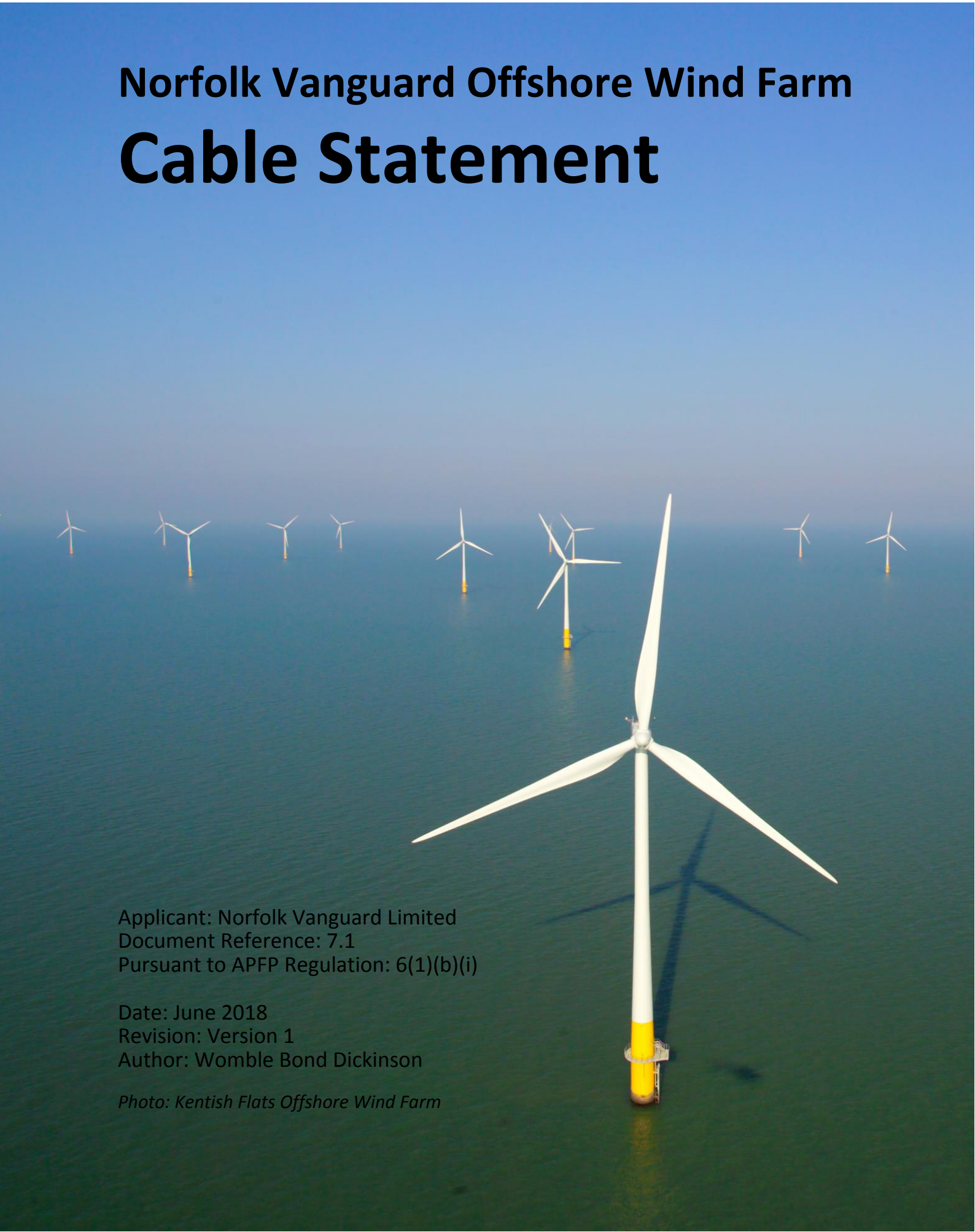
VATTENFALL

Norfolk Vanguard Offshore Wind Farm

Cable Statement



Applicant: Norfolk Vanguard Limited
Document Reference: 7.1
Pursuant to APFP Regulation: 6(1)(b)(i)

Date: June 2018
Revision: Version 1
Author: Womble Bond Dickinson

Photo: Kentish Flats Offshore Wind Farm

Document Reference: 7.1

June 2018

For and on behalf of Norfolk Vanguard Limited

Approved by: Rebecca Sherwood and Ruari Lean

Signed:

[redacted]

[redacted]

Date: 07/06/2018

Norfolk Vanguard Limited

Norfolk Vanguard Offshore Wind Farm

Cable Statement

Document Reference	7.1
APFP Regulation	6(1)(b)(i)
Author	Womble Bond Dickinson
Date	07 June 2018
Revision	1

CONTENTS

1 Summary

1.1 Norfolk Vanguard Limited (the **Applicant**) is planning to develop the Norfolk Vanguard Offshore Wind Farm (the **Project**) with up to 200 turbines and an export capacity of up to 1,800 MW. The Project would be located approximately 47 km from the coast of Norfolk at its closest point to land, covering an area of approximately 592 km^2 over two distinct areas, Norfolk Vanguard East and Norfolk Vanguard West.

1.2 As the total export capacity will exceed 100 MW, the Project is deemed to be a Nationally Significant Infrastructure Project (**NSIP**), and therefore the Applicant is submitting an application to the Secretary of State under Section 37 of the Planning Act 2008 for a Development Consent Order (**DCO**) for the construction and operation of the Project.

1.3 The Applicant is considering constructing the Project in up to two phases.

1.4 This Cable Statement has been prepared in accordance with Regulation 6(1)(b)(i) of the Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009 (the **APFP Regulations**) which requires the applicant for a DCO for the construction of an offshore generating station to provide a statement regarding the route and method of installation of any cable connecting the generating station to the onshore electricity transmission network.

1.5 The Applicant's DCO application contains all of the electrical infrastructure required for the Project, summarised as follows:

1.5.1 The offshore electrical components for the Project consisting of array, inter-connector and export cables that transmit the power from the wind turbine generators (**WTG**) to landfall. The offshore electrical assets also consist of up to two offshore electrical platforms.

1.5.2 The onshore electrical works consist of up to four cables installed within ducts running from transition jointing pits at the landfall to an onshore project substation, and an underground connection between the onshore project substation and the existing National Grid substation at Necton, Norfolk.

1.6 The onshore works also include the option to lay the cables ducts for a future offshore wind farm project – the Applicant's sister project, Norfolk Boreas.

1.7 The Grid Connection Agreement that has been secured by the Applicant is for a connection located at Necton in Norfolk. To facilitate the Project, an extension to the existing Necton National Grid substation will be required along with modifications to the existing overhead lines.

2 Introduction

2.1 This Cable Statement has been prepared by Norfolk Vanguard Limited (the **Applicant**) pursuant to Regulation 6(1)(b)(i) of the Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (the **APFP Regulations**).

2.2 This Statement forms part of the application to the Secretary of State for the Project for a Development Consent Order (**DCO**) to construct and operate an offshore generating station with up to 200 turbines and an export capacity of up to 1,800 MW. As the export capacity of the Project will exceed 100 MW it is a Nationally Significant Infrastructure Project (**NSIP**) as defined under sections 14(1)(a) and 15(3) of the Planning Act 2008.

2.3 The Project would be located more than 47 km from the coast of Norfolk, occupying an offshore array site of approximately 592 km^2 over two distinct areas, Norfolk Vanguard East and Norfolk Vanguard West.

2.4 The offshore array is located in the northern half of the former Zone 5 (East Anglia Zone) in the North Sea, which is being developed as two individual wind farms – Norfolk Vanguard and its sister project Norfolk Boreas (which will be consented under a separate DCO application); both of which will require the appropriate statutory consents and approvals. The Project is the first to be proposed. Norfolk Boreas offshore wind farm comprises the next stage of development of this area, for which a DCO application is expected to be submitted in 2019.

2.5 Further information on the location and design of the Project is set out in the accompanying Environmental Statement (Volume 1, Chapter 5 Project Description) (Document 6.1).

2.6 This Statement provides details of the proposed offshore and onshore cable routes and cable installation methods and is intended to provide a summary of the detailed information set out in the Chapter 5 Project Description of the Environmental Statement.

3 Description of Grid Connection Works

3.1 The Applicant's application for a DCO (the **Application**) contains all of the electrical cable works required for the Project.

Electrical solution

3.2 The Applicant will deploy High Voltage Direct Current (**HVDC**) technology for the Project. HVDC cabling will be used between the offshore electrical platform(s) and the onshore project substation, with High Voltage Alternate Current (**HVAC**) inter-array cabling; between the offshore array and the offshore electrical platforms; and for the interface cabling between the onshore project substation and the existing Necton National Grid substation. This electrical solution will require the following:

3.2.1 Up to two offshore electrical platforms and an interconnection between them, up to four subsea export cables, and up to four onshore land cables linking the offshore electrical platform and onshore project substation.

3.3 The Applicant is considering constructing the Project in up to two phases.

Offshore works

3.4 Array cables will collect and transfer power generated by the WTGs to the offshore electrical platform(s). The cables connect the WTGs together into strings, with the number of WTGs connected together depending on factors such as the generation capacity of each WTG on the relevant cable network, distance between WTGs and the cable sizes available. The strings of WTGs would then in turn be connected to the offshore electrical platforms.

3.5 Up to two offshore electrical platforms would collect electricity from the WTGs and transport it to landfall via up to four HVDC subsea export cables.

3.6 The subsea export cables would connect the offshore development to a landfall at Happisburgh South, North Norfolk on the Norfolk coast. The offshore cable corridor is approximately 90 km in length from the edge of the Project site to the landfall location.

Onshore works at the landfall

3.7 The transition jointing pits, where the offshore cables join the onshore cables, would be located at the landfall at Happisburgh South, North Norfolk. To enable the export cables from the Project to be brought through to the transition jointing pits, long horizontal directional drilling (**HDD**) will be utilised from two HDD rigs, with two ducts installed to accommodate the cables. Up to two onshore transition pits located adjacent to each other will be required.

Onshore cable route

3.8 The onshore cable route would run between the onshore transition jointing pits and the onshore project substation at Necton in Norfolk. The route is approximately 60km long in a predominantly westerly direction from Happisburgh South, North Norfolk, passing through mainly agricultural land. The onshore cable route is 45m wide and would contain the main HVDC onshore export cables installed within cable ducts, as well as a running track, and topsoil and subsoil storage areas. The onshore cable route requires up to 4 trenches, within which cable ducts are installed. Cable ducts will also be consented to accommodate the future Norfolk Boreas project.

Onshore project substation

3.9 The proposed site for the onshore project substation is located to the East of the existing Necton National Grid substation. The onshore project substation will comprise a compound containing up to two converter buildings and electrical equipment to enable connection to the National Grid. The substation will convert the exported power from HVDC to HVAC, to 400kV (grid voltage). The substation also contains equipment to help maintain stable grid voltage.

3.10 The onshore project substation would be located within a single compound that would not exceed 7.5ha. The total number of buildings housing the principal electrical equipment within the compound would not exceed two and their total footprint would not exceed 110 metres in length and 70 metres in width. Heights of buildings within the compound would not exceed 19 metres above existing ground level, and outdoor electrical equipment (e.g. lightning protection

masts) would not exceed a height of 25 metres above existing ground level. The worst case parameters have been assessed and included in the draft DCO.

3.11 The onshore project substation would be connected to the existing Necton National Grid substation by means of underground cables laid directly into the ground, or installed into pre-laid ducts.

4 Consenting of Grid Connection

4.1 Part 1 of Schedule 1 of the draft DCO describes the works for which development consent is being sought.

Offshore works

4.2 The WTGs, up to two accommodation platforms, up to two meteorological masts, and a network of subsea array cables form part of the Generating Station NSIP set out within Work No. 1.

4.3 Up to two offshore electrical platforms comprise Work No. 2 and the cable connections between the offshore electrical platforms and the subsea export cables seaward of mean low water between the offshore electrical platforms and the landfall at Happisburgh South (to seaward of mean low water) comprise Work Nos. 3 and 4A.

Intertidal area

4.4 The subsea export cables between mean low water and mean high water at Happisburgh South comprise Work No. 4B.

4.5 Works numbered 2, 3, 4A and 4B are considered to be "associated development" to the Generating Station NSIP within Section 115 of the Planning Act 2008, in that they are not an aim in themselves but are required to export the electricity generated by the turbines.

Onshore works

4.6 The Applicant has included its onshore works, from mean high water to the onshore project substation and the extension to the existing National Grid substation, as "associated development" within its DCO application to the Secretary of State.

4.7 The export cables from mean high water to the transition jointing pits at Happisburgh South comprise Work No. 4C, the underground cables running from the transition jointing pits to the Applicant's onshore project substation comprise Work No. 5 to Work No. 7D, and the onshore project substation and connection to the existing Necton National Grid substation, including associated surface water management, embankments, boundary treatments, bunding, and landscaping, comprise Work Nos. 8A to 10C.

4.8 The overhead line modification works at the Necton National Grid substation comprises Work No.11; and the permanent accesses connecting the A47 to the onshore project substation and the Necton National Grid substation extension comprise Work No.12.

5 Description of Generating Equipment

5.1 The WTGs consist of three primary components; the tower, the nacelle and the rotor. The rotor is the device which, through circular motion, extracts the energy from the wind. The nacelle houses the equipment that can turn rotational motion into electrical energy. The tower supports the nacelle and gives the rotor the necessary height.

5.2 The capacity of the Project will depend on the number of WTGs that are installed and their individual rating. The Project would consist of up to 200 WTGs, with an export capacity of up to 1,800 MW.

5.3 In the UK, offshore wind farm developers such as the Applicant can either construct the offshore transmission assets themselves or opt for an Offshore Transmission Owner (**OFTO**) to do so. OFTO assets generally consist of the onshore infrastructure required to connect to the national electricity transmission system, the offshore export cables and offshore electrical stations.

5.4 If the Applicant constructs the assets itself, then it must transfer the assets to an OFTO post-construction and pre-operation. OFTOs are selected on a competitive basis through a tender process. It is anticipated that the Applicant will opt for the generator build option which means that the offshore transmission assets will be transferred to an OFTO post construction and pre-operation.

6 Offshore Cable Installation

Phasing of construction

6.1 The Applicant is considering constructing the Project in up to two phases. The potential construction scenarios are presented in more detail in Chapter 5 of the Environmental Statement (Document 6.1).

Cable installation methods

Array cables

6.2 The array cables will be buried, where it is feasible to do so. Optimum burial depth may not be achieved in areas of rock outcrop, where there is a high frequency of boulders or at cable crossings. Where optimum burial depth is not achieved the cable may be protected to prevent movement of the cables, to prevent any risk to other marine users and to protect the cables from impacts arising from other marine activities such as fishing.

6.3 The array cables are expected to be installed from a cable laying vessel, which will be equipped with specialist cable handling equipment and will have support vessels in attendance as necessary, for example anchor handling. The cables are loaded on to cable carousels or cable drums, mounted on the deck of the vessel.

6.4 There are several different methods available for the installation of offshore cables, including the following:

- Ploughing

  This method consists of a forward blade cutting through the seabed whilst laying the cables behind. Ploughs used for cable burial can either be used as post lay burial tools or as a simultaneous lay and burial tool. Usually the cable is simultaneously laid and buried; the cable plough lifts a section of the seabed deposit and places the cable below. The seabed deposit is then returned to its original position. In areas of very hard substrate, modifications to this technique may be used, including use of a rock cutter plough or vibrating share plough.

- Trenching or cutting

  This method consists of three operations. First, a trench is excavated or cut while placing the sediment and fill next to the trench. The cable is subsequently laid in the trench and lastly the sediment or fill is returned to the trench. Pre-lay cutting of trenches (or “pre-trenching”) could also be used whereby a large trench is cut in one or multiple passes to the correct depth before the cable is laid back in trench at a later date. The trench can be backfilled naturally or if required with a backfill plough or other method of material replacement. The use of backfill ploughs is normally not favoured due to the danger of damaging the cable.

- Jetting

  The cable is first laid on the seafloor. A Remotely Operated Vehicle (ROV) equipped with high pressure water jets then proceeds along the cable route, fluidising the seabed around the cable, allowing the cable to be lowered into the trench. The fluidised sediment subsequently settles back onto the seabed. In shallow waters a vertical injector could be used. This is a large jetting and cutting shear which is strapped to the side of a barge and the cable is laid in the foot of the trench. The burial depth is controlled by means of raising or lowering the tool and horizontal positioning, by means of adjusting the barge anchor.

6.5 The extent to which these cable burial techniques will be used will be dependent upon the results of detailed pre-construction seabed surveys of the final cable route and the associated cable burial assessment process.

6.6 The Deemed Marine Licences (**DML**) within the draft DCO require the submission and approval of a cable specification, installation and monitoring plan, which must include a cable laying plan and proposals for monitoring the offshore cables during the operational lifetime of the Project (condition 14(1)(g) of the generation DML and condition 9(1)(g) of the transmission DML).

Export cables

6.7 The same techniques described for array cable installation will be used to install the export cables between the offshore electrical platforms to the point offshore where the landfall ducts exit the seabed.

6.8 Export cables between the offshore electrical platforms and landfall may require a number of connections or joints along their length. Jointing of the offshore export cable will be undertaken at sea. Each jointing connection will require approximately ten days for completion. Additional time will also be required to recover both ends of the cable to the vessel for jointing and to re-bury the cable following jointing. Due to the complexity of offshore jointing, the number of joints will be kept to a minimum.

Cable protection

6.9 In some cases the above installation techniques may not be able to be applied and it may be necessary to use alternative methods for installing the cables where they cannot be buried. Details of some of the techniques employed are given below:

- Concrete mattresses

  These are prefabricated flexible concrete coverings that are laid on top of the cable. Grout or sand filled bags could be used as an alternative to concrete mattresses for smaller scale activities.

- Rock Placement

  Rock placement involves the laying of a rock layer on top of the unburied cable to offer protection from and to fishing gear and vessel anchors.

- Frond mattresses

  Frond mattresses could be used to provide protection by stimulating the settlement of sediment over the cable. This method develops a sandbank over time protecting the cable but is only suitable in certain water conditions. This method may be used in close proximity to offshore structures although experience has shown that storms can strip deposited materials from the frond.

- Uraduct

  Uraduct is effectively a protective shell which comes in two halves and is fixed around the cable to provide mechanical protection. Uraduct is generally used for short spans at crossings or near offshore structures where there is a high risk from falling objects. Uraduct does not provide protection from damage due to fishing trawls or anchor drags.

6.10 Where cable crossings occur, they will be protected using the concrete mattress or rock placement methods for cable protection described above.

6.11 The deemed Marine Licences within the draft DCO require the Marine Management Organisation's (**MMO**) approval of a scour protection and cable protection plan providing details of the need, type, sources, quantity and installation methods for scour protection and cable protection, which must be updated and resubmitted for approval by the MMO if changes to it are proposed following cable laying operations (condition 14(1)(e) of the generation DML and condition 9(1)(e) of the transmission DML).

Cable landfall and directional drilling works

6.12 The offshore cables will be required to be installed under the beach to be jointed to the onshore cables at the transition jointing pits on the landward side of the landfall site. To enable this installation, long HDD is proposed to be employed. Drilling is carried out from a compound on the land side of the sea defences or cliffs. As the Applicant will be using a long HDD option, the drill emerges beyond the low water mark. The drill is then retrieved and a flexible duct is pulled into the drilled hole.

6.13 The cable is floated ashore from a cable laying vessel or barge lying as close to shore as possible on a high tide and the free end of the cable is attached to a pull-wire that passes

through the HDD duct. An onshore winch is used to pull the end of the cable through the duct and into the transition jointing pit.

7 Onshore Cable Installation

Transition jointing pits

7.1 Each cable circuit will require a separate jointing pit to connect the offshore and onshore cables at the landfall which will be grouped together and staggered as necessary to be accommodated within the permanent cable corridor. The jointing pit will comprise of an excavated area of 15m x 10m x 5m, per circuit, with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

7.2 Link boxes for each of the required transition jointing pits may be utilised to allow the HVDC cable sheaths to be bonded to earth to maximise cable ratings. Link boxes would not be required at all jointing locations and can typically be placed at 5km intervals. The number and placement of the link boxes would be determined as part of the detailed design. The link box, with dimensions of 1.5m x 1.5m would be buried to ground level within an excavated pit, providing access via a secured access panel. Alternatively, above ground link box cabinets (1.2m x 0.8m x 1.8m) may be utilised which are typically sited on a 0.15m deep concrete slab.

Onshore cabling

7.3 The main cable installation method will be through the use of open cut trenching with High Density Polyethylene (**HDPE**) ducts installed, backfilled and cables pulled though the pre-laid ducts at a later date. Up to two cable pull phases will be required depending on whether the single offshore phase or two offshore phase approach applies.

7.4 For duct installation, topsoil will be stripped from sections of the onshore cable route and stored and capped to minimise wind and water erosion within the working width. The profile of the soil will be carefully maintained during the storage process. The cable trenches will then be excavated, typically utilising tracked excavators. The excavated subsoil will be stored separately from the topsoil, capped and the profile of the soil maintained during the storage process.

7.5 A stabilised backfill such as Cement Bound Sand (CBS) will be installed at the base of the trench. A duct for each cable and a separate duct or ducts for fibre optic cables will be laid on the CBS base and backfilled with CBS to a covering depth of 100mm. This approach ensures a consistent homogeneous medium for the dissipation of heat generated by the cables during operation.

7.6 The CBS backfill will be covered with high voltage cable warning tiles and the trench backfilled with subsoil material excavated from the trench. A warning marker tape will be placed 100mm above the cable tiles. The stored topsoil will be replaced upon the backfilled subsoil to reinstate the trench to pre-construction condition, so far as reasonably possible.

7.7 Cables will be pulled through the installed ducts later in the construction programme in a staged approach as set out above. This approach allows the civil works to be completed in advance of cable delivery.

7.8 Cable drums will be delivered by HGV low loader to the open joint pit locations. The cable drum will be located adjacent to the joint pit on a temporary hard standing and a winch attached to the cable, pulling the cable off the drum from one joint pit to another, through the buried ducts. Cable jointing can be conducted once both lengths of cable that terminate within it have been installed.

7.9 Joint pits will be required along the cable route to allow cable pulling and jointing of two sections of cable. The joint pits will typically be located at approximately 800m intervals, although site specific constraints may result in shorter intervals where necessary.

7.10 Link boxes are required in close proximity (within 10m) to a subset of jointing pit locations.

7.11 Trenchless installation will be employed at certain locations, including at the River Wensum and River Bure, Kings Beck, Wendling Beck (upstream and downstream), Wendling Carr County Wildlife Site (CWS), Marriott's Way CWS / Public Right of Way, Paston Way and Knapton Cutting CWS, North Walsam and Dilham Canal, the Witton Hall Plantation along Old Hall Road, Little Wood County Wildlife Site, land south of the Dillington Carr County Wildlife Site, Kerdiston proposed County Wildlife Site, Norfolk Coast Path, Network Rail line at North Walsham that runs from Norwich to Cromer Network, Mid-Norfolk Railway line at Dereham

that runs from Wymondham to North Elmham, and Trunk Roads including the A47, A140, A149.

Onshore project substation

7.12 The onshore project substation will consist of an HVDC substation. Construction will include a number of key stages, including earthworks, foundations, superstructure and equipment installation.

7.13 In September 2016, the Applicant secured a Grid Connection Agreement from National Grid for a connection located at Necton. The 400 kV HVAC cable route from the onshore project substation to the existing Necton National Grid substation will be installed in accordance with the main cable laying and installation works set out above, by means of underground cables laid directly into the ground, or installed into pre-laid ducts where pre-laid ducts have already been installed.

This page is intentionally blank.