scenarios are assessed within the Project's Cumulative Effects Assessment (CEA). As with the assessment of the effects arising from the development of North Falls alone outlined above, each technical chapter has selected one of these build out scenarios as the worst case for the technical topic, depending on the parameters relevant to that topic. To help provide clarity when reading the technical chapter CEA sections, Table 5.2 sets out how these scenarios interact with the grid connection options outlined above.

Table 5.2 Summary of cumulative build out scenarios for North Falls and Five Estuaries (assessed in the CEA)

Joint build-out scenario	North Falls grid connection option	Additional Five Estuaries works considered within the CEA
Scenario 1 (Installation of cable ducts for two projects; plus remaining electrical infrastructure for North Falls, including shared use of haul road, accesses and TCCs)	Option 2	• Installation of onshore export cable (including landfall); • Construction of onshore substation and ancillary works; • National Grid connection works.
Scenario 2 (Installation of cable ducts and electrical infrastructure for North Falls only, although with shared use of haul road, accesses and TCCs)	Option 1	• Installation of cable ducts (excluding TCCs, haul road, accesses);

Joint build-out scenario	North Falls grid connection option	Additional Five Estuaries works considered within the CEA
		• Installation of onshore export cable (including landfall); • Construction of onshore substation and ancillary works; • National Grid connection works.
Scenario 3 (Installation of cable ducts and electrical infrastructure for North Falls only)	Option 1	• Installation of TCCs, haul road and accesses; • Installation of cable ducts; • Installation of onshore export cable (including landfall); • Construction of onshore substation and ancillary works; • National Grid connection works.

22. For the onshore and project wide technical chapters, Option 2 (North Falls ducting for additional cabling for Five Estuaries) in most cases represents the worst case for the "North Falls alone" assessment. However, when considering effects cumulatively, the parameters associated with Scenario 2 or 3 – and therefore Option 1 (North Falls and Five Estuaries not sharing duct installation activity), not Option 2 – represents the worst case assessment, as these scenarios assume reduced (Scenario 2) or no (Scenario 3) efficiencies in relation to ducts for the two projects.

5.4 Outline of the Project components

23. The key offshore components considered in this ES comprise:

- Under Options 1 and 2:
    - (WTGs and their associated foundations;
    - Up to two offshore substation platforms (OSP) and their associated foundations to aggregate electricity from the wind turbine generators and facilitate the export of electricity via the Project's offshore export cables;
    - Subsea cables:
        - Array cables between the WTGs and between the WTGs and the OSP(s);
        - Platform interconnector cable between the OSPs, if required.
        - Offshore export cables between the OSP(s) and landfall;
    - Scour protection around foundations, where required; and
    - Surface laid cable protection, where required.
- Under Option 3:

- WTGs and their associated foundations;
- Up to one OSP and associated foundation to aggregate electricity from the wind turbine generators;
- One offshore converter platform (OCP) and associated foundation to increase the voltage of electricity for export and convert the High Voltage Alternative Current (HVAC) power generated by the wind turbine generators into High Voltage Direct Current (HVDC) power for export via an HVDC interconnector cable supplied by a third party (which does not form part of this DCO application);
- Array cables between the WTGs and between the WTGs and OSP(s)/OCP;
- Platform interconnector cable between the OSP and OCP;
- Scour protection around foundations, where required; and
- Surface laid cable protection, where required.

24. Under Options 1 and 2, the key onshore components considered in this ES comprise:

- Landfall;
- Onshore export cables housed within cable ducts and associated joint bays and link boxes;
- Onshore substation and ancillary works;
- Connection to the national grid;
- Works to improve Bentley Road and provision of temporary footway/cycleway; and
- Temporary works to facilitate construction (TCCs, temporary means of access).

25. Under Option 2, this also includes:

- Cable ducts for the installation for Five Estuaries onshore export cables.

5.5 Offshore

5.5.1 Offshore location

5.5.1.1 *Array area*

26. The array area covers approximately 95km^2 (27.7nm^2). At closest point, the boundary is approximately 40km (21.6nm) from shore. The site boundary is shown on Figure 5.1 (Document Reference: 3.2.3).

27. Water depths within the array area range from c. 5m to 58m (relative to the Lowest Astronomical Tide (LAT)), with a mean depth of c. 30mLAT. The substrate in the array area is dominated by sandy gravel/ gravelly sand (discussed further in Chapter 8 Marine Geology Oceanography and Physical Processes, Document Reference: 3.1.10). Mobile sand waves of up to 13m peaks are present in parts of the array area.

28. The range of constraints considered in the selection of the array area are discussed in Chapter 4 Site Selection and Assessment of Alternatives of this ES (Document Reference: 3.1.6).

5.5.1.2 *Offshore cable corridor (required for Options 1 and 2 only)*

29. The electricity generated by the WTGs will be brought to shore by the offshore export cables which will be located within the offshore cable corridor which runs from the array area to the landfall location (Section 5.6.1).

30. The majority of the offshore cable corridor is less than 30mLAT in water depth and the substrate is predominantly sandy gravel/gravelly sand, with some mud content in the nearshore areas. Mobile sand waves of up to 7m peaks are present in parts of the offshore cable corridor.

31. The offshore cable corridor passes to the north and outside of the Margate and Long Sands SAC and Kentish Knock East MCZ, with a small overlap with the Outer Thames Estuary Special Protection Area (SPA) as it approaches landfall. The range of constraints considered in the routing of the offshore cable corridor are discussed in Chapter 4 Site Selection and Assessment of Alternatives of this ES (Document Reference: 3.1.6).

5.5.2 Offshore project details summary

32. The key components of the offshore project are described in Table 5.3. In accordance with the Rochdale Envelope approach, the parameters in Table 5.3 represent the limits of the envelope and should not be combined (e.g. the maximum tip height would not occur with the minimum clearance above sea level).

Table 5.3 Offshore project characteristics

Feature	Worst case parameters
All grid connection options	
Number of WTGs	57
Array area	95km^2
Array area distance to shore (closest distance)	40km
Maximum WTG rotor diameter	337m
Maximum rotor tip height	377.4m above Mean High Water Springs (MHWS)
Minimum rotor tip clearance above sea level	27m above MHWS
Minimum separation between WTGs	1,180m in the downwind direction; and 944m in the crosswind direction.
Maximum array cable length	170km
Maximum platform interconnector cable length	20km
Array cable and platform interconnector cable target minimum burial depth (where buried)	0.6m
Options 1 and 2 only	
Offshore cable corridor length	57km
No. of cable circuits	2

Feature	Worst case parameters
Offshore export cable target minimum burial depth (where buried)	0.6m
No. of OSPs	2
Option 3 only	
No. of OCPs	1
No. of OSP	1

5.5.3 Offshore infrastructure

5.5.3.1 *Wind turbine generators*

33. This section provides a description of the WTG options considered for North Falls and the parameters that the ES assessment is based on. Conventional three bladed, horizontal axis WTGs will be used, comprised of the following main components, and illustrated in Plate 5.1.

- Rotor, comprising:
  - Blades;
  - Hub - connects the blades to the main shaft and ultimately to the rest of the drive train;
- Nacelle - houses the electrical generator, control electronics and drive system (Plate 5.2); and
- Structural support - tubular steel tower atop a foundation structure.

34. Options for minimum and maximum WTG size and the associated characteristics being considered in this ES are provided in Table 5.4.

Table 5.4 Project design envelope WTG parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number for indicative size	57	34
Maximum rotor diameter (m)	236	337
Maximum blade tip height above MHWS (m)	276.4	377.4
Minimum lower blade tip height above MHWS (m)	27m	
Indicative nominal rotations per minute(rpm)	8.4	7.5
Minimum hub height above MHWS (m)	145.4	195.4
Maximum hub height above MHWS (m)	158.4	209.4

35. At this stage, wind turbine types have not been determined. There is potential that the site could host more than one wind turbine type/model, all within the parameters outlined above.

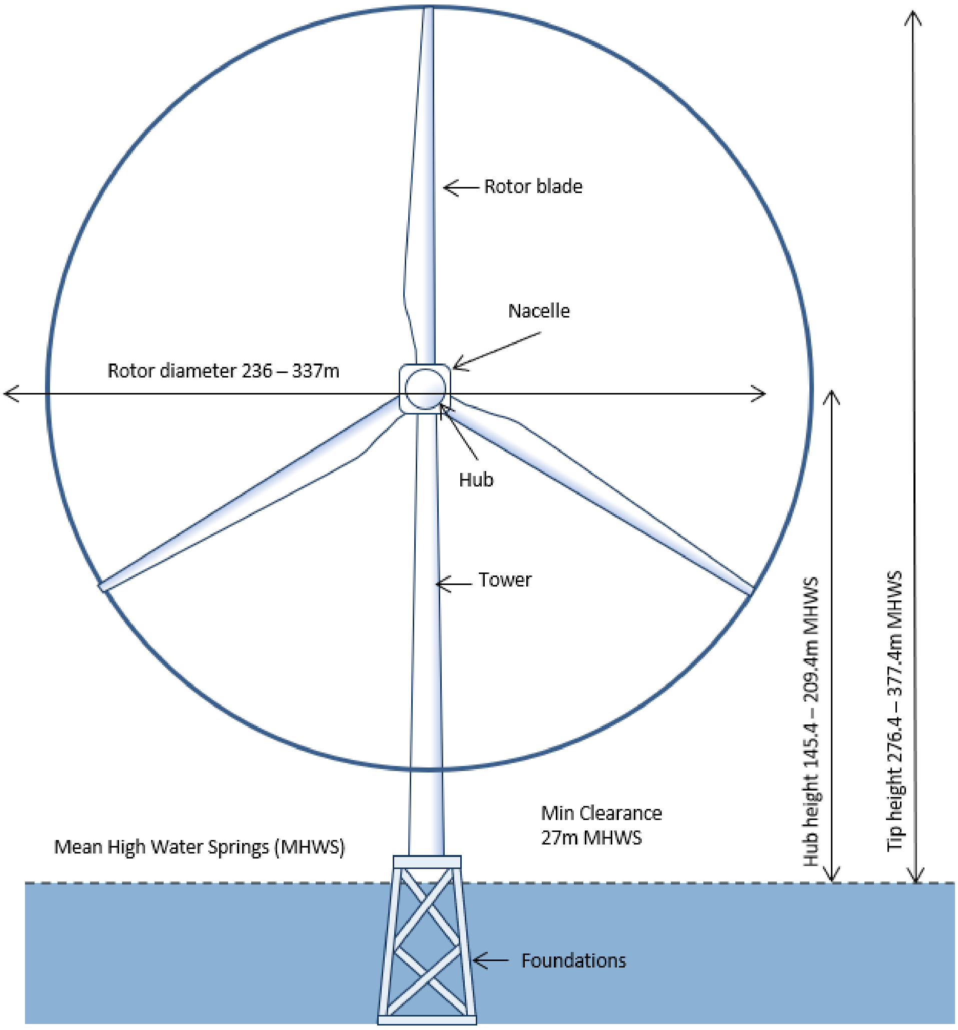

Plate 5.1 Key WTG dimensions

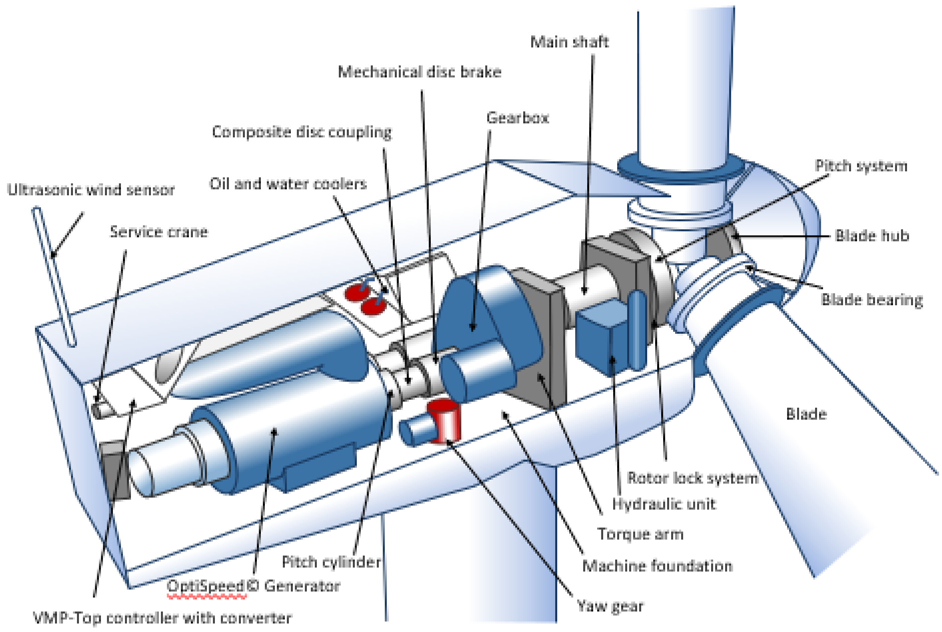

Plate 5.2 Indicative nacelle components

5.5.3.2 *Wind turbine layout*

36. The eventual layout of the wind farm would be decided post-consent, taking into account wind resource, ground conditions identified by site investigation works, navigational requirements and the size of turbine selected. Turbine size selection is driven by commercial factors, and market conditions at the time. In developing the final layout, the Applicant would aim to minimise environmental impacts (e.g. through micro-siting) and impacts to other users whilst maximising energy yield and cost efficiency. Therefore, exact locations are not included in the DCO application.

37. The wind turbine layout can be described in general terms at this stage. The minimum separation between wind turbines would be:

- 5 x the rotor diameter (i.e. 1,180m for the smallest turbines with 236m rotor diameter or 1,685m for the largest turbines with 337m rotor diameter) in the downwind direction; and
- 4 x the rotor diameter (i.e. 944m for the smallest turbines with 236m rotor diameter or 1,348m for the largest turbines with 337m rotor diameter) in the cross wind direction.

5.5.3.3 *WTG foundations and substructures*

38. This section provides detail on the WTG foundations and substructures that are assessed in this ES for the Project. The decision on the types of foundation and substructure to support the WTGs and offshore substation platform(s) will be made post-consent. Foundation types will be selected following detailed design, based on suitability of the ground conditions, water depths and wind turbine models. There may be only one type used, or a combination of foundation types may be used.

39. The foundation types currently being considered for use are:

- Monopile (Plate 5.3);
- Mono suction bucket (Plate 5.4);
- GBS (Plate 5.5);
- Jacket with 3 or 4 legs (Plate 5.6) attached to the seabed by:
    - Pin-piles;
    - Suction buckets; and
    - Gravity/ballast legs.

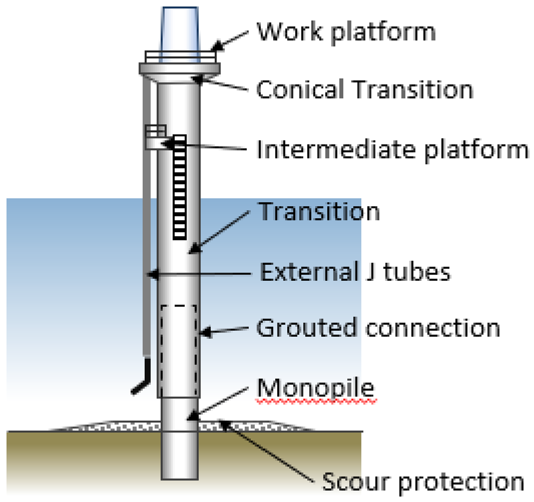

Plate 5.3 Typical monopile

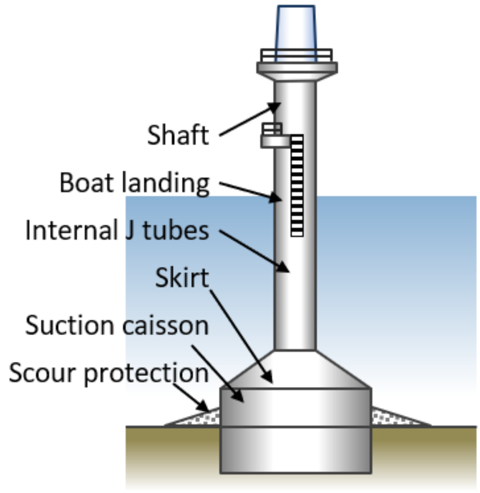

Plate 5.4 Typical mono suction bucket structure

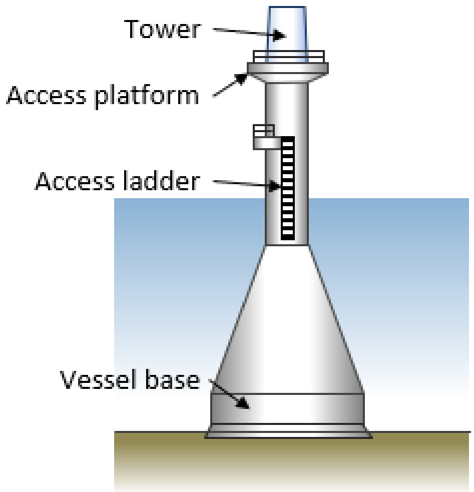

Plate 5.5 Typical gravity-based structure

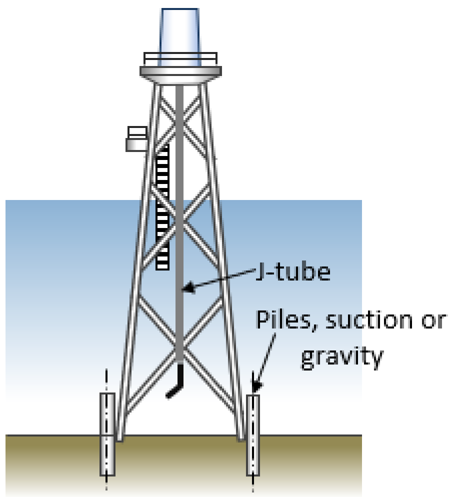

Plate 5.6 Typical jacket structure with pin-pile, suction caisson or gravity legs

5.5.3.3.1 Monopile

40. Monopile foundations can be driven using a hydraulic hammer ('piling'), or a combination of piling and drilling. Monopiles are normally constructed from welded tubular steel sections, however additional materials such as metals, aluminium or composites may be used for secondary structures such as ladders, handrails etc. The piles support the weight of the tower and turbine and rely on the surrounding geology to provide lateral resistance to horizontal forces such as wind and waves. The WTG tower will be connected to the monopile structure with a transition piece installed over or inside the monopile, typically connected to the WTG tower using grout.

41. Drilling may also be required at up to 10% of the site if monopile foundations are chosen. Monopile parameters including drill arisings related to monopiles are included in Table 5.5.

Table 5.5 Monopile design parameters

Parameter	Value for smallest turbines	Value for largest turbines
Piles		
Maximum number of piles	57	34
Maximum pile diameter (m)	10	17
Indicative pile penetration depth (m)	45	45
Maximum hammer energy (kJ)	6,000	
Drilling (if required)		
Indicative drill penetration depth (m)	45	45
Maximum drill diameter (m)	11	18
Maximum volume arisings per pile (m^3)	4,276	11,451
Average drill arisings per pile	3,534	10,214
Proportion of foundations requiring drilling	10%	
Total volume of WTG arisings (m^3)	20,145	34,728

5.5.3.3.2 Mono suction bucket

42. Suction buckets (caissons) may comprise a single steel cylindrical tower (the shaft), a transition structure (the lid) and cylindrical skirt which penetrates into the seabed. Parameters for the suction bucket foundations are outlined in Table 5.6 below.

Table 5.6 Mono suction bucket parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number of suction buckets	57	34
Maximum bucket diameter (OD) (m)	38	
Indicative bucket penetration depth (m)	25	
Suction bucket height above seabed (m)	10	

5.5.3.3.3 GBS

43. There are many possible shapes and sizes being proposed by manufacturers for GBS. GBS usually comprise a base, a conical section, and a cylindrical section (Plate 5.5). Usually the base is hexagonal, octagonal, or circular. Footprint sizes for the base are outlined in Table 5.7.

Table 5.7 GBS parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number of foundations	57	34
Maximum diameter (m)	65	
Seabed Preparation Diameter (m)	70	
Gravity based height above seabed (m)	15	

5.5.3.3.4 Jacket with pin-piles

44. Jacket substructures are a steel lattice construction (tubular steel and welded joints) secured to the seabed either by hollow steel pin-piles (either driven or drilled depending on the geology), gravity base or suction buckets.

45. The design envelope for jacket substructures is shown in Table 5.8.

Table 5.8 Pin-piled jacket design parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number of foundations	57	34
Maximum number of legs per jacket	4	
Maximum number of pin piles per leg	2	
Maximum number of pin piles per jacket	8	
Maximum number of pin piles	456	272
Maximum WTG pin pile diameter (m)	6	
Maximum OSP/OCP pin pile diameter (m)	3.5	
Maximum hammer energy for pin-piled WTG foundations (kJ)	4,400	
Maximum hammer energy for pin-piled OSP/OCP foundations (kJ)	3,000	

5.5.3.3.5 Jacket with suction buckets

46. A jacket foundation on suction buckets (caissons) may be used. This would consist of a jacket, that would be installed on three or four suction bucket 'legs'. Parameters for the suction bucket foundations are outlined in Table 5.9 below.

Table 5.9 Jacket with suction bucket parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number of buckets (based on 4 leg jacket)	228	136
Maximum bucket diameter (m)	15	23
Separation of adjacent legs at seabed (m)	60	
Separation of adjacent legs at sea surface (m)	50	
Suction bucket height above seabed (m)	1.5	

5.5.3.3.6 Jacket with gravity/ballast legs

47. A jacket foundation on gravity/ballasted legs may be used. This would consist of three or four gravity 'legs'. Footprint sizes for the gravity legs are outlined in Table 5.10.

Table 5.10 Gravity base design parameters

Parameter	Value for smallest turbines	Value for largest turbines
Maximum number of gravity legs (based on 4 leg jacket)	228	136

Parameter	Value for smallest turbines	Value for largest turbines
Maximum base diameter (m)	23	
Seabed Preparation Diameter (m)	25	
Gravity based height above seabed (m)	15	

5.5.3.4 *Offshore substation platform*

48. North Falls will require a maximum of two OSPs under Options 1 and 2 (Plate 5.7) depending on the electrical system voltage and final layout, or one OSP under Option 3 (along with an OCP, described in Section 5.5.3.5). The OSPs provide a connection point for the array cables and contain primary electrical equipment and ancillary components that are required to transform the voltage of the electricity generated at the WTGs to a higher voltage suitable for transporting power to the onshore electrical transmission network via the offshore export cables.

Plate 5.7 Example OSP (image courtesy of RWE Renewables)

49. The offshore platforms are likely to contain a combination of one or more of the following facilities:

- Cooling systems;
- Medium voltage (MV) to high voltage (HV) step-up power transformers;

- HV Reactors;
- MV and/or HV switchgear;
- Other electrical power systems;
- Instrumentation, metering equipment and control systems;
- Standby generators;
- Auxiliary and uninterruptible power supply systems;
- Navigation, aviation, and safety marking and lighting;
- Helicopter landing facilities, including bird deterrent system;
- Systems for vessel access and/or retrieval;
- Vessel and helicopter refuelling facilities;
- Potable water;
- Black water separation;
- Storage (including stores, fuel, and spares);
- Cranes; and
- Communication systems and control hub facilities.

50. The location of the OSP(s) within the array area will be confirmed during the post consent detailed design process. The design of the OSP(s) will include a platform 'topside', supported above sea level on a foundation structure (see Section 5.5.3.6). Topside design parameters for the OSP(s) are shown in Table 5.11.

Table 5.11 OSP(s) topside parameters

Parameter	Worst case values
Maximum topside length (m)	60
Maximum topside width (m)	40
Maximum topside height (m) (excluding crane and helideck)	+41.6m above MHWS
Maximum topside height (m) (including crane and communications antennas)	+61.68m above MHWS

5.5.3.5 *Offshore converter platform (required for Option 3 only)*

51. Should Option 3 (an offshore connection) be selected, an offshore converter platform would be required to facilitate the transmission of electricity from the North Falls WTGs and/or OSP to a third party HVDC interconnector cable (the HVDC interconnector cable does not form part of this DCO application).

52. This would be a fixed structure (e.g. Plate 5.8) located within the array area. The OCP would contain HVAC and HVDC electrical equipment to aggregate the power from the wind turbine generators, increase the voltage to a more suitable level for export and convert the HVAC power generated by the wind turbine generators into HVDC power for export to shore via the third party HVDC interconnector cable.

Plate 5.8 Example OCP (source: SSER, 2021)

53. The location of the OCP within the array area will be confirmed during the post consent detailed design process, (subject to the selection of Option 3 and the final cable route of the third party HVDC interconnector cable).

54. The design of the OCP would include a topside platform, supported above sea level on a foundation structure (see Section 5.5.3.6). Topside parameters for the OCP are shown in Table 5.12.

Table 5.12 OCP topside parameters

Parameter	Worst case values
Maximum topside length (m)	130
Maximum topside width (m)	80
Maximum topside height (m) (excluding crane and helideck)	+61.6m above MHWS
Maximum topside height (m) (including crane and communications antennas)	+111.62m above MHWS

5.5.3.6 *Offshore substation and converter platform foundations*

55. Foundation options for the OSP and OCP include:

- Monopile (Plate 5.3);
- GBS (Plate 5.5);
- Jacket with 3 or 4 legs (Plate 5.6) attached to the seabed by:
  - Pin-piles; and/or
  - Suction buckets.

56. Foundation design parameters for the OSP(s) and OCP are shown in Table 5.13.

57. Under Options 1 and 2, there would be up to two OSPs and under Option 3, there would be up to one OSP and one OCP. Therefore, under either scenario there would be a maximum of two platforms with associated foundations.

Table 5.13 OSP and OCP foundation design parameters

Parameter	OSP	OCP
Monopiles		
Maximum column diameter (m)	17	
Hammer energy required (for pile driving) (kJ)	6,000	
Indicative drill penetration depth (m)	45	
Maximum drill diameter (m)	18	
Maximum volume arisings per foundation (m^3)	11,451	
Proportion of foundations requiring drilling	50%	
Total volume of arisings (m^3)	11,451	
GBS		
Max diameter (m)	65	
Seabed preparation diameter (m)	70	
Gravity based height above seabed (m)	15	
Pin-piled jacket		
Number of legs	6	
Separation of adjacent legs at seabed level (m)	50 x 40	80 x 50
Separation of adjacent legs at LAT (m)	35 x 40	
Pin pile diameter (m)	3.5	
Maximum hammer energy (kJ)	3,300	
Jacket with suction bucket		
Number of gravity legs	6	
Separation of adjacent legs at seabed level (m)	50 x 40	80 x 60
Separation of adjacent legs at LAT (m)	35 x 40	
Max diameter (m)	25	
Indicative bucket penetration depth (m)	17	
Suction bucket height above seabed (m)	1.5	

5.5.3.7 *Scour protection for substructures*

58. Foundations may require scour protection to avoid sediment being eroded away from the base of the foundations as a result of the flow of water. The exact requirements will be identified post consent, prior to the start of construction, based on the final WTG and OSP/OCP locations and detailed site surveys.

Purpose made vessels (e.g. Plate 5.9) are used to accurately install rock, which is normally completed using a fall-pipe lay system.

Plate 5.9 Indicative scour protection deployment vessel (source: Jan De Nul Group, 2023)

59. Typical options for scour protection include one, or a combination of the following examples:

- Rock or gravel placement;
- Concrete mattresses;
- Flow energy dissipation devices (used to describe various solutions that dissipate flow energy and entrap sediment, and including options such as frond mats, mats of large-linked hoops, and structures covered with long spikes). It is noted that these technologies are often only appropriate for use in areas with significant mobile seabed sediments, and examples such as the spiked designs are only appropriate for use in areas which are not trawled;
- Protective aprons or coverings (solid structures of varying shapes, typically prefabricated in concrete or high-density plastics); and
- Bagged solutions, (including geotextile sand containers, rock-filled gabion bags or nets, and grout bags, filled with material sourced from the site or elsewhere).

60. The maximum diameter, area and volume requirements for scour protection per foundation are provided in Table 5.14 and Table 5.15. The overall maximum volume of scour protection for the Project is associated with the GBS foundation.

Table 5.14 Scour protection quantities for WTGs (worst case scenario in bold)

Parameters	Monopile	Mono suction bucket	Suction jacket	GBS	Gravity jacket legs	Piled jacket
Max diameter at top of scour protection (incl. foundation structure) [m]	85	190	115	**325**	115	17.5
Max outer scour protection diameter at seabed (incl. foundation structure) (m)	93	198	123	**333**	123	25.5
Max scour protection area per foundation (excl. structure footprint area (m^2)	6,566	29657	45,867	**83,774**	47,529	2,004
Max scour protection area per foundation (incl. structure footprint area) (m^2)	6,793	30791	47,529	**87,092**	47,529	2,043
Total scour protection seabed footprint area (km^2)	0.530	1.69	2.614	**4.775**	2.614	0.114
Max scour protection volume per foundation (m^3)	11,988	56,850	21,413	**170,025**	21,413	707
Max scour protection volume for project (m^3)	407,600	3,240,465	1,220,546	**9,313,113**	1,220,546	40,291

Table 5.15 Scour protection quantities for OSPs/OCP (worst case scenario in bold)

Parameters	Monopile	Suction jacket	GBS	Piled jacket
Max diameter at top of scour protection (incl. foundation structure) [m]	85	125	**325**	17.5
Max outer scour protection diameter at seabed (incl. foundation structure) (m)	93	133	**333**	25.5
Max scour protection area per foundation (excl. structure footprint area (m2)	6,566	80,412	**83,774**	3,007
Max scour protection area per foundation (incl. structure footprint area) (m2)	6,793	83,357	**87,092**	3,064
Total scour protection seabed footprint area (km2)	0.013	0.161	**0.168**	0.006
Max scour protection volume per foundation (m3)	11,988	25,158	**163,388**	707
Max scour protection volume for project (m3)	23,977	50,316	**326,776**	1,414

5.5.3.8 *Subsea cables*

5.5.3.8.1 Array cables

61. HVAC array cables will link together the WTGs and link the WTGs with the OSP(s)/OCP. Array cable parameters are included in Table 5.16. Information on potential cable protection requirements for unburied cable is provided in Section 5.5.3.8.4.

Table 5.16 Array cables parameters

Parameter	Value
System voltage (kV)	66 to 132
Indicative external cable diameter (mm)	220
Target minimum burial depth (m)	0.6
Average burial depth (m)	1.2
Maximum potential length of array cable (km)	170
Width of trench by installation (m)	1
Width of seabed disturbance during installation (m)	24
Array cable sandwave levelling volume (m3)	27,293,114
Cable installation spoil volume (m3)	204,000
Total seabed disturbed (km2)	4.08
Maximum length of surface laid cable (km)	34 (20% of cable length)

5.5.3.8.2 Platform interconnector cable

62. An HVAC platform interconnector cable will link together the two OSPs (if required, under Options 1 and 2) or the OCP and OSP (under Option 3). Platform interconnector cable parameters are included in Table 5.17. Information on potential cable protection requirements for unburied cable is provided in Section 5.5.3.8.4.

Table 5.17 Platform interconnector cable parameters

Parameter	Value
System voltage (kV)	Up to 275
Indicative external cable diameter (mm)	220
Target minimum burial depth (m)	0.6
Average burial depth (m)	1.2
Maximum potential length of platform interconnector cable (km)	20
Width of trench by installation (m)	1
Width of seabed disturbance during installation (m)	24
Platform interconnector cable sandwave levelling volume (m3)	1,436,480
Platform interconnector cable installation spoil volume (m3)	24,000
Total seabed disturbed (km2)	0.48
Maximum length of surface laid cable (km)	4 (20% of cable length)

5.5.3.8.3 Offshore export cables (required for Option 1 and 2 only)

63. Under Options 1 and 2, offshore export cables would carry HVAC electricity from the OSP(s) back to the landfall, and then in turn onto the onshore export cables. The offshore export cables will incorporate auxiliary cables such as Supervisory Control and Data Acquisition (SCADA) cables.

64. Offshore export cable parameters are included in Table 5.18. Information on potential cable protection requirements for unburied cable is provided in Section 5.5.3.8.4.

Table 5.18 Offshore export cables parameters

Parameter	Value
Max number of offshore export cables	2
Export cable voltage (kV)	Up to 275
Indicative external cable diameter (mm)	310
Offshore cable corridor length (km)	57
Offshore export cable length (km)	125.4
Minimum spacing between offshore export cables (m)	50
Target minimum burial depth (m)	0.6
Average burial depth (m)	1.2
Width of trench by installation (m)	1
Export cable sandwave levelling volume (m^3)	1,544,891
Cable installation spoil volume (m^3)	150,480
Total seabed disturbed (km^2)	3
Maximum length of surface laid cable (km)	12.5km (10% of cable length)

5.5.3.8.4 Cable protection

65. Where burial is not practicable, e.g., at crossings or due to hard geology, cables would be surface laid with cable protection installed on top.

66. There is also likely to be a requirement for cable protection to be installed around the following cables as they transition from the seabed to/from the relevant infrastructure via internal or external J-tubes or I-tubes (hollow tubes hung from the foundation that are in the shape of a "J" of an "I"):

- Array cable entering/exiting the WTGs and entering the OSP(s);
- Platform interconnector cable entering the OSPs/OCP; and
- Export cables exiting the OSP(s).

67. There will likely be a proprietary cable protection system installed around the cable itself whilst on the back deck of the vessel and before cable pull in. Additionally, there is a possibility of retrospectively installed secondary cable protection, such as rock placement or mattresses. The exact amount of cable protection required on each cable end will depend on the burial depths achieved by the export or array cable installation and assessment of the scour and movement that could occur during the operating life of the Project.

68. The exact form of cable protection used will depend upon local ground conditions, hydrodynamic processes, and the selected cable protection contractor. However, the final choice may include one or more of the following: concrete 'mattresses'; rock placement; geotextile bags filled with stone, rock, or gravel; polyethylene or steel pipe half shells, or sheathes; and bags of grout, concrete, or another substance that cures hard over time.

69. Mattresses are formed by interweaving a number of concrete blocks with rope and wire. They are lowered to the seabed on a frame. Once positioning over the cable has been confirmed, the frame release mechanism is triggered, and the mattress is deployed. This single mattress placement will be repeated over the length of cable which is either unburied or has not achieved target depth. Mattresses provide protection from direct anchor strikes but are less capable of dealing with anchor drag. Should this protection method be used for crossings, a mattress separation layer may first be laid on the seabed.

70. If rock placement, or filled bags are used to protect cables, they are typically used to construct a berm on the seabed on top of the cable. The rock placement method of cable protection involves placing rocks of different grade sizes from a fall pipe vessel over the cable. Initially smaller stones are placed over the cable as a covering layer. This provides protection from any impact from larger grade size rocks, which are then placed on top. Rock bags are placed via a crane and deployed to the seabed in the correct position.

71. Half shells sections, made of metal or plastic, are bolted together forming a circular protection barrier around the cable. Additionally, rock may be placed on top to provide protection from anchors or fishing gear.

72. Where appropriate, cable clips, e.g. Plate 5.10 (also known as cable anchors, or anchor clamps) may also be utilised to secure cables to the seabed.

Plate 5.10 Indicative cable clip (source: Reda *et al,* 2021)

73. The parameters outlined in Table 5.19 provide the design envelope for the range of predicted surface laid cable protection.

Table 5.19 Maximum cables protection parameters

Parameter	Value
Array cable protection (All grid connection options)	
Length of array cable protection (m)	34,000

Parameter	Value
Width of cable protection on seabed (m)	6
Height of cable protection (m)	1.4
Area of cable protection (m^2)	204,000
Volume of cable protection (m^3)	119,000
Platform interconnector cable protection (All grid connection options)	
Length of export cable protection (m)	4,000
Width of cable protection on seabed (m)	6
Height of cable protection (m)	1.4
Area of cable protection (m^2)	24,000
Volume of cable protection (m^3)	14,000
Offshore export cable protection (Options 1 and 2 only)	
Length of export cable protection (m)	12,540
Width of cable protection on seabed (m)	6
Height of cable protection (m)	1.4
Area of cable protection (m^2)	75,240
Volume of cable protection (m^3)	43,890

5.5.3.9 *Navigational markers*

74. The wind farm would be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA) and the Trinity House Lighthouse Service (THLS) in respect of marking, lighting, and fog-horn specifications. CAA guidelines as outlined in “CAA Policy and Guidelines on Wind Turbines” (February, 2016) would be adhered to. THLS recommendations would be followed as described in “Provision and Maintenance of Local Aids to Navigation Marking Offshore Renewable Energy Installations” and “the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation 0-139 on the Marking of Man-Made Offshore Structures”, (IALA 2013).

75. Lighting requirements would follow the Maritime and Coastguard Agency (MCA) (2021) guidance, Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response. This will ensure that adequate consideration with regard to lighting of offshore structures is given for Search and Rescue and Emergency Response.

76. For the purposes of the EIA, the following assumptions have been made with regards to lighting of North Falls:

- Aviation light
  - Only on specific structures, usually the perimeter, mounted on the top of the nacelles;
  - Off during the day;

    - Red, up to 2,000 Candela (Cd) light displayed at night only;
    - Dimmable to 200 Cd when visibility is greater than 5 km at night;
    - Synchronised flashing Morse "W";
    - A reduced intensity at and below the horizontal;
    - 360° visibility;
    - Compatible with Night Vision Imaging Systems (NVIS); and
    - UPS: 8 hours required to maintain all aviation warning lights.
- Helihoist light:
    - Low intensity green 200 Cd light; and
    - Off, unless the turbine is being prepared for helicopter approach.

77. The colour scheme for nacelles, blades and towers is typically RAL 7035 (light grey). Foundation steelwork is generally in RAL 1023 (traffic light yellow) up to the Highest Astronomical Tide (HAT) +15m or to Aids to Navigations, whichever is the highest.

5.5.4 Offshore construction methods

5.5.4.1 *Seabed preparation*

5.5.4.1.1 Pre-construction surveys

78. A pre-construction survey would be undertaken in advance of cable and foundation installation works. The results of this survey would be used to plan micrositing, where appropriate.

5.5.4.1.2 UXO clearance

79. The pre-construction surveys will also be analysed to identify unexploded ordnance which is required to be cleared prior to construction. For the purposes of assessment, an estimated 40 clearance operations are predicted:

- 15 in the array area (required for all grid connection options); and
- 25 in the offshore cable corridor (Options 1 and 2 only).

80. The maximum net explosive quantity of unexploded ordnance (UXO) in this region is predicted to be 698kg, however the impact assessments include a conservative worst case scenario of 750kg in accordance with Natural England (2022).

81. The UXO clearance procedure would be subject to additional marine licencing, to be progressed once the area in which UXO clearance activities are proposed and type of UXO are known.

5.5.4.1.3 Boulder clearance

82. Pre-construction surveys will identify any requirement for boulder clearance. An estimated:

- 25 boulders in the array area (required for all grid connection options); and
- 15 boulders in the offshore cable corridor (Options 1 and 2 only).

83. An estimated boulder size of up to 5m in diameter has been included in the assessments. Boulders would be relocated within the offshore project area, outside the foundation locations or route of the cable installation.

5.5.4.1.4 Pre-lay grapnel run

84. Before cable-laying operations commence, it would be necessary to ensure that the route is free from obstructions such as discarded trawling gear or abandoned cables identified as part of the pre-construction survey. A survey vessel would be used to clear all such identified debris, in a 'pre-lay grapnel run'.

85. The maximum width of seabed disturbance along the pre-grapnel run would be 24m per cable.

5.5.4.1.5 Sandwave levelling

86. Mobile sand waves could result in exposure and scouring of the cable or the cable being held in suspension over time. To prevent this, sandwave levelling may be undertaken to enable the cables to be buried into stable sediment beneath the sandwaves. In addition, some foundation options, in-particular GBS would require a level seabed prior to installation.

87. An interim cable burial study has been completed to inform the project design envelope, along with analysis of the predicted sandwave levelling. Parameters are included in Table 5.16 and Table 5.18.

88. Sediment disposal from seabed preparation is discussed in Section 5.5.10.

5.5.5 Foundation installation

5.5.5.1 *Pile driving*

89. The installation of piled foundations would typically consist of the following key stages:

- Prepare seabed (if necessary) prior to installation (Section 5.5.4.1);
- Delivery of monopiles or jackets to site via barge or by installation vessel. It may also be possible to tow floated piles to site using tugs;
- Mobilisation of jack-up rig with heavy craneage at installation location. It may also be necessary to mobilise a support vessel;
- Pile upended by crane to vertical position;
- Pile lowered to seabed;
- Locating of driving hammer on top of pile using craneage, and pile driven to required depth. Where ground conditions are difficult, it may also be necessary to carry out drilling (Section 5.5.5.2) using drilling equipment operated from the installation vessel before completing the driving; and
- Installation of scour protection as appropriate.

90. A drivability assessment will be conducted post-consent when further information is available regarding the ground conditions to determine the required piling requirements (e.g., hammer energy, blow rate). At this stage it is estimated that the maximum hammer energy used for pile installation would be 4,400kJ for WTG pin piles and 6,000kJ for monopiles.

91. A soft start, followed by a gradual ramping up of hammer energy over consecutive blows will be undertaken. The associated parameters for monopile and pin pile soft start and ramp up are shown in Table 5.20 and Table 5.21, respectively.

Table 5.20 Monopile soft start and ramp up

Parameter	Soft start	Ramp up				Max Hammer Energy
Hammer Energy	900	1,800	2,700	3,700	4,800	6,000
%Max energy	15%	30%	45%	62%	80%	100%
Strikes per minute	10	20	20	20	20	34
Duration (min)	10	30	30	30	30	320
Number of strikes	100	600	600	600	600	10,880
Total Duration (min)	450					

Table 5.21 Pin-pile soft start and ramp up

Parameter	Soft start	Ramp up				Max Hammer Energy
Hammer Energy	660	1,320	1,980	2,640	3,520	4,400
%Max energy	15%	30%	45%	60%	80%	100%
Strikes per minute	10	20	20	20	20	34
Duration (min)	10	20	20	20	20	180
Number of strikes	100	400	400	400	400	6,120
Total Duration (min)	270					

92. The maximum predicted time for installation is 7.5 hours for a monopile and 4.5 hours per pin pile. With up to four pin piles per jacket, the total piling duration would be 18 hours (not including breaks in between to move and set up the next pile).

93. There could be two piling operations occurring simultaneously. Within a 24 hour period, a maximum of three monopiles or six pin-piles could be installed sequentially.

94. An assessment of the underwater noise levels that could be generated by the Project is provided in Appendix 12.3 Underwater Noise Modelling Report (Document Reference: 3.3.8).

5.5.5.2 *Drill arisings*

95. As outlined above, piles may be installed by a combination of drilling and driving.

96. Various drilling methodologies are possible, but drills are typically lifted by crane into a part-installed pile, ride inside the pile during drilling, and are removed in the event driving recommences. Drills may bore out to a diameter equal to the internal diameter of the pile, or they may be capable of expanding their cutting disk below the tip of the pile and boring out to the piles maximum outer diameter or greater (under-reaming). Drilling systems are available in sizes ranging from those required for small jacket pin piles, to large diameter concrete monopiles. Water is continuously pumped into the drill area and any drill arisings generated are flushed out and allowed to disperse naturally at the sea surface.

97. It is estimated up to 10% of the WTG locations and 50% of the OSP locations could need drilling. The maximum drill arisings are shown in Table 5.5 and Table 5.11.

98. Sediment disposal for drill arisings is discussed in Section 5.5.10.

5.5.5.3 *Gravity base*

99. The installation method of GBS is dependent on design and fabrication methods and will be refined following the completion of post-consent commercial and technical discussions. The overall installation methodology would typically be as follows:

- Prepare seabed (if necessary) prior to installation (Section 5.5.4.1);
- GBS transported to site via barge or floated to site, hauled by tugs;
- Mobilise heavy lift floating crane (if foundation is non-buoyant solution);
- Lift foundation from barge and lower to prepared area of seabed, or adjust buoyancy of floating foundation and sink to prepared area of seabed;
- Install ballast as necessary; and
- Installation of scour protection as appropriate.

100. Ballast works would be undertaken by a trailer suction hopper dredger. The scour protection works would typically be installed by a dynamic positioning rock dumping vessel equipped with a fall pipe. The scour materials would be placed in one or multiple layers.

5.5.5.4 *Suction buckets*

101. Suction buckets (caissons) would be used for jacket installation only. The installation methodology for suction buckets would typically be as follows:

- Prepare seabed (if necessary) prior to installation (Section 5.5.4.1);
- If suction buckets foundations are used these could be towed to site by tugs, as they are designed to be buoyant, or they could be transported on a barge like monopiles. The buckets skirt and shaft are generally delivered and installed as a single part;
- Suction bucket foundation is ballasted and lowered to seabed;
- Initial penetration occurs under foundation self-weight;
- Pumps are attached to the bucket and water evacuated. Typically, there are a number of chambers within the bucket in order to implement a controlled installation and to control levels. Sometimes water jetting is used at the tip of the skirt to facilitate penetration;
- Install backfill as necessary;
- Installation of scour protection as appropriate.

5.5.6 Topside installation methods

5.5.6.1 *Tower and rotor installation*

102. The nacelle and wind turbine blades would either be transported to site and installed by the installation vessel or transported on a barge where they would be lifted off and installed by crane on a separate installation vessel. The installation of the wind turbines would typically involve multiple lifting operations,

with multiple tower sections erected, followed by the nacelle with pre-assembled hub, and then the blades.

103. Traditional installation methods consist of tower segments lifted in place and bolted together, hub and nacelle conjoined in case of single blade installation.

104. Although not current practice, it is possible that wind turbines could be fully assembled and commissioned onshore or partially assembled (e.g. rotors assembled) and transported to site as larger units for installation.

5.5.6.2 *OSP and OCP*

105. The installation of the OSP and OCP foundations would be as described in Section 5.5.5 for the relevant foundation options (discussed in Section 5.5.3.6). The topsides would be transported to the array area on a barge and lifted onto the platform via a crane on the vessel (see Plate 5.11).

Plate 5.11 Indicative OSP topside installation (source: EnergyFacts, 2020)

5.5.7 Cable burial methods

106. Both array and offshore export cables will be buried below the seabed where practicable. The installation method and target burial depth will be defined post consent based on a cable burial risk assessment considering ground conditions. It is anticipated that the offshore cables will be installed via ploughing, jetting, trenching, or a combination of these techniques, depending on ground conditions along the specific cable route. Other installation methods could also be considered.

107. The parameters outlined in Section 5.5.3.8 provide the design envelope for the range of predicted installation methods.

108. The rate of the burial progress will depend on a number of factors (e.g., seabed conditions), however an indicative installation rate of approximately 150-400 m/h is expected.

5.5.7.1 *Ploughing*

109. This method involves a blade, which cuts through the seabed and the cable is laid behind. Ploughs are generally pulled directly by a surface vessel or, they can be mounted onto a self-propelled tracked vehicle which runs along the seabed. Cable ploughs are usually deployed in simultaneous ‘lay and trench’ mode although it is possible to use the plough to cut a trench for the cable to be installed at a later date provided the ground conditions are suitable. When installing the cable in simultaneous lay and trench operation the plough may use cable depressors to push the cable into position at the base of the cut trench; as the plough proceeds the trench is backfilled to provide immediate burial.

110. Ploughs can be used in seabed geology ranging from very soft mud through to firm clays but, in general, ploughs are not suited to harder substrates such as boulder clay. Some ploughs are fitted with water jet assist options and/or hydraulic chain cutters to work through patches of harder substrates.

5.5.7.2 *Jetting*

111. This method involves directing water jets towards the seabed to fluidise and displace the seabed sediment. This forms a typically rectangular trench into which the cable generally settles under its own weight. The water jets are usually deployed on jetting arms beneath a remotely operated vehicle (ROV) system that can be free-swimming or based on passive skids or active tracks. There are also towed jetting skids available for the installation of cables. During the formation of the trench the displaced sediment is forced into suspension and settles out at a rate determined by the sediment particle size, density and ambient flow conditions. The jetting process is not intended to displace sediment to an extent that it is totally removed out of the trench; moreover, it requires that the fluidised sediment is available to fall back into the trench for immediate burial through settling. It is only the finer fractions of sediments that are likely to be held in suspension long enough to become prone to dispersal away from the trench as a plume. A key benefit of a jetting tool is that it can operate close to structures and it is also possible to use jetting tools for remedial burial if required. Typically, there are two methods of water jetting available: ‘Seabed Fluidisation’ and ‘Forward Jetting a Trench’.

112. Seabed Fluidisation involves first laying the cable on the seabed and afterwards positioning a jetting sledge above the cable. Jets on the sledge flush water beneath the cable fluidising the soil whereby the cable, by its own weight, sinks to the depth set by the operator.

113. Forward Jetting a Trench uses water jets to jet out a trench ahead of cable lay. The cable can typically be laid into the trench behind the jetting lance.

5.5.7.3 *Trenching*

114. Trenching involves the excavation of a trench whilst temporarily placing the excavated sediment adjacent to the trench. The cable is then laid, and the displaced sediment used to back-fill the trench, covering the cable. This is most commonly used where the cable must be installed through an area of rock or seabed composed of a more resistant material. Trenching is a difficult, time-consuming and expensive method to use compared to other methods and therefore unlikely to be the preferred option for the majority of the cable corridor.

5.5.8 Connection of cables to WTGs, OSPs and OCP

115. The connection of cable to WTGs, OSPs and if required under Option 3, the OCP, would be done by the support of ROVs. The cable will be pulled into the WTG, OSP or OCP via a J-tube (or alternative cable entry system), and later connected to the WTG, OSP or OCP. A typical methodology for installing the cable into a J-tube (shown on Plate 5.3 and Plate 5.6) is as follows, although alternative cable entry details and installation methods are being considered:

- A cable barge or a specialist cable installation vessel would be mobilised to the site. The cables would be supplied either on cable reels or as a continuous length;
- The vessel would transit to site and take up station adjacent to a wind turbine structure and either holds station on dynamic positioning (DP) or sets out a mooring pattern using anchors. A cable end would be floated off from the cable reel on the vessel towards the wind turbine structure and connected to a pre-installed messenger wire in the J-tube. The messenger wire would then allow the cable to be pulled up the J-tube;
- The cable would be pulled up the J–tube in a controlled manner with careful monitoring. When the cable reaches the cable temporary hang-off (at a later date a cable jointer would terminate the cable and install the permanent hang-off), the pulling operation ceases and the cable joint is made. The cable would be laid away from the J-tube on the first wind turbine towards the J-tube on the second wind turbine.
- When the cable installation vessel nears the J-tube on the second wind turbine structure, the cable end would be taken from the reel, ready for pulling up the J-tube; and
- The cable end would then be attached to the messenger wire from the bell mouth of the second J-tube. A tow wire would then be taken from the cable installation vessel and connected to the messenger line at the top of the J–tube and the pulling operation is repeated in the same manner as was employed at the first J-tube.

5.5.9 Jointing of offshore cables

116. Each section of cable is laid from the cable lay vessel (Plate 5.12) either from a static coil or a revolving turn carousel, turntable or drum (Plate 5.13) depending upon the characteristics of the cable. The cable is led via a cable pick-up arrangement and an associated cable track way through linear cable engines and is led overboard through a cable chute/stinger usually mounted at the stern of the vessel. For smaller array cable sizes, it is possible to use barges to lay the cable and these are generally at multiple short lengths. These sections must then be joined.

Plate 5.12 Indicative cable installation vessel (source: Van Oord, undated)

Plate 5.13 Example offshore cable drum (image courtesy of RWE Renewables)

5.5.10 Sediment disposal

117. If seabed preparation or drilling is required these methods would generate some spoil material that would require disposal. It is proposed the spoil will be disposed of within the offshore project area, with the spoil subsequently winnowed away by the natural tide and wave driven processes (see Chapter 8 Marine Geology, Oceanography and Physical Processes, Document Reference: 3.1.10).

118. A Site Characterisation Report (Document Reference: 7.26) is provided with the DCO application to inform licencing of the offshore project area as a disposal site.

5.5.11 Vessel and helicopter requirements during construction

5.5.11.1 *Vessel numbers and movements*

119. The number of each type of vessels required during the construction phase and the number of two-way round trips between port and site (defined as a 'vessel movements') are summarised in Table 5.22.

120. The total number of vessels operating onsite simultaneously at the peak of the offshore construction activity is assumed to be 35.

Table 5.22 Construction vessel numbers and movements

Vessel type	Indicative peak number of vessels	Number of movements
All grid connection options:		
Foundation installation: • Scour Layer Vessels • Gravity Base Foundation Vessels • Jack-up installation vessels (JUVs) • Support vessels • Transport vessels • Crew transfer vessels (CTVs)/Accommodation vessels • Transition piece installation vessels	35	1016
WTG topside installation: • WTG installation vessels • Support vessels • CTVs/Accommodation vessels • Commissioning vessels	15	655
OSP/OCP topside installation: • Installation vessels • Support vessels • Transport vessels • CTVs/Accommodation vessels • JUV *Vessel movements for two OSPs for Options 1 and 2; or one OSP and one OCP for Option 3 are within this envelope.*	24	104
Array cable installation vessels (includes support, cable protection and anchor handling vessels)	12	325
Option 1 and 2 only		
Export cable installation vessels (including at landfall): • Main laying vessels • Main burial vessels • Main jointing vessels • Support vessels	12	432

5.5.11.2 *Helicopter movements*

121. There may be a requirement for helicopters to travel to and from the North Falls offshore project area to assist with construction activities. It is estimated that

approximately 100 helicopter round trips may be required during the offshore construction period.

5.5.11.3 *Anchoring and jack-up*

122. Where they are used, jack-up barges (Plate 5.14) and anchored vessels will have a seabed footprint.

123. There would be six jack up locations for each WTG and OSP/OCP on average during construction. Each jack up leg could have a footprint of up to 275m^2 and it is assumed a jack up barge could have six legs, resulting in a total footprint of 584,100m^2 for 57 WTG and two OSPs/OCP.

124. Anchoring may also be required during foundation installation, with an average of five anchoring events per foundation (at up to 57 WTG and two OSPs). Assuming an anchor width of 4.85m and drag of 24m (footprint of 116.39m^2), and eight anchors per vessel, the total footprint would be 274,704m^2.

125. Anchoring may also be required during installation of the export cables, platform interconnector cable and array cables. It is estimated there would be:

- 386 anchoring events during array cable installation;
- 46 anchoring events during platform interconnector cable installation; and
- 546 during export cable installation (required for Options 1 and 2 only).

126. Assuming an anchor width of 4.85m and drag of 12.51m (footprint of 60.69m^2), and nine anchors per vessel, the total footprint would be:

- 210,761m^2 for array cables;
- 25,117m^2 for platform interconnector cable; and
- 297,850m^2 for export cables (required for Options 1 and 2 only).

Plate 5.14 Example jack-up barge (image courtesy of RWE Renewables)

5.5.11.4 *Safety zones*

127. During construction and periods of major maintenance, NFOW would seek to agree appropriate safety zones around any potentially hazardous works.

128. Application for safety zones will be made post consent under 'The Electricity (Offshore Generating Stations) (Safety Zones) (Applications Procedures and Control of Access) Regulations 2007' (S.I. No 2007/1948).

129. The Applicant will apply for safety zones of 500m around any structure where construction and major maintenance is ongoing (i.e., where there may be sensitive vessel operations underway). In addition, pre-commissioning safety zones of 50m in radius will be applied for around structures up until the point of final commissioning of the Project.

130. Advisory safe passing distances may also be promulgated around any sensitive operations, where a safety zone does not apply (e.g., cable installation).

131. Safety zones are discussed further in Chapter 15 Shipping and Navigation (Document Reference: 3.1.17) and in the Safety Zone Statement (Document Reference: 7.23).

5.5.12 Oils, fluids and effluents

132. Oils in the wind turbines shall be biodegradable where practicable. All wind turbines will have provision to retain all spilt fluids within nacelle/tower. The volume of oil and fluids will vary depending on wind turbine design, i.e., conventional (geared) design or gearless (direct drive), whether one or two or more rotor bearings are used in the design and the amount of redundancy designed into the system.

133. All chemicals used will be certified to the relevant standard. The following indicative substances are typical in offshore wind farm infrastructure:

- Grease;
- Synthetic oil / hydraulic oil;
- Nitrogen;
- Water / glycerol;
- Mineral, natural or synthetic transformer oil e.g., mineral oil, silicone or midel; and
- SF6 gas or equivalent alternative.

5.5.13 Offshore construction programme

134. The final design (e.g., number of turbines, platform, cables, etc.) and supply chain will affect the construction programme, as well as weather conditions during construction.

135. The overall North Falls construction programme is anticipated to be approximately 5 years, with onshore construction works starting in year 1 (Section 5.7.7) and offshore construction works in year 4. UXO clearance would be subject to separate licencing and is likely to occur during year 3.

136. Indicative programmes are provided below in Table 5.23. Offshore working hours during construction are anticipated to be 24/7.

Table 5.23 Indicative offshore construction programme (likely timescale for works shown in dark green, potential construction window in light green)

	Year 1-3	Year 4				Year 5			
	(*Onshore works, see Table 5.29*)	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Substation installation									
Substation commissioning									
Export cable installation									
Foundation installation									
Array cable installation									
Wind turbine installation									
Commissioning									

5.5.14 Offshore operation and maintenance

5.5.14.1 *Operation*

137. The operation and control of the wind farm would be managed by a SCADA system, connecting each turbine to the onshore control room. The SCADA system would enable the remote control of individual turbines, the wind farm in general, as well as remote interrogation, information transfer, storage and the shutdown or restart of any wind turbine if required.

5.5.14.2 *Maintenance*

138. All offshore infrastructure including wind turbines, foundations, cables and offshore substations would be monitored and maintained during the operation and maintenance (O&M) period in order to maximise operational efficiency and safety for other sea users.

139. Typical maintenance activities would include:

- General scheduled service of wind farm components (e.g., painting and cleaning of WTG structures, servicing of electrical equipment);
- Unscheduled repair and maintenance of wind farm components (e.g., major WTG and electrical equipment components and/or minor repairs/replacements such as ladders, J tubes and anodes)
- Oil sampling / change;
- UPS (uninterruptible power supply) battery change;
- Service and inspections of wind turbine safety equipment, nacelle crane, service lift, high voltage system, blades;
- Cable burial inspection;
- Cable repair and replacement;
- Foundation inspection and repair; and
- Cable crossing inspection and repair.

5.5.14.2.1 Cable repairs

140. During the life of the Project, there should be no need for scheduled repair or replacement of the subsea cables, however, reactive (unscheduled) repairs and periodic inspection may be required.

141. An estimated four repairs of the export cables (applicable to Options 1 and 2 only) and five repairs of the array cables and/or platform interconnector cable, approximately, over the Project life is included in the EIA. It is assumed 600m length of cable would be removed and replaced in the event of a repair operation.

142. In most cases a failure would be repaired by taking out the damaged part of the cable, cutting the cable, inserting a joint, bringing a new segment of cable and jointing the new segment with the old cable.

143. The cable would be unburied using jetting (or removal of mattress/rock protection) and then once the repair is done the opposite (reinstalling the mattress, rock dumping, jetting or other methods of cable burial or protection).

5.5.14.2.2 Cable reburial

144. Periodic surveys would be required to ensure the cables remain buried and if they do become exposed, re-burial works would be undertaken. The following estimated reburial over the Project life is included in the EIA:

- Reburial of 2.75% of the array cable length;
- Reburial of 2.75% of the platform interconnector cable length; and
- Reburial of 4% of the offshore export cable length.

5.5.14.2.3 WTG maintenance

145. The wind farm would be maintained from shore using a number of O&M vessels (e.g., crew transfer vessels) possibly supported by helicopters.

146. Although it is not anticipated that large components (e.g., wind turbine blades or substation transformers) would frequently require replacement during the operational phase, the failure of one of these components is possible. Should this be required, a jack-up vessel may need to operate for a number of months to carry out these major maintenance activities at the affected turbines.

147. During some of the O&M visits (Table 5.24), cleaning of the foundations and ancillary structures may occur. This would involve scraping and/or jet washing marine growth and bird guano from the turbine structures. The jet washing would be done with seawater and therefore only natural materials would enter the marine environment.

5.5.14.2.4 UXO clearance

148. During O&M, clearance of UXO may be required and an estimate of one UXO clearance operation per year in the offshore project area is assessed in the ES.

149. As with UXO clearance during construction (Section 5.5.4.1.2), the maximum net explosive quantity of UXO in this region is predicted to be 698kg, however the impact assessments include a conservative worst case scenario of 750kg in accordance with Natural England (2022).

150. The UXO clearance procedure would be subject to additional marine licencing, to be progressed once the area in which UXO clearance activities are proposed and type of UXO are known.

5.5.15 Vessel and helicopter requirements during O&M

5.5.15.1 *Vessel types and movements*

151. The number of each type of vessels required during the O&M phase and the annual number of round trips between port and site (defined as a 'vessel movements') are summarised in Table 5.24.

152. The total number of annual vessel movements (two way round trips) is estimated to be 1,222. There may be slight differences in vessel requirements for Options 1 and 2, compared with Option 3, namely there would be no export cable to maintain for Option 3. However, as the expected maintenance of the export cable is minimal (see Sections 5.5.14.2.1 and 5.5.14.2.2), there will be little difference in annual vessel movements. The vessel numbers and movements are therefore applied to all options, as a worst case scenario for the purpose of the impact assessments.

Table 5.24 Indicative O&M vessel numbers and movements

Vessel type	Number of vessels	Annual number of movements
Jack up vessels	2	7
Service operations vessels	2	52
Small O&M vessels (e.g., crew transfer vessels)	6	1095
Lift vessels	2	7
Cable maintenance vessels	2	1
Auxiliary vessels	8	60

5.5.15.2 *Helicopter movements*

153. There may be a requirement for helicopters to travel to and from the North Falls array area to assist with O&M activities. It is estimated that approximately 100 helicopter round trips may be required during the O&M period.

5.5.15.3 *Anchoring and jack-up*

154. For all grid connection options, it is estimated that 177 jack-up events could be required per year.

155. As described in Section 5.5.11.3, jack up vessels would have an estimated footprint of 1,650m^2, based on 275m^2 per leg and 6 legs.

156. Anchoring may be required during any required repairs of the export, array cables and platform-interconnector cables (Section 5.5.14.2.1). As described in Section 5.5.11.3, anchoring would have an estimated footprint of 60.69m^2 per anchor with up to nine anchors per vessel. It is therefore estimated the anchor footprint during cable repairs could be 546m^2 per repair.

5.5.15.4 *Safety zones*

157. During O&M activities NFOW would seek to agree appropriate safety zones around wind turbines if required during major maintenance works. Safety zones are discussed in Chapter 15 Shipping and Navigation (Document Reference: 3.1.17) and in the Safety Zone Statement (Document Reference: 7.23).

5.5.15.5 *O&M port*

158. An O&M facility would be required, however this does not form part of the DCO application. The facility would be located in a service port (yet to be chosen). An office, storage or warehouse facility and quayside loading area would be needed.

5.5.16 Offshore decommissioning

159. The scope of the decommissioning works would be determined by the relevant legislation and guidance at the time of decommissioning.

160. Offshore, this is likely to include removal of all of the wind turbine components and part of the foundations (those above seabed level). Cables, cable protection and scour protection would likely be left in situ. The anticipated techniques for the various foundation types are as described below. The timescale for decommissioning works is estimated to be approximately 3 years.

161. The number of vessels and helicopters required for decommissioning are expected to be similar to construction (see Section 5.5.11.2).

162. As an alternative to decommissioning, NFOW may wish to consider re-powering the wind farm. Should NFOW choose to pursue this option, this will be subject to a new application for consent.

5.5.16.1 *Monopile foundations*

163. The overall removal methodology for steel monopile foundations would typically be as follows:

- Removal of turbine, mast, switchgear and ancillaries, and cutting of cables (leaving buried array cables in situ);
- Mobilisation of service vessel;
- Local jetting and/or suction around base of monopile to a depth of approximately 1-2m;
- Deployment of underwater remote abrasive cutting equipment from service vessel;
- Mobilisation of heavy lift DP vessel or jack-up rig and attachment of crane slings to top of monopile and transition piece (TP);
- Abrasive cutting of monopile at a depth of approximately 1-2m below the seabed;
- Lifting of combined monopile/TP by crane on DP vessel or jack-up rig onto barge;
- Transportation of monopile/TP to port and dry dock for dismantling and reuse where possible, or recycling where practicable.

164. It would not be intended to reinstate the local excavations remaining at the monopile locations as it is anticipated that this would refill naturally over time.

5.5.16.2 *Pin-pile jacket foundation decommissioning*

165. The overall removal methodology for pin pile foundations would typically be as follows:

- Removal of turbine, mast, switchgear and ancillaries, and cutting of cables (leaving buried array cables in-situ);
- Local jetting and/or suction around legs of jacket to a depth of approximately 1-2m;
- Deployment of underwater remote abrasive cutting equipment from service vessel;
- Mobilisation of heavy lift DP vessel or jack-up rig and attachment of crane slings to jacket;
- Abrasive cutting of pile legs at a depth of approximately 1-2m below the seabed;
- Lifting of jacket by crane on DP vessel or jack-up rig onto barge; and
- Transportation of jacket to port and dry dock for dismantling and reuse where possible, or recycling where practicable.

166. It would not be intended to reinstate the local excavations remaining at the pile leg locations as it is anticipated that this would refill naturally over time.

5.5.16.3 *Gravity base structures*

167. The overall removal methodology for gravity base structures would typically be as follows:

- Removal of turbine, mast, switchgear and ancillaries, and cutting of cables (leaving buried array cables in-situ);
- Mobilisation of heavy lift DP vessel or fleet of tugs (dependent on whether foundation design is buoyant or requires heavy lift);
- Removal of marine growth and sediment from base and jetting under base plate to remove adhesive effects of grout (if present) or cohesive bearing material. If a deep skirt has been used, the skirt may require cutting;
- It may also be necessary to locally remove scour protection via dredging;
- For buoyant design: controlled de-ballasting of foundation using remote pumping equipment and/or installation of buoyancy aids. Foundation will become buoyant on de-ballasting;
- For design requiring heavy lift: lifting of foundation from seabed onto barge (as per installation, a bespoke transportation barge may be required dependent on the design); and
- Transportation of foundation to port and dry dock (via towing or on barge dependent on foundation type) for deconstruction and reuse where possible, or recycling where practicable.

5.5.16.4 *Suction bucket foundations*

168. The overall removal methodology for suction bucket foundations would typically be as follows:

- Removal of turbine, mast, switchgear and ancillaries, and cutting of cables (leaving buried array cables in-situ);
- Mobilisation of service vessel with pumping equipment and ROV, and mobilisation of tugs. It may also be necessary to mobilise a DP vessel with craneage to facilitate with the refloating and subsequent manipulation of the foundation;
- Removal of sediment and marine growth from suction bucket lid, and jetting of pump connections on lid. It may also be necessary to locally remove scour protection via dredging;
- De-ballasting or adding of buoyancy aids to foundation as required by design;
- Connection of pumping equipment to suction bucket valves;
- Controlled pumping of water into bucket/caisson chambers. The bucket will rise from its installed position to the surface as the internal pressure overcomes the side wall friction. Some manipulation from craneage on a DP vessel may also be required; and
- Towing of foundation to port and dry dock for dismantling and reuse where possible, or recycling where practicable.

5.5.16.5 *Removal of scour protection*

169. Where scour protection materials have been used, it is likely that they would be left in place. There would be some disturbance of the scour protection materials during the removal of the foundations but they would simply fall to the seabed and flatten over time.

5.5.16.6 *Removal of cabling and cable protection*

170. There is no existing statutory requirement for removal of decommissioned cables. Furthermore, removing buried cables and/or cable protection is technically challenging and may have greater adverse impact than leaving in situ. This would be subject to further environmental evaluation prior to decommissioning to inform the approach to decommissioning.

171. Exposed sections of cable are more likely to be cut and removed to ensure they do not become hazards to other users of the seabed, such as shipping and fishing.

172. If removal is undertaken, techniques are likely to be similar to those considered for the installation, in a reverse process to expose and remove them. Once the cables are exposed, grapples would likely be used to pull the cables onto the decks of cable removal vessels. The cables would then be cut into manageable lengths and returned to shore for recycling.

173. The area of seabed impacted during the removal of the cables could therefore be equal to the area impacted during the installation of the cables.

5.5.16.7 *Safety zones*

174. During decommissioning NFOW would seek to agree appropriate safety zones around any potentially hazardous works. Safety zones are discussed in Chapter 15 Shipping and Navigation (Document Reference: 3.1.17) and in the Safety Zone Statement (Document Reference: 7.23).

5.5.17 Offshore embedded mitigation

175. The following key mitigation commitments have been made in designing the offshore components of the Project:

- The Project boundary has been significantly refined during the pre-application phase, discussed further in Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6) and in summary:
    - Removal of overlap with the Kentish Knock East MCZ (discussed further in ES Chapter 10 Benthic and Intertidal Ecology (Document Reference: 3.1.12));
    - Removal of the northern array area (discussed further in ES Chapter 15 Shipping and Navigation and ES Chapter 29 Seascape, landscape and Visual Impact Assessment (Document Reference: 3.1.31);
    - Removal of interconnector cable corridor between the northern and southern array areas assessed at PEIR;
    - Increased buffer from the International Maritime Organisation designated vessel routing measure (discussed further in ES Chapter 15 Shipping and Navigation (Document Reference: 3.1.17)); and

    - Increased buffer from the Outer Thames Estuary Special Protection Area (discussed further in ES Chapter 13 Offshore Ornithology (Document Reference: 3.1.15)).
- The offshore cable corridor was designed in consultation with key nature conservation and shipping consultees to minimise impacts on these receptors (discussed further in Chapter 4 Site Selection and Assessment of Alternatives, Document Reference: 3.1.6);
- Micrositing and microrouting to avoid sensitive receptors, where practicable, based on pre-construction surveys; and
- There will be a soft start and ramp up of pile driving.

5.6 Landfall (required for grid connection Options 1 and 2 only)

176. 'Landfall' refers to the area between the subtidal Horizontal Directional Drill (HDD) exit pit and location at which the offshore export cables are connected to the onshore export cables within transition joint bays. It also refers to the land within the onshore landfall compound, where temporary works to facilitate cable installation at the landfall will take place.

177. Housing for the cables, typically comprised of High Density Polyethylene (HDPE) ducts, is proposed to be installed at landfall using HDD methodology. The offshore export cables are then pulled through the pre-installed ducts, which terminate at the transition joint bays, where they are jointed to the onshore export cables. Further details regarding landfall infrastructure and construction are set out below.

5.6.1 Landfall location

178. The export cables will be brought ashore in the landfall at Kirby Brook, as shown on Figure 5.2 (Document Reference: 3.2.3).

5.6.2 Landfall project details summary

Table 5.25 Landfall project characteristics

Feature	Parameters
Maximum number of cable circuits	2
Maximum number of transition joint bays	2
Permanent land take for each transition joint bay (per bay)	4 x 15m
Landfall compound dimensions	75 x 150m
Proposed landfall installation method	HDD
Maximum number of HDDs	3
Maximum length of HDD	1,100m
Drill exit location	Subtidal exit in the subtidal zone c.1.5km from Mean Low Water Springs (MLWS).
Maximum depth of HDD	20m

5.6.3 Landfall construction methods

5.6.3.1 *Horizontal directional drilling*

179. HDD involves a three-stage process (as shown in Plate 5.15) wherein:

- A small diameter pilot bore is drilled along the designated route;
- The pilot bore is enlarged by passing a larger cutter tool known as the reamer through the bore a number of times to progressively enlarge the bore to the required diameter; and
- Ducts are installed within the enlarged hole and the offshore export cable is pulled through the ducting.

180. Drilling is facilitated with the aid of a viscous fluid known as drilling fluid. It is typically a mixture of water and bentonite (an inert form of clay), and which may contain other additives which would be required depending on the nature of the drilling process used. The drilling fluid is continuously pumped to the cutting head or drill bit to facilitate the removal of cuttings, stabilise the borehole, cool the cutting head, and lubricate the passage of the duct. Drilling fluid would be recycled where practicable, with fluid pressures monitored throughout the process to minimise the potential for 'breakout' (also referred to as 'frac-out') of the drilling fluid. A breakout may occur if the drilling fluid escapes through natural fissures in the bedrock or other weaknesses in geology and reaches the surface. A contingency plan will be prepared in advance of works, detailing the procedures to be followed in the event of breakout, secured by DCO Requirement. An Outline Horizontal Directional Drill Method Statement and Contingency Plan, providing details of the potential risk of breakout, how these have been reduced and what measures will go into the contingency plan, has been prepared and submitted as part of the DCO application (Document Reference: 7.15).

181. A small pilot hole is drilled from an onshore entry pit and advanced in stages until a predetermined distance from the seabed exit point is reached (forward reaming). This is likely to be approximately 20-50m from the seabed exit point. The pilot hole would be drilled along a predetermined path using a mud-motor or jet bit on the end of a pilot string. As the pilot hole extends through the superficial layer of ground (typically topsoil and made ground), casing (typically a metal pipe or collar around 20-50m long) may be installed in the bore to assist in maintaining the integrity of the upper ground layer. Pilot hole drilling operations continue until the exit point is approached, although at landfall the pilot hole would not break through the final section of seabed. Then the smaller pilot string is removed with the casing (if used).

182. Once the pilot hole is completed, the bore will be enlarged by passing a larger cutting tool known as a reamer. This would be achieved by passing the reamer through the bore a number of times to progressively enlarge the bore to the diameter required for duct installation. During the final reaming, the bore would progress to the final exit point on the seabed – this process is called punch-out. Typically, reaming takes place in a forward direction, from the HDD rig outward along the pilot hole and back.

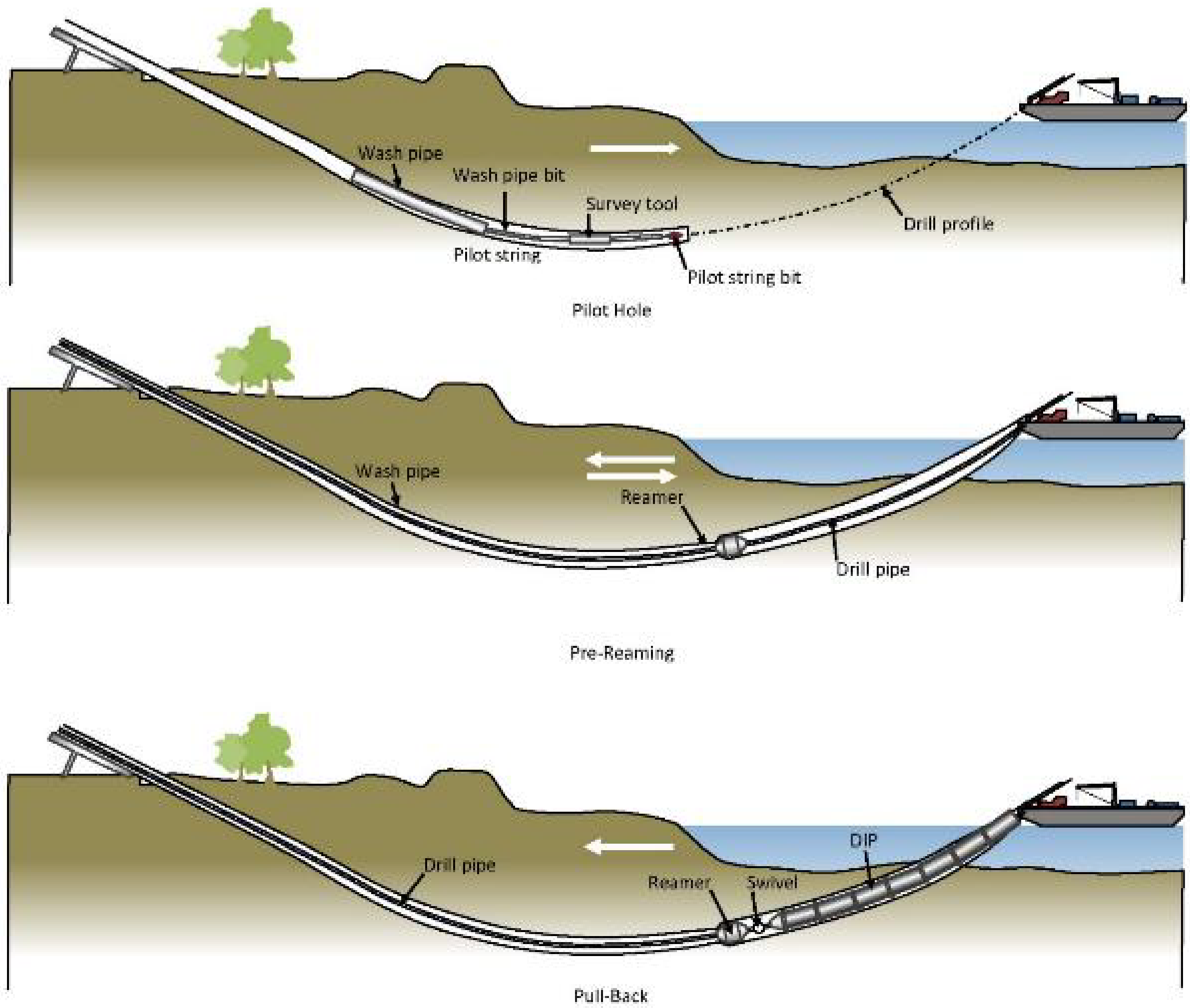

Plate 5.15 Example HDD working method at landfall

183. The ducts would be typically floated into position at the offshore exit point via barges. The ducts would then be flooded with water and pulled into the reamed drill hole from the entry pit, using a drill rig. Alternatively, the ducts could be welded in sections onshore and pulled from the offshore side. Once the duct is installed, the ends would be covered or plugged until the offshore export cable is ready to be installed.

184. Following installation, the duct would be backfilled and surrounded with bentonite or a similar material for thermal resistivity purposes.

185. Installation by HDD would require a fenced landfall compound. A maximum 150 x 75m temporary landfall compound for up to two transition joint bays may be required.

186. The HDD works would progress with the following stages:

- Mobilise equipment to the selected landfall site and prepare a temporary construction base including hardstanding, temporary office cabins and bunded re-fuelling areas;
- Install a deadman anchor, typically of heavy duty sheet pile anchor wall, to prevent the HDD rig moving forward (absorb thrust during drilling);

- Position the HDD rig (see Plate 5.16 for example rig) behind the deadman wall close to entry pit and drill a pilot hole;
- Enlarge the pilot hole by reaming;
- ‘Punch-out’ of the seabed during the final reaming to complete the drill;
- Install the duct into the enlarged hole;
- If required, cover or plug the duct until the offshore export cable is ready to be pulled into the duct; and
- Removal of construction equipment and partial reinstatement of the site to its previous condition. Site is not fully reinstated as the site will be used again during the cable installation process (see below).

Plate 5.16 Example of an HDD drill rig at landfall – the cable duct is closest in the foreground (image courtesy of RWE Renewables)

5.6.3.2 *Cable installation*

187. Once the offshore export cable is ready to be installed into the duct at landfall, the following steps would be required:

- Upon arrival of the export cable installation vessel, the duct exit would be exposed. This may be achieved with methods such as use of a mass flow excavator (a submersible tool used to clear sediment without damaging the duct);
- The export cable installation vessel would be positioned at the HDD exit point by anchors prior to undertaking the cable pull-in operation, and the offshore export cables would be pulled ashore through the duct; and
- Following the completion of the pull-in operation (and subsequent termination and cable testing) the export cable installation vessel would commence cable lay operations for the remainder of the export cable.
- Subsequent to the cable lay operations, the cable in the transition zone between the HDD duct and full depth of the cable trench would be lowered

utilising diver-based jet lancing and dredging operations, most likely supported from a small anchored or spudded / jack-up barge.

5.6.3.3 *Cable jointing and transition joint bays*

188. The heavily armoured offshore export cables and the onshore cables are jointed within transition joint bays located at the landfall compound. A maximum of two transition joint bays (one per cable circuit) would be constructed within the HDD temporary construction compound at landfall. The landfall compound location is shown on Figure 5.2 (Document Reference: 3.2.3). Once the cables are jointed, each transition joint bay is backfilled and the cables buried. The only visible above ground structures are the concrete link boxes (see Plate 5.17 and Plate 5.26 for link boxes before and after reinstatement).

189. The installation of each transition joint bay would involve the following:

- Mechanical excavation of the transition joint bay chamber (excavation would be slightly larger than the joint bay dimensions). Excavated material would be stored and used as backfill with any excess removed from site and suitably disposed of;
- Dewatering of excavations may be required. This would require the establishment of a pump for dewatering the excavations;
- Construction of transition joint bay chamber:
    - Each transition joint bay will be constructed of a reinforced concrete base slab to provide a clean surface for jointing of the cables;
    - After jointing is completed, the predetermined area around the cables is typically backfilled with suitable engineered material, such as Cement Bound Sand (CBS);
    - The remaining area of the transition joint bay are backfilled with suitable excavated soil.

190. The permanent below-ground footprint of each transition joint bay would be up to 4 x 15m. The depth of burial would be up to 2.15m. The ground surface would be reinstated to its original condition and use following completion of the construction works, as practicable.

Plate 5.17 Example transition joint bay including the concrete link boxes – the tops of which are the only structures that are visible above ground once reinstatement is complete (image courtesy of RWE Renewables)

5.6.4 Landfall design decisions

191. The following key design decisions have been made in designing the Project's landfall location and construction methodology:

- An early decision was made to mitigate impacts upon the Holland Haven Marshes Site of Special Scientific Interest (SSSI) through the following:
    - HDD will be used as the preferred construction method at the landfall, reducing the potential for disturbance of surface features of the SSSI;
    - The landfall compound is located entirely outside the SSSI boundary; and
    - Following consultation with Natural England and the Environment Agency during the Project's Evidence Plan Process, a contingency plan will be developed to manage the risks of HDD breakout during landfall construction, secured by DCO Requirement. An Outline Horizontal Directional Drill Method Statement and Contingency Plan is submitted with the DCO application (Document Reference: 7.15).

192. In addition, the following decisions have been made:

- Transition joint bays will be buried, with the land above reinstated to pre-construction ground level, with the exception of link box chambers where access will be required from ground level (via manholes). Once constructed, transition joint bays and link box chambers will be designed to have a high degree of flood resilience.
- Post-construction, the ground surface will be re-instated to its previous condition and use (as practicable).

5.6.5 Co-ordination with Five Estuaries

193. Identification of the landfall and landfall compound location has been undertaken in co-ordination with Five Estuaries (see Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6)). Five Estuaries are also proposing to undertake cable landfall works within the landfall compound identified in Figure 5.2, with the works for both projects being undertaken separately.

5.7 Onshore (required for grid connection Options 1 and 2 only)

194. The Project's onshore infrastructure comprises the following elements:

- onshore export cables housed within cable ducts connecting the offshore export cables at landfall to the onshore substation and on to the National Grid connection point;
- Onshore substation and ancillary works;
- Connection to the national grid;
- Works to improve Bentley Road and provision of temporary footway/cycleway.

195. Further details regarding project's onshore infrastructure and construction are set out below.

5.7.1 Onshore location

196. The Project's onshore infrastructure is proposed to be located entirely within the Tendring peninsula of Essex, and includes the following, as shown on Figure 5.2 (Document Reference: 3.2.3):

- Onshore cable route, between 72 - 130m wide and including space for temporary works for the installation of cable ducts and the installation of onshore export cables, including areas for TCCs, construction and operation and maintenance accesses;
- Onshore substation, proposed to be located west of Little Bromley;
- Onshore substation works area, which includes land required for temporary construction, export cables, means of access, drainage, landscaping, environmental mitigation;
- The search area for the EACN (the Project's National Grid connection point) within which the cables from the onshore substation will connect to the national grid.

197. Collectively, the footprint of the Project's onshore infrastructure is referred to herein as the 'onshore project area', and is shown on Figure 5.2 (Document Reference: 3.2.3).

5.7.2 Onshore project details summary

198. Key onshore project characteristics are summarised in Table 5.26 below. Detailed project characteristics for each element of onshore infrastructure is described in subsequent sections.

Table 5.26 Onshore project characteristics

Feature	Worst case parameters
Both onshore grid connection options (Options 1 and 2)	
Electrical connection type	HVAC
Expected grid connection location	Within Norwich to Tilbury proposed substation location (EACN) (see Figure 5.2, Document Reference: 3.2.3).
Maximum number of onshore circuits	Up to 2 circuits, typically comprising 3 power cables, 3 telecommunications cables and 1 earth cable in each circuit (up seven cables in total).
Proposed cable installation method	Open cut trenching and trenchless techniques (e.g., HDD) in sensitive locations (see Appendix 5.1 Crossing Schedule (Document Reference: 3.3.2).
Indicative onshore cable route construction width	Up to 72m (open cut trenching) Up to 90m (trenchless crossings) Up to 130m (complex trenchless crossings)
Cable trench dimensions	1.2m (width at base) – 3.75m (width at top) x 2m (depth)
Approximate onshore export cable length	24km
Maximum depth at trenchless crossings	20m
Estimated number of TCCs for the onshore cable route	Up to 11
Temporary construction compound footprints	150 x 150m (main) 100 x 100m (satellite) 75 x 150 (trenchless crossing compounds)
Onshore substation type	Air Insulated Switchgear (AIS)
Maximum onshore substation platform footprint	280 x 210m
Maximum onshore substation construction compound footprint	250 x 150m
Maximum onshore substation equipment height	18m
Grid Connection Option 1 only	
Number of sets of cable ducts installed (and number of trenches excavated)	2
Grid Connection Option 2 only	
Number of sets of cable ducts installed (and number of trenches excavated)	4

5.7.3 Onshore export cables

199. At this stage in the Project's design, an onshore cable route has been identified with the capacity to deliver grid connection Option 2, i.e. the installation of four sets of cable ducts (as required for North Falls and Five Estuaries). The cable route has been designed for a typical width of up to 72m in areas where open cut trenching is the proposed construction method, 90m where trenchless techniques are proposed and up to 130m in areas where the trenchless crossing is particularly complex. This cable route has been designed to also be wider in areas where further studies and assessment are required during the detailed design stage to resolve the precise location of the route.

200. The onshore cable route is shown on Figure 5.2 (Document Reference: 3.2.3).

201. The parameters of the onshore export cables are provided below in Table 5.27.

Table 5.27 Onshore export cables characteristics

Feature	Parameters
Electrical connection type	HVAC
Maximum number of onshore circuits	Up to 2 circuits, comprising up to 3 power cables, 3 telecommunications cables and 1 earth cable in each circuit
Estimated number of cable construction compounds	Up to 11
Temporary construction compound footprints	150 x 150m (main) 100 x 100m (satellite) 75 x 150 (trenchless crossing compounds)
Indicative external cable diameter	150mm
Indicative onshore cable route construction width	Up to 72m (open cut trenching) Up to 90m (trenchless crossings) Up to 130m (complex trenchless crossings)
Approximate onshore cable length	24km
Number of ducts required per circuit (where ducted) (i.e. one 'set')	Up to 7
Joint bay dimensions	4 x 15m
Estimated number of link boxes	96
Maximum cable trench dimensions	1.2m (width at base) – 3.75m (width at top) x 2m (depth)
Minimum target cable burial depth	1.2m
Minimum cable burial depth (to top of protection tile)	0.9m
Typical minimum depth of trenchless crossings below watercourses (bed level)	3m
Maximum depth at trenchless crossings	20m
Haul road carriageway width - allowable within the cable swathe	6m
Haul road width passing places and drainage – allowable within the cable swathe	10m
Estimated distance between haul road passing places	500m
Hedge replanting restrictions	Shrubs max 5m high within 6m of each cable centre.
Grid Connection Option 1 only	
Total maximum number of ducts onshore	Up to 14
Number of joint bays	(approximately every 500m) or up to 96
Number of trenches for all cables	Up to 2
Grid Connection Option 2 only	
Total maximum number of ducts onshore	Up to 28
Number of joint bays	(approximately every 500m) or up to 192

Feature	Parameters
Number of trenches for all cables	Up to 4

5.7.3.1 *Site establishment*

5.7.3.1.1 Construction accesses

202. New accesses from the local highway network will be constructed in advance of the construction works in that location to facilitate access to the onshore cable route. In most cases road modifications are required to facilitate the safe ingress and egress from the public highways at these locations. The locations of the 'zones' where proposed construction accesses will be located are shown on Figure 5.2 (Document Reference: 3.2.3), and the unique access identification numbers are shown on the Access to Works Plan (Document Reference: 5.9) provided with the DCO application.

203. All construction accesses would be removed, and land reinstated following the completion of construction. The exception to this would be under Scenario 2, where the temporary works would be used by Five Estuaries, who would then undertake reinstatement at the end of their construction period.

204. In addition to site access, there are also a number of crossing points where construction traffic utilising the onshore cable route haul road is required to cross the local road network. Construction traffic will not be permitted to access the onshore cable route from the public highway at these crossings points and will be limited to directly crossing from one side of the road to the other to continue along the haul road. These crossing points are shown on the Access to Works Plan (Document Reference: 5.9) provided with the DCO application.

5.7.3.1.2 TCCs

205. TCCs are required to support the onshore cable installation. A maximum of 11 TCCs will be required, including one main TCC. TCCs would also be required at landfall and the onshore substation. The proposed locations for the TCCs are shown on Figure 5.2 (Document Reference: 3.2.3),

206. TCCs are required to support the cable duct installation and cable pulling works. They act as a hub for the onshore construction works and would house the central offices, welfare facilities, and stores for cables, ducts, substances cover under control of substances hazardous to health (CoSHH) and other supplies required to complete the cable duct installation works, as well as acting as a staging post for equipment and component deliveries (see Plate 5.18). They may also support cement-bound sand or concrete batching plants, for the creation of link boxes. If used, such temporary batching plants would consist of material storage bins, conveyor systems and silos. TCCs would be fenced and be supported by temporary lighting where required. TCCs would be established in advance of the construction works in that location and would remain in situ for the duration of construction in any one location.

207. Where there is no existing hardstanding, TCCs would be constructed by laying a geotextile membrane or similar directly on top of the subsoil which would have stone spread over the top. Following completion of construction, geotextile / stone would be removed, and the site reinstated.

208. Temporary site drainage will be installed during construction at each TCC, with the routing and discharging of water undertaken in accordance with principles set out in the outlined in the OCoCP (Document Reference: 7.13), with final

construction drainage details to be secured within the final CoCP, submitted post-consent.

Plate 5.18 Example TCC (image courtesy of RWE Renewables)

5.7.3.1.3 Construction drainage

209. Prior to construction, a surface water drainage design would be developed and implemented to minimise water within the cable trench and ensure ongoing drainage of surrounding land. Water filling the trenches would be appropriately treated to ensure no adverse effects on the local watercourses.

210. Detailed construction drainage would be developed post-consent by a specialist drainage contractor, taking into account existing land drainage. A soakaway drainage pit may be required, where infiltration rate is found suitable, if no suitable outfall to a nearby by watercourse is possible.

211. Post-construction, agricultural drainage would be reinstated to include the replacement of any drains that were damaged during the construction process.

212. Construction drainage methods are outlined in the OCoCP (Document Reference: 7.13), with final construction drainage details to be secured within the final CoCP, submitted post-consent.

5.7.3.1.4 Topsoil strip and soil management

213. Topsoil would be stripped in advance of works in any one area of the onshore cable route in advance of construction.

214. Stripped topsoil and excavated subsoil would be stored separately within the onshore route. The area to be used for storing the topsoil would be cleared of vegetation and any waste arising from construction works (e.g., building rubble and fill materials). Topsoil would also be stripped from any land to be used for storing subsoil.

215. Effective stockpiles would be created by:

- Removing vegetation and waste materials from the area before forming stockpiles;
- Storing topsoil and subsoil layers separately;
- Locating stockpiles away from trees, hedgerows, drains, watercourses or excavations;
- Managing the site so that soil storage periods are kept as short as possible;
- Stockpiling soils in the driest condition possible;
- Using tracked equipment wherever possible to reduce compaction; and
- Protecting stockpiles from erosion by seeding or covering them.

216. Soil would be managed in line with MAFF *Good Practice Guide for Handling Soils* (2000) and Defra *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites* (2009).

217. Soil management is discussed further in Chapter 22 Land Use and Agriculture (Document Reference: 3.1.24), and outline soil management measures are included within the OCoCP (Document Reference: 7.13), with a final Soil Management Plan to be secured within the final CoCP, submitted post-consent.

5.7.3.1.5 Haul road

218. The haul road would provide safe access for construction vehicles along the onshore cable route, between TCCs and the work fronts. This would minimise the amount of vehicle movements between work areas on the existing road network. The haul road traffic surface would typically be 6m wide (and up to 10m wide at passing bay locations, located at approximately 500m intervals) with drainage and verges either side (see Plate 5.19). As a worst-case it is assumed to be required along the full length of the onshore cable route. Speed limits on the haul road are expected to be limited to 20 miles per hour (mph).

219. Following an initial topsoil strip, the haul road would be installed in stages as each work front progresses. It would be formed of protective matting, temporary metalled road or permeable gravel aggregate dependent on the ground conditions, vehicle requirements and any necessary protection for underground services.

220. Should the onshore cable route cross an open ditch or drain, and access for the haul road is required, an appropriately sized culvert may be installed within the ditch. The haul road would be installed over the top of the culvert to maintain access along the onshore cable route either side of the ditch. The culvert would be installed in the channel bed so as to avoid upstream impoundment and would be sized to accommodate reasonable worst-case water volumes and flows. The culverts may remain in place for the duration of the cable duct installation and subsequent cable pull.

221. At larger crossings, temporary bridges may be employed to allow continuation of the haul road. At sensitive locations, such as rail or river crossings, the haul road would effectively stop and would re-start on the opposite side.

222. When cable duct installation is completed, the haul road would be removed, and the ground reinstated using stored topsoil. Some sections of the haul road may need to be retained or reinstated to maintain access for the subsequent cable pulling stage. The exception to this would be under Scenario 2, where the

temporary works would be used by Five Estuaries, who would then undertake reinstatement at the end of their construction period.

Plate 5.19 Example haul road (image courtesy of RWE Renewables)

5.7.3.2 *Cable duct installation*

223. The onshore export cables comprise two separate circuits, with up to three HVAC power cables per circuit. The onshore export cables would be laid underground in HDPE ducts and would transport electrical power from landfall transition joint bay to the onshore substation.

224. The primary cable installation method would be open cut trenching, with cable ducts installed within the trench(es) and surrounded with suitably engineered soil (CBS) before backfilling with selected excavated soil. Cables would then be pulled through the pre-laid ducts at a later stage in the construction programme. Where it has not been possible for the onshore cable route to avoid crossing constraints such as transport routes (road and rail) or watercourses, then alternative trenchless crossing methodologies will be required, such as HDD.

225. Precise construction methods would differ according to the nature of the environment through which the onshore cable route was being constructed. Of particular importance are the underlying soils and strata, existing hydrological regimes, the terrain, existing physical constraints (such as other underground services) and environmental constraints (such as development or environmentally sensitive areas).

226. The installation of the onshore export cable ducts is expected to take between 18 – 27 months in total (for the installation of four ducts). The number of teams associated with the installation of the onshore export cables is yet to be determined, as is the length of onshore cable route to be worked on each day (see Section 5.7.7 for details of the onshore construction programme).

227. All aspects of the construction work would be in accordance with the Construction (Design and Management) Regulations 2015, as amended or replaced.

5.7.3.2.1 Open cut trenching

228. Cables ducts would be predominantly installed in up to two (grid connection Option 1) or four (grid connection Option 2) open cut trenches and would be installed approximately 1.2m below ground level (bgl). Cables would typically be 150mm in diameter (the duct being larger, approximately 300mm). An indicative open cut trenching cable cross-section is provided in Plate 5.20 below.

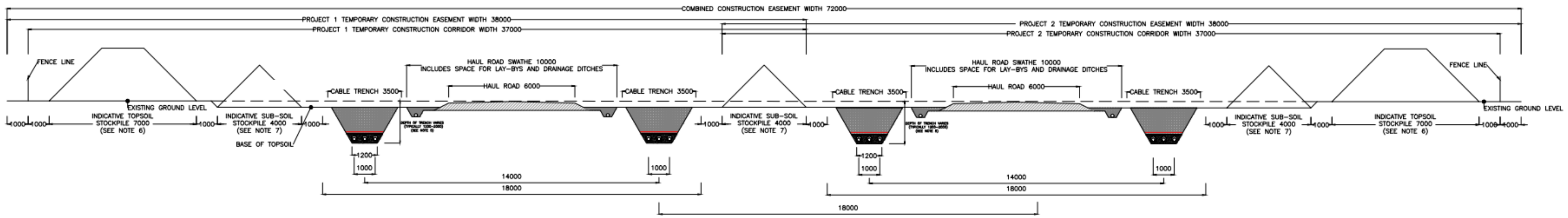

Plate 5.20 Typical construction swathe cross-section for open cut trenching (showing grid connection Option 1 (38m) and grid connection Option 2 (72m))

229. Each cable trench would require distributed temperature sensing (DTS) cabling to be installed next to the ducts or cables. Typically, this system comprises of a fibre optic cable within a protective sheath or duct. The DTS identifies faults in the buried cable during operation, allowing the precise location of any fault to be identified and more accurate excavation of the ground to facilitate the cable repair. Fibre optic and SCADA cables would also be installed adjacent to the onshore export cables.

230. Prior to installation, topsoil would be stripped from the section of the onshore cable route to be worked on and stored within the working width. The cable trenches would then be excavated. The excavated subsoil would be stored separately from the topsoil, and both would be managed to minimise soil erosion. Soil management is discussed further in Section 5.7.3.1.4 below, and in Chapter 22 Land Use and Agriculture (Document Reference: 3.1.24).

Plate 5.21 Typical open cut trench (image courtesy of RWE Renewables)

231. The cable duct installation works would be a continuous activity with a 'work front', with installation being undertaken within one section of the onshore cable route before moving on to the next. In any given location, once the cable ducts have been installed the trenches would be backfilled and the work front would continue moving onto the next section. This would minimise the amount of land being worked on at any one time.

232. Ducts would be buried to a minimum depth of 0.9m (from top of protection tiles to surface) and installed using two methods:

- Hand laying of the ducts, which is suited to short and / or complicated sections; and
- The use of a ducting trailer or trenching machine for longer uninterrupted trenching sections.

Hand laying method

233. Ducts would be palletised and manoeuvred along the easement using a telehandler (or equivalent). Operatives in the trench would lay zip ties in the base of the trench following the profile of the trench base and sides at

predetermined intervals ahead of the ducts being laid. Ducts are then laid out alongside the trench prior to lifting and lowering into the trench. The ducts would then be joined together in the trench.

Ducting trailer method

234. For longer sections of ducting a ducting trailer or trenching machine may be used. This enables the ducts to be joined on the trailer platform and lowered directly into the trench as the tractor moves the trailer forward. The ducts are zip tied into the correct formation prior to leaving the working platform. The use of the duct trailer or trenching machine minimises the need for personnel to work in the trench.

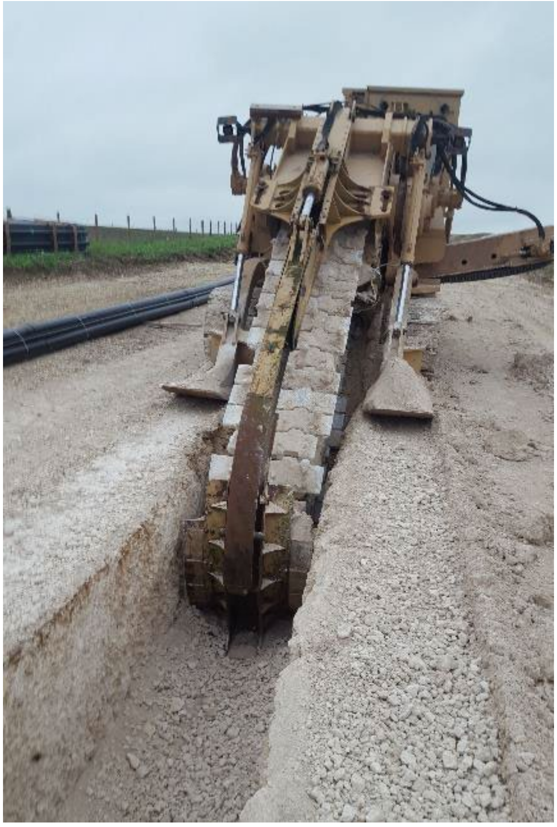

Plate 5.22 Example cable trenching machine (image courtesy of RWE Renewables)

Duct surround and backfill

235. Depending on the thermal resistivity of the soil and the height of the water table, it is likely that a stabilised backfill such as CBS would be required to encase the ducting. This is commonly used to ensure that the thermal conductivity of the material around the cables is of a known consistent value for the length of installation.

236. CBS has a low thermal resistance to conduct the heat produced during electricity transmission away from the high voltage cables. Additionally, as CBS tends to consist of a weak sand to cement ratio (typically 14:1), it is relatively easy to remove if maintenance or removal of ducts is required.

237. Once the ducts are encased in CBS (typically covering a depth of 100mm above the ducts to ensure the thermal resistivity requirements are met) a compaction plate would be used until the required level of compaction is achieved. Protection tiles and/or warning tapes are laid on top of the CBS. The trench would then be backfilled in stages using the subsoil stored at the side of the

trench(es) and compacted using suitable compaction plant. A warning tape is laid 100mm above the protection tiles, at a minimum depth of 0.9m below ground. Following construction, the stored topsoil would then be replaced on top of the backfilled subsoil to reinstate the trench(es) to pre-construction conditions, so far as is reasonably practicable.

Plate 5.23 Example a backfilled trench (image courtesy of RWE Renewables)

5.7.3.2.2 Obstacle crossings

238. Where it has not been practicable for the onshore cable route to avoid crossing constraints such as major roads and rail crossings, major watercourses or certain ecologically sensitive features (e.g., woodland, certain hedgerows), then trenchless duct installation methodologies will be used.

239. A crossing schedule has been provided in Appendix 5.1 (Document Reference: 3.3.2) which sets out the preferred cable installation method at all obstacles encountered along the onshore cable route. This schedule has been updated throughout the EIA process as more detail regarding the environmental constraints and engineering feasibility of each crossing is known.

Horizontal Directional Drilling (HDD)

240. The primary trenchless technique used will be HDD. The HDD process involves drilling underneath the feature being avoided. The process uses a drilling head to drill a pilot hole along a predetermined profile based on an analysis of ground conditions and cable installation requirements. This pilot hole is then widened using larger drilling heads until the hole is wide enough to fit the cable ducts.

241. Bentonite is pumped to the drilling head during the drilling process to remove drill cuttings and to stabilise the hole and ensure it does not collapse. Once the HDD drilling has taken place the ducts are pulled through the drilled hole.

242. Further details of HDD are described in Section 5.6.3.1.

Plate 5.24 HDD rig (image courtesy of RWE Renewables)

Other trenchless crossing methodologies

243. In addition to HDD, alternative crossing methods such as micro tunnelling or auger boring may be considered depending on the engineering constraints posed at each location. No final decision on trenchless method at each crossing points has been made at this stage.

244. For both micro tunnelling or auger boring a circular or rectangular pit (shaft or cofferdam) is constructed each side of the feature to be crossed. These are typically 1m below the invert level of the duct to be installed. The duct is driven through the side wall from the launch pit to a reception pit. The method of driving varies to suit prevailing ground conditions.

245. Auger boring involves drilling of a pilot pipe through the ground from the launch shaft to the reception shaft. An auger is attached to the end which clears the opening of soil and is itself followed by the permanent duct. Auger boring is suitable in most cases with the exception of sands or obstructions such as cobbles or boulders.

246. Micro-tunnelling involves remote control tunnel boring machines tunnelling themselves from the launch to reception shaft conveying spoil to the launch shaft via conveyors. The permanent duct immediately follows the machine, installed by jacking from the launch pit. This method can be used in most ground as the drilling head can be configured to prevailing ground conditions.

Minor crossings methodologies (open cut trenching)

247. Other obstacles, such as certain minor road, watercourse, or hedgerows crossings where trenchless techniques are not feasible will need to be crossed using alternative approaches. These are summarised below.

Minor road crossings

248. Where the onshore cable route cross certain minor roads, tracks and Public Rights of Way (PRoW), open cut trenching methods are proposed in combination with traffic management.

249. Where appropriate, single lane traffic management would be utilised during installation with signal controls to manage traffic movement. Where the width of a road does not permit single lane traffic management and road widening is not feasible, alternative methods such as temporary road closure or diversion could be required.

250. Where standard traffic management techniques are not deemed to be suitable, it may be necessary to revert to a trenchless crossing solution.

251. The approach for each crossing would be agreed with the relevant authority prior to works beginning and would be detailed in the Construction Traffic Management Plan (CTMP), secured by DCO Requirement. An Outline CTMP (OCTMP) is provided with the DCO application (Document Reference: 7.16). Temporary closures or diversions would only be required for the duration of time that duct installation takes place in that location. Temporary crossings of the onshore cable route could then be installed to allow public or private access to continue where the haul road is required to remain in service. The crossings would be managed to allow safe operation.

252. Reinstatement of the trench(es) would broadly follow the same process described in Section 5.7.3.2.1, however, the road surface would be reinstated to a specification agreed with the local highway authority.

Minor watercourse crossings

253. Where certain minor watercourses such as field drains are to be crossed, the approach could be open cut trenching combined with temporary damming and diverting of the watercourse. The suitability of this method would be agreed at the detailed design stage.

254. The watercourse would be dammed at either side of the cable crossing point, typically using sandbags and ditching clay, and the water within the watercourse would be pumped or piped (for example, using a flume at bed level) across the dammed section to effectively maintain flow across the dammed section. The cable trench(es) would then be excavated within the dammed section in the manner described in Section 5.7.3.2.1 whilst ensuring that the watercourse bed materials are stored separately to subsoils. Ducts would be installed at a depth that would avoid impacts to the active channel bed.

255. Reinstatement of the trench(es) would be conducted to the pre-construction depth of the watercourse, taking care to reinstate the channel bed material and subsoils in the order that they were removed. The dams would then be removed. Temporary dams and diversion would only be required for the duration of time that duct installation takes place in that location.

256. The haul road could also require culverting or temporary bridging in these locations to allow continued access up and down the onshore cable route. These would remain in place for the duration that the haul road is required and would be removed once cable duct installation is complete. Some sections of the haul road may need to be retained to maintain access for the subsequent cable pulling phase.

5.7.3.3 *Cable installation*

5.7.3.3.1 Cable pull

257. Cables would be pulled through the pre-installed ducts later in the construction programme (refer to Section 5.7.7). The trench(es) would not need to be

completely reopened, and the cable pull would take place from jointing bays located approximately every 500m along the onshore cable route.

258. Typically, this would be achieved by accessing the onshore cable route directly from existing accesses (e.g., the existing road network) where possible. Cable pull would follow on immediately from duct install, and hence sections of the haul road would need to be retained following the duct installation works to facilitate access for the cable pull. At this stage it is unknown exactly what proportion of the haul road would need to be retained and as a worst-case it is assumed that 100% of the haul road would remain in place throughout the cable pulling works. Under North Falls and Five Estuaries co-ordination Scenarios 1 and 2, the haul road would also need to be retained in these same areas for use by Five Estuaries cable pull immediately following the construction by North Falls, or vice versa. In these instances, removal of the haul road would be undertaken by the second project to progress to construction (see Section 5.7.3.4 below for further details on reinstatement).

259. During the cable pull and jointing works, cable drums would be delivered by heavy goods vehicle (HGV) low loader to the joint bay locations and a winch attach to the cable. The cable would then be winched off the drum from one joint pit to another, through the buried ducts. Cable jointing would be conducted once both lengths of cable have been installed within each joint bay.

5.7.3.3.2 Cable jointing and jointing bays

260. Joint bays would be required along the route of the onshore export cables to connect sections of cable. The joint bays would be formed upon completion of the duct installation works before the cables are installed and would typically be up to 15m long and 4m wide. The depth of the joint bays is yet to be determined, but is typically up to 2.05m deep, with a minimum of 0.9m of cover.

261. Joint bays would be constructed with a concrete raft floor, battered sides and also include a containerised enclosure within which the jointing takes place. Earth mats would be installed within the joint bays and at the link box positions which would consist of four earth rods driven into the ground and connected via earth tape to provide a low resistive connection to earth. The joint bays would be backfilled with CBS to ensure that the cables are stabilised from future thermo-mechanical movement. Following CBS backfill, subsoil and topsoil would be reinstated above the joint bay.

262. All excavation and reinstatement activities for the joint bays would be conducted in the same manner as that described for the cable trenching activities. At joint bay locations, a proportion of the originally excavated soils would be surplus and may require removal from the site. Adoption of a Code of Practice which complies with CL:AIRE (Contaminated Land: Applications in Real Environments) would be developed to manage the re-use and disposal of excavated soils on site, and included within the CoCP, secured by DCO Requirement.

Plate 5.25 Example jointing bay with cable pulled through (image courtesy of RWE Renewables)

5.7.3.3.3 Link boxes

263. Link boxes are required in proximity to the jointing bay locations to allow the cables to be bonded to earth to maximise cable ratings. Link boxes would not be required at all jointing bay locations, but as a worst-case scenario it is assumed that they could be required at a frequency of one every 500m. The number and placement of the link boxes would be determined as part of the detailed design.

264. The link boxes would require periodic access by technicians for inspection and testing. Where possible, the link boxes would be located adjacent to field boundaries and in accessible locations.

265. The link boxes need to be accessible during operation of the cables. The link boxes would also include a secure access panel.

Plate 5.26 Example link box following reinstatement (image courtesy of RWE Renewables)

5.7.3.4 *Reinstatement and site demobilisation*

266. Following completion of the works, all areas of the onshore cable route including cable trenches, spoil storage, haul road and temporary construction compounds will be reinstated to their original condition. This process will be continuous during construction as each area of the works is completed. Under North Falls and Five Estuaries co-ordination Scenarios 1 and 2, the haul road and TCCs would also need to be retained in these same areas for use by Five Estuaries cable pull immediately following the construction by North Falls, or vice versa. In these instances, removal of the haul road and TCCs would be undertaken by the second project to progress to construction.

267. Reinstatement will include replanting of any hedgerows removed and reinstatement of any watercourses temporarily diverted during construction. Hedgerows will be replanted following the approach described in Chapter 23 Onshore Ecology (Document Reference: 3.1.25). Certain canopy trees will be restricted from being planted within 6m of the buried cables.

268. PRoW or other access tracks temporarily diverted during construction will also be reinstated to their original route.

5.7.3.5 *Operations and maintenance*

269. There is no ongoing requirement for regular maintenance of the onshore cables following installation, although cable would be monitored during the Project's lifetime. Access to the onshore export cables would be required to conduct emergency repairs, if necessary. In the event of such repairs, access to each field parcel along the onshore cable route would be from existing field entry points or accessing the onshore cable route from road crossings. The location of operational and maintenance access points are shown on Figure 5.2

(Document Reference: 3.2.3). Emergency repairs would entail excavating the jointing bay and repulling the affected section of cable.

5.7.3.6 *Decommissioning*

270. No decision has been made regarding the final decommissioning policy for the onshore export cables, as it is recognised that industry good practice, rules and legislation change over time. It is likely the cables would be removed from the ducts and recycled, with the transition pits and ducts capped and sealed then left in situ.

5.7.4 Onshore substation and grid connection

271. At this stage in the design of the onshore substation, a location of the onshore substation platform has been defined, as has a wider onshore substation works area, which will contain ancillary works including all temporary construction works, a TCC, access, drainage, landscaping and environmental mitigation. Indicative layouts for these ancillary works are shown on Figure 5.2, Document Reference: 3.2.3.

272. The onshore substation will be an AIS design where the high voltage equipment is installed outdoors with open air terminations.

273. A maximum of area of 280 x 210m would be required for the onshore substation platform, with additional land required for access, drainage, landscaping and environmental mitigation.

274. The onshore substation is anticipated to include the following elements:

- Control building;
- STATCOM buildings and switchgear;
- Storage / amenity building;
- Transformers (including noise enclosures);
- Reactor noise enclosures;
- Water tanks;
- Distribution Network Operation (DNO) packaged substation; and
- DNO meter cabinet.

275. The largest structures within the onshore substation listed above would be the STATCOM building with an approximate height of 7m; the tallest height of any electrical equipment would be switchgear with a height of 13m; and the tallest height of any structure would be lightning masts, which would be a maximum of 18m tall.

Plate 5.27 AIS control building (image courtesy of RWE Renewables)

Plate 5.28 Transformer with noise enclosure (image courtesy of RWE Renewables)

Plate 5.29 Onshore substation (image courtesy of RWE Renewables)

5.7.4.1 *Design*

276. The onshore substation will seek to adhere to principle of 'good design' for energy infrastructure as outlined in NPS EN-1 (DESNZ, 2023a). To this end, NFOW has prepared a Design Vision document (Document Reference: 2.3) which outlines a series of design principles that have and will continue to be used to guide the development proposals for the Project. The principles seek to enhance and strengthen the landscape character of the North Falls setting, ensuring that a sensitive and high-quality development is successfully integrated within the local community. North Falls have undertaken a Design Review of these principles with the Design Council in advance of the DCO application. The recommendations of the review have been provided with Design Council Review Letters, appended to the Design Vision (Document Reference: 2.3). The recommendations of the Design Review will be considered further during the Project's detailed design, post-consent.

277. This document will underpin all ongoing design work for the Project and will frame the development of the onshore substation design to ensure it meets the principles of good design for energy infrastructure.

5.7.4.2 *Onshore substation parameters*

278. Table 5.28 shows the main construction parameters for the onshore substation.

Table 5.28 Onshore substation parameters

Feature	Parameters
Maximum onshore substation platform footprint	280 x 210m

Feature	Parameters
Maximum external equipment height (lightning masts)	18m
Maximum electrical equipment height (switchgear)	13m
Maximum building height (STATCOM building)	7m
Construction compound indicative dimensions (m)	150 x 250m
Component transport indicative max. height on loaded transporter (m)	5m
Component transport max. axle load for loaded transporter (tonnes)	24 tonnes

5.7.4.3 *Onshore substation construction method*

279. A new construction access and onshore substation construction compound will be created in advance of construction. The access is proposed to involving routing vehicles from the A120 via Bentley Road, and then along the construction haul road to reach the onshore substation works area to avoid routing vehicles through Little Bromley (see Section 5.7.5 below for details of the works proposed to Bentley Road to facilitate construction). The access will facilitate access for HGVs as well as abnormal indivisible loads (AILs) for certain elements of the onshore substation's electrical infrastructure (e.g., transformers). Where there is no existing hardstanding, the onshore substation construction compound would be constructed by laying a geotextile membrane or similar directly on top of the subsoil which would have stone spread over the top. All construction access and the onshore substation construction compound would be removed, and land reinstated following the completion of construction, unless requested to remain in situ by the relevant landowner and subject to the landowner obtaining any necessary consents. The exception to this would be under Scenario 2, where the temporary works would be used by Five Estuaries, who would then undertake reinstatement at the end of their construction period.

280. The site would be subject to a topsoil strip, and the ground levels graded as required by the final design. Stripped material would be reused on site where possible, potentially as part of any identified bunding or screening identified through the impact assessment process.

281. Deeper soils would be excavated from areas where the ground profile needs to be lowered (cut) and moved into the areas where the ground level needs to be raised (fill). The thickness of each fill layer would need to be determined in accordance with the specification of the material and the design of the substation platform. Where the specification of the existing soils is not up to the required load bearing standard additional material may need to be imported to the site. Any excess material would be disposed of at a licenced disposal site.

282. After grading of the site is complete, excavations would then proceed with the laying of foundations, trenches, and drainage. At this stage it is not known whether the foundations would be ground bearing or piled. This would be determined by geotechnical ground investigation post-consent that would inform the detailed design. However, for the purposes of the assessment piled foundations are assumed to be required at the onshore substation. As a worst

case, this would comprise piling for transformer pads (12 in total) of a maximum 5m depth x 500mm width.

283. Following the completion of any cut and fill exercise and installation of drainage and foundations, the onshore substation platform would need to be finished with a layer of imported stone fill combined with a concrete pour. The thickness of this concrete platform would be determined during detailed design based on the geotechnical ground investigation.

284. The buildings would likely be constructed from a steel frame with cladding panels. The steel frame would be fabricated off site and then erected at the substation location with the use of cranes. The cladding would be fitted once the framework is in place.

285. The onshore substation electrical equipment would then be delivered to site and installed. Due to the size and weight of assets such as transformers, specialist delivery methods would be employed, and assets would be offloaded at site with the use of a mobile gantry crane.

286. The onshore substation would be enclosed by a temporary perimeter fence for the duration of the construction period with a permanent fence installed as part of the construction works.

287. The 400kV onshore cables from the onshore substation to the National Grid connection point would typically be installed by direct burial method. This method will require a trench to be excavated between the onshore substation and the grid connection for the cables to be laid directly and jointed before being installed. Where sensitive features (e.g. Grange Road) are located along the 400kV onshore cable route, then trenchless crossings will be required. See Section 5.7.3 for details of cable burial construction methods.

5.7.4.4 *Drainage*

288. An Outline Operational Drainage Strategy has been developed for the Project (Document Reference: 7.19). This Outline Operational Drainage Strategy outlines the principles of the strategy to manage surface water runoff during operation. Post-consent, a detailed Operational Drainage Plan to be developed based on the outline developed to date. Production of this plan is secured by DCO Requirement.

289. The Outline Operational Drainage Strategy states that the final Operational Drainage Plan would be designed to meet the technical requirements set out in the National Planning Policy Framework (NPPF). The surface water drainage system would use SuDS techniques which would be accommodated primarily within the onshore substation works area. Surface water discharge rates would be controlled to prevent any increase in flood risk to surrounding land from present day levels.

290. Some form of surface water attenuation could be required with sufficient capacity to retain a peak rainfall event (100-year event plus climate change). Controls would be in place to ensure that water discharge back to the surrounding area matches the existing greenfield runoff rates, discharging into the closest watercourse, which will be the drainage ditch location south of Ardleigh Road (see Figure 5.2, Document Reference: 3.2.3). The full specification for the water attenuation and drainage system would be addressed as part of detailed design post-consent.

291. Foul drainage would be collected in a septic tank located within the onshore substation. The specific approach would be determined during the detailed design phase with consideration for the number of visiting hours for site attendees during operation taken into account.

5.7.4.5 *Access*

292. A new operational access will be constructed to service the onshore substation. This will be required to facilitate access for light vehicles for routine maintenance, however will be designed to accommodate all vehicle movements where required. Access will be made from Ardleigh Road. Further details on this access are provided in Chapter 27 Traffic and Transport (Document Reference: 3.1.29).

5.7.4.6 *Landscaping and environmental enhancement*

293. Impacts and potential mitigation measures associated with the screening of the onshore substation are discussed in Chapter 30 Landscape and Visual Impact Assessment (Document Reference: 3.1.32). The location of soft and hard landscaping and visual screening will be determined as part of detailed design post-consent. An indicative landscape mitigation plan is provided in ES Figure 30.1.6 (Document Reference: 3.2.26) and described in the Outline Landscape and Ecological Management Strategy (Document Reference: 7.14). The indicative landscape mitigation plan has been designed to accommodate two potential onshore substations, i.e. both North Falls and Five Estuaries, within the onshore substation works area.

294. The Project is also exploring opportunities to deliver a minimum of 10% biodiversity net gain for the onshore elements of the Project. The biodiversity net gain delivered would be determined following completion of the latest version of the Defra Biodiversity Metric (currently version 4.0), an indicative version of which has been provided in the Biodiversity Net Gain Strategy as part of the DCO application (Document Reference: 7.22). As part of this, environmental enhancement is proposed to be included within the onshore substation landscaping design.

5.7.4.7 *Connection to the National Grid*

295. The 400kV onshore cable route will comprise underground circuit(s) running from the new North Falls onshore substation to the new NGET EACN 400kV substation proposed to be constructed east of the village of Ardleigh, to the west of the North Falls onshore project area.

296. The new National Grid substation facilitates the connection of the offshore generation to the main National Electricity Transmission System and will include high voltage transformers, reactors and other typical high voltage plant and equipment.

297. National Grid's substation will be consented separately by NGET as part of their DCO for the Norwich to Tilbury project. The works to construct the new National Grid substation will be undertaken by NGET.

298. The following is expected to be part of the new National Grid substation construction works and consented by NGET:

- Construction of either the gas insulated switchgear (GIS) building or concrete pad(s) for GIS and AIS options respectively, including all groundworks; and
- Provision of a construction access for HGVs to the National Grid substation.

299. The North Falls DCO application includes works for the cable connection between the new North Falls onshore substation to the new National Grid substation and some specific works to facilitate the connection within the National Grid substation as follows (the 'National Grid substation connection works'):

- Installation of switchgear bays in the National Grid EACN 400kV Substation;
- Installation of troughs / ducts to facilitate the 400kV circuits, Protection & Control cables from the North Falls onshore substation into the switchgear bays;
- Installation and termination of the 400kV circuits and Protection & Control cables between the North Falls substation and the switchgear in the National Grid substation;
- Installation of protection and control equipment (if required) within the National Grid relay building; and
- Temporary infrastructure such as haul roads and construction compounds to facilitate access, egress, laydown, storage, and welfare containers which would be placed within close proximity of the work area.

300. Although not specified at this stage, it is anticipated that the type of civils plant, equipment and activities (and therefore the associated construction noise levels), will be broadly similar to that proposed for the North Falls onshore substation works, although on a smaller scale and duration.

301. The configuration of the North Falls switchgear within the footprint of the National Grid substation will depend on a number of factors including the detailed design of the equipment required and the final layout of the new National Grid substation.

5.7.4.8 *Status of National Grid proposals*

302. National Grid originally identified a search area within which they anticipate their new substation will be located. This is the hatched highlighted area (shown as 'Electricity Transmission (NGET)') illustrated on Figure 5.2 (Document Reference: 3.2.3), within the North Falls DCO Order limits. Subsequent to this, National Grid published PEIR documentation on 10 April 2024 which confirmed that the new proposed EACN substation will be located within this hatched area, and also provided a refined location for the 520 x 230m EACN substation operational footprint within this hatched area.

303. At this stage, detailed 400kV onshore cable route design work to connect the North Falls onshore substation to the EACN substation has not been undertaken, and so for the purposes of assessment it has still been assumed to the 400kV onshore cable route could be located anywhere within the hatched area. Therefore, the whole search area has been included within the North Falls DCO Order limits to ensure that the works required to connect the new North Falls onshore substation to the new National Grid substation (as set out above) will be captured within the North Falls onshore project area.

5.7.4.9 *Operations and maintenance*

304. The onshore substation would not be manned, however access would be required periodically for routine maintenance activities. Normal operating conditions would not require lighting at the onshore substation, although low level movement detecting security lighting may be utilised for health and safety

purposes. Temporary lighting during working hours would be provided during maintenance activities only.

305. During operation, in the unlikely event of transformer failure, an AIL access route to the onshore substation would need to be re-established in order to bring a replacement transformer to the onshore substation. Should this be required, the onshore substation construction access haul road running from Bentley Road to Ardleigh Road would be reinstated in its entirety for the delivery of the transformer, including reinstatement of the construction access an TCC west of Bentley Road, then removed again once the transformer has been delivered. This activity would take up to 7 months in total.

5.7.4.10 *Decommissioning*

306. No decision has been made regarding the final decommissioning plan for the onshore project substation, as it is recognised that industry good practice, rules and legislation change over time.

307. A decommissioning Requirement will be included in the draft DCO which will require a written scheme of decommissioning for onshore works to be produced prior to decommissioning. Should activities be likely to lead to materially different effects to those assessed in the ES for the DCO, then a full EIA would be required ahead of any decommissioning works being undertaken.

308. The detailed activities and methodology for decommissioning would be determined later within the Project lifetime, in line with relevant policies at that time, but would be expected to include:

- Dismantling and removal of electrical equipment;
- Removal of cabling from site;
- Removal of any building service equipment;
- Demolition of the buildings and removal of fences; and
- Landscaping and reinstatement of the site.

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

5.7.5 Bentley Road improvement works

310. In order to ensure that the construction haul road west of Bentley Road can be used for both HGV and AIL access to the onshore substation during construction, North Falls are proposing to undertake upgrade works to Bentley Road to ensure that the carriageway is suitable for two-way HGV movements of the volume required to facilitate construction of North Falls. These upgrade works may also be utilised by Five Estuaries (and potentially National Grid for the construction of the EACN 400kV Substation), and to minimise the effects on any non-motorised road users.

311. The upgrade works entail the following:

- Improvements to the turn-off from the A120;
- Widening of the carriageway to 6.5m along the length of Bentley Road from the A120 to the new construction access to the west off Bentley Road;

- Creation of a new temporary, segregated non-motorised user route along the length of Bentley Road from the A120 to the new construction access to the west off Bentley Road (if required).

312. These works are proposed to be serviced using existing TCCs covered under Section 5.7.3.1 above.

313. These works are proposed to be secured and handed over to ECC for adoption following the completion of construction, as a legacy benefits of the works.

5.7.6 Co-ordination with Five Estuaries

314. Identification of the onshore cable route and onshore substation location has been undertaken in co-ordination with Five Estuaries (see Chapter 4 Site Selection and Assessment of Alternatives (Document Reference: 3.1.6)).

315. The indicative cable route cross section has been designed to accommodation a single installation of four cable ducts (Scenario 1), or two separate installation activities for two ducts each (Scenarios 2 and 3), depending on which build-out scenario is possible. The TCCs, accesses and haul roads are designed to be shared by both projects (under Scenarios 1 and 2) where applicable.

316. The two onshore substations will be constructed and owned separately by NFOW / VEOWL (and transferred to the appointed OFTOs), but the option to co-ordinate on landscaping, environmental mitigation, access and drainage at the substation has been retained and will be set out during detailed design post-consent.

5.7.7 Onshore construction programme

5.7.7.1 *Pre-construction works*

317. Pre-construction works are expected to take place from 2027. The main pre-construction activities are noted below and would be applicable to the onshore substation and works to install the onshore export cables:

- Demarcation of construction area;
- Ground investigations and pre-construction surveys;
- Road / junction modifications and any new junctions off existing highways;
- Pre-construction drainage - installation of buried drainage along the onshore cable route and at the onshore substation, which requires an understanding of the existing agricultural drainage environment;
- Hedgerow and tree removal - hedgerow and tree removal is seasonal and can be influenced by ecological factors. Removing these ahead of the main works mitigates against potential programme delays;
- Ecological mitigation - any advanced pre-construction mitigation activities, for example installation of artificial bat roosts; and
- Archaeological mitigation - pre-construction activities agreed with Historic England and local historic environment stakeholders;
- Diversion of any PRoWs (if required).

5.7.7.2 *Main works*

318. A high-level indicative construction programme for the Project's onshore works is presented in Table 5.29 below. The programme illustrates the likely duration of the major installation elements, and how they may relate to one another.

319. The planned construction start date for the main works is expected to be 2027.

320. Onshore construction (landward of mean low water) would normally only take place between:

- 0700 to 1900 hours Monday to Saturday, with no activity on Sundays or bank holidays[1].
  - NB: between 1300 – 1900 on Saturdays certain 'high impact' activities will be restricted. These will be specified in the CoCP (the outline version of which is submitted with the DCO Application (Document Reference: 7.13)).

321. Outside of these hours, construction work may be required for essential activities, the full list of which is set out in the OCoCP (Document Reference: 7.13), and which includes:

- Continuous periods of operation, such as concrete pouring, drilling, and pulling cables through ducts; and
- Delivery of abnormal indivisible loads that may otherwise cause congestions on the local road network.

[1] Note that staff may arrive on site earlier / leave site after these working times.

Table 5.29 Indicative onshore construction programme (*worst case duration shown below*)

	Year 1				Year 2				Year 3				Year 4				Year 5			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Bentley Road improvement works (*6 - 9 months*)																				
Onshore cable route construction (including landfall and trenchless crossings, and cable pull) (*18 – 27 months, of which cable pull = 12 months)*																				
Onshore substation construction (*21 – 27 months*)																				
Onshore substation commissioning and site demobilisation (*9 – 15 months*)																				

5.8 References

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North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

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