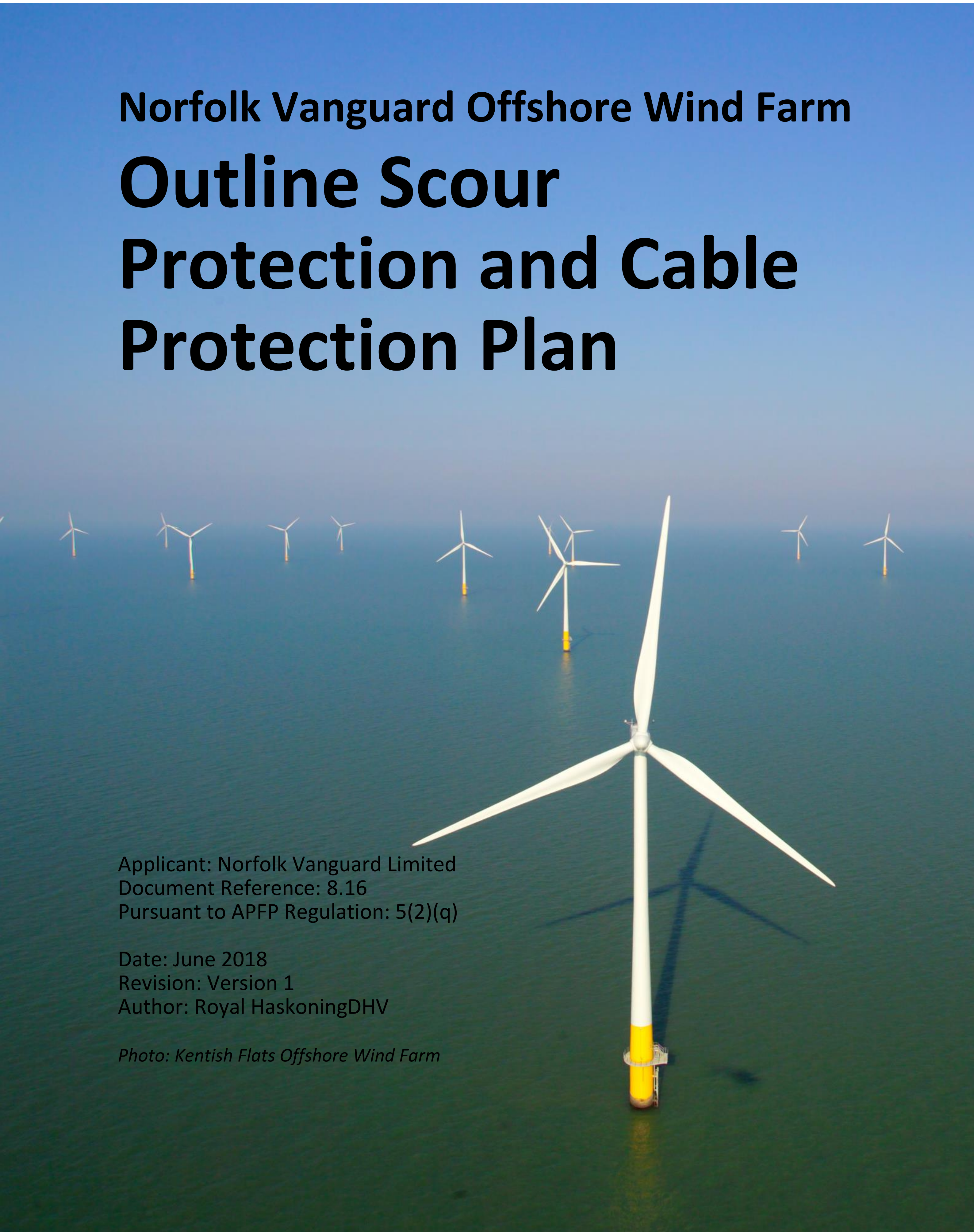
Norfolk Vanguard Offshore Wind Farm

Outline Scour Protection and Cable Protection Plan



Applicant: Norfolk Vanguard Limited
Document Reference: 8.16
Pursuant to APFP Regulation: 5(2)(q)

Date: June 2018
Revision: Version 1
Author: Royal HaskoningDHV

Photo: Kentish Flats Offshore Wind Farm

Document Reference: 8.16

June 2018

For and on behalf of Norfolk Vanguard Limited. Approved by: Ruari Lean, Rebecca Sherwood Signed: [redacted] Date: 8th June 2018

For and on behalf of Royal HaskoningDHV Drafted by: Gemma Keenan Approved by: Alistair Davison Signed: [redacted] Date: 30th May 2018

Date	Issue No.	Remarks / Reason for Issue	Author	Checked	Approved
27/03/18	01D	First draft for Vattenfall review	GK	PP	PP
10/05/18	02D	Second draft for Vattenfall review	GK	PP	PP
30/05/18	01F	Final for DCO submission	GK	PP	PP

Table of Contents

Figures

Tables

Glossary

DML	Deemed Marine Licence
EIA	Environmental Impact Assessment
ES	Environmental Statement
GBS	Gravity Base Structure
HDD	Horizontal Directional Drilling
LiDAR	Light Detection and Ranging
MMO	Marine Management Organisation
MW	Megawatt
NV East	Norfolk Vanguard East
NV West	Norfolk Vanguard West
OFTO	Offshore Transmission Operator
OWF	Offshore Wind Farm
SAC	Special Area of Conservation
ZEA	Zone Environmental Appraisal

Terminology

Array cables	Cables which link the wind turbines and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link the offshore electrical platforms
Landfall	Where the offshore cables come ashore at Happisburgh South
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead
Offshore cable corridor	The corridor of seabed from the Norfolk Vanguard OWF sites to the landfall site within which the offshore export cables would be located.
Offshore electrical platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which bring electricity from the offshore electrical platform to the landfall.
Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the offshore cable corridor
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area under the Energy Act 2004.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
The Applicant	Norfolk Vanguard Limited
The OWF sites	The two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West
The project	Norfolk Vanguard Offshore Wind Farm, including the onshore and offshore infrastructure

1 INTRODUCTION

1.1 Background

1. Norfolk Vanguard Limited ('the Applicant', an affiliate company of Vattenfall Wind Power Limited) is seeking a Development Consent Order (DCO) for Norfolk Vanguard, an offshore wind farm (OWF) in the southern North Sea.

2. The OWF comprises two distinct areas, Norfolk Vanguard East (NV East) and Norfolk Vanguard West (NV West) ('the OWF sites'), within which wind turbines, associated platforms and array cables will be located. The offshore wind farm will be connected to the shore by offshore export cables installed within the offshore cable corridor from the wind farm to a landfall point at Happisburgh South, Norfolk. From there onshore cables would transport power over approximately 60km to the onshore project substation at Necton, Norfolk. A full project description is given in the Environmental Statement, Chapter 5 Project Description.

3. Once built, Norfolk Vanguard would have a capacity of up to 1800MW, with the offshore components comprising:

- Wind turbines;
- Offshore electrical platforms;
- Accommodation platforms;
- Met masts;
- Lidar;
- Array cables;
- Inter-connector cables; and
- Export cables.

4. The key onshore components of the project are as follows:

- Landfall;
- Onshore cable route, accesses, trenchless crossing (e.g. Horizontal Directional Drilling (HDD)) zones and mobilisation areas;
- Onshore project substation; and
- Extension to the Necton National Grid substation and overhead line modifications.

5. Norfolk Vanguard is located approximately 47km from the closest point the Norfolk Coast. NV East covers an area of approximately 297km^2 and NV West covers an area of around 295km^2.

6. Norfolk Vanguard Limited is currently considering constructing the project in either a single phase or two phases (up to a maximum of 1800MW). The layout of the wind turbines will be defined post consent but will be based on the following maxima:

- 1800MW in NV East, 0MW in NV West; or
- 0MW in NV East, 1800MW in NV West.

7. Any other potential layouts that are considered up to a maximum of 1800MW (e.g. 1,200MW in NV West and 600MW in NV East; 600MW in NV West and 1,200MW in NV East; or 900MW in NV West and 900MW in NV East) lie within the envelope of these scenarios.

1.2 Purpose of this document

8. This Outline Scour Protection and Cable Protection Plan outlines the key principles of how Norfolk Vanguard Limited intends to manage the protection of foundations and cables from the effects of scour and hazards (e.g. snagging anchors in the case of cables), both immediately post-construction and throughout the operational life of Norfolk Vanguard. This statement also provides a summary of the effects of scour and cable protection as presented in the Environmental Statement (ES).

9. Geophysical and geotechnical surveys were completed by Fugro between 19th June and 4th September 2012 for NV East (formerly East Anglia FOUR) and between 7th September and 14th November 2016 for NV West and the offshore cable corridor. As such, there is a good understanding of the existing marine physical processes environment at Norfolk Vanguard and its adjacent areas. Further information on the underlying geological conditions of the sites will be developed through further geophysical and geotechnical surveys prior to construction.

10. The EIA has assumed a worst case scenario of all foundations having scour protection in order to provide a conservative assessment.

11. Cable burial is expected to be possible throughout the offshore cable corridor, with the exception of cable crossing locations. In order to provide a conservative and future-proof impact assessment, a contingency estimate for cable protection is included in the assessment, should cable burial not be possible (e.g. due to unexpected hard substrate being encountered during the preconstruction surveys or cable burial).

12. A final Scour Protection and Cable Protection Plan would be developed post-consent in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies, as the final design develops and based on information arising from pre-construction surveys.

2 FOUNDATION SCOUR PROTECTION

13. The effects of scour are influenced by the marine processes acting upon offshore infrastructure, such as cables and turbine foundations. Depending on metocean conditions, scour and cable protection may be required around foundations and cables to protect against currents and waves that may cause erosion of the seabed.

14. For all types of foundations, scour protection material is likely to be installed where required during the construction process in order to mitigate the effects of scour and hence release of suspended sediment and bed level changes in the vicinity of each wind turbine location.

15. ES Chapter 5 Project Description, Table 5.5 provides detail on the worst-case scenario footprint (including scour protection) for turbines, electrical and accommodation platforms, met masts and LiDAR. These assumptions are based on the maximum requirements for each foundation type, these predicted areas are summarised below:

- Jacket (pile and suction caisson): Scour protection covering an area which is five times the foundation diameter;
- Monopile: Scour protection covering an area which is five times the pile diameter;
- Gravity Base Structure (GBS): Scour protection covering an area which is five times the diameter around foundation;
- Suction Caisson: Scour protection covering an area which is five times the foundation diameter; and
- Floating tension leg: The structure would be held to the seabed under tensioned mooring cables anchoring the structure to the seabed. Anchors would either be pin piles, caissons or a single GBS. As such the scour protection would cover an area which is five times the diameter of each possible anchor foundation.

16. As detailed in section 5.4.3 of ES Chapter 5, for all foundation types scour protection would comprise quarried rock, well graded with d50=200 to 400, (i.e. half the stones will be less than a specified median (200 to 400mm diameter) and half will be greater).

17. Alternative scour protection solutions such as 'frond systems' are also being considered. These comprise continuous lines of overlapping buoyant polypropylene fronds that when activated create a viscous drag barrier that significantly reduces current velocity. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by anchors pre-attached to the mesh base by polyester webbing lines. Grouted mattresses are also being considered.

18. The quantities and extent of scour protection would be dependent on current speed, sediment type and the foundation details and would therefore be determined post

consent based on the final design and pre-construction surveys. The maximum worst-case scenario has assumed that a maximum of 53,195,398m^3 of scour protection will be required in total, for all foundations (see Table 1). The maximum height of scour protection at any given point would be 5m.

19. The location of turbine foundations and therefore scour protection would be determined post consent based on the final design and pre-construction surveys but all could be located in NV East; all in NV West; or split between the two OWF sites.

Table 1 Worst case scenario for scour protection

Foundation	Scour protection per foundation (m^3)	Maximum number of foundations	Total scour protection (m^3)
Turbines	264,600	200	52,920,000
Offshore electrical platforms	50,000	2	100,000
Accommodation platforms	50,000	2	100,000
Met masts	37,699	2	75,398
LiDAR	0	2	0
Total			**53,195,398**

3 CABLE PROTECTION

3.1 Unburied cables

20. The preferred method for cable protection would be burial, however as discussed in section 1.2, there may be some locations where array, export or interconnector cables cannot be buried due to cable crossings or substrate type and so alternative methods of protection may be required.

21. As previously discussed, cable burial is expected to be possible throughout the offshore cable corridor, with the exception of cable crossing locations. In order to provide a conservative and future-proof impact assessment, the following contingency estimates for cable protection are included in the assessment, should cable burial not be possible due to hard substrate which was not identified in the site characterisation surveys:

- Up to 20km of protection per cable pair (40km in total) for the whole offshore cable corridor;
    - Of which, 4km per pair (8km in total) could be within the Haisborough Hammond and Winterton Special Area of Conservation (SAC);
- Up to 60km for array cables;
- Up to 15km for interconnector cables;
- The maximum width and height of cable protection for unburied cable would be 5m and 0.5m, respectively; and
- The maximum width and height of cable protection at cable crossings would be 10m and 0.9m, respectively.

22. Norfolk Vanguard Limited is committed to minimising the placement of cable protection within the Haisborough, Hammond and Winterton Special Area of Conservation (SAC) and is confident that burial will be possible throughout the SAC. However, to allow for the unlikely event that hard substrate is encountered in the SAC, placement of cable protection for up to 4km per cable (24km in total within the SAC) over the life of the project has been assessed in the ES. This is included within the total cable protection parameters for the export cables, described above.

3.2 Cables approaching turbines and platforms

23. It would necessary for cables to be surface laid as they approach each turbine and electrical platform in order for the cables to be connected into J tubes. An estimate of up to 50m length per cable entering and leaving each device is anticipated, i.e. 100m length per turbine and electrical platform.

3.3 Crossings

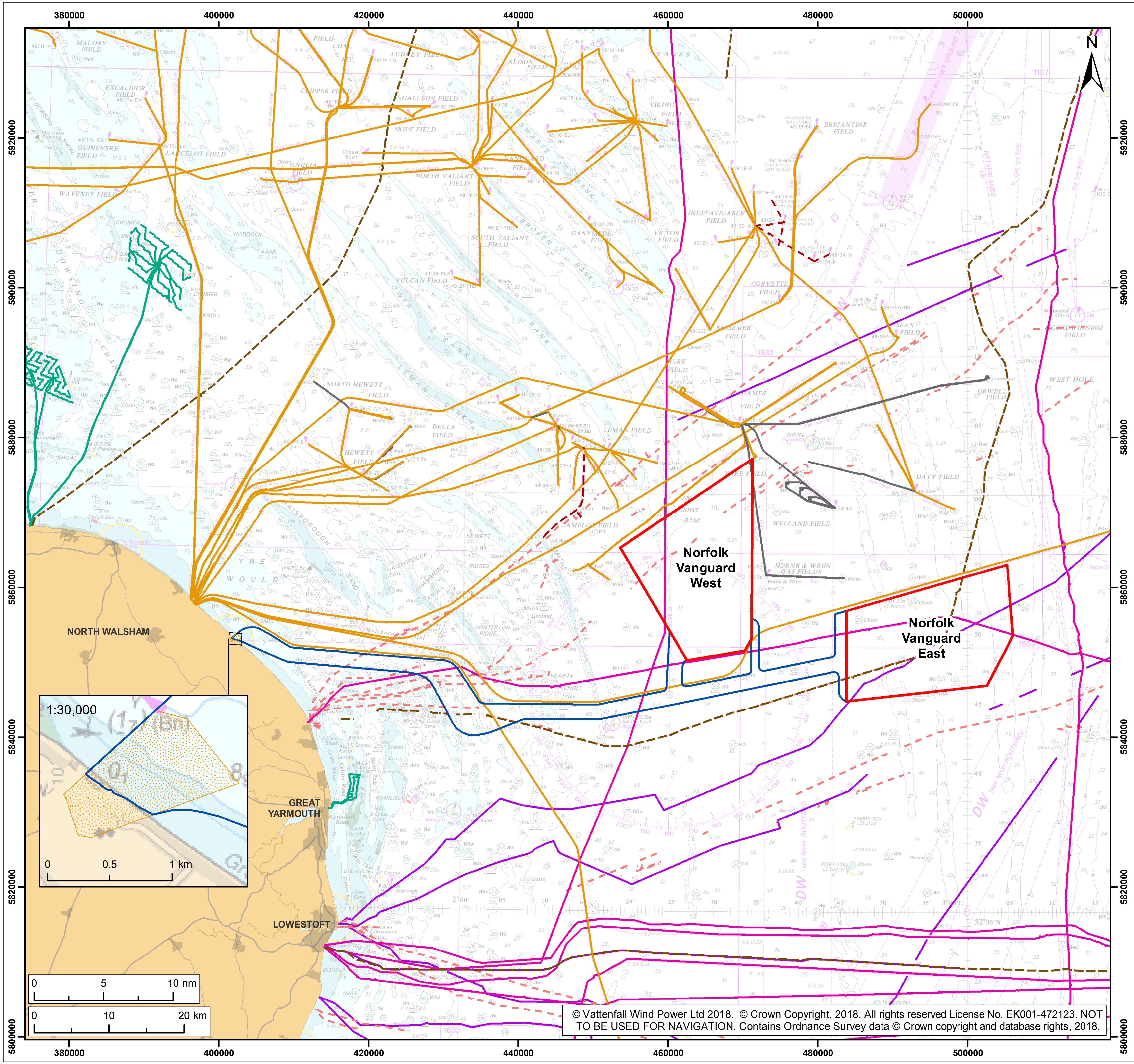
24. Where each Norfolk Vanguard export cable is required to cross an obstacle such as an existing pipeline or cable (see Figure 3.1), protection would be installed to protect the obstacle being crossed. Each Norfolk Vanguard cable would then be placed on top of the layer of protection with a further layer of cable protection placed on top.

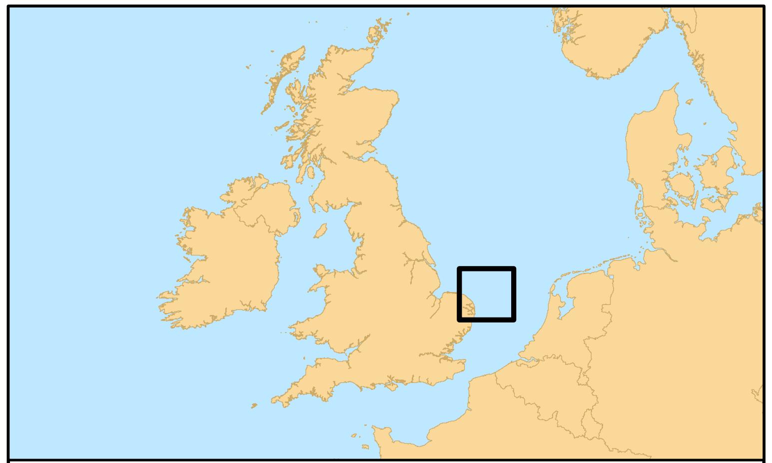
25. There are up to nine cables and two pipelines which the Norfolk Vanguard export cables would need to cross (five cables and one pipeline within the SAC). Each crossing would require a carefully agreed procedure between the cable owners. Each crossing agreement will be finalised post consent and following further, pre-construction marine surveys. The maximum width and length of cable protection for cable crossings would be 10m and 100m, respectively. The maximum height of cable crossings is 0.9m.

3.4 Landfall

26. Cable protection may be required at each of the landfall Horizontal Directional Drilling (HDD) exit points. This could entail a footprint of up to 36m^2, based on the use of one concrete mattress[1] (approximately 6m length x 3m width x 0.3m height) as well as rock dumping (approximately 5m length x 5m width x 0.5m height) at each exit point (up to two cable pair exit points).

[1] A concrete mattress is a proven way of providing protection to subsea cables. It comprises a grid of heavy cast concrete blocks linked by wire.





Legend:

- Norfolk Vanguard
- Offshore cable corridor
- Landfall zone

Pipelines[1]

- Abandoned
- Active
- Not in use

Subsea Cables[2]

- Active
- Disused
- other offshore wind farm cable

Subsea Cables[3]

- Active
- Out of service

[1] Oil & Gas UK ltd, 2018.
[2] KisOrca, 2017.
[3] Global Marine 2011.

Project:	Report:
Norfolk Vanguard	Scour Protection and Cable Management Plan

Title:

Existing Cables and Pipelines

Figure: 3.1 Drawing No: PB4476-006-003-001

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
03	30/05/2018	BH	GK	A3	1:500,000
02	23/05/2018	BH	GK	A3	1:500,000

Co-ordinate system: ETRS 1989 UTM Zone 31N **EPSG:** 25831

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3.5 Types of cable protection

27. As detailed in section 5.4.14.1 of Chapter 5 Project Description, the following cable protection options may be used and this would be determined during the final design of the project:

- Rock placement;
- Concrete mattresses;
- Grout or sand bags;
- Frond mattresses; and
- Uraduct or similar.

3.6 Cable protection quantities and location

28. The quantities, extent and location of cable protection would be dependent on the final design and findings of the pre-construction surveys. Table 2 provides an overview of the maximum area and volume of cable protection as well as providing an overview of where certain cable protection may be required.

Table 2 Cable protection parameters

	Length (m)	Width (m)	Height (m)	Total area (m^2)	Total volume (m^3)	Location (see Figure 3.1)
Array cables						
Unburied (based on 10% of the total cabling)	60000	5	0.5	300,000	150000	NV East and/or NV West
Approaching turbines (100m x 200 turbines)	20000	5	0.5	100,000	50000	NV East and/or NV West
Crossings (based on 10 crossings)	1000	10	0.9m in total, including existing cable	10,000	9000	NV East and/or NV West
Interconnector cables						
Approaching electrical platforms (100m x 2 platforms)	200	5	0.5	1,000	500	NV East and/or NV West
Unburied (based on 10% of the total cabling)	15000	5	0.5	75,000	37,500	OWF sites and/or within offshore cable corridor between NV East and NV West
Crossings (none)	N/A	N/A	N/A	N/A	N/A	N/A
Export cables						
Unburied (based on 10% of the total cabling)	40,000	5	0.5	200,000	100,000	Within the offshore cable corridor, up to 20% could be within the Haisborough Hammond and Winterton SAC
Crossings (based on 22 crossings)	2200	10	0.9m in total, including existing cable	22,000	19,800	At location of existing cables and pipelines shown on Figure 3.1
Protection at the landfall HDD exit locations - mattress	12	3	0.3	36	11	At the -5.5m LAT depth contour or deeper within the offshore cable corridor (approximate length of 1000m from the onshore drilling location)
Protection at the landfall HDD exit locations – rock dumping	10	5	0.5	50	25	

4 SCOUR AND CABLE PROTECTION ASSESSMENT IN ES CHAPTERS

29. The offshore chapters of the ES (Chapters 8 – 18) present potential impacts relating to the presence of scour and cable protection during the operational phase of Norfolk Vanguard, where relevant. It is important to highlight that the assessments presented in the ES are based upon the worst case scenario relevant to a given potential impact, as drawn from details pertaining to the type, quantity and location of scour and cable protection specified in the Project Description. Table 3 details the ES chapters and relevant impact assessments which consider these impacts.

Table 3 Impacts relating to the presence of scour and cable protection

ES Chapter	Impacts Considered
Chapter 8: Marine Geology, Oceanography and Physical Processes	
Table 8.15	Changes to the tidal regime due to the presence of structures in the OWF sites (wind turbines and platforms). • Changes to tidal currents created by presence of wind turbines • Changes to waves created by presence of wind turbines
Table 8.15	Changes to the sediment transport regime due to the presence of structures in the OWF sites
Table 8.15	Loss of seabed morphology due to the footprint of wind turbine foundation structures
Table 8.15	Morphological and sediment transport effects due to cable protection measures for array and interconnector cables
Table 8.15	Morphological and sediment transport effects due to cable protection measures for offshore export cables (including nearshore and at the coastal landfall)
Chapter 10: Benthic and Intertidal Ecology	
Table 10.12	Permanent loss of seabed habitat in the OWF sites due to the presence of wind turbine and platform foundations, scour protection, array cables, inter-connector cables, and cable protection.
Table 10.12	Permanent loss of seabed habitat in the offshore cable corridor due to cable protection
Table 10.12	Colonisation of turbines/cable protection/scour protection due to the presence of turbines, cable protection and scour protection
Chapter 11: Fish and Shellfish Ecology	
Table 11.11	Permanent loss of seabed habitat in the OWF sites through the presence of wind turbine and platform foundations, scour protection, array cables, inter-connector cables, and cable protection
Table 11.11	Introduction of hard substrate (turbine foundations and scour/cable protection) leading to effects on fish and shellfish receptors by creating reef habitat
Chapter 14: Commercial Fisheries	
Table 14.4	Complete loss or restricted access to traditional fishing grounds due to due to the presence of turbines, cable protection and scour protection
Table 14.4	Obstacles on the sea bed post construction due to the presence of turbines, cable protection and scour protection
Table 14.4	Interference with fishing activities due to the presence of turbines, cable protection and scour protection
Table 14.4	Displacement of fishing activity into other areas due to the presence of turbines, cable protection and scour protection

ES Chapter	Impacts Considered
Chapter 17: Offshore Archaeology and Cultural Heritage	
Table 17.16	Direct impact to potential heritage assets from cable repairs and Seabed contact by legs of jack-up vessels and / or anchors (maintenance)
Table 17.16	Indirect impact to heritage assets from changes to physical processes such as tidal current, waves, and Seabed morphology and sediment transport along array, interconnector and offshore export cables
Table 17.16	Impacts to the setting of heritage assets and historic seascape character due to the presence of wind farm infrastructure and activities associated with operations and maintenance

5 SUMMARY

30. Norfolk Vanguard Limited considers that details pertaining to the type, quantity and location of scour and cable protection have been specified within the Project Description (Volume 1, Chapter 5) to a sufficient extent to allow assessment of potential impacts within relevant offshore ES chapters. It is noted that the specification of cable and scour protection within the project envelope enables a required level of flexibility to be retained in the final engineering of these aspects. In consideration of this flexibility, the assessments presented in the ES are based upon the worst case scenario relevant to a given potential impact, as drawn from the project envelope and presented in the relevant offshore ES chapter.

31. It should be noted that volumes of scour protection and cable protection are controlled within the DCO (see Schedule 1, Part 3, Requirement 5) and in the DMLs (Part 4, Condition 3). DCO Schedules 9 and 10 condition 14(1)(e) and Schedules 11 and 12 condition 9(1)(e) of the DMLs requires that the final Scour Protection and Cable Protection Plan must be agreed with the MMO.

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