RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Environmental Statement

Volume 7

Chapter 5 – Project Description (Clean) (Revision 3)

January 2025

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03	N/A	N/A	Updates to address comments following the January 2025 Issue Specific Hearings, including:
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03	135, 136	5.7.1.8 - Construction Compounds	A description of key equipment that could be located in the substation Zone Temporary Construction Compounds has been added in response to the LIR.
03	138	5.7.2	Further details on the AIS / GIS Switchgear and confirmation that AIS forms the 'worst case' in terms of footprint and in for the Landscape and Visual Impact Assessment
03	140	5.7.2	Correction of typo in para 357 (Table 5.29 rather than Table 5.30)
03	141	5.7.2	Clarification on maximum number of lightning masts
03	143	5.7.2.1	Confirmation that worst case substation zone layout uses AIS switchgear design
03	143	Table 5.29	Correction of typo 'HVDC converter station instead of 'GIS converter station'

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Glossary

Term	Definition
Accommodation Platform	An offshore platform (situated within either the DBS East or DBS West Array Area) that would provide accommodation and mess facilities for staff when carrying out activities for the Projects.
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or [that part of] the Inter-Platform Cable Corridor [within which no wind turbines are proposed]. Each area is referred to separately as an Array Area.
Array cables	Offshore cables which link the wind turbines to the Offshore Converter Platform(s).
Collector Platforms (CPs)	Receive the AC power generated by the wind turbines through the array cables, collect it and transform the voltage for onward transmission to the Offshore Converter Platforms (OCPs).
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Development Scenario	Description of how the DBS East and/or DBS West Projects would be constructed either in isolation, sequentially or concurrently.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Electrical Switching Platform (ESP)	The Electrical Switching Platform (ESP), if required would be located either within one of the Array Areas (alongside an Offshore Converter Platform (OCP)) or the Export Cable Platform Search Area.
Export Cable Platform Search Area	The Export Cable Platform Search Area is located mid-way along the Offshore Export Cable Corridor and is the area of search for the Electrical Switching Platform (ESP).

Term	Definition
Haul Road	The track along the Onshore Export Cable Corridor used by traffic to access different sections of the onshore export cable route for construction.
Horizontal Directional Drill (HDD)	HDD is a trenchless technique to bring the offshore cables ashore at the landfall. It can also be used for crossing obstacles such as roads, railways and watercourses onshore.
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Inter-Platform Cables	Buried offshore cables which link offshore platforms.
Inter-Platform Cable Corridor	The area where Inter-Platform Cables would route between the DBS East and DBS West Array Areas, should both Projects be constructed.
Intertidal	Area on a shore that lies between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS).
Jointing Bays	Underground structures constructed at regular intervals along the onshore cable route to join sections of cable and facilitate installation of the cables into the buried ducts.
Landfall	The point on the coastline at which the Offshore Export Cables are brought onshore, connecting to the Onshore Export Cables at the Transition Joint Bay (TJB) above mean high water.
Link Boxes	An underground metal box placed within a concrete pit where the metal sheaths between adjacent export cable sections are connected and earthed, installed with a ground level manhole to allow access to the Link Box for regular maintenance or fault-finding purposes.

Term	Definition
Mean High Water Springs (MHWS)	MHWS is the average of the heights of two successive high waters during a 24 hour period.
Mean Low Water Springs (MLWS)	MLWS is the average of the heights of two successive low waters during a 24 hour period.
Offshore Converter Platforms (OCPs)	The OCPs are fixed structures located within the Array Areas that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the Offshore Export Cables to the Project's Onshore Grid Connection Points.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cables	The cables which would bring electricity from the offshore platforms to the Transition Joint Bays (TJBs).
Offshore Export Cable Corridor	This is the area which will contain the Offshore Export Cables (and potentially the ESP) between the Offshore Converter Platforms and Transition Joint Bays at the landfall.
Onshore Converter Stations	A compound containing electrical equipment required to transform HVDC and stabilise electricity generated by the Projects so that it can be connected to the electricity transmission network as HVAC. There will be one Onshore Converter Station for each Project.
Onshore Development Area	The Onshore Development Area for ES is the boundary within which all onshore infrastructure required for the Projects would be located including Landfall Zone, Onshore Export Cable Corridor, accesses, Temporary Construction Compounds and Onshore Converter Stations. (as shown on **Volume 7, Figure 5-2 (application ref: 7.5.1)**.
Onshore Export Cables	Onshore Export Cables take the electric from the Transition Joint Bay to the Onshore Converter Stations.

Term	Definition
Onshore Export Cable Corridor	This is the area which includes cable trenches, Haul Roads, spoil storage areas, and limits of deviation for micro-siting. For assessment purposes, the cable corridor does not include the Onshore Converter Stations, Transition Joint Bays or temporary access routes; but includes Temporary Construction Compounds (purely for the cable route).
Onshore Substation Zone	Parcel of land within the Onshore Development Area where the Onshore Converter Station infrastructure (including the Haul Roads, temporary construction compounds and associated cable routeing) would be located.
Safety zones	Legislated under the Energy Act 2004, safety zones are rolling buffer areas which protect construction activities by preventing unauthorised vessels from entering their boundary.
Scoping opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.
Scoping report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Scour protection	Protective materials to avoid sediment erosion from the base of the wind turbine foundations and offshore substation platform foundations due to water flow.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the commencement of construction activities. Either Project could be built first.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Term	Definition
Topic Specific Study Area	The area where potential impacts from the Projects could occur, as defined for each individual EIA topic.
Transition Joint Bay (TJB)	The Transition Joint Bay (TJB) is an underground structure at the landfall that houses the joints between the Offshore Export Cables and the Onshore Export Cables.
Transition Joint Bay (TJB) Compound	A temporary construction compound located within the 'Landfall Zone' to undertake the trenchless crossing technique e.g. Horizontal Directional Drilling (HDD) and for the construction of the Transition Joint Bays.
Turbine string	Term referring to a number of cables installed in series on a single cable branch forming a string (or collection) circuit.

Acronyms

Term	Definition
AfL	Agreement for Lease
CAA	Civil Aviation Authority
CBS	Cement Bound Sand
COMAH	Control of Major Accident Hazards
CP	Collector Platform
CSIMP	Cable Specification, Installation and Monitoring Plan
CTV	Crew Transfer Vessel
DBS	Dogger Bank South
DCO	Development Consent Order
DP	Dynamic Positioning
DTS	Distributed Temperature Sensing
EIA	Environmental Impact Assessment
ES	Environmental Statement
ESO	Electricity System Operator
ESP	Electrical Switching Platform
GBS	Gravity Base Structures
GIS	Gas Insulated Switchgear
GW	Gigawatt
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling

Term	Definition
HV	High Voltage
HVDC	High Voltage Direct Current
km	Kilometres
kV	Kilovolt
LAT	Lowest Astronomical Tide
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MGN	Marine Guidance Notice
MHWS	Mean High Water Springs
MW	Megawatts
NPPF	National Planning Policy Framework
NRA	Navigational Risk Assessment
NSIP	Nationally Significant Infrastructure Project
O&M	Operations and Maintenance
OCoCP	Outline Code of Construction Practice
OCP	Offshore Converter Platform
Ofgem	Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
PEIR	Preliminary Environmental Information Report
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation

Term	Definition
SCADA	Supervisory Control and Data Acquisition
SF6	Sulphur Hexafluoride
SVC	Static Var Compensator
TCE	The Crown Estate
THLS	Trinity House Lighthouse Service
TJB	Transition Joint Bay
UPS	Uninterruptible Power Supply
UXO	Unexploded Ordnance

5 Project Description

5.1 Introduction

1. This chapter of the Environmental Statement (ES) provides a description of the key components of the proposed Dogger Bank South (DBS) East and DBS West Offshore Wind Farms (herein 'the Projects') as well as detailing how the Projects would be constructed, operated, maintained and decommissioned. These details inform and underpin the assessments that have been undertaken, although **Volume 7**, **Chapters 8 – 30 (application ref: 7.8 to 7.30)** should be referred to for details of the worst case scenarios that apply for each topic assessment.

2. The Projects would have a combined maximum number of 200 turbines. The DBS West and DBS East Array Areas are situated at a minimum of 100 (kilometres) km and 122km from shore respectively (**Volume 7, Figure 5-1 (application ref: 7.5.1)**).

3. The proposed onshore construction works consist of installation of buried Onshore Export Cables, from a landfall on the East Riding of Yorkshire coastline near Skipsea to (up to) two newly constructed Onshore Converter Stations before onward onshore cable routeing to a proposed new National Grid substation close to the existing Creyke Beck substation known as Birkhill Wood, to the south of Beverley. Hereafter referred to as the proposed Birkhill Wood National Grid Substation.

4. The key offshore components comprise:

- Wind turbines;
- Offshore platforms, including offshore Collector Platforms (CPs) and / or converter platforms (OCPs), an Electrical Switching Platform (ESP) and an Accommodation Platform (hereafter collectively referred to as offshore platforms unless specified);
- Foundation structures for wind turbines and offshore platforms;
- Array cables;
- Inter-platform cables;
- Offshore Export Cables from the Array Areas to the landfall;
- Landfall works seaward of Mean Low Water Springs (MLWS) for a long trenchless crossing; and
- Scour/cable protection (where required).

5. The key onshore components comprise:

- Landfall works between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS) for a short trenchless crossing;
- Construction of Transition Joint Bays (TJBs);
- Onshore Export Cables installed underground from the TJBs to the Onshore Converter Stations and associated Jointing Bays and Link Boxes;
- Onshore Converter Stations;
- Onward 400 kilovolt (kV) connection to the proposed Birkhill Wood National Grid Substation;
- Trenchless crossing locations (e.g., Horizontal Directional Drilling (HDD));
- Construction and operational accesses; and
- Construction compounds.

5.1.1 Project Development Scenarios

6. As set out in **Volume 7, Chapter 1 Introduction (application ref: 7.1)**, whilst the Projects are each Nationally Significant Infrastructure Projects (NSIPs) in their own right, a single application for development consent has been made to address both wind farms, and the associated transmission infrastructure. A single planning process and Development Consent Order (DCO) application provides consistency in the approach to the assessment, consultation and examination. While a single DCO application has been made for both Projects, five separate Deemed Marine Licences are included as schedules to the DCO to cover each Array Area, their associated transmission infrastructure and the inter-project cabling required for the Projects. This approach allows for ease of separate ownership of each of the asset should their ownership change over time.

7. The Applicants have developed DBS East and DBS West transmission infrastructure as co-ordinated projects in accordance with the National Grid Electricity System Operator (ESO) evolving Holistic Network Design (HND), as updated in February 2024 (HND, 2024). The HND has confirmed the Projects will have a radial connection to the proposed National Grid Substation at Birkhill Wood.

8. Where practicable the two Projects co-locate infrastructure to reduce overall environmental impacts and disruption.

9. Whilst the Projects are the subject of a single DCO application (with a combined Environmental Impact Assessment (EIA) process and associated submissions), each Project is assessed individually, so that mitigation is Project specific (where appropriate). As such, the assessments cover the following three Development Scenarios:

- DBS East or DBS West are developed In Isolation (the In isolation Scenario);
- Both DBS East and DBS West are developed Concurrent (the Concurrent Scenario), or
- Both DBS East and DBS West are developed Sequentially (the Sequential Scenario).

10. Both the DBS West and DBS East Projects would use High Voltage Direct Current (HVDC) to transmit electricity generated offshore to the landfall and onward to the Onshore Converter Stations. The onward transmission from the Onshore Converter Stations to the Proposed Birkhill Wood National Grid Substation would use High Voltage Alternating Current (HVAC). High Voltage Alternating Current (HVAC) was removed as a transmission technology option for transmission from the generating station to the Onshore Converter Stations following the Preliminary Environmental Information Report (PEIR). Further details on this are provided in **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4).**

11. The route of the Onshore Cable Corridor is shown on **Volume 7, Figure 5-2 (application ref: 7.5.1)** as well as the indicative Onshore Development Area design on **Volume 7, Figure 5-3 (application ref: 7.5.1).** Four export cables would be required for two HVDC projects, with two HVDC Onshore Converter Stations required within the Onshore Substation Zone. This is illustrated in **Volume 7, Figure 5-4 (application ref: 7.5.1).**

12. In order to ensure that a robust assessment has been undertaken, all three Development Scenarios have been considered to ensure the realistic worst case scenario for each topic has been assessed. Further details are provided within the worst case tables in **Volume 7, Chapters 8 – 30 (application ref: 7.8 to 7.30)**.

13. The EIA considers the appropriate realistic worst case associated with the different Development Scenarios and presents the results accordingly. The information provided in this chapter is designed to clearly show how the project design envelope would differ depending on which scenario may be taken forward.

14. In summary, the following principles set out the framework for how the Projects may be developed, as detailed in **Table 5-1**:

- DBS West and DBS East may be constructed at the same time, or at different times;
- If built in isolation, either Project could be constructed in five years;
- If built concurrent, both Projects could be constructed in five years;
- If built sequentially, construction on either Project could commence first, but with staggered / overlapping construction; and
- If built sequentially, construction of the first Project would be completed within 5 years, with construction of the second Project being completed within 7 years.

15. Therefore, the maximum construction period over which the construction of both Projects could take place is seven years.

Table 5-1 Development Scenarios and Construction Durations

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum Construction Duration Offshore (Years)	Maximum Construction Duration Onshore (Years)
In Isolation	Either DBS East or DBS West is built In Isolation.	Five	Five	Four
Sequential	DBS East and DBS West are both built Sequentially, either Project could commence construction first with staggered / overlapping construction.	Seven	A five year period of construction for each project with a lag of up to two years in the start of construction of the second project (excluding landfall duct installation) – reflecting the maximum duration of	Construction works (i.e. onshore cable civil works, including duct installation) to be completed for both Projects simultaneously in the first four years, with additional works at the landfall, substation zone and cable joint bays in the

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum Construction Duration Offshore (Years)	Maximum Construction Duration Onshore (Years)
			effects of seven years.	following two years. Maximum duration of effects of six years.
Concurrent	DBS East and DBS West are both built Concurrent reflecting the maximum peak effects.	Five	Five	Four

16. The impact assessments consider the Development Scenarios presented above.

17. It is unlikely that an In Isolation Development Scenario would be taken forwards. However, it has been considered to ensure a robust EIA is undertaken.

18. If an In Isolation Scenario is taken forwards, only the eastern Onshore Converter Station within the Onshore Substation Zone **(Volume 7, Figure 5-4 (application ref: 7.5.1)**) would be constructed in order to avoid any sterilisation of the land. No onshore cable ducts, Onshore Converter Station foundation platform or ancillary infrastructure, such as sustainable drainage systems, would be installed for a second Project. The onward cable route to the proposed Birkhill Wood National Grid Substation would use the route north of the Ineos pipeline, referred to as the Northern route, which is shown on **Volume 7, Figure 5-3 (application ref: 7.5.1)**.

19. If a Sequential Scenario is taken forward the construction of the trenchless duct installation works at the landfall, trenchless crossings and the trenching and installation of cable ducts along the cable route would be completed for both Projects onshore at the same time. In addition, earthworks, drainage and permanent access for the second Onshore Converter Station would be completed simultaneously. These construction activities are described further throughout the chapter.

20. Once the initial construction works for both Projects have been completed onshore, there may be a period of construction inactivity onshore until the second Project is ready for connection. Further construction works would then commence onshore at the landfall TJBs, Onshore Converter Station(s) and Jointing Bays along the cable corridor to pull cables for the second project through the pre-installed ducts for the second Project. These works would take place within the Maximum Onshore Construction Duration of six years set out in **Table 5-1**. Construction activities and durations are described further in section 5.7.1.3 and proposed reinstatement associated with each Development Scenario is described in section 5.7.1.7. Works offshore would be continuous.

21. If a Concurrent Scenario is taken forwards then both Projects' construction activities would be undertaken simultaneously throughout the construction duration for offshore and onshore, commencing and completing construction at the same time for each Project.

22. The In Isolation, Concurrent and Sequential Development Scenarios allow for flexibility to build out the Projects using a phased approach. This would allow the Projects to adapt to National Grid Electricity Transmission Operator's development plans for the onshore grid connection points.

5.1.2 Flexibility and the Project Design Envelope

23. The Project Design Envelope described in this chapter provides reasoned values for a series of project design parameters. The detailed design of the Projects would be developed and refined within this consented envelope prior to construction, with the final design lying between the maximum extent of the consent (where provided). This approach to the EIA, also known as the 'Rochdale Envelope' approach, is further described in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)**.

24. The information presented in this chapter outlines the options and flexibility required for the delivery of the Projects along with the range of potential design and activity parameters upon which the subsequent impact assessment chapters are based.

25. The need for flexibility in the consent is a key aspect of any large development but is particularly significant for offshore wind projects where technology continues to evolve quickly. Therefore, the project design envelope must provide sufficient flexibility to enable the Applicants and their contractors to use the most up to date, efficient and cost-effective technology and techniques in the construction, operation, maintenance and decommissioning of the Projects.

26. Key aspects of the Projects for which flexibility in the project design envelope is required include:

- Wind turbine type and capacity, including associated parameters such as maximum tip height and foundation type, to benefit from improvements in technology prior to offshore construction;
- Construction and maintenance methodologies, as above, to enable competitive procurement and the most cost-effective option to be adopted post-consent; and
- The Development Scenarios detailed in section 5.1.1, namely that either DBS East or DBS West are developed In Isolation, or DBS East and DBS West are both developed, either Concurrently or Sequentially.

5.1.3 Site Description

5.1.3.1 Offshore

27. The Projects are located in the Dogger Bank region of the southern North Sea, with the closest point to the coast being 100km from DBS West and 122km from DBS East. The Offshore Development Area includes the refined versions of the Projects' Array Areas as defined by The Crown Estate Agreements for Lease (AfL) areas plus a 1km temporary construction area buffer and the Offshore Export Cable Corridor with a 500m temporary construction area on both sides of the Offshore Export Cable Corridor (**Volume 7, Figure 5-3 (application ref: 7.5.1**). The Offshore Export Cable Corridor also widens to approximately 3km at the Langeled pipeline crossing location and when approaching landfall. The DBS West Offshore Export Cable Corridor extends to a broader corridor where it approaches the boundary of the DBS West Array Area.

28. The minimum and maximum water depths within the Array Areas at the time of the site-specific geophysical survey ranged from 14.24m to 41.8m below the lowest astronomical tide (LAT)) (Fugro, 2023). The bathymetric profile across the Array Areas indicates that the seabed rises from north-west to south-east up the western flank of Dogger Bank and then becomes broadly flat across the top of the bank before falling again on the southern flank (see **Plate 5-1**). The seabed along the Offshore Export Cable Corridor gently slopes from the proposed landfall location where water depths are shallow to a maximum of -67.69m LAT about 8km offshore. Water depths then reduce to a minimum of -15m LAT as the Offshore Export Cable Corridor approaches the Array Areas (see **Plate 5-2**).

29. The geology of the Array Areas is expected to comprise a sequence of Pleistocene sands and clays, overlain by Holocene marine sands. The thickness of the Pleistocene and Holocene sediments beneath the Projects' Array Areas is typically approximately 100m and bedrock is characterised by undifferentiated Mesozoic claystone, mudstone, siltstone and potentially chalk.

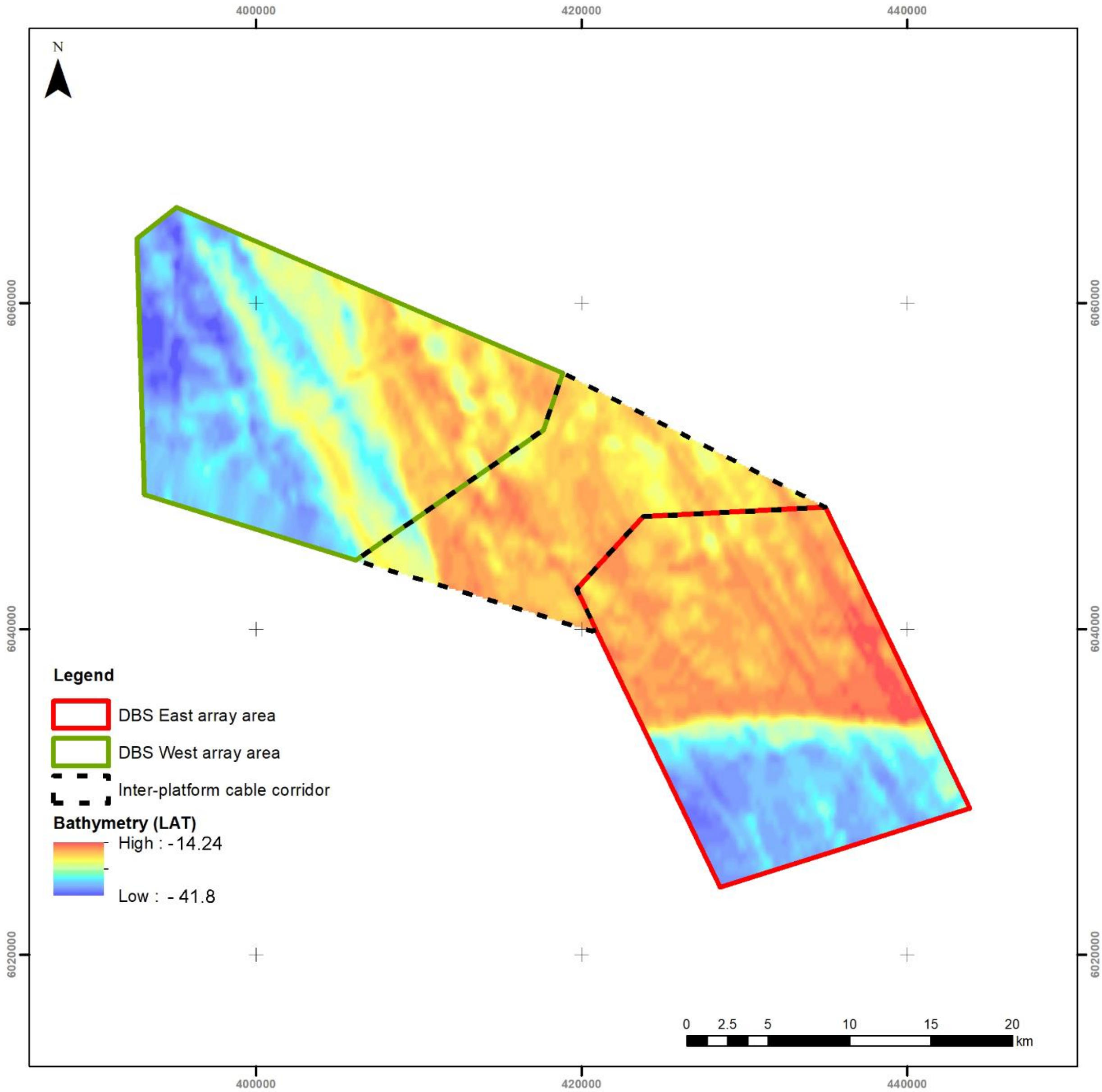

Plate 5-1 Array Areas Bathymetry Overview

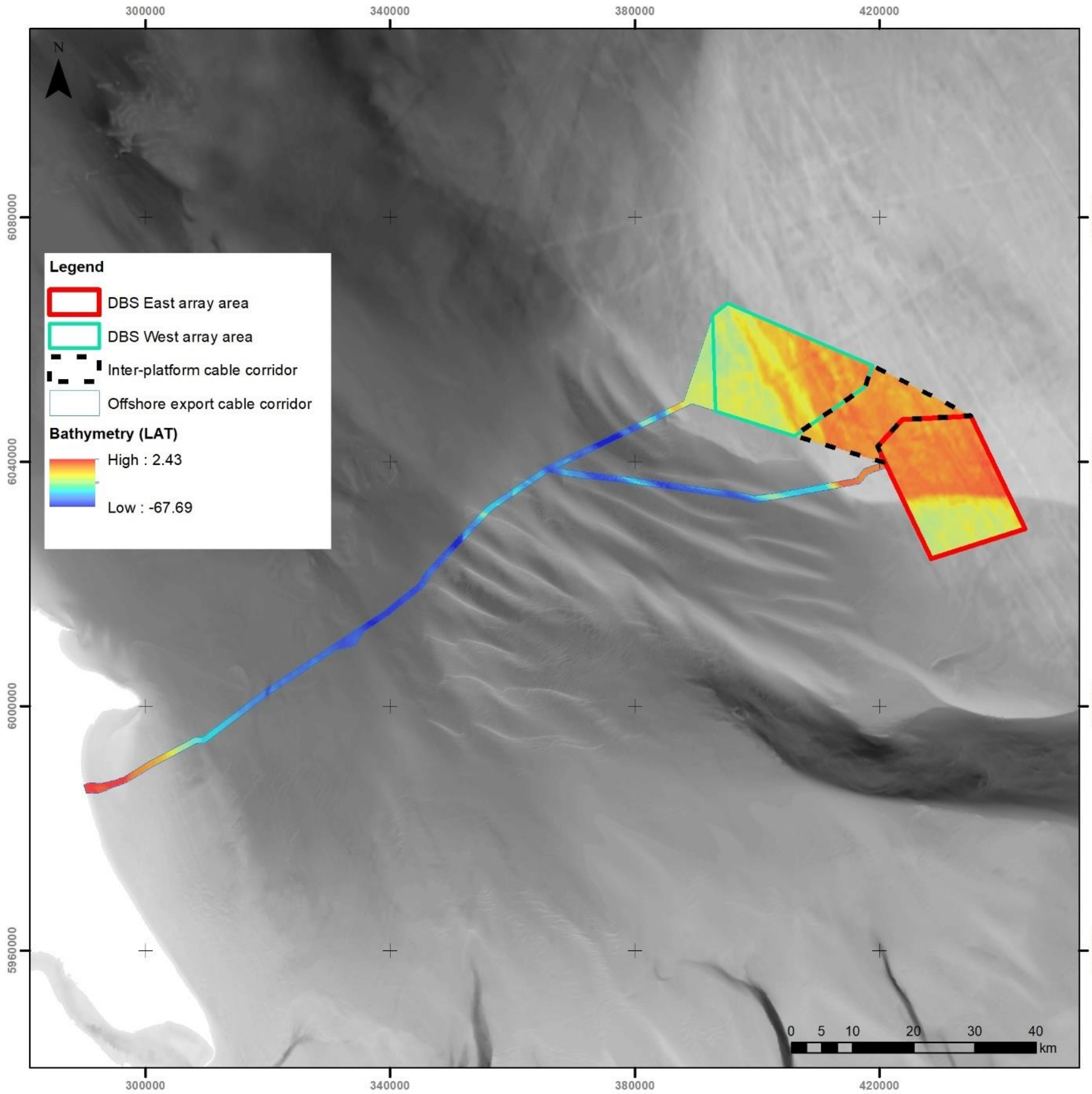

Plate 5-2 Offshore Export Cable Corridor Bathymetry Overview

30. The shallow geology along the Offshore Export Cable Corridor predominantly comprises a surficial layer of transgressive and marine Holocene sands, increasing in thickness from west to east. To a variable spatial and vertical extent, Holocene sediments form a cover overlying glacial deposits of the Weichselian glaciation, including Dogger Bank Formation, Botney Cut Formation, and Bolders Bank Formation, often as channel infill deposits. These deposits are typically underlain by Pleistocene deposits to the east, and undifferentiated Triassic/Jurassic mudstones and Upper Cretaceous Chalk bedrock in central and western parts of the corridor, with Chalk dominant towards landfall. Locally, in central and western areas of the corridor, bedrock outcrops and sub-crops within the depth of interest for cable installation. Where pre-Weichselian Pleistocene deposits are present, these are comprised of sands, gravelly sands and clays, likely to derive from the Eem, Egmond Ground and Swarte Bank Formations, and Early to Middle Pleistocene formations of the Yarmouth Roads and Markham's Hole, increasing in thickness from west to east. This results in an increased depth to bedrock towards the array. There is potential for peat/organic rich material to be present within the periglacial deposits of the Dogger Bank/Botney Cut Formations and transgressive early Holocene sand deposits, particularly towards landfall where peat is locally observed onshore.

31. The Array Areas of both Projects lie within the boundaries of the Dogger Bank Special Area of Conservation (SAC) and Southern North Sea SAC. The Offshore Export Cable Corridor passes through the Dogger Bank SAC and Southern North Sea SAC. The Offshore Export Cable Corridor routes approximately 700m north-west of the Holderness Offshore Marine Conservation Zone (MCZ) and 3km south-east of the Flamborough Head SAC as it approaches the coast. While the temporary construction area of the Offshore Export Cable Corridor overlaps with the Holderness Inshore MCZ, the permanent cable corridor is located approximately 100m north of the site.

5.1.3.2 Onshore

32. The onshore grid connection points for the Projects were determined by the Holistic Network Design (HND) process, the results of which were published in February 2024 (HND, 2024). HND identified connections for both Projects to the UK electricity network at the proposed Birkhill Wood National Grid Substation.

33. The onshore site selection process has sought to avoid settlements, sensitive habitats and taken into account other technical and environmental constraints (**Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4**). As a result, the Landfall Zone, Onshore Export Cable Corridor and the Onshore Substation Zone are located in predominantly agricultural areas. There are a number of towns and villages in proximity to the Projects infrastructure including Skipsea, Sigglesthorne, Catwick, Long Riston, Routh, Tickton, Walkington and Beverley **(Volume 7, Figure 5-2 (application ref: 7.5.1)**).

34. From the landfall location near Skipsea, the Onshore Export Cable Corridor travels west, crossing Hornsea Road (B1242), and continuing to Dunnington Lane before turning and heading south past Dunnington, Nunkeeling, Catfoss, and across West Road (A1035) at Sigglesthorne.

35. The Onshore Export Cable Corridor then turns southwest and continues, passing north of the village of Long Riston, crossing Whitecross Road (A165) and again crossing Hornsea Road (A1035) as it heads west north of Tickton. The route then crosses Driffield Road (A164) to the north of Beverley before turning south crossing Constitution Hill (A1035) to the west of Beverley, down across York Road, Newbald Road, and Broadgate (B1230), before reaching the Onshore Substation Zone located at Beverley Road between the A1079 and A164.The high level Onshore Export Cable Corridor route is shown in **Volume 7, Figure 5-2 (application ref: 7.5.1)** with the detailed indicative onshore design shown in **Volume 7, Figure 5-3 (application ref: 7.5.1).**

36. The Onshore Converter Stations would be located in proximity to the onshore grid connection points at the proposed Birkhill Wood National Grid Substation which lies approximately 2.5km South East of the Onshore Substation Zone. The Onshore Converter Stations would contain the necessary electrical and auxiliary equipment and components for transforming the power from the Projects to 400kV to meet the UK Grid Code for connection to the transmission grid.

37. From the Onshore Substation Zone, the onward 400kV cable route to the proposed Birkhill Wood National Grid Substation, crosses Beverly Road (A164) before splitting into a northern and southern cable route (as shown on **Volume 7, Figure 5-3 (application ref: 7.5.1).** These cable routes would converge again at the proposed Birkhill Wood National Grid Substation.

5.2 Consultation

38. The Applicants have undertaken an extensive programme of community and stakeholder consultation to inform the EIA process and the design of the Projects. Further details are provided in:

- **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** – an overview of the consultation undertaken in the context of the wider EIA process; and
- **Volume 7, Chapter 7 Consultation (application ref: 7.7)** – summarises the consultation undertaken to inform and focus the approach to each technical aspect of the EIA. Specific details of how the Projects have taken account of the comments received are provided in each chapter of the ES where relevant.

39. Full details of the consultation process including wider community consultation are presented in the **Consultation Report (Volume 5, application ref: 5.1),** submitted as part of the DCO application. **Volume 7, Appendix 5-1 (application ref: 7.5.5.1)** summarises the key consultation responses that relate specifically to the development of the project description. Further details are provided in the relevant technical chapters.

5.3 Project Design Changes from PEIR to ES

40. **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4**) details the project design changes from PEIR to DCO. Those changes pertinent to the offshore and onshore design are summarised below.

41. Summary of changes to offshore design:

- Array Area boundaries and Offshore Export Cable Corridor options have been refined;
- Gravity base and suction bucket foundations were removed for all turbines and platforms located within the Array Areas (GBS foundations retained for platforms within the ECC);
- Maximum monopile pile diameter was reduced, therefore reducing the maximum hammer energy required;
- Reduction in the maximum number of Offshore Export Cables from six to four following the removal of HVAC technology from the Projects Design Envelope;
- Reduction in maximum platform number from eleven to eight following the removal of HVAC technology from the Projects design envelope; and
- Reduction in width of the Offshore Export Cable Corridor approach to landfall.

42. High level summary of changes to onshore design:

- Onshore Export Cable Corridor has been refined following stakeholder consultation and preliminary environmental assessment;
- Removal of Landfall Zone 9;
- Maximum number of completed ducts at the landfall reduced from nine to six;
- Maximum number of trenches along the Onshore Export Cable Corridor reduced from seven to four;
- Onshore Export Cable Corridor width reduced from 100m to 75m;
- Removal of HVAC technology resulting in a smaller Onshore Converter Station footprint; and
- Selection of the Onshore Substation Zone from two options presented at PEIR, to a single Zone (Zone 4) capable of supporting co-located substations.

5.4 Overview of the Projects

43. Between 113 and 200 wind turbines would be installed across both Projects. For assessment purposes, it is assumed that between 57 and 100 wind turbines may be installed for DBS East or DBS West in isolation[1]. The locations of the Project Array Areas and Offshore Export Cable Corridors are shown on **Volume 7, Figure 5-2 (application ref: 7.5.1).**

44. Depending on the Development Scenario (section 5.1.1), the Array Areas would be connected to one another via Inter-Platform Cables, with a maximum of six electrical platforms combined between the Projects. The Offshore Export Cable Corridor would connect the Array Areas with the landfall near Skipsea. These would consist of up to four electrical cables and two fibre-optic communications cables installed along an integrated corridor running from landfall to a distance of approximately 80km from shore, where the cable corridors serving each Project would diverge into two branches serving the individual Projects. Two electrical cables and one fibre optic cable would be located within each branch. In the worst case scenario, these cables would be installed within individual separate trenches. The fibre-optic cables would be bundled with the electrical cables up to the nearshore, at which they may split out into separate trenches towards the landfall. As such up to six trenchless crossing ducts may be required for the Projects at landfall. An Onshore Export Cable Corridor would link the landfall with the newly constructed Onshore Converter Stations before onward onshore cable routeing to the proposed Birkhill Wood National Grid Substation.

45. An overview schematic of the key onshore and offshore project infrastructure is provided in **Plate 5-3**.

46. The earliest that construction could commence under any scenario is anticipated to be 2026 with the onshore construction works likely to commence first. Section 5.8 provides an indicative construction programme for each Development Scenario, for both the offshore and onshore works.

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[1] In situations where a number does not divide equally between DBS East and DBS West (e.g. 113 large turbines), they are rounded up to higher number (e.g. 57 large turbines as opposed to 56.5) for the purposes of assessing the worst case scenario

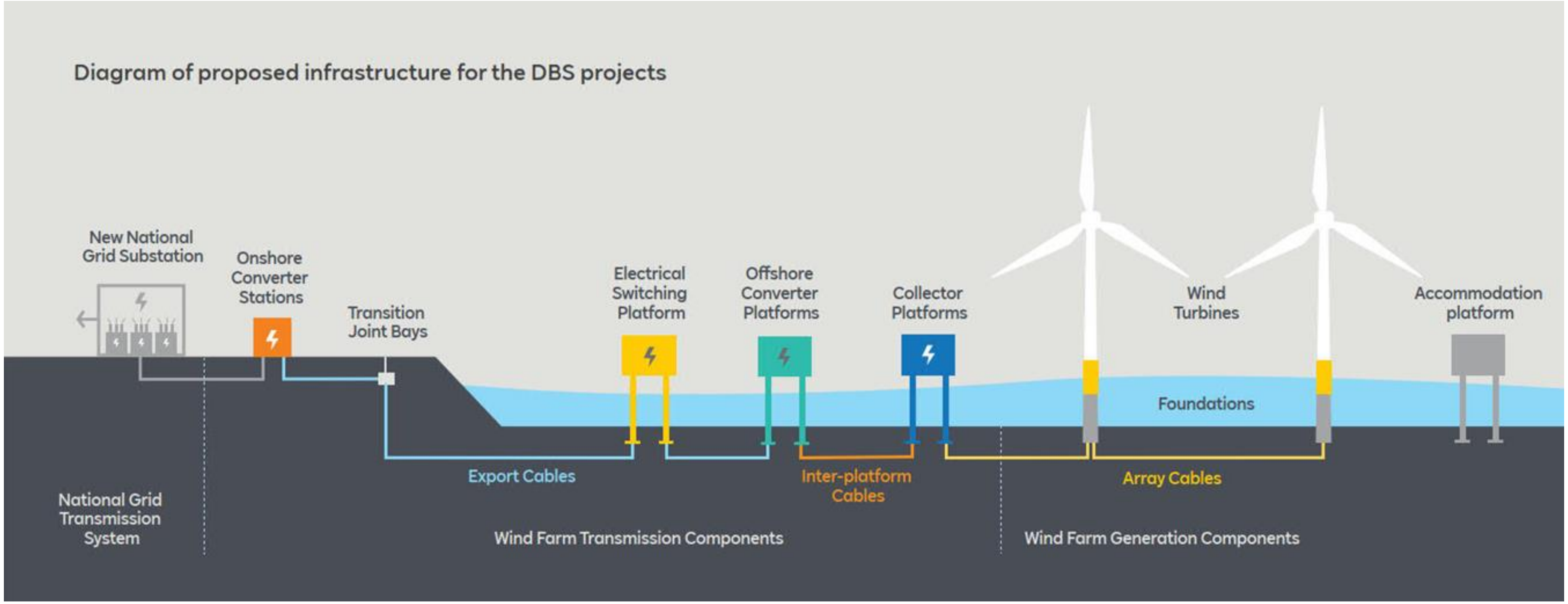

Plate 5-3 Project Overview Schematic (N.B. not to scale)

5.4.1 Key Project Components

47. The following section provides an overview of the key offshore and onshore project components which are described in further detail in sections 5.5 to 5.7.

48. The key offshore components are:

- Offshore wind turbines and their associated foundations;
- Offshore platforms and their associated foundations;
- Scour protection around foundations; and
- Sub-sea cables comprising:
  - Offshore Export Cables (linking the OCPs to the landfall);
  - Inter-platform cables;
  - Array cables (linking the wind turbines to the OCPs);
  - External cable protection on sub-sea cables as required; and
  - Fibre optic communications cables.

49. The key components at the landfall are:

- Installation of up to six completed ducts which would be installed using a trenchless technique such as Horizontal Directional Drill (HDD). This consists of three ducts per project (two power cable ducts plus a smaller duct for a fibre optic communications cable). In the event of a trenchless crossing failure the equipment would be remove and the void filled and another attempt would be made in another location within the Landfall Zone.
- Up to four TJBs to house the connection between the offshore and onshore.

50. The key onshore components are:

- Ducts installed underground to house the electrical cables along the onshore cable corridor;
- Onshore cables installed within ducts except under specific circumstances for example where an unknown obstacle is identified which may result in direct lay;
- Joint bays and links boxes installed along the cable corridor;
- Trenchless crossing points at certain locations such as some roads, railways and sensitive habitats (e.g. rivers of conservation importance);
- Temporary Construction Compounds (TCC's) (Main or Satellite) and vehicular accesses;

- Temporary bridges and culverts;
- Permanent bridges and culverts;
- Onshore Converter Stations and Onward HVAC Cable Connections to the proposed Birkhill Wood National Grid Substation; and
- Permanent operational converter station and cable route access.

5.5 Offshore

5.5.1 Offshore Scheme Summary

51. A summary of the key elements of the offshore infrastructure is provided in **Table 5-2.**

Table 5-2 Offshore Scheme Summary

Parameter	Details		
	DBS East	DBS West	Combined
Indicative construction duration (years) (excluding landfall works)	5	5	5 (up to 7 years if sequential build)
Anticipated design life (years)	30	30	30 (32 if sequential build)
Maximum number of wind turbines[2]	57-100	57-100	113-200
Total Array Area agreed in Agreement for Lease (km²)[3]	494.5	494.5	989
Total Array Area assessed for ES (km²)	349	355	874[3]

[2] In situations where a number does not divide equally between DBS East and DBS West (e.g. 113 turbines), rounded up to higher number (e.g. 57 31.5MW turbines as opposed to 56.5).

[3] Total Array Area assessed for ES for the Projects combined includes 170km² for Inter Platform Cabling Corridor located between DBS East and DBS West.

Parameter	Details		
	DBS East	DBS West	Combined
Closest point from Array Area to coast (km)	122	100	100
Maximum length of export cable to landfall (per cable) (km)	188	153	N/A
Maximum offshore cable length (km) for all cables	376	306	682
Maximum number of export cables and trenches	2	2	4
Maximum total length of all array cables (km)	325	325	650
Approximate turbine rotor diameter – small turbines (m)	259		
Maximum turbine rotor diameter – large turbines (m)	344.08		
Maximum tip height above MHWS (m)	394.08		
Minimum lower blade tip clearance to MSL (m)	34		
Maximum rotor swept area (small turbines) (km^2)	5.263	5.263	10.526

Parameter	Details		
	DBS East	DBS West	Combined
Maximum rotor swept area (large turbines) (km²)	5.299	5.299	10.51
Minimum turbine spacing (centre to centre, in-row or inter-row spacing) (m)	830		
Rotor cut-out wind speed (m/s) (assumed)	>25		
Maximum inter-platform cable length (km)	115	129	342
Wind turbine foundation type options	Steel monopile, piled jacket		
Maximum number of offshore platforms[4]	4 (if required the ESP may be located in the export cable corridor or Array Area)	4 (if required the ESP may be located in the export cable corridor or Array Area)	8 (if required the ESP may be located in the export cable corridor or a single Array Area)
Offshore platform foundation type options (Array Areas)	Steel monopile, piled jacket		

[4] In some instances the parameters for the Projects in sequence / concurrently are not double those of the Projects in isolation. For example, there is only ever one Accommodation Platform and one ESP under any design scenario. To ensure the WCS has been assessed, however, such platforms are accounted for in each possible scenario.

Parameter	Details		
	DBS East	DBS West	Combined
Offshore platform foundation type options (Offshore Export Cable Corridor)	Steel monopile, piled jacket, gravity based foundation		

5.5.1.1 Maximum Spatial Footprints of Offshore Infrastructure

52. The spatial footprints of the construction or decommissioning works fib(generally assessed as temporary footprints) as well as those during the lifetime of the wind farms during operation are summarised in sections 5.5.1.1.1 to 5.5.1.1.4. All figures are presented on a worst case basis e.g. for wind turbine foundations, the maximum footprint described is that which would result from the installation of the highest possible number of small monopile foundations (all with scour protection), which is the scenario with the largest footprint on the seabed.

5.5.1.1.1 Temporary Construction Footprint

53. **Table 5-3** describes the maximum temporary construction footprints in the Array Areas and cable corridors. This includes seabed preparation for foundation installation and cable installation.

Table 5-3 Indicative Maximum Temporary Construction Footprints

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – DBS East and DBS West together
Maximum seabed preparation area (including scour protection)– wind turbine foundations (m^2)	200 (total) small turbine monopile foundations, 100 small turbine monopile foundations for DBS East or DBS West in isolation	358,498	358,498	716,966

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – DBS East and DBS West together
Maximum seabed preparation area (including scour protection) – Offshore platforms (Array Areas) (m^2)	Eight monopile foundations for DBS East and DBS West together, four monopile foundations for DBS East or DBS West in isolation	24,889	24,889	49,778
Maximum seabed preparation area (including scour protection – Offshore platforms (Offshore Export Cable Corridor) (m^2)	One GBS foundation	64,871	64,871	64,871
Maximum jack up vessel footprint – wind turbine and offshore platform installation (m^2)	6 jack-up locations per turbine and offshore platform (275m^2 per jack up leg x 4 legs x 6 operations per turbine x 200 turbines + 8 offshore platforms)	682,000	682,000	1,364,000
Maximum anchoring footprint – wind turbine and offshore platform installation (m^2)	116m^2 footprint x 4 anchors per activity x 5 activities requiring the deployment of anchors x 200 turbines + 8	242,112	242,112	484,224

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – DBS East and DBS West together
	offshore platforms			
Pre-grapnel run (all cables)	Pre-lay grapnel run (PLGR) activities would fall within the footprint of the cable trench disturbance width.			
Maximum export cable installation footprint (m^2)	Maximum footprint for export cable installation – (combined number of cables x 20m disturbance width)	7,510,800	6,120,400	13,631,200
Maximum array and inter-platform cable installation footprint (m^2)	Array cable trench area (array cable and inter-platform cable length x 20m jetting disturbance width)	8,800,000	9,076,000	19,831,000
Maximum sandwave levelling footprint – Array Areas (m^2)	Maximum footprint disturbed by sandwave levelling for Inter-Platform Cables	1,100,000	1,134,500	2,478,875
Maximum sandwave levelling footprint – Offshore Export Cable Corridor (m^2)	Maximum footprint disturbed by sandwave levelling for Offshore Export Cable Corridor	12,282,010	10,833,835	23,115,845
Maximum anchoring	Indicative Length of cable route	22,061	22,061	44,091

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – DBS East and DBS West together
footprint – export cable installation (m²)	installed with anchors – 10km			
Maximum vessel jack-up footprint – offshore platform (m²)	1,100m² combined leg area x five operations per platform x one platform	5,500	5,500	5,500
Total (Array Areas and Offshore Export Cable Corridor (m²)		31,092,743	28,564,668	61,761,463

5.5.1.1.2 Array Areas Lifetime Footprint

54. **Table 5-4** describes the maximum lifetime footprints in the Array Areas. This includes the foundations, crossings, and external cable protection for unburied cables. It should be noted that through design refinements made through the Projects development, the footprints detailed in this chapter are lower than those estimated in The Crown Estate's Plan Level Habitats Regulations Assessment (HRA), conducted for offshore wind farms leased in the recent Offshore Wind Leasing Round 4. See section 5.5.2 for further details.

Table 5-4 Maximum Lifetime Footprints in the Array Areas (Wind Turbines, Offshore Platforms and Cables)

Infrastructure	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Maximum wind turbine foundation footprint (m²)	200 turbines x 3,117m² total scour protection per turbine	311,725	311,725	623,449

Infrastructure	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Maximum offshore platform foundation footprint (m^2)	Offshore platforms with scour protection	21,642	21,642	43,285
Maximum array and inter-platform cable protection footprint (unburied cables) (m^2)	Total array and inter-platform cable protection	493,134	513,870	1,159,884
Maximum array and inter-platform external cable protection footprint (cable crossings) (m^2)	Total footprint of pipeline / cable crossing material (array + inter–platform cables)	61,300	73,600	226,600
Total (m^2)		887,801	920,837	2,053,218

5.5.1.1.3 Offshore Export Cable Corridor Lifetime Footprint

55. **Table 5-5** describes the maximum lifetime footprints for the Offshore Export Cable Corridor. This concerns crossings and any external cable protection that may be used (including at the landfall exits), in addition to potential foundation structures for the ESP (see section 5.5.4.2 for further information). It should be noted the footprints detailed in this chapter differ from those estimated in The Crown Estate's Round 4 Plan Level HRA. See section 5.5.7 for further details.

Table 5-5 Maximum Lifetime Footprints Within the Offshore Export Cable Corridor

Infrastructure	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Maximum external cable protection footprint – unburied cables (m^2)	1,000,282	788,941	1,789,222

Infrastructure	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Maximum external cable protection footprint – cable crossings (m^2)	147,133	147,133	294,267
Total worst case scour protection for ESP (m^2)	56,410	56,410	56,410
Total (m^2)	1,203,825	992,484	2,139,899

5.5.1.1.4 Operation and Maintenance Temporary Footprint (All Areas)

56. **Table 5-6** describes the maximum temporary footprints during O&M in both the Array Areas and the export cable corridors. This includes the use of jack-up vessels for major component replacement, cable repair and cable reburial works.

Table 5-6 Maximum Temporary O&M Footprints in the Array Areas and Cable Corridors

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Maximum jack-up vessel footprints for major maintenance activities across Projects lifespan (m^2)	Seabed disturbance – 279 events x 1,100m^2 per event (DBS East or DBS West In Isolation) 558 events x 1,100m^2 per event (DBS East and DBS West)	306,900	306,900	613,800
Maximum array and inter-platform cable repair or replacement footprint across	Seabed disturbance – Array cables - Nine events x 6,000m^2 per event (DBS East or DBS West In Isolation) 17 events x 6,000m^2 per event (DBS East and DBS West) Inter-platform cables - Two events x 6,000m^2 per event	66,000	66,000	138,000

Activity	Worst case scenario description	Footprint – DBS East	Footprint – DBS West	Footprint – (combined)
Projects lifespan (m^2)	(DBS East or DBS West In Isolation) Six events x 6,000m^2 per event (DBS East and DBS West)			
Maximum export cable repair or replacement footprint across Projects lifespan (m^2)	Seabed disturbance - Seven / five events x 6,000m^2 per event (DBS East or DBS West respectively) 12 events x 6,000m^2 per event (DBS East and DBS West)	42,000	30,000	72,000
Total (m^2)		414,900	402,900	823,800

5.5.2 Wind Turbines

5.5.2.1 Wind Turbine Parameters

57. The project design envelope includes a range of wind turbines in order to accommodate the ongoing rapid development in wind turbine technology. Wind turbine dimensions vary widely, even for wind turbines with similar generating capacities, but for the Projects the 'small' wind turbine indicatively represents wind turbine models on the market today (with capacities of circa 15- 16MW) or evolutions of these models. The 'large' wind turbine reflects models that are predicted to become available in the timeline of the Projects, and which may have generating capacities in excess of 20MW. It is very difficult to predict future wind turbine market developments, but it is possible that wind turbines towards the small or large ends of the project design envelope are eventually selected for construction.

58. Accounting for this range and the assumed total capacity of the Projects there could be between 57 and 100 wind turbines at each of DBS East and DBS West, equating to up to 200 turbines across the two Projects. Wind turbine parameters are summarised in **Table 5-2** and **Plate 5-4**. It should be noted the parameters detailed in this table are lower than those estimated in The Crown Estate's Round 4 Plan Level HRA. See section 5.5.7 for further details.

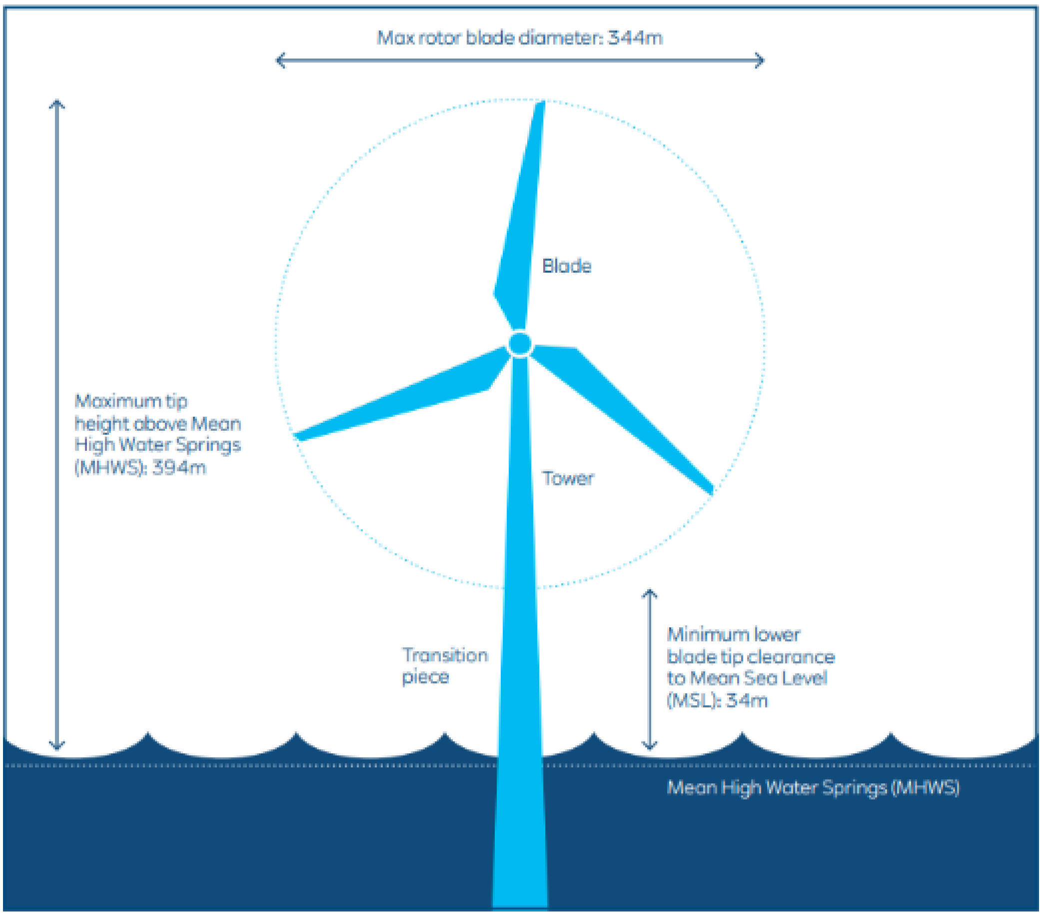

Plate 5-4 Indicative Wind Turbine Parameters[5]

[5] All measurements are provided to the nearest integer.

5.5.2.2 Wind Turbine Layout

59. The wind turbine layout would not be finalised until much closer to the time of construction, following completion of detailed pre-construction wind resource studies, site investigations and the selection of the preferred wind turbines and their foundations. A layout would be selected from within the consented parameters to optimise energy output and the foundation installation process accounting for ground conditions. The wake downstream of a wind turbine rotor is characterised by decreased wind speed and increased turbulence compared to the flow upstream of the rotor. An optimum layout would ensure that the flow in front of a wind turbine is affected as little as possible by wake effects from other wind turbines.

60. At this time, the layout can therefore only be described in general terms with the minimum separation distance between wind turbines as described in **Table 5-2**. Inter-row spacing is the distance between the main rows of wind turbines and in-row spacing is the distance separating wind turbines in the main rows, which would be orientated to face the prevailing wind, or as close to this as is practical. In-row spacing and inter-row spacing may vary across the Array Areas.

61. The layout would require Maritime and Coastguard Agency (MCA) approval prior to construction to minimise risk to surface vessels, including rescue boats and search and rescue aircraft, as per Marine Guidance Notice (MGN) 654 (MCA, 2021) **(Volume 7, Chapter 14 Shipping and Navigation (application ref: 7.14)** and **Volume 7, Chapter 15 Aviation and Radar (application ref: 7.15)** for further details).

5.5.2.3 Wind Turbine Installation

62. The precise detail of the installation process would be confirmed prior to construction. However, it would follow one of the methodologies outlined below (details of the pre-installation works are given in relation to the foundations, section 5.5.3.1):

- Wind turbine components would be loaded on to the installation vessel (typically a jack-up vessel or an anchored floating vessel) at the marshalling base port. The installation vessel would then transit to the Array Area and the components would be lifted by the vessel's crane onto the foundation or transition piece (depending on the foundation type being used). For each wind turbine, the tower would be installed first, followed by the nacelle, then the blades. Technicians would fasten components together as they are lifted into place. Each wind turbine installation is likely to take in the order of one day, assuming no weather delays.

- Alternatively, the wind turbine components may be loaded onto barges or dedicated transport vessels at the marshalling base port and installed by an installation vessel that remains on site throughout the installation campaign.
- It is also possible that complete wind turbines could be pre-assembled and commissioned onshore and transported to site for installation as single units.

63. The total duration of the installation campaigns for the wind turbines is expected to be a maximum of 30 months if the Projects are constructed In Isolation or Concurrently or up to 54 months if the Projects are developed Sequentially.

64. Each installation vessel or barge may be assisted by a range of support vessels. These are typically smaller vessels that may be tugs, guard vessels, anchor handling vessels, or similar. These vessels would make the same general movements to, from and around the Array Areas as the installation vessels that they are supporting. See section 5.5.8 for further details of vessel types, numbers, and movements.

5.5.2.4 Wind Turbine Oils, Fluids and Materials

65. Wind turbines and the associated equipment require a number of oils, fluids and other materials for their safe use and operation. Biodegradable oils would be selected where possible. All chemicals used would be certified to the relevant standard and all wind turbines would have provision to retain any spilt fluids within the structure where possible.

66. The required volume of oil and fluids would vary depending on the design i.e. conventional design or gearless, whether one or two or more rotor bearings are used in the design and the amount of redundancy designed into the system. Typical materials used include:

- Yaw grease;
- Yaw gear oil;
- Main bearing grease;
- Transformer (ester oil);
- Cooling fluid (water/glycol);
- Hydraulic oil;
- Pitch lubrication (grease);
- Pitch system hydraulic accumulators (nitrogen);

- Pitch gearbox oil;
- Gearbox oil; and
- Sulphur hexafluoride (SF6) gas.

5.5.3 Wind Turbine Foundations

67. The following sections describe the foundation types under consideration for the wind turbines for the Projects: monopiles and pin pile jackets (**Plate 5-5**), as well as details of the pre-installation works. It should be noted that following consultation from PEIR and review of the project design envelope, gravity base foundations and suction bucket jackets have been removed from the design envelope for wind turbine foundations.

68. It is possible that more than one type of wind turbine foundation would be installed on DBS East and DBS West, accounting for the construction programme (i.e. when the Projects are constructed and whether they are constructed at the same time), ground conditions, water depth, wind turbine model and wind resource.

69. The foundations would be manufactured at an onshore facility and most likely delivered to site as fully assembled units with all ancillary structures attached. As with many aspects of the wind farm construction process, different logistical approaches are being explored within the industry as technologies and methodologies continue to evolve.

70. Fabrication and construction methods would depend on the foundation type selected, as described in the sections below.

Monopile

- Maximum Number – 200
- Maximum Diameter – 15m
- Maximum hammer energy – up to 6,000kJ

Pin Pile Jacket

- Maximum Number – 200
- Maximum Number of Legs per Foundation – 4
- Maximum Number of Legs - 800
- Maximum Leg Diameter – 3.5m
- Maximum hammer energy – up to 3,000kJ

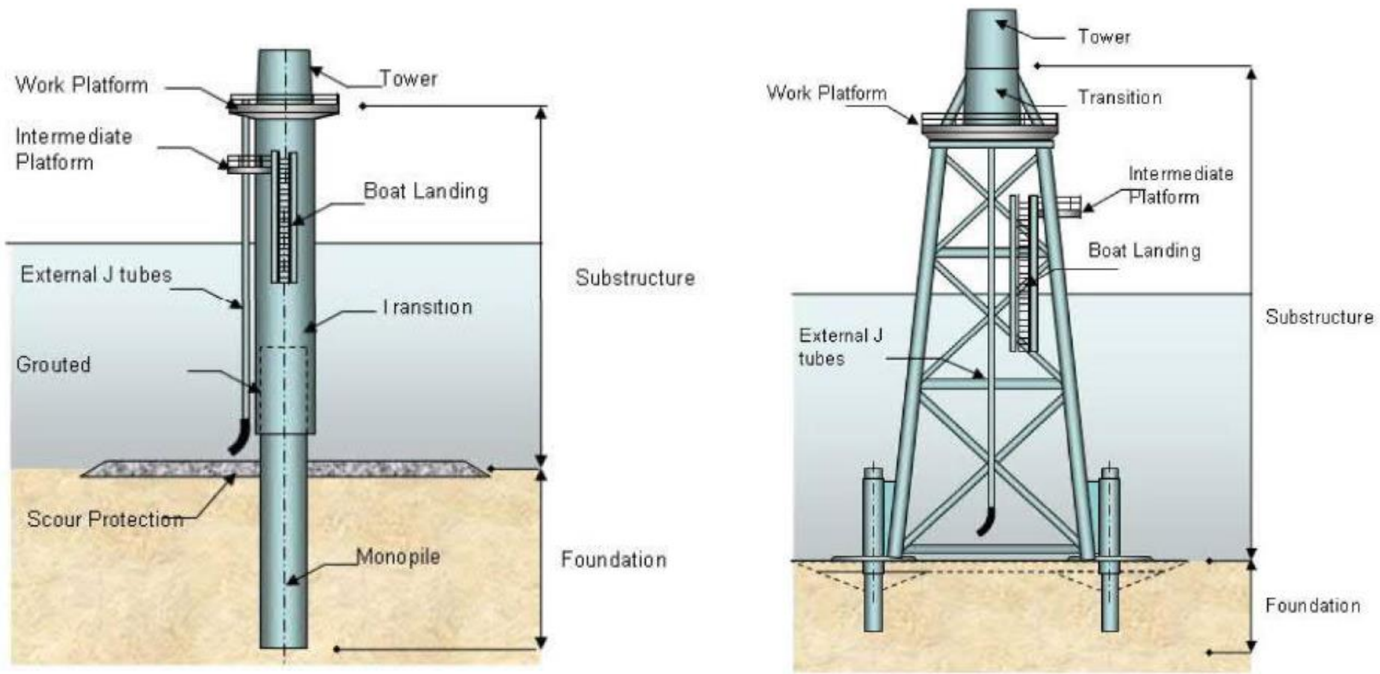

Plate 5-5 Summary of Wind Turbine Foundation Types

5.5.3.1 Pre-Installation Works

71. Pre-installation works may include:

- Pre-construction surveys to confirm that the seabed is clear of any obstructions prior to installation activities commencing (including unexploded ordnance (UXO)) and to provide information to inform any micro-siting of infrastructure, clearance operations, seabed preparation and for environmental monitoring purposes.
- UXO clearance requirements would be informed by the results of the pre-constructions surveys. Micrositing would be used to avoid UXO where possible. However, where this is not possible, clearance may be required to safely remove or detonate any UXO that present a hazard to the construction activities or the ongoing operation of the wind farms. An example of UXO on the Sofia OWF is shown in **Plate 5-6**.

Plate 5-6 Example of UXO from the Sofia OWF

5.5.3.2 Monopiles

5.5.3.2.1 Overview and Materials

72. A monopile is a large tubular structure onto which a cylindrical Transition Piece (TP) may be installed. Alternatively the design may consist of a monopile only (a TP-less design). The pile and/or transition piece may be tapered or change in diameter along their length. The key parameters for monopile foundations are presented in **Table 5-7**.

73. Monopiles and transition pieces are fabricated from steel, with a number of secondary structures on the associated transition pieces such as handrails, ladders and working platforms that may be produced from a range of materials such as steel, concrete, aluminium, other metals and composites.

Table 5-7 Monopile Foundation Parameters

Parameter	Small Turbines	Large Turbines
Maximum penetration (piled solution) (m)	40	60
Indicative pile diameter (m)	11	15
Maximum drill arisings per foundation (m^3)	4,524	12,064
Maximum drill arisings across both Projects combined (m^3)	45,239	68,160
Maximum footprint on the seabed per foundation (excl. scour protection) (m^2)	95	177
Maximum outer scour protection diameter at seabed (incl. foundation structure) (m)	63	83
Maximum area of scour protection per foundation (incl. structure footprint area) (m^2)	3,117	5,411
Maximum scour protection volume per foundation (m^3) (rock)	5,278	9,450

5.5.3.2.2 Seabed Preparation

74. Cable installation may require some form of seabed preparation which may include pre-lay grapnel runs and/or pre-lay plough, boulder relocation and / or sandwave clearance. In general, the preparations would be limited to the area directly associated with the array cable or export cable corridor.

5.5.3.2.3 Scour Protection

75. Scour protection material may be required around the base of some or all foundations to protect from current and wave action, thus ensuring structural integrity. Scour protection types may include, but are not limited to, rock filter layers (typically laid before foundation installation) with a rock armour layer, rock/stone filled geotextile bags (typically laid after foundation installation), and/or anti scour mattress solutions.

76. The maximum diameter, area, and volume requirements for scour protection per foundation are provided in **Table 5-7** and **Table 5-9**.

5.5.3.2.4 Installation

77. Monopiles are installed vertically into the seabed by either driving (use of a piledriving hammer), or a combination of driving and drilling techniques where harder ground conditions are present. Other appropriate alternative methods may be used as they become available.

78. Dynamically positioned vessel installation technology to limit the seabed impacts may be utilised for the Projects. However, this may not be possible across the whole site due to the water depths or metocean conditions. At a smaller number of locations an anchor spread may be required during foundation installation. As a worst case, calculations on anchoring are based on anchor deployment occurring at every turbine.

79. Alternatively, or possibly in addition to a dynamic positioning vessel, a jack-up vessel may be deployed for foundations installation.

80. The installation process typically comprises the following stages:

- Lift monopile into the pile gripper on the side of the installation vessel;
- Lift hammer onto monopile and drive monopile into seabed to required embedment depth (anticipated to be up to approximately 60m embedment, dependent upon ground conditions and water depth);
- Lift hammer from monopile and remove pile gripper;
- Lift transition piece onto monopile; and
- Secure transition piece. Transition piece bolted or grouted to the monopile (if required). The grout used is an inert cement mix that is pumped into a specially designed space between the transition piece and the monopile. It is also possible that the transition piece would be integrated with the monopile, in a ‘TP-less’ concept, in which case this installation stage would not be required. Further installation of secondary and tertiary steel works such as access systems and corrosion protection systems may also be required.

81. Where conventional piling is unable to achieve necessary pile penetration, additional methods may be used (e.g. drilling, water jetting, vibro-piling and/or electro-osmosis).

82. Drilling arisings would be disposed of adjacent to installed foundations, as has been performed on existing UK offshore wind farms, including the RWE project at Gwynt y Môr.

83. It is expected that a single monopile foundation installation would take approximately 24 hours on average from vessel arrival to vessel departure, without weather delays. If drilling is required, then the installation duration would be increased.

5.5.3.2.5 Pile Driving

84. For the piling of monopile foundations, larger hammer spreads are more efficient and are likely to reduce the overall installation time and number of blows required to install each pile. However, the actual energy output would be optimised to that required for successful installation. At the time of writing, 5,500kJ spreads are available although the expectation is that larger hammers in the region of 6,000kJ may become available prior to the start of construction of the Projects and may be needed for larger diameter piles. A drivability assessment would be carried out prior to construction when further information is available regarding the ground conditions, to determine the required piling requirements (e.g. hammer energy and blow rate).

85. For this assessment, the maximum hammer energy used for monopile installation is assumed to be 6,000kJ for the largest 15m diameter monopiles. This figure represents a reduction in maximum hammer energy indicated at PEIR. Each piling event would commence with a soft start at a lower hammer energy, followed by a gradual ramp-up for at least 20 minutes to the maximum hammer energy required. The maximum hammer energy is only likely to be required at a few of the piling installation locations.

86. As an alternative to traditional impact piling, the feasibility of alternative installation methods will also be explored pre-construction. Such methods include:

- Vibration piling
  - A method in which the pile is vibrated into the sediment rather than being hammered in. The type and classification of the sound that is generated with vibratory versus impact pile driving is different. The sound generated from vibratory pile driving is classified as more

non-impulsive, continuous sound as opposed to the impulsive and sharp sounds produced from impact pile driving.

- Blue piling
  - A piling solution that uses the deceleration of a large water mass contained in a water vessel to deliver a long-lasting blow to the pile. This technology aims to reduce the noise generated at the source during installation.
- Electro-osmosis
  - A piling technique that utilises electro-osmosis (defined as the movement of water through a porous medium, such as soil, by the application of an externally applied electrical potential) while piling to reduce resistance in the underlying sediment when piling (Rose and Grubbs, 1979).
- Water jetting
  - Either used in conjunction with, or separate from, traditional impact piling, this method utilises a carefully directed and pressurized flow of water to assist in achieving pile penetration. The jetting technique liquefies the soils at the pile tip during pile placement, decreasing the bearing capacity of the soils, causing the pile to descend toward its final tip elevation with much less soil resistance and may lead to a reduced hammer energy being required.

87. It should be noted that these techniques are not yet proven for offshore wind foundations, but are included in the design envelope to allow for future technology developments. Even if feasible, it is likely that such techniques could only be used for part of the installation of each pile, with impact piling being required to complete the installation. As such, the worst case scenario for assessment purposes is reflected by the impact piling parameters.

88. The key impact piling parameters (worst case) are described in **Table 5-8**. Further information describing the detailed piling parameters used to inform the assessment, including the underwater noise modelling are provided in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

Table 5-8 Monopile Piling Parameters for Wind Turbines

Parameter	Value
Maximum Diameter (m)	15
Maximum hammer energy (kJ)	6,000
Indicative pile depth (m)	60
Typical piling time per foundation (mins) (includes soft-start and ramp-up, and providing allowance for issues such as low blow rate, etc.)	320
Maximum piling duration per foundation (hours)	8
Maximum simultaneous piling events	2

5.5.3.2.6 Drilling

89. Whilst pile driving is the most likely installation method, in the event that ground conditions are not suited to piling, monopiles may be drilled, or both drilled and driven, into the seabed. For this purpose, it is estimated that up to an equivalent of 5% of the wind turbine locations could need drilling, i.e. a likely maximum equivalent to five for each of DBS East and DBS West. Potential volumes of drill arisings for the Projects are detailed in **Table 5-7**.

90. The drill arisings (spoil) would be disposed of adjacent to the foundation location, above or slightly below the sea surface, from where they would be expected to settle onto the seabed in the immediate vicinity of each foundation (see **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** for further details).

5.5.3.3 Jackets

5.5.3.3.1 Piled Jackets

91. Piled jacket foundations are secured to the seabed by small diameter pin piles (four pin piles per foundation) which are driven into the seabed through pile sleeves at each leg. Alternatively, the pin piles may be pre-installed into the seabed through a template, prior to the arrival of the jacket structure. The pin piles are connected to the jacket legs via a grouted or deformed connection.

92. The installation process typically comprises the following stages:

- Piling template placed on seabed;

- Piles installed;
- Piling template recovered for re-use; and
- Jacket lowered onto piles.

93. Or:

- Jacket lowered onto seabed; and
- Piles installed.

94. Pin pile installation methodology is similar to that for the monopiles. However, the hammer energy utilised for installation would be up to 3,000kJ due to the smaller size of the piles, with four piles per turbine foundation jacket.

95. Depending on the approach taken it would typically take about 24 hours for the pilling operations and an estimated further 24 hours for the jacket installation and the grouting to be undertaken.

96. The key parameters for jacket foundations (worst case) are presented in **Table 5-9**. Jackets are primarily fabricated from steel. Secondary structures such as handrails, ladders and working platforms may be produced from a range of materials such as steel, concrete, aluminium, other metals and composites.

5.5.3.3.2 Drilling

97. Whilst pile driving is the most likely installation method for the jacket pin piles, in the event that ground conditions are not suited to piling, the jacket pin piles may be drilled, or both drilled and driven, into the seabed. For this purpose, it is estimated that an equivalent of up to 5% of the jacket pin pile locations could need drilling.

98. The drill arisings (spoil) would be disposed of adjacent to the foundation location, above or slightly below the sea surface, from where they would be expected to settle onto the seabed in the immediate vicinity of each foundation (see **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** for further details).

Table 5-9 Jacket Foundation Parameters (Wind Turbines)

Parameter	Small Turbines	Large Turbines
Pin Pile Jacket		
Maximum. number of legs per foundation	4	4
Number of legs across wind farm	800	452
Maximum drill arisings per foundation (m^3)	2,012	4,712
Maximum volume of arisings (m^3)	20,106	26,625
Indicative height of platform above LAT (m)	20.5	20.5
Indicative separation of adjacent legs at seabed level (m)	20	34
Indicative separation of adjacent legs at LAT (m)	16	24
Indicative leg diameter (m)	2.5	3.5
Indicative pin pile diameter (m)	3	4
Maximum hammer energy (kJ)	up to 3,000	
Total piling time per pin pile (mins) (includes soft-start and ramp-up, and providing allowance for issues such as low blow rate)	190	
Maximum number of simultaneous piling events	3	
Maximum outer scour protection diameter at seabed per leg (including foundation structure) (m)	23	28
Maximum scour protection area per foundation (incl. structure footprint area monopile) (m^2)	1,662	2,463
Maximum scour protection volume per foundation (m^3) (rock)	2,229	3,542

5.5.4 Offshore Platforms

5.5.4.1 Offshore Converter Platforms / Collector Platforms

99. The cables from each string of wind turbines would be brought to a Collector Platform (CP), located appropriately to optimise the array, inter-platform, and export cable lengths. Power would then be sent onto an OCP, where the generated power would be transformed to a higher AC voltage of up to 525kV.

100. There would be up to six CPs / OCPs, as described in section 5.1.1. In the case that six CPs / OCPs are constructed there would be three located in in DBS East and three in DBS West. The location of the CPs / OCPs would be confirmed during the detailed design process, accounting for the wind turbine layout, but would be within the Array Area of each wind farm.

101. The basic CP / OCP design would consist of a topside structure configured in a multiple deck arrangement, with the decks either open with modular equipment, or fully clad. Weather sensitive equipment would be housed accordingly. Equipment and facilities may consist of:

- Medium voltage (MV) to high voltage (HV) step-up power transformers;
- HVDC valve hall;
- HV Reactors;
- MV and/or HV switchgear;
- Other electrical power systems;
- Instrumentation, metering equipment and control systems;
- Standby generators;
- Large-scale energy storage systems (batteries etc.), plus associated systems;
- Auxiliary and uninterruptible power supply systems;
- Navigation, aviation and safety marking and lighting;
- Helicopter landing facilities;
- Systems for vessel access and/or retrieval;
- Vessel and helicopter refuelling facilities;
- Potable water;
- Black water separation;
- Storage (including stores, fuel, and spares);
- Offshore accommodation and mess facilities
- Cranes;

- Communication systems and control hub facilities;
- Offshore vessel charging point;
- Indirect seawater cooling system including seawater lift and return caissons;
- HVAC systems;
- Electrolysis and chlorination system;
- System to manage contaminated fluids; and
- Drone landing pad.

102. Indicative parameters for a single OCP topside are provided in **Table 5-10** below, with an example offshore platform (from the Triton Knoll offshore wind farm) being shown in **Plate 5-7**.

Table 5-10 Indicative Topside Parameters for a single CP / OCP

Parameter	Value
Indicative topside weight (tonnes)	20,000
Maximum topside length (m)	125
Maximum topside width (m)	100
Maximum topside area (m^2)	12,500
Maximum topside height (m) (excluding crane and helideck)	105
Maximum topside height (m) (including crane)	195
Height of lightning protection above topside (LAT)	10

Plate 5-7 Example Offshore Platform from the Triton Knoll Offshore Wind Farm[6]

5.5.4.2 Other Platforms

103. In addition to the CPs / OCPs, up to two other platforms may be required for the Projects, being:

- ESP; and
- Accommodation Platform.

104. An ESP was required as part of the original HND. A radial connection has now been confirmed by the HND. However, to allow for further evolution of the HND, the ESP is included for assessment. The platform, if required may be located either within one of the Array Areas (likely alongside a converter station) or mid-way along the Offshore Export Cable Corridor.

[6] Note this platform is a HVAC Offshore Substation Platform, image included for reference only

105. In addition, a single Accommodation Platform may be required, which would be located within either the DBS East or DBS West Array Area.

5.5.4.3 Platform Foundations

5.5.4.3.1 Parameters and Materials

106. The foundation types that may be used for the platforms within the Array Areas are monopiles and pin-pile jackets. For the potential ESP within the Offshore Export Cable Corridor, monopiles, pin-pile jackets or gravity based foundations may be used.

107. Scour protection may be required around the base of the foundations to protect against localised erosion of the seabed. The types of scour protection that could be used and installation methods are as described for the wind turbine foundations (section 5.5.3.2).

108. The worst case platform parameters for each foundation type, including details on scour protection, are detailed in **Table 5-11**.

Table 5-11 Worst Case Platform Foundation Parameters, Including Scour Protection

Parameters	Value
Monopile	
Maximum number	8 (Six CPs / OCPs + Two Other Platforms)
Maximum pile diameter (m)	15
Maximum hammer energy (kJ)	6,000
Maximum outer scour protection diameter at seabed (including foundation structure) (m)	83
Maximum scour protection area per offshore platform foundation (including structure footprint area monopile) (m^2)	5,411
Maximum scour protection area for all offshore platform foundations (including structure footprint area monopile) (m^2)	43,285
Maximum scour protection volume per offshore platform monopile foundation (m^3) (rock)	9,450

Parameters	Value
Maximum offshore platform foundation scour protection volume for project (rock) (m^3)	75,600
Pin-pile jacket	
Maximum number	8 (Six CPs / OCPs + Two Other Platforms)
Number of legs per platform	8
Separation of adjacent legs at seabed level (m)	25
Separation of adjacent legs at LAT (m)	25
Indicative leg diameter (m)	2.8
Indicative pin pile diameter (m)	3.8
Maximum hammer energy (kJ)	3,000
Maximum outer scour protection diameter at seabed (including foundation structure) (m)	27
Maximum scour protection area per offshore platform foundation ((including) structure footprint area pin pile (m^2)	4,580
Maximum scour protection area for all foundations (including structure footprint area pin pile) (m^2)	36,644
Maximum scour protection volume per foundation leg (m^3) (rock)	808
Maximum scour protection volume for project (rock) (m^3)	51,712
Gravity-based structure	
Maximum number	1 ESP

Parameters	Value
Maximum base diameter (OD) (m)	65
Indicative seabed preparation diameter (m)	70
Indicative scour protection width (m)	260
Maximum gravity based height above seabed (m)	10
Maximum outer scour protection diameter at seabed (including foundation structure) (m)	268
Maximum scour protection area per offshore platform foundation (including structure footprint area) (m^2)	56,410
Maximum scour protection volume per offshore platform foundation (m^3) (rock)	102,842

109. The jacket foundation would mainly be comprised of steel. However, it is possible that some secondary structures, such as handrails, gratings and ladders could be produced using other metals, such as aluminium, or composites. Also, concrete could be used to form the working platform.

110. Some of the equipment at each offshore platform would contain fluids. The key types of fluids that may be used include:

- Diesel fuel for the emergency generators (in diesel storage tanks);
- Oil for the transformers (oil would be monitored and filtered, top-up may be required);
- Engine oil;
- Glycol;
- Sewage and grey water;
- Lead acid contained within batteries; and
- SF_6.

111. The offshore platform design would include bunds to collect oil spills which would be disposed of according to industry best practice procedures. Transfer of oil/fuel between the offshore platforms and service vessels would also follow best practice procedures, with additional procedures in place should there be a spill to the marine environment.

112. Any significant oil spillage would be collected in a separate oil waste tank. Both oil waste and other wastes (waste water etc.) would be disposed of according to industry best practice procedures. All other waste streams would be processed on the platform or transferred to shore as required.

5.5.4.3.2 Platform Installation

113. The general installation process for offshore platforms would be as follows:

- Offshore platforms are generally installed in two stages, firstly the foundation would be installed, secondly the topside would be lifted from a transport vessel/barge, onto the foundation;
- The foundation installation method would, depending upon the design, be similar to the wind turbine foundation installation methods described in section 5.5.2, with the addition of gravity base jacket typology for the potential ECR platform only (included below);
- The foundation and topside may be transported on the same transport vessel/barge, or separately;
- The foundation may also be transported by the installation vessel;
- The foundation, particularly if it is a gravity based concept, may also be towed and floated into position with the support of a number of tug and anchor handling vessels. The final ballasting and installation activities would be supported from an installation vessel or a construction support vessel; and
- The gravity based foundation may be ballasted to the seabed utilising either water or other dry ballast materials. This is dependent on the final design requirements of the structure.

114. For the electrical equipment platforms, a jack-up vessel may be stationed alongside the structure to facilitate commissioning activities. It is likely that a Service Operation Vessel would also remain in the field.

115. Drill arisings would be disposed of adjacent to the foundation location, above or slightly below the sea surface, from where they would be expected to settle onto the seabed in the immediate vicinity of each foundation (see **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** for further details). The key parameters (worst case) for monopile and pin-pile jacket platform piling are described in **Table 5-8** and **Table 5-9**.

5.5.5 Underwater Noise

116. A number of activities during the construction, operation and decommissioning of the Projects would create underwater noise. The most significant noise sources are likely to be piling of the foundations and clearance of UXO. An underwater noise modelling study has been undertaken in support of the assessment and is provided in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**.

5.5.6 Navigation Lighting Requirements and Colour Scheme

117. With respect to lighting and marking, the wind turbines and platform topsides would be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA), MCA and Trinity House Lighthouse Service (THLS).

118. Further details including reference to the relevant guidance and regulations is presented in **Volume 7, Chapter 14 Shipping and Navigation (application ref: 7.14)** and **Volume 7, Chapter 15 Aviation and Radar (application ref: 7.15).**

5.5.7 Further Electrical Infrastructure – Cables

119. The wind farm electrical array cables connecting the wind turbines to the CPs would collect the HVAC power produced at the wind turbines. This power would then be sent to an OCP via the Inter-Platform Cables, where the power is converted to HVDC. This is then exported to the UK electricity transmission network via the export cables. The electrical transmission system, made up of the CPs/OCPs and export cables would be constructed by the Applicants and the ownership would be transferred to an Offshore Transmission Owner (OFTO) in accordance with applicable rules and regulations in a transaction managed by the Office of Gas and Electricity Markets (Ofgem).

120. The electrical cables that make up the offshore electrical infrastructure include:

- Offshore Export Cables (linking the OCPs to the landfall);
- Inter-platform cables (linking CPs and OCP and

- Array cables (linking the wind turbines to the CPs).

121. These are described in the following sections.

5.5.7.1 Offshore Export Cables

122. Depending on the design scenario chosen, there would be up to four single core HVDC Offshore Export Cables. Fibre optic cables would be bound externally to one of the export cables belonging to each project. The power cable voltage would be up to 525kV with an indicative external cable diameter of 155mm.

123. The total length of the export cables depends on the Development Scenario in question (**Table 5-12**). The maximum offshore cable length would be up to 682km (188km for DBS East and 153km for DBS West per cable, with two power cables required per project, or four power cables in total).

124. For DBS East In Isolation, the maximum length per offshore export cable is 188km, giving a total of 376km as two cables are required.

125. For DBS West In Isolation, the maximum length per offshore export cable is 153km giving a total of 306km as two cables are required.

126. The Offshore Export Cables make landfall near Skipsea, where they would be connected to the onshore cables in TJBs, having been installed by HDD, or similar trenchless technique.

127. Each offshore export cable would be installed in a separate trench with an indicative spacing of 50m between the cables, where two export cables are installed in parallel. For the purpose of the DCO application and environmental assessment, an Offshore Export Cable Corridor has been defined in order to encompass all required cables and the adjacent area of seabed that may be subject for temporary works, such as anchoring, lay-down or the use of jack-up vessels.

128. The Offshore Export Cable Corridor is 1km wide but funnels out to up to approximately 3km on approach to the landfall and the crossing of the existing Langled pipeline, and approximately 15km on the approach to the DBS West Array Area. The greater width of the corridor at these locations is designed to provide greater flexibility in the detailed routeing of the export cables at the pre-construction stage. The corridor provides space for the installation works and any foreseeable operation and maintenance activities such as cable reburial or repairs.

129. The construction buffer zone measures 500m either side of the Offshore Export Cable Corridor, and provides room for temporary works such as anchoring, jacking up, placement of buoyage and relocation of fishing gear. No permanent infrastructure would be installed within the construction buffer zone. As the burial route for the Projects has not yet been finalised, the construction buffer zone is retained in locations even where the Offshore Export Cable Corridor widens to over 1km to accommodate the necessary construction room in the event any Offshore Export Cables are buried near the perimeter of the Offshore Export Cable Corridor boundary.

130. Due to the length of the Offshore Export Cable Corridor, and the limitations upon cable carousel size/weight on the installation vessel, it is very likely that the export cables would be installed in sections with pre-planned cable joints along the Offshore Export Cable Corridor. At the pre-planned cable jointing locations, the two ends of the cables are laid on the seabed with sufficient slack to allow them to be lifted onto a suitable vessel. The cable jointing is then completed onboard the vessel before the cable is lowered back down to the seabed. The cable is then buried, if possible, or protected using measures as described in section 5.5.7.7. A similar procedure is deployed for cable repairs.

Table 5-12 Offshore Export Cable Parameters

Parameter	DBS East	DBS West	Both Projects
Maximum length of export cable measured from OCPs to landfall (all cables) (km)	376	306	682
Export cable corridor width (km)	Approximately 1km plus a 0.5km temporary construction area buffer on both sides, but widening and varying at a small number of locations		
Export cable corridor width at landfall (approximate) (km)	3		
Maximum number of export power cables	2	2	4
Maximum number of trenches	2*	2*	4*

Parameter	DBS East	DBS West	Both Projects
Typical spacing between cables in trenches (m)	50		
Maximum Offshore Export Cable Corridor temporary disturbance width during installation (per cable) (m)	20		
Export cable operating voltage (kV)	Up to +/-525		

**Trenches would split into three and six trenches on approach to landfall due to the co-located fibre-optic communications cable splitting from the Offshore Export Cables prior to making landfall.*

5.5.7.2 Inter-Platform Cables

131. Inter-platform cables would be required to connect CPs to the OCPs, to connect the OCPs between the Projects, and to connect the OCPs to the Accommodation Platform and ESP.

132. The inter-platform cable voltage would be up to 275kV, with an indicative external cable diameter of up to 275mm. They would be integrated with fibre optic cables.

133. Inter-platform cable parameters are set out in **Table 5-13**.

Table 5-13 Inter-Platform Cable Parameters

Parameter	Details
Maximum length of Inter-Platform Cables for DBS East and DBS West combined scenario (km)	342
Maximum length of Inter-Platform Cables for DBS East In Isolation design scenario (km)	115
Maximum length of Inter-Platform Cables for DBS West In Isolation design scenario (km)	129
Maximum inter-platform cable temporary disturbance width during installation (per cable) (m)	20
Indicative external cable diameter (mm)	275

5.5.7.3 Array Cables

134. Array cables link the wind turbines to the CPs. The cable system design would be based on radial strings from the CPs connecting multiple wind turbines per string

135. The array cables would be up to 132kV, with an indicative external cable diameter of up to 220mm. Cable circuits (strings) would be optimised according to the electrical load they are required to carry, with up to three different cable dimensions being used. They would be integrated with fibre optic cables.

136. Each array cable would be installed in its own trench, with the maximum length of array cables being 650km. Array cable parameters are set out in **Table 5-14**.

Table 5-14 Inter Array Cable Parameters

Parameter	DBS East	DBS West	Combined
Maximum length of array cables (km)	325	325	650
Maximum array cable temporary disturbance width during installation (per cable) (m)	20		
Maximum array cable voltage (kV)	Up to 132		

5.5.7.4 Cable Installation Methods

5.5.7.4.1 Removal of Existing Out of Service Cables

137. Where the cable routes cross out-of-service cables, depending on the length of cable and burial depth, these would either be recovered from the seabed by grapple hook or similar method prior to the start of installation or cut at an appropriate distance either side of the cable and the free ends secured to the seabed by clump weights. The agreement of the relevant asset owner would be sought prior to taking such action.

5.5.7.4.2 Boulder clearance

138. Boulders that present an obstacle to the construction activities would be confirmed by the pre-construction surveys. In the instance that a boulder cannot be avoided, it would be relocated to an adjacent area of seabed within the Offshore Development Area where they do not present an obstacle to the works, and where possible to an area of seabed with similar sediment type and avoiding any known sensitive habitats. If required, boulder clearance would be undertaken by sub-sea grab or plough.

5.5.7.4.3 UXO Clearance

139. Specific surveys to identify potential locations of UXO would not be undertaken until after the DCO is granted. This is to allow more detailed engineering work to be carried out on the cable routes and locations of turbines to allow a targeted survey for potential UXO to be undertaken.

140. However, to aid in reporting for the ES Ordtek (2023) has produced a report predicting the number of potential UXO that may be found within the Offshore Development Area. This has been achieved through the examination of data sources including past potential UXO quantities seen on similar projects, geophysical data available for the Projects and historic use of the Offshore Development Area. It is expected that 41 UXO would need to be cleared during the construction phase. It should be noted that the real-world number of UXO may differ from these predicted figures (**Table 5-15**).

Table 5-15 Predictive UXO Numbers Requiring Clearance Within the Offshore Development Area

UXO Type	Nearshore Cable Route (<10m LAT)	Offshore Cable Route (>10m LAT)	DBS East Array Area	DBS West Array Area	Subtotal
German SC-50 Bomb	1	2	0	0	3
British 250lb MC Bomb	1	1	0	0	2
WWI German Mine	0	3	2	2	7

UXO Type	Nearshore Cable Route (<10m LAT)	Offshore Cable Route (>10m LAT)	DBS East Array Area	DBS West Array Area	Subtotal
WWI British Mine	0	2	1	1	4
British 500lb MC Bomb	3	3	1	1	8
WWI U-Boat Torpedo (Multiple Variants)	0	1	0	0	1
German SC-250 Bomb	0	1	1	1	3
WWII British Buoyant Mine	0	2	1	1	4
German SC-500 Bomb	0	1	1	1	3
British 1000lb MC Bomb	0	1	1	1	3
WWII U-Boat Torpedo (Multiple Variants)	0	1	0	0	1
British 2000lb MC Bomb	0	0	0	0	0

UXO Type	Nearshore Cable Route (<10m LAT)	Offshore Cable Route (>10m LAT)	DBS East Array Area	DBS West Array Area	Subtotal
German LMB Mine	0	1	0	0	1
German TMB Mine	0	0	0	0	0
German SC-1000 Bomb	0	1	0	0	1
German TMC Mine	0	0	0	0	0
Totals	5	20	8	8	41

141. A Marine Licence application would be applied for post-consent to allow for the investigation and clearance of any UXO to ensure appropriate mitigation is put in place.

5.5.7.4.4 Pre-Lay Grapnel Run

142. Before cable-laying operations commence, it must be ensured that the route is free from obstructions such as discarded fishing gear, anchors or abandoned cables, wires and ropes that may be identified as part of the pre-construction surveys. A survey vessel would be used to undertake a pre-lay grapnel run (PLGR) to clear such identified debris.

143. The width of seabed disturbance along the PLGR is estimated to be up to 6m, which would be encompassed by the maximum 20m footprint of cable installation works – see **Table 5-12, Table 5-13** and **Table 5-14** for further details.

5.5.7.4.5 Sandwave levelling

144. Areas of mobile seabed (typically either in sandwaves or megaripples) may present a risk to the cable burial process either by preventing the cable burial tools from operating efficiently or by resulting in exposure and scouring of the cable once installed. In some cases, this could result over time in the cable being left 'free-spanning' over the seabed. Free spanning cables present a risk to other marine users and result in a large amount of strain being placed on the cables, significantly increasing the chance of their failure and the subsequent need for repair works.

145. In order to prevent this, cables can be placed where possible in the troughs of sandwaves to the reference seabed level, which would minimise the potential for cables becoming exposed. However, where this is not possible, the alternative is to dredge the top of the sandwaves prior to installation down to the seabed reference level. This process is termed sandwave levelling. If this was required, it would be completed before the cable is laid on the seabed.

146. Current worst case sandwave levelling scenarios are detailed in **Table 5-16**.

Table 5-16 Worst Case Sandwave Levelling Scenarios

Parameter	DBS East In Isolation	DBS West In Isolation	DBS West and DBS East Sequentially or Concurrently
Maximum seabed footprint disturbed by sandwave levelling within Array Areas (m^2)	1,100,000	1,134,500	2,478,875
Maximum volume of sandwave material to be dredged/relocated within Array Areas (m^3)	445,500	459,473	1,003,944
Maximum seabed footprint disturbed by sandwave levelling within	12,282,010	10,833,835	23,115,845

Parameter	DBS East In Isolation	DBS West In Isolation	DBS West and DBS East Sequentially or Concurrently
Offshore Export Cable Corridor (m^2)			
Maximum sandwave material to be dredged/relocated within Offshore Export Cable Corridor (m^3)	33,121,800	29,302,899	62,424,700

5.5.7.5 Cable Burial

147. The purpose of cable burial is to ensure that the cables are protected from damage, either from other activities such as fishing and shipping, or from naturally occurring physical processes acting on the seabed.

148. Burial of the cables would be through any combination of ploughing, jetting, or mechanical cutting. The dimensions of the cable trenches and the overall seabed footprint affected by the burial process would depend on the installation method. The installation method and target burial depth will be confirmed post consent based on a cable burial risk assessment considering ground conditions as well as the potential for impacts upon cables such as from trawling and vessel anchors. For the purposes of the ES, a target burial depth of between 0.5m and 1.5m (relative to the non-mobile seafloor level) has been assumed for all cable burial activities, depending on the cable location. Information on the potential burial techniques is provided below.

5.5.7.5.1 Ploughing

149. A plough uses a forward blade to cut through the seabed, while burying the cable behind it. Ploughs can be used as a pre-trench tool (i.e. the cables are laid into a trench for later backfilling), a post-lay burial tool (i.e. the cable is first laid in position on the seabed before being ploughed in) or, more commonly, as a simultaneous lay and burial tool. Ploughing tools can be pulled directly by a surface vessel or can be mounted onto self-propelled caterpillar tracked vehicles which run along the seabed taking power from a surface vessel. The plough inserts the cable into the seabed as it moves. The indicative width of disturbance from ploughing is 15m.

150. There are two types of plough: displacement and non-displacement. The difference is important in terms of understanding the effect on the seabed. Displacement ploughs are typically used to pre-cut a trench in hard ground conditions, creating a trench that remains open for subsequent cable installation. A second backfilling pass of the plough is then undertaken to bury the cable.

151. By contrast, a non-displacement plough is designed to trench and bury the cable in a single pass, consequently causing less disturbance on the seabed as part of either a simultaneous or post lay and burial process. The plough may be fitted with additional equipment to help improve performance in certain soils, for example water jets for burying in sand.

5.5.7.5.2 Jetting

152. Jetting uses high powered jets of water to fluidise the seabed sediments and lower the cable to the required depth. Jetting may be undertaken either as a separate operation on a cable that has been pre-laid on the seabed, or by simultaneously laying and jetting. As with a plough, the jetting tool can either be pulled directly by a surface vessel or mounted onto self-propelled caterpillar tracked vehicles. The indicative width of disturbance from jetting is 18m.

5.5.7.5.3 Mechanical Cutting

153. This method involves the excavation of a trench (either by pre-trenching or simultaneously with cable laying), with the excavated material placed alongside. The cable is then laid in the trench and the sediment returned to the trench to complete the burial of the cable, either mechanically or by natural processes. The indicative trench width from mechanical cutting is 18m. An example mechanical cutting tool that could be used is the Global Marine Q1400 Trenching System (Global Marine, 2019).

5.5.7.5.4 Trench Sizes

154. The maximum temporary disturbance width for export, inter-platform and array cable installation would be up to 20m, encompassing the pre-grapnel run and trenching works. The respective indicative trench widths are as follows:

- Pre-lay ploughing 6m;
- Post-lay ploughing 0.5m;
- Jet trenching 1m; and
- Mechanical trenching 0.6m.

5.5.7.6 Array Cable Installation

155. Each section of cable would be laid from the cable lay vessel either from a static coil or a revolving carousel, turntable, or drum. The cable would be pulled into the turbine foundation via a J-tube (or alternative cable entry system) and hung-off inside the foundation structure before being connected to the turbine electrical system.

156. A typical methodology for installing the cable into a J-tube is:

- Mobilisation of a specialist cable installation vessel to site.
- A vessel would take up station adjacent to a wind turbine foundation. The cable end would be connected to a pre-installed messenger wire at the wind turbine foundation. The messenger wire would be recovered by a Remotely Operated Vehicle (ROV). The messenger wire would then allow the cable to be pulled into the wind turbine foundation from a temporary pre-installed winch arrangement at the wind turbine foundation. An ROV would be used to monitor the cable entering the J-tube or cable entry system.
- When the first cable end is pulled in with required overlength, the cable is secured with a temporary hang-off arrangement and cable installation continue towards the wind turbine foundation for second end pull-in and hang-off. Separate teams would be mobilized for installing permanent hang-off of the cable and terminate the cable cores and fibre optic cables.
- Second end cable pull-in, hang-off and termination would in principle be similar to the first end, except for overboarding of the last end of the cable from the installation vessel that would be by means of a quadrant.
- The same principle for cable installation is applicable for wind turbine foundations without a J-tube. The main differences are the interface between the cable protection system and the foundation entry; without a J-tube the cable is free hanging inside the foundation structure.

5.5.7.7 External Cable Protection

5.5.7.7.1 Need for External Cable Protection

157. There are certain situations where the use of external cable protection may be required. These include:

- At pre-planned cable jointing locations along the Offshore Export Cable Corridor;
- Where an adequate degree of protection has not been achieved from the burial process. This may be as a result of challenging ground

conditions, or unforeseen circumstances with the burial process, such as break down of the burial tool/s;
- Where the array cables approach the wind turbines and OCPs, as described above in section 5.5.7.6;
- At cable and pipeline crossings (section 5.5.7.7.3);
- At the trenchless crossing (likely HDD) exit pit (offshore only) (section 5.1); and
- In the event that cables become unburied as a result of seabed mobility during the operation of the wind farms or (where necessary) in the event of making a cable repair (discussed in section 5.5.7.7.5).

158. In all cases, the amount of external cable protection would be minimised as far as is possible.

159. Since it is not possible to bury the array cables in close proximity to the wind turbines and platforms due to the scour protection that would be installed, the cables would be surface laid with cable protection on the approach to each foundation. An allowance of up to 45km of cable protection (total across both Projects) is included for this purpose. It should be noted however, that this figure would be partly within the footprint of the foundation scour protection.

5.5.7.7.2 Types of External Cable Protection

160. A range of external cable protection systems are available and include:

- Rock placement – the laying of loose rock on top of the cable. Use of rock is often preferred as it is well proven to offer excellent protection in the marine environment, is suitable for application over large areas and is relatively simple and cost effective to deploy;
- Concrete mattresses – prefabricated flexible concrete coverings laid on top of the cable. Deployment is slow and therefore mattresses only tend to be used for short sections of cable;
- Frond mattresses – similar to concrete mattresses but the addition of fronds is used to encourage the settlement of sediment over the mattress and the cable underneath. Only suitable in certain hydrodynamic and sedimentary conditions;
- Protective aprons or coverings – solid structures of varying shapes, typically prefabricated in concrete or similar;
- Bagged solutions – including geotextile sand containers, rock-filled gabion bags or nets, and grout bags, filled with material sourced from the site or elsewhere); and

- Uraduct shell, Tekmar or similar cable protection system – a protective shell fixed around the cable. Generally used for short spans at crossings or near offshore structures where the cable exits the seabed before entering the structure. Such systems alone do not typically provide protection from damage due to fishing trawls or anchor drags.

161. Protection systems may be placed alone or in combination with other types and may be secured to the seabed where necessary.

5.5.7.7.3 Unburied Cables

162. An allowance is made for external cable protection where an adequate degree of protection has not been achieved from the burial process. The cable protection is assumed to have an indicative width on the seabed of up to 15.2m for the Offshore Export Cables and Inter-Platform Cables, and 6m for the array cables. A total allowance for both Projects of up to 117.7km is assumed for the export cables, 35.3km for the Inter-Platform Cables and 103.9km for the array cables.

5.5.7.7.4 Cable and Pipeline Crossings

163. A number of cable and pipeline crossings would be required for the Projects. Potential crossings include:

- Shearwater to Bacton gas pipeline (DBS West only);
- Esmond to Bacton gas pipeline (DBS West only);
- Esmond to Forbes gas pipeline (DBS West only);
- Esmond to Gordon gas pipeline (DBS East and DBS West);
- Cygnus to ETS gas pipeline (DBS East only);
- Cavendish gas pipeline (DBS East only);
- Cavendish methanol pipeline (DBS East only);
- Langeled pipeline (Offshore Export Cable Corridor only);
- Northern Endurance CCS pipeline (Offshore Export Cable Corridor only);
- Hornsea 4 export cable corridor (Up to six cables, Offshore Export Cable Corridor only);
- Third Eastern Link HVDC cable (referred to as TGDC, Offshore Export Cable Corridor only); and
- Fourth Eastern Link HVDC cable (referred to as E4L5, Offshore Export Cable Corridor only).
- National Grid HND Bootstrap (route not yet finalised, potentially within the Array Areas).

164. Additional new third party infrastructure may be installed ahead of DBS, requiring further crossings.

165. **Table 5-17** Below details the maximum estimated cable and pipeline crossing parameters for the Projects Offshore Export Cables, Inter-Platform Cables or Array Cables. All crossings would be designed to allow over trawling by fishing vessels.

Table 5-17 Maximum Estimated Parameters for Cable and Pipeline Crossings

	Offshore Export Cable Crossings	Inter-Platform Cable Crossings	Array Cable Crossings
Maximum estimated width per crossing	15.2m	15.2m	6m
Maximum estimated length per crossing	400m	400m	400m
Maximum estimated height per crossing	1.4m	1.4m	1m

166. Crossings are designed to protect the obstacle being crossed, as well as the Projects cables once they have been installed. Detailed methodologies for the crossing of cables and pipelines would be determined in consultation with the owners of the infrastructure to be crossed. However, a number of techniques may be utilised, including:

- Pre-lay and post lay concrete mattresses;
- Pre-lay and post lay rock placement; and
- Pre-lay cable with Uraduct (or similar) shell structure protection and post-lay rock placement / rock bags.

5.5.7.7.5 Summary of Potential Cable Protection Requirements

167. A summary of all potential cable protection requirements is provided in **Table 5-18**. As noted previously, these figures are lower than that assumed in The Crown Estate's Round 4 Plan Level HRA. A detailed **Cable Burial Risk Assessment** is included alongside the DCO application for the Projects (**Volume 8, application ref: 8.20**).

Table 5-18 Cable Protection Summary

Cables	Maximum estimated number of cable and pipeline crossings	Maximum estimated area of crossing protection	Maximum estimated area of cable protection for unburied cables	Total estimated area of crossing and cable protection
DBS East In Isolation				
Offshore Export Cable Corridor	24	147,133m²	1,000,282m²	1,147,415m²
Inter-Platform Cable	4	24,500m²	183,312m²	207,812m²
Array Cable	15	36,800m²	312,900m²	349,700m²
Total	41	208,433m²	1,496,494m²	1,754,927m²
DBS West In Isolation				
Offshore Export Cable Corridor	24	147,133m²	788,941m²	936,074m²
Inter-Platform Cable	2	12,200m²	205,504m²	217,734m²
Array Cable	25	61,400m²	310,500m²	371,850m²
Total	49	220,733m²	1,304,945m²	1,525,658m²
DBS West and DBS East Sequentially or Concurrently				
Offshore Export Cable Corridor	48	294,267m²	1,789,223m²	2,083,490m²
Inter-Platform Cable	21	128,400m²	536,484m²	664,884m²

Cables	Maximum estimated number of cable and pipeline crossings	Maximum estimated area of crossing protection	Maximum estimated area of cable protection for unburied cables	Total estimated area of crossing and cable protection
Array Cable	40	98,200m²	623,400m²	721,600m²
Total	105	520,867m²	2,949,107m²	3,469,974m²

5.5.8 Construction Vessels

168. A variety of vessels would be used during the construction phase, although the exact number and specification would not be known until much closer to the time of construction. Similarly, whilst it is likely that both DBS East and DBS West would be operated from the RWE O&M port at Grimsby, the construction ports would not be confirmed until nearer the start of construction.

169. In order to inform the environmental assessment, **Table 5-19** below gives an indication of the maximum construction vessel quantities and related movements to and from port that can be expected on site at any one time. Due to construction sequencing not all types of vessels would be on site at the same time.

170. A total of 7,510 or 3,857 vessel round-trips are estimated during construction of both Projects on a worst case basis, assuming the Projects are constructed Sequentially or In Isolation respectively.

Table 5-19 Construction Vessel Peak Numbers

Vessel Type	Peak Number On-Site Simultaneously Per Spread (DBS East / DBS West In Isolation)	Peak Number On-Site Simultaneously Per Spread (Both Projects Concurrently / Sequentially)	Maximum Return Trips (DBS East / DBS West In Isolation)	Maximum Return Trips (Both Projects Concurrently / Sequentially)
Site preparation vessels	2	3	52	78
Scour/filter layer installation vessels	2	6	88	175
Gravity base foundation ballast vessels	1	1	11	11
Foundation installation vessels	16	24	133	267
Transition piece installation vessels	6	9	17	33
Turbine installation spread	10	20	74	148

Vessel Type	Peak Number On-Site Simultaneously Per Spread (DBS East / DBS West In Isolation)	Peak Number On-Site Simultaneously Per Spread (Both Projects Concurrently / Sequentially)	Maximum Return Trips (DBS East / DBS West In Isolation)	Maximum Return Trips (Both Projects Concurrently / Sequentially)
Commissioning vessels	2	3	78	78
Accommodation vessels	1	2	2	2
Array cable vessels	12	24	386	352
Export cable vessels	6	12	952	1,912
Landfall cable installation vessels	1	1	3	3
Substation topside installation vessels	4	4	24	24
Substation foundation installation vessels	8	8	48	48

Vessel Type	Peak Number On-Site Simultaneously Per Spread (DBS East / DBS West In Isolation)	Peak Number On-Site Simultaneously Per Spread (Both Projects Concurrently / Sequentially)	Maximum Return Trips (DBS East / DBS West In Isolation)	Maximum Return Trips (Both Projects Concurrently / Sequentially)
Other vessels	10	20	2190	4,380
Total	**80**	**137**	**3,857**	**7,510**

171. Where they are used, jack-up barges and anchored vessels would have a seabed footprint (**Table 5-20**) (these footprints are also incorporated in section 5.5.1.1). For this purpose, it is assumed that there would be one operation for each foundation installation (most likely using anchors) and a further operation for each wind turbine installation (most likely using a jack-up). Jack-up vessels may have four or six legs/spudcans, generally with a smaller footprint if there are six legs. Where the jack up vessel has four legs it is assumed each would have a footprint of up to 275m². The footprint for deployment and recovery of one anchor would be approximately 116m².

Table 5-20 Construction Vessel Footprints (Foundation, Wind Turbine and OCP Installation)

Parameter	DBS East In Isolation (100 small turbines)	DBS West In Isolation (100 small turbines)	DBS West and DBS East Sequentially or Concurrently (200 small turbines)
Jack-up vessels			
Indicative area per jack-up leg (m²)	275	275	275
No. of legs per jack-up vessel	4	4	4
Indicative area per jack-up vessel (m²)	1,100	1,100	1,100
Indicative no. of jack-up operations per turbine	6	6	6
Indicative jack-up area per turbine (m²)	6,600	6,600	6,600
Indicative jack-up area for turbine installation (m²)	660,000	660,000	1,320,000
Indicative vessel jack-up footprint for all offshore platforms (m²)	22,000	22,000	44,000

Parameter	DBS East In Isolation (100 small turbines)	DBS West In Isolation (100 small turbines)	DBS West and DBS East Sequentially or Concurrently (200 small turbines)
Anchoring - Installation of turbine & offshore platform foundation			
Indicative individual anchor footprint area for deployment & recovery of one ancho (m²)	116	116	116
Indicative anchor placements per activity	4	4	4
Indicative anchoring footprint per activity (m²)	466	466	466
Number of activities requiring anchoring per turbine	4	4	4
Indicative total Impacted Area for one turbine / platform (m²)	1,862	1,862	1,862
Indicative anchoring footprint for turbine and platform installation (m²)	195,552	195,552	387,739
Anchoring - Installation of turbine & offshore platform topsides			
Indicative individual anchor footprint area for deployment & recovery of one ancho (m²)	116	116	116

Parameter	DBS East In Isolation (100 small turbines)	DBS West In Isolation (100 small turbines)	DBS West and DBS East Sequentially or Concurrently (200 small turbines)
Indicative anchor placements per activity	4	4	4
Indicative anchoring footprint per activity (m²)	466	466	466
Number of activities requiring anchoring per turbine / platform	1	1	1
Indicative total Impacted Area for one turbine / platform (m²)	466	466	466
Indicative anchoring footprint for turbine / platform installation (m²)	48,888	48,888	96,845

172. Anchoring may also be used during offshore export cable installation where a simultaneous lay and plough methodology is used. **Table 5-21** below details the indicative anchoring footprint during offshore export cable installation.

Table 5-21 Indicative Anchoring Footprint for Export Cable Installation

Parameter	DBS East In Isolation	DBS West In Isolation	DBS West and DBS East Sequentially or Concurrently
Indicative length of cable route installed with anchors (km)	10	10	10
Indicative impacted footprint for deployment of all anchors used during installation activity (m^2) per anchor deployment	485	485	485
Indicative impacted volume for one deployment (m^3)	728	728	728
Maximum number of Offshore Export Cables	2	2	4
Indicative skid length for installation (m)	44,122	44,122	44,122
Indicative maximum total number of vessel moves	45	45	91
Maximum total impacted area for anchoring (m^2)	22,061	22,061	44,091

5.5.9 Helicopters

173. A maximum of 730 return trips per year (if both Projects are constructed) may be made by helicopters during the construction phase. A maximum of 365 return trips per year may be made for either Project being built In Isolation.

5.5.10 Safety Zones

174. Safety zones may be used to help ensure safe working during all phases of the development, namely, to ensure a safe distance is maintained between the wind farm structures and vessels. The implementation of all safety zones would be subject to application and approval prior to the start of construction. The safety zones that may be applied for are summarised in **Table 5-22**.

175. Further information on safety zones is provided in **Volume 7, Chapter 14 Shipping and Navigation (application ref: 7.14)**.

Table 5-22 Safety Zones That May be Applied For

Potential Safety Zone	Details
Construction & Commissioning	Up to 500m around each wind turbine foundation or platforms when any vessels with limited mobility are present, reducing to a 50m safety zone when no vessels are present
Major Maintenance	Up to 500m when major maintenance is in progress (use of jack-up vessel or similar).
Decommissioning	Up to 500m at the end of the working life of a wind turbine foundation or platform when it is being decommissioned.

5.5.11 Offshore Operation and Maintenance

176. The ongoing operation of the wind farms over the Projects' design life would require a number of operation and maintenance activities.

177. **Outline Offshore Operations and Maintenance Plan (Volume 8, application ref: 8.24)** has been provided with the DCO application and provides further details of the anticipated activities and how they would be controlled by the DCO or any further consents that may be required.

5.5.11.1 General Maintenance Activities

178. A programme of monitoring and scheduled maintenance would be undertaken through the lifetime of the wind farms to ensure that all offshore infrastructure is maintained in safe working order and to maximise operational efficiency. Operational control of the wind farms would be through a Supervisory Control and Data Acquisition (SCADA) system, which would connect each turbine to the onshore control room. This system would enable the remote control of individual turbines, as well as remote interrogation, information transfer and data storage.

179. Surveys, including geophysical survey (most typically multibeam echosounder and/or side scan sonar) and through the use of remotely operated vehicles, would be performed at regular intervals throughout the operational lifetime of the wind farms. A typical geophysical survey programme for asset integrity purposes does not require a Marine Licence. The work programme would generally focus on areas of primary interest, for example areas of greatest seabed mobility.

180. Typical general maintenance activities include, but are not limited to:

- Wind turbine inspections and service;
- Oil sampling and/or change;
- Uninterruptible power supply (UPS) battery change;
- Service and inspections of wind turbine safety equipment, nacelle crane, service lift, high voltage system, blades;
- Offshore platform inspection/repair;
- Foundation inspection and repair;
- Cable repair and replacement;
- Cable remedial reburial;
- Cable crossing inspection and repair; and
- Unplanned and planned corrective work.

181. Sub-sea cables are designed for the lifetime of the Projects, however reactive repairs, replacements or remedial cable reburial work may be required, which are addressed in sections Cable Repair or Replacement and 5.5.11.4 below. Major replacements of wind turbine components such as gearboxes may be required during the lifespan of the Projects. Other large components (e.g., wind turbine blades or OCP transformers) are not expected to need replacement frequently during the operational phase, although failure of these components is possible. In the event of major component replacement, a jack-up vessel may be required to operate

continuously for significant periods to carry out major maintenance activities of this type. For this purpose, it is assumed that there could be up to 558 jack-up movements over the operational lifespan of DBS East and DBS West combined, or up to 279 jack-up movements over the operational lifespan of DBS East or DBS West In Isolation.

5.5.11.2 Vessel Operations

182. Vessel visits to the wind farms would be required each year to allow for scheduled and unscheduled maintenance activities. **Table 5-23** provides a breakdown of the maximum number of vessels that may be required at any one time per year during normal operation (i.e. excluding unforeseeable serial defects) and the anticipated maximum number of vessel movements per year during operation.

Table 5-23 Anticipated Trips to the Wind Farms During Operations – Peak Vessel Quantities and Annual Vessel Round-Trips

Vessel Type	Indicative peak numbers of vessels required at any one time (DBS East or DBS West)	Indicative peak numbers of vessels required at any one time (both projects)	Indicative annual vessel round trips (DBS East or DBS West)	Indicative annual vessel round trips (both projects)
Jack-Up vessels	2	3	9	16
Service Operations Vessels (SOVs)	2	2	52	104
Accommodation O&M vessels	2	2	52	104
Small O&M vessel (CTV)	2	2	52	104
Lift vessels	2	2	9	16
Cable maintenance vessels	2	2	1	1

Vessel Type	Indicative peak numbers of vessels required at any one time (DBS East or DBS West)	Indicative peak numbers of vessels required at any one time (both projects)	Indicative annual vessel round trips (DBS East or DBS West)	Indicative annual vessel round trips (both projects)
Auxiliary vessels	8	8	64	128
Helicopter	1	1	0.5/month	1/month
Helicopter – turbine transfers[7]	0	0	6	12

5.5.11.3 Cable Repair or Replacement

183. The basic methodology for carrying out a cable repair would involve removal of the damaged or faulty section of the cable, cutting of that section (unless replacing the whole cable), followed by the insertion of a new cable section to be joined to the existing cable. The seabed footprint of cable repair and replacement works is summarised in **Table 5-24**.

184. The section of cable to be repaired would be exposed using techniques such as jetting or mass flow excavation (if buried) and/or removal of any external cable protection. Once the repair is completed, jetting or other suitable methods of trenching would be used to rebury the cable and/or the external cable protection reinstalled. In addition, cable protection may require inspection and maintenance during the operational phase of the Projects. For the longer inter-platform and export cables, an extended cable loop would typically be surface laid onto the seabed close to and to one side of the original cable, prior to the cable being protected as described above. As the original cable would be recovered from the trench prior to cutting, it’s possible that the length of cable to be re-buried, and any external cable protection (if required), would be greater than the length of cable repaired.

[7] *Helicopter return trips are for emergency situations only, not for general operations.*

185. For array cables, the entire length of a cable (between 0.8km and 6km subject to turbine spacing) could require replacement and therefore 6km has been assumed as the worst case. The methodology for cable replacement would be identical to cable installation, with the addition of the removal of the cable from the turbine/platform structure and seabed before installation of the replacement.

5.5.11.4 Cable Reburial

186. In the event that cables become exposed due to the natural movement of the seabed over the lifetime of the Projects, it may be necessary to undertake remedial reburial work to ensure that the cables are adequately protected, without the need to resort to the use of external cable protection measures. The need for reburial work would be informed by an ongoing programme of geophysical surveys.

187. The seabed footprint of cable reburial works is summarised in **Table 5-24** below.

188. An In-Principle Monitoring Plan has been submitted with the DCO application which outlines the proposed monitoring, the details of which would be agreed post consent with the relevant Regulators and SNCBs. Post-construction surveys are a condition of the DMLs in the draft DCO.

Table 5-24 Footprint of Potential Cable Re-Burial and Cable Protection Replacement for Both DBS East and DBS West

Parameter	DBS East In Isolation	DBS West In Isolation	DBS East or DBS West Together
Maximum estimated array cable repairs/replacement - lifetime quantity	9	9	17
Maximum estimated inter platform cable repairs/replacement - lifetime quantity	2	2	6
Maximum estimated array cable repairs/replacement - seabed disturbance per event (m^2)	6,000	6,000	6,000
Maximum estimated area Array Area disturbance over Projects operational lifespan (m^2)	66,000	66,000	138,000

Parameter	DBS East In Isolation	DBS West In Isolation	DBS East or DBS West Together
Maximum estimated offshore export cable repairs/replacement - lifetime quantity	7	5	12
Maximum estimated offshore export cable repairs/replacement - seabed disturbance per event (m^2)	6,000	6,000	6,000
Maximum estimated area of offshore export cable disturbance over Projects operational lifespan (m^2)	42,000	30,000	72,000
Maximum estimated export cable protection requiring replacement over the Projects' lifespan	2.5km (dependent on survey results)	2.5km (dependent on survey results)	5km (dependent on survey results)

5.5.11.5 O&M Port

189. The maintenance port and facilities would be located on the East coast of the UK, and it is assumed that all direct labour would be resident within the area. It is likely that the existing facilities at the Grimsby Port would be utilised (and expanded where necessary) as the base for operations management of the Projects, as this would yield synergies and enable effective coordination with the existing operations team at the RWE Grimsby Hub.

5.5.12 Repowering

190. Once any potential life extension opportunities have been exhausted (through those maintenance activities described above and as provided for within the DCO), repowering may be considered at or near the end of the design life of the Projects. Repowering could involve the replacement of turbines and/or foundations with those of a different specification or design, for example to enable the installation of more efficient wind turbines.

191. In this event, if the specifications and designs of the new turbines and/or foundations were outside the existing maximum design scenario, or the impacts of constructing, operating, and decommissioning them were to fall outside those considered in this EIA, repowering would require further consent (and EIA) and is therefore outside of the scope of this document. At this time, it is not expected that repowering would require removal of existing or installation of new offshore (or onshore) cables.

5.5.13 Offshore Decommissioning

192. At the end of the operational lifetime of the Projects, it is anticipated that all structures above the seabed or ground level would be completely removed. The decommissioning sequence would generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The decommissioning duration of the offshore infrastructure may take the same amount of time as construction of the Projects, up to five years per Project, although this indicative timing may reduce.

193. The Energy Act 2004 requires that a decommissioning plan must be submitted to and approved by the Secretary of State, a draft of which would be submitted prior to the construction of the Projects. The decommissioning plan and programme would be updated during the Projects' lifespan in accordance with requirements.

194. To take account of changing best practice and new technologies, the approach and methodologies employed at decommissioning would be cognisant of the legislation and policy requirements at the time of decommissioning.

5.5.13.1 Wind Turbines and Platforms

195. Wind turbines would be removed by reversing the methods used to install them. Piled foundations would likely be cut approximately 1m below the seabed, with due consideration made of likely changes in seabed level and removed. This could be achieved by inserting a pile cutting device. Once the piles are cut, the foundations could be lifted and removed from the site.

196. At this point in time, it is not thought to be reasonably practicable or environmentally prudent to remove entire piles from the seabed, however, the Applicants would track the development of technology to enable this and would consider such decommissioning methodologies at the time of decommissioning.

197. The offshore platforms would most likely be a reverse installation where the decommissioning would be in two phases, in the first phase the topside would be lifted from the foundation to a transport vessel/barge and sailed to a suitable harbour for decommissioning. In the second phase the foundation would be decommissioned; piled foundations would be decommissioned as described above.

5.5.13.2 Offshore Cables

198. It is expected that most array and export cables (and any associated cable protection) would be left in situ. Exposed sections of cable are more likely to be cut and removed to ensure they don't become hazards to other users of the seabed. At this point in time, it cannot be accurately determined whether and which cables would be exposed at the time of decommissioning.

199. In the event that cables are removed, it is likely that equipment similar to that which is used to install the cables could be used to reverse the burial process and expose them. Therefore, the area of seabed impacted during the removal of the cables could be the same as the area impacted during the installation of the cables. Divers and/or ROVs may be used to support the cable removal vessels.

200. Once the cables are exposed, a grapnel would be used to pull the cables onto the decks of cable removal vessels. The cables would be cut into manageable lengths and returned to shore. Once onshore, it is likely that the cables would be deconstructed to recover and recycle the copper and/or aluminium and steel within them.

5.6 Landfall

5.6.1 Background

201. The Offshore Export Cables would make landfall near Skipsea. The Offshore Export Cables would be connected to the Onshore Export Cables in the Transition Joint Bay (TJBs), which would be constructed prior to the installation of the Offshore Export Cables nearshore. The landfall location near Skipsea is shown on **Volume 7, Figure 5-3b and Figure 5-3c (application ref: 7.5.1)**.

202. The Landfall Zone extends inland to allow the TJBs to be located beyond any areas at risk of natural coastal erosion, and to provide space for temporary construction logistics and access requirements.

203. The landfall location near Skipsea was chosen as the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)**.

204. To allow the connection of the Offshore and Onshore Export Cables up to six completed ducts would be installed using a trenchless technique such as HDD. This consists of three ducts per project (two power cable ducts plus a smaller duct for a fibre optic communications cable).

205. The Projects would employ either a short or long trenchless landfall solution which would respectively require the installation of exit pits in either the intertidal zone or offshore in shallow subtidal waters. These Development Scenarios are explained in section 5.1.1.

5.6.2 Landfall Zone Works

206. The Landfall Zone covers the area from Mean Low Water Springs (MLWS) inland, including the beach and intertidal area, to the point at which the Onshore Export Cables extend from the TJBs Compound to the main Onshore Export Cable Corridor. There would be no direct access to the beach from the TJB Compound. The only access to the beach would be via the emergency access route as described in section 5.6.3

207. The total Landfall Zone area is 420,000m^2. However, only a proportion of this total area would be used during construction. The larger area has been identified to allow flexibility in design and positioning of the TJBs, TJB Compound and Satellite Temporary Construction Compound within the Landfall Zone. The TJB Compound would be required to accommodate the drilling rigs and ducting. The associated main welfare facilities would be within the Satellite Temporary Construction Compound.

208. The precise location of the TJBs would be subject to detailed design which would consider technical characteristics such as the geotechnical qualities of the substrata, in addition to social, environmental and ecological issues.

209. The Offshore Export Cables would be connected to the Onshore Export Cables in the TJBs. The TJBs would be constructed prior to the installation of the Offshore Export Cables, thus allowing the jointing of the Offshore Export Cables to the Onshore Export Cables.

210. The TJBs would be installed within the TJB Compound. The indicative locations of the TJB Compound and Satellite Temporary Construction Compound within the Landfall Zone are shown on **Volume 7, Figure 5-3c (application ref: 7.5.1)**. The expected dimensions of the TJB Compound and Satellite Temporary Construction Compound for each of the Development Scenarios is shown in **Table 5-27**.

211. Prior to any construction, survey works and site clearance would be undertaken, including geotechnical, topographical, UXO, and environmental surveys. The TCC site would be cleared (topsoil removal etc) in line with environmental requirements. A temporary vehicular access route would be constructed to allow for transport to/from the TCCs located within the Landfall Zone. There would be no direct access from these compounds to the beach or intertidal zone.

212. A trenchless solution (likely to be HDD) would be used to install ducts that would house the cables under the beach. A total of six completed ducts would be installed. The ducts would run from the TJBs located landward of landfall, to an exit location which may be at an intertidal location (short trenchless crossing) or further offshore within the subtidal zone (long trenchless crossing). TJBs are permanent infrastructure where the Offshore and Onshore Export Cables are joined. The Offshore Export Cables would be pulled ashore through these pre-installed trenchless crossing ducts and would interface with the Onshore Export Cables at the TJBs. No above ground permanent infrastructure would be installed within the intertidal area above LAT.

213. As referenced in section 5.6.1, the Projects are considering either a short and or long trenchless landfall exit. A short exit would result in a trenchless landfall exit within the intertidal zone, the area onshore that lies between MHWS and MLWS. This is considered as part of the design envelope.

214. A long trenchless landfall exit would not require any works within the intertidal zone as the exit would be below MLWS i.e. a subtidal exit. A long trenchless landfall exit is the preferred solution, but a short exit has been assessed where it would be considered as the environmental worst case. Duct installation would start boring a hole from the Landfall Zone TJB Compound, travel beneath the beach, and would exit either in the intertidal or subtidal zone at a suitable water depth. A duct would be installed within the bore from either TJB Compound or the exit location to provide a permanent cable installation pathway.

215. Up to 6 completed ducts would be installed. This consists of 3 ducts per Project (two power cable ducts plus a smaller duct for a fibre optic communications cable). Should duct installation fail during construction, all equipment would be removed, the void filled and a further attempt made. The maximum number of completed ducts would not exceed (six in any Development Scenario). **Plate 5-8** provides an Illustrative section and plan of a single duct as either short or long HDD options.

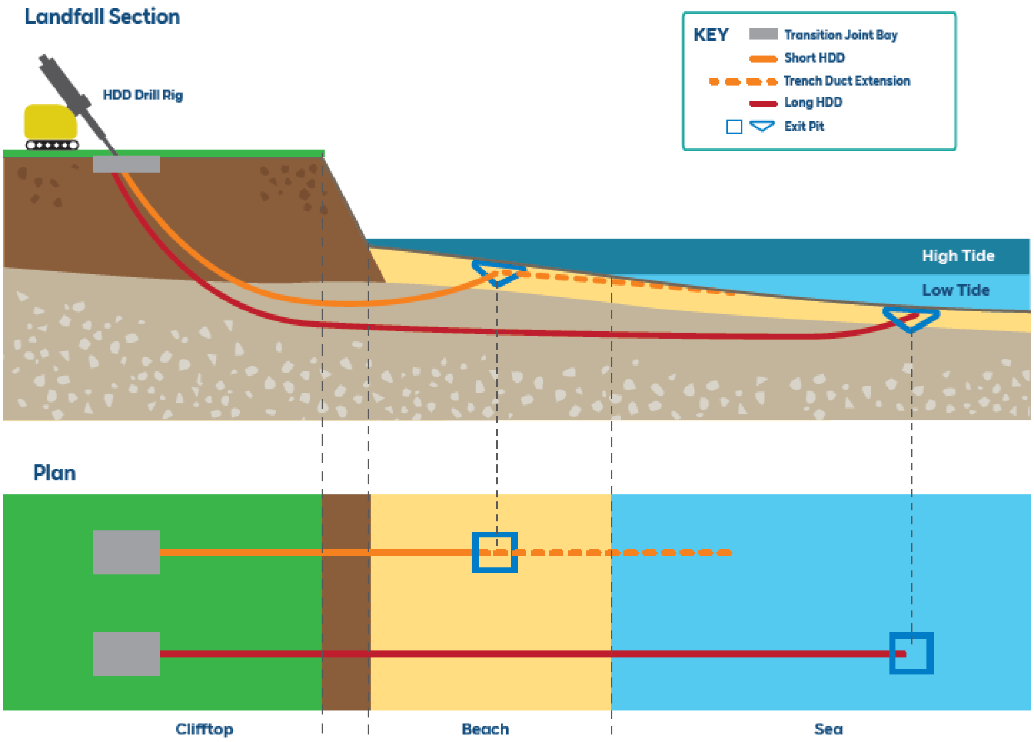

Plate 5-8 Illustrative Section and Plan Landfall Works HDD options

216. Landfall works are likely to include:

- Construction of a temporary access to the landfall compounds;
- Construction of the landfall TJB Compound and Satellite Temporary Construction Compound to support the construction of the TJB's within the Landfall Zone;
- Mobilisation of trenchless installation equipment to the TJB Compound;
- Trenchless crossing (likely HDD) works (likely to require 24 hour working);
- Preparation of trenchless landfall exit pits prior to punch out (intertidal or sub-tidal);
- Assembly and pull-in of duct from barge (alternatively, they may be pushed from landfall side);
- Construction of duct extensions (if required);
- Temporary backfill of landfall exits (if required between duct installation and cable pulling works) Construction of TJBs, within the TJB Compound;
- Preparation of landfall duct exit for receiving offshore high voltage cables;
- Pull-in of offshore high voltage cables from vessel;
- Transition jointing offshore / onshore cables;
- Backfilling of TJBs; and
- Reinstatement works.

217. The drill, or other trenchless installation, bore would be of sufficient depth below the ground level to have no effect on coastal erosion. The TJBs would be located beyond any areas at risk of natural coastal erosion across the anticipated operational life of the Projects. The location of the TJB's, along with the respective indicative trenchless landfall drill lengths, will take cliff erosion and a 30 to 32 year operational duration into consideration.

218. The Trenchless installation will utilise specialist equipment to bore a hole ready for duct installation. Drilling fluids may be used to lubricate the cutting head and maintain the drill path until the permanent duct is in place to form a stable, self-supporting path between the TJB location and landfall exit. A drilling fluid management system would be employed at the TJB Compound during construction to monitor and control the volume of drilling fluid being used.

5.6.2.1 Transition Joint Bays

219. TJBs are required to connect the Offshore Export Cables to the Onshore Export Cables, The TJBs provides a clean, dry environment where the onshore and offshore cables are jointed, and to protect the joints once completed. Following the trenchless duct installation the TJB pits would be dug into the ground and lined with concrete. Once both the Onshore and Offshore cables are installed, the joint is completed, the TJBs are covered and the land above reinstated.

220. Prior to TJB construction a temporary working platform and trenchless entry pits will be established in the TJB locations to install the trenchless installation equipment. The equipment is removed following completion of the duct installation. The TJB is then excavated and prepared alongside any temporary facilities required onshore for the cable pulling operation.

221. The permanent TJB generally comprises of a reinforced concrete slab and may either have reinforced concrete walls with a reinforced concrete cover or comprise of the slab only with cement bound sand and other sand used as backfill to protect the cable joints. The TJBs are generally buried at a depth to allow the majority of land to return to normal uses such as agricultural land. Each TJB is accompanied by a Link Box to allow testing and monitoring of cable joints. The Link Boxes are smaller in footprint than the TJBs, with a manhole inspection cover at the surface. The Link Boxes manhole covers are the only permanent above ground infrastructure at the Landfall Zone. A maximum of 4 Link Boxes (one for each TJB) would be installed, the dimensions would be up to 2.5 x 4m, as detailed in **Table 5-25.** Access would be required during operation to Link Boxes (associated with each TJB).

222. Following successful testing of the cables at the TJBs the Landfall Zone Satellite Temporary Construction Compound and access route would be reinstated to the original condition; this work would include the removal of all equipment and facilities, temporary fencing, Haul Road and reinstatement of topsoil.

223. In a Sequential Scenario the TJBs for the second Project would not be installed by the first Project.

5.6.2.2 Landfall Parameters

224. **Table 5-25** shows the main construction parameters for the Landfall Zone.

Table 5-25 Landfall Zone Construction Onshore Maximum Parameters

Landfall Zone	DBS East and DBS West In Isolation	DBS East or DBS West Concurrently	DBS East or DBS West Sequentially
Number of complete trenchless crossing ducts	3	6	6
Indicative trenchless crossing depth (m)	20	20	20
Number of Transition Joint Bays	2	4	4
Transition Joint Bay(s) dimensions (m) – each	5 x 20	5 x 20	5 x 20
Permanent land take for total number of TJBs (m^2) – including below ground infrastructure	200	400	400
Number of Link Boxes – the only above ground infrastructure	2	4	4
Link Box Dimensions (m)	2.5 x 4	2.5 x 4	2.5 x 4
Permanent land take for total number of Link Boxes – only above ground infrastructure (m^2)	20	40	40
TJB Compound dimensions (m)	110x75	190x75	190x75
Satellite Temporary Construction Compound dimensions (m)	75x75	75x75	75x75
Duration of construction works at landfall zone (months)	Up to 18	Up to 18	Up to 48

5.6.2.3 Trenchless Landfall Exits

225. The exit pit would be prepared by excavating an area before or during the trenchless landfall installation, to capture the arisings, drilling fluid and the boring device when it punches out of the ground.

226. Exit pits for landfall would be located either within the intertidal or subtidal zone depending on whether a long landfall (dredged) or short trenchless landfall (excavated/dredged) is pursued. There would be up to a maximum of 6 exit pits. The size of the excavation pits is mainly determined by the control accuracy of the borehole (width), the exit angle of the borehole (length), the water level at high water (height) and the subsequent minimum cover of the cable (depth). Maximum dimensions of 20m x 10m x 3m (length x width x depth) are assumed for each exit pit as identified in **Table 5-26**.

227. At the end of the drilling work, the pit enclosure would be emptied of drilling fluid residues. Any drilling fluid which collects within the exit pit would settle and then be pumped out. A drilling fluid management system along with other control measures would be employed during construction to monitor and limit the volume of inert drilling fluid entering the marine environment. The duct end would be prepared either for cable pulling or temporary backfill if there is a pause prior to cable installation.

Table 5-5-26 Landfall Maximum Parameters

Landfall	DBS East and DBS West In Isolation	DBS East or DBS West Concurrently	DBS East or DBS West Sequentially
Number of support vessels (approximate)	2	2	2
Number of pontoons	1	1	1
Number of exit pits	3	6	6
Indicative duration of landfall works	18	18	48
No. of Exit pits	3	6	6
Dimensions of each exit pits (length x width x depth) (m)	20 x 10 x 3	20 x 10 x 3	20 x 10 x 3

228. It is currently anticipated that two floating units and/or a Jack-up barge(s) would be required to support landfall exits in the intertidal or subtidal. On a working pontoon or jack-up barge, a sufficiently large crawler crane would be installed for all lifting work. In addition, the recreation / sanitary containers would be set up here and storage areas would be provided. The working pontoon would have an area of approximately 12 x 50m. The crawler crane would be able to move longitudinally on the pontoon to further increase the reach. In addition to the working pontoon, a transport / storage pontoon with dimensions of approximately 12 x 20m may be required, on which additional material (sheet piles / drill rods) could be stored. Furthermore, the unit can also be used for transport.

229. For transportation, the pontoon units would be moved with the help of one to two tugboats. The site personnel would be transported to and from the site daily by a small crew transfer vessel.

5.6.2.4 Long Trenchless Landfall- Subtidal Zone

230. The subtidal zone extends beyond MLWS, with the exit point determined considering the limitations of the trenchless methodology in the ground conditions and the draught requirements of the duct and cable installation vessels.

231. Works for the long trenchless landfall (with exit pits within the subtidal zone) include:

- Dredging of exit pits within the subtidal zone;
- Punch out of the bore installed from the TJB;
- Assembly of duct whilst being pulled through the bore to the landfall (may occur in the opposite direction); and
- Capping and burial of duct end prior to cable installation.

232. The ducts would be capped and buried until the cable installation... Once the cables are ready to be pulled through, the ducts would be re-exposed to pull in the cable. Once installation is complete the exit pits would be backfilled using available side-cast material and the remainder left to naturally backfill.

233. In a Sequential Scenario, the first Project would install the ducts for the second Project at the same time to ensure environmental impacts and disruption are minimised.

5.6.2.4.1 Short Trenchless Landfall- Intertidal Zone

234. The intertidal zone (between MHWS and MLWS) of the Projects is separated from the rest of the Landfall Zone by a series of beach cliffs. There is no direct access between the intertidal zone / beach and the TJB Compound within the Landfall Zone.

235. For an intertidal exit there would be a minimum 50m set back distance from the beach cliffs to the exit pits. This is to ensure the stability of the beach cliffs.

236. Intertidal works for the short trenchless landfall (with exit pits within the intertidal zone) include:

- Excavation of exit pits within the intertidal zone;
- Punch out of the bore installed from the TJB;
- Assembly of duct whilst being pulled through the bore to the landfall (may occur in the opposite direction);
- Laying of additional lengths of ducting in trenches (if required) from exit pits to a depth suitable for offshore cable installation using vessel or a plough, this may extend beyond MLWS (Offshore Export Cable installation methods below MLWS, are described in section 5.5.7);
- Capping and burial of duct end prior to cable installation.

237. The short trenchless exit pits will be excavated using low draught vessel based dredging or excavation plant undertaking low tide work accessed by landing craft to produce a suitable excavation.

5.6.2.4.2 Intertidal to Subtidal Trenching Works

238. Trenching may be required to install duct extensions or the Offshore Export Cables directly from the trenchless exit pits. Duct extensions could enable the landfall ducts to be extended further offshore from the exit pits to below LAT to facilitate cable installation from an installation vessel or plough situated offshore. This would take place in the intertidal or subtidal, depending on the installation technique selected, as described above. Offshore cable installation techniques are described further in section 5.5.7.

239. These duct extensions would be of a similar diameter to the trenchless landfall ducts. They would be installed in their own trench, buried at a similar depth to the export cables. The duct extension trenches would be backfilled by excavators suitable for intertidal works before the arrival of the cable installation vessel.

240. A 20m corridor of disturbance for each individual export cable and communication cable, up to a maximum of 6, is assumed. A multicat vessel or jack-up barge would typically be used for various intertidal and subtidal construction activities, such as excavation and dive support. A shallow draught barge may be located at the exit point for a period of approximately 10 to 14 days while each trenchless landfall is completed, and each duct is installed.

5.6.2.5 Offshore Export Cable Installation

241. The Offshore Export Cables would then be installed at a suitable time, as part of the main Offshore Export Cable installation campaign, taking into account weather, tide and the wider offshore works schedule, by positioning the cables at the offshore exit point and pulling through the ducts to the TJBs.

242. Some preparation of the exit duct may be required using the methods detailed in section 5.6.2.3, in the intertidal or subtidal to enable the installation of the offshore cables using a method such as ploughing, at a suitable water depth. This may require the support of jack-up vessels. Additional temporary stabilisation and support methods may be required for the duration of the pulling operation.

243. The duct exit will be exposed and prepared to receive the cable and temporary cable guides may be installed. Winching equipment will be establish at the TJB and a winch cable passed through the duct to the landfall exit pit ready for the cable.

244. The Offshore Export Cable will be connected to the winch and then pulled through the duct fed from the specialist cable installation vessel in to the TJB location where it will be anchored prior to the jointing operation at its termination point.

5.6.2.6 Intertidal access during the works

245. The trenchless crossing works should not require any prolonged periods of restrictions or closures to the beach for public access, although it is possible that some work activities would be required to be performed on the beach that may require short periods of restricted access. Vehicles would only access the beach from offshore barges/vessels and not onshore via the ‘emergency beach access’ or over the cliffs. Any areas subject to short-term restricted access would be agreed in advance with East Riding of Yorkshire Council and the Environment Agency prior to construction.

5.6.2.7 Decommissioning

246. To minimise the environmental disturbance during wind farm decommissioning the preferred option is to leave cables buried in place in the ground with the cable ends cut, sealed and securely buried as a precautionary measure. Alternatively, partial removal of the cable may be achieved by pulling the cables back out of the ducts. This may be preferred to recover and recycle the copper and/or aluminium and steel within them.

5.6.3 Emergency Intertidal Access

247. The proposed emergency beach access may be required during construction and would be located to the north of Ulrome.

248. The emergency access route would be located along the beach running north from the intertidal area of the Landfall Zone at Skipsea, utilising an existing access over the cliff and a farm track connecting with North Turnpike Road, a distance of approximately 2km in length, as shown on **Volume 7, Figure 5-3b (application ref: 7.5.1**

249. A Satellite Temporary Construction Compound, as shown on Chapter 5 Project Description, Figure 5-3b **(application ref: 7.5.1)** would also be located at the end of the farm track adjacent to an existing boat storage area. Access to the boat storage area would be maintained when then emergency access is in use.

250. This access would only be used in the event of a construction emergency, such as a frac-out, whereby drilling fluid is released to the ground surface during trenchless crossing installation.

251. For an HDD trenchless technique frac-out risk occurs during the HDD drilling period where they are progressing below the beach (likely first month of each HDD drill).

252. Should the emergency access be required during construction, vehicles suitable to track on the beach would access the intertidal via a temporary access ramp and/ or ground protection matting shoreward of MHWS to avoid impacts on sensitive Maritime Cliff and Slope habitat.

253. As the cliff face is highly dynamic and constantly changing, the temporary access over the cliff would be designed when the Contractor is appointed.

254. The design would take the current condition of the area into consideration and would, as a worst case, temporarily remain in place for the duration of the drilling works, expected to be up to 18 months.

255. Any maritime cliff and slope habitat present would be protected from any crossing vehicles with suitable ground protection matting and it would be monitored during construction to ensure the habitat is not damaged.

256. This would be returned to its current land use on completion of the works for the emergency beach access and would not impact the Maritime Cliff and Slope habitat.

257. No permanent works would be undertaken along the beach to accommodate this emergency access route. . The TCC would be returned to its current use on completion of the works at the Landfall Zone.

258. Full details of the Emergency Intertidal Access, including the temporary access ramp (if required) will be included within the **Drilling Fluid Management Plan,** an Appendix to the final Code of Construction Practice which will is secured by draft DCO Requirement 19 Code of Construction Practice.

5.7 Onshore

5.7.1 Onshore Export Cable Corridor

259. The Onshore Export Cable works includes all the infrastructure necessary to connect the Offshore Export Cables via TJBs to the Onshore Converter Stations. The cables would be buried along the full route. The following onshore cable works would take place for the Projects simultaneously under each of the three Development Scenarios, with the exception of the cable pulls and Jointing Bay construction which would take place once the second Project is ready to connect under a Sequential scenario.

260. The Onshore Export cable works include:

- Initial site investigation works;
- Site survey and environmental pre-construction activities such as authorised vegetation clearance required in preparation for construction;
- Preparation of the Onshore Export Cable Corridor for main construction activities such as erecting fencing and preliminary right of way works;
- Construction of temporary access to the cable corridor infrastructure;
- Temporary strip and storage of topsoil for agricultural areas;
- Construction of Main and Satellite Temporary Construction compounds (TCC's);
- Construction of cable Jointing Bays;
- Construction of trenchless crossing on the Onshore Export Cable Corridor;
- Construction of temporary Haul Roads to facilitate the Onshore Export Cable installation;
- Excavation of trenches and installation of cable ducts;
- Installation of below ground chamber at the Jointing Bays/Link Box locations, required to provide maintenance and inspection access to the cable system;
- Laying or pull-in of high voltage cables within ducts;
- Installation of ground level 'Link Boxes' and marker posts;
- Backfilling of Jointing Bays and cable trenches with suitable material for electrical performance and protection of cables;
- Reinstatement works;

- Design and construction of trenchless crossings for existing infrastructure and natural features. This includes roads, railways, rivers and streams. This may be achieved by construction of culverts/cable structures of trenchless methods including HDD or other appropriate methodologies; and
- Installation of ducts and cable in hard ground or road carriageways where required including temporary traffic management and reinstatement of the surfacing surface.

5.7.1.1 Location

261. A 75m wide Onshore Export Cable Corridor from the TJBs to the Onshore Converter Stations, widening to 90m at complex trenchless crossings is being considered for the purposes of the EIA presented in **Volume 7, Figure 5-4 (application ref: 7.5.1)**.

262. From the landfall near Skipsea, the Onshore Export Cable Corridor travels west, crossing Hornsea Road (B1242), and continuing to Dunnington Lane before turning and heading south past Dunnington, Nunkeeling, Catfoss, and across West Road (A1035) at Sigglesthorne.

263. The Onshore Export Cable Corridor then turns southwest and continues passing the village of Riston Grange, crossing Whitecross Road (A165) and again crossing Hornsea Road (A1035) as it heads west north of Tickton. The route then crosses Driffield Road (A164) to the north of Beverley before turning south crossing Constitution Hill (A1035) to the west of Beverley, down across York Road, Newbald Road, and Broadgate (B1230), before reaching the Onshore Substation Zone located at Beverley Road along the A1079 and A164.

5.7.1.2 Onshore Export Cable Corridor Parameter

264. **Table 5-27** and **Plate 5-9** shows the main construction parameters for the Onshore Export Cable Corridor.

Table 5-27 Onshore Export Cable Corridor Maximum Construction Parameters

Onshore Export Cable Corridor	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Onshore Export Cable Corridor length from the Landfall Zone to the Onshore Substation Zone (km) (approximate)	32	32	32
Number of Export circuits	1 x HVDC	2 x HVDC	2 x HVDC
Number of power cables per circuit	2no. 1-core power cables for each HVDC circuit	2no. 1-core power cables for each HVDC circuit	2no. 1-core power cables for each HVDC circuit
Number of fibre optic (communication) cables per circuit	1	1	1
Number of earth cables per circuit	1	1	1
Number of trenches	Up to 2	Up to 4	Up to 4
Cable duct trench dimensions (m)	1.1m base to 3.9m surface (x1 HVDC cable per trench)	1.1m base to 3.9m surface (x1 HVDC cable per trench)	1.1m base to 3.9m surface (x1 HVDC cable per trench)

Onshore Export Cable Corridor	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
	3.35m base to 6.2m surface (x2 HVDC cables per trench)	3.35m base to 6.2m surface (x2 HVDC cables per trench)	3.35m base to 6.2m surface (x2 HVDC cables per trench)
Number of Temporary Construction Compounds (TCC's)	17 2 Main TCC's 15 Satellite TCC's	17 2 Main TCC's 15 Satellite TCC's	17 2 Main TCC's 15 Satellite TCC's
Size of Main Temporary Construction Compound (m^2)	10,000 (100x100m)[8]	10,000 (100x100m)[8]	10,000(100x100m)[8]
Size of Satellite Temporary Construction Compounds(m^2)	5,625 (75x75m)[8]	5,625(75x75m)[8]	5,625(75x75m)[8]
Cable corridor width (m)	41m	75m	75m
Cable corridor width at complex trenchless crossings (m)	45m	90m	90m

[8] Actual size may vary due to site specifics

Onshore Export Cable Corridor	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Depth of trench to top of duct / cables (m) (approximate)	1.3 – 1.7	1.3 – 1.7	1.3 – 1.7
Burial depth (m) where restrictions are not present (average)	2	2	2
Indicative burial depth (m) (approximate)	1.6	1.6	1.6
Typical Jointing Bay frequency (km)	Every 0.75 – 1.5	Every 0.75 – 1.5	Every 0.75 – 1.5
No. Jointing Bays (approximate)	103	205	205
Jointing Bay construction dimensions (m)	10 x 25	10 x 25	10 x 25
Jointing Bay infrastructure dimensions (all below ground) (m)	3 x 8	3 x 8	3 x 8
Jointing Bay burial depth from existing ground level to bottom of Jointing Bay (m)	2.2	2.2	2.2

Onshore Export Cable Corridor	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Minimum Jointing Bay burial depth from existing ground level to top of Jointing Bay (m)	1.35	1.35	1.35
Number of Earth / Link Boxes and associated manhole covers	103	205	205
Link Box construction dimensions (m)	6.5x8	6.5x8	6.5x8
Link Box dimensions / manhole cover permanent infrastructure above ground (m)	2.5x4	2.5x4	2.5x4
Haul Road Width (m)	5 (increasing to 8 at passing places)	5 (increasing to 8 at passing places)	5 (increasing to 8 at passing places)

Onshore Export Cable Corridor	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Permanent easement[9]	15m along the cable corridor.	24m along the cable corridor	24m along the cable corridor
Duration of works	33	33	57

[9] At trenchless crossings the permanent easement width would be located within the Onshore Development Area and determined by the depth of the trenchless crossing at the detailed design stage.

5.7.1.3 Onshore Construction Activities

265. Site investigation activities including boreholes, trial pits and geophysics surveys were completed at key trenchless crossing locations and the Onshore Substation and Landfall Zones in 2023 to establish ground conditions and inform the design. Additional works will be undertaken in the intertidal in 2024 to inform the detailed landfall and trenchless crossing design. These works will be carried out using specialist ground investigation equipment, temporary welfare, storage, and mobile plant such as excavators and dumpers.

266. **Draft DCO** Requirement 19 **(Volume 3, application ref: 3.1)** requires a Contaminated Land and Groundwater Scheme to be prepared to identify any contamination and any remedial measures which may be required, prior to construction. Piling and Hydrogeological risk assessments will also be undertaken as detailed in section 6.2.2.1 and 6.2.2.2 of the **Outline Code of Construction Practice** (**OCoCP) (Volume 8, application ref: 8.9).**

267. The majority of the work in soil storage areas would be executed using mechanical plant for earthmoving and excavation activities. This would typically include bulldozers, various excavators and dumper trucks and lorries for material handling. Highways works may be required including improvements as part of the **Outline Construction Traffic Management Plan (OCTMP) (Volume 8, application ref: 8.13)**; new junctions and cuttings and embankments to ensure road stability.

268. Work areas would be cleared, and the topsoil stripped and stored in stockpiles in line with the **Outline Soil Management Plan Appendix A** of the **OCoCP (Volume 8, application ref: 8.9)**.

269. Imported material (gravels/stones/geotextiles/road surfacing where required) would then be imported via road to the designated access point and used to form stable surfaced areas for construction activities including access points, compounds for temporary offices units, storage and parking and formation or permanent area platforms to the required level and falls.

270. A drainage scheme would be designed to manage water formation on temporary surfaces areas and control discharge from construction areas. More detail is provided in section 5.7.1.4.6. Cable ducting and other below ground structures would be installed. This would include excavation of subsoil to the required depth, duct installation and backfill with suitable materials to ensure cable electrical/thermal performance and protection. In some specific locations there may be the requirement for direct lay of cables. These items would be delivered to site. The number, installation and arrangement of cables is dependent upon the final scheme electrical requirements.

271. Concrete and other imported construction materials would be used to form structures/foundations/slabs where required (including but not limited to cable Jointing Bays, road accesses and Haul Road crossings of major utilities), along with any required formwork and reinforcement. The recycled content of imported materials would be considered by the Contractor, where appropriate. Further detail on imported materials for the Haul Road are provided in Section 5.7.1.4.2.

272. Excess soil arising would be used on site where possible for earthworks and landscaping with unsuitable material being removed from site for suitable re-cycling or disposal. Additional imported material for landscaping may be required. Cutting and breaking equipment would be used to open up hard surfaces as required during the works. Appropriate materials would be used to reinstate these areas in line with their future use requirements such as pavements, highways or hard standing areas.

273. Where the corridor width is restricted additional soil storage land areas would be required with additional vehicles used to transport from the excavation location to the storage areas and back. This would be within the Onshore Development Area and not require any additional land take.

274. Hoarding, fencing, signage route diversions etc. would be used to separate the work areas from the general public. The fence boundary would be in place around all construction compounds (including the Onshore Converter Station compound(s)) and at the outer limits of the onshore cable corridor along the whole onshore cable route. Fencing may also be required along access routes from the public road network to the construction compounds and Onshore Converter Station compound with a lockable gate at the access locations from the public road network. Stock-proof fencing may be suitable for use in agricultural land areas. Heras-type or wooden temporary fencing would likely be required at the construction compounds and / or close to residential areas. Temporary fencing would be up to 2.4m in height.

275. Areas of agricultural land between Jointing Bays would be reinstated as quickly as possible and within 2 years.

276. A typical example of Onshore Export Cable works for two Projects, constructed Concurrent, is show in **Plate 5-9**.

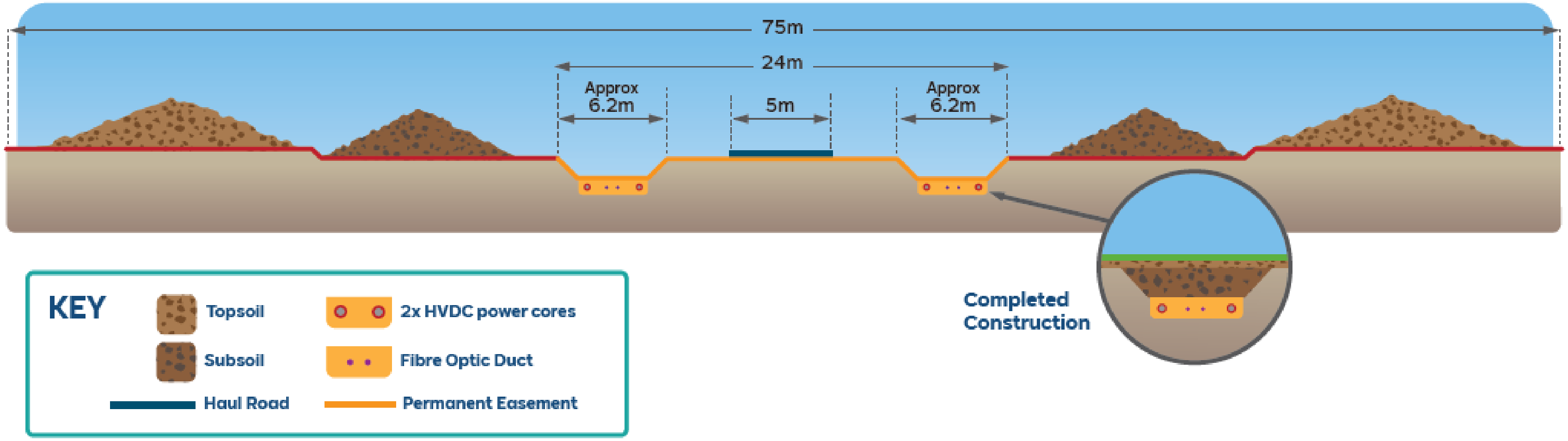

Plate 5-9 illustrative Section of Onshore Export Cable Corridor to the Onshore Converter Stations, Including Power Cores and Ducts, Construction Haul Road and Proposed Topsoil Laydown Areas Either Side

5.7.1.4 Other Onshore Construction Activities

277. Where the route requires protective measures due to close proximity or crossing of the export cable to existing infrastructure and natural features, additional specialist construction activity may be required such as:

- Temporary works to monitor, support, or protect sensitive infrastructure;
- Construction of works compounds and additional deep excavations and shafts with earthworks where required for cable crossings or for trenchless activities;
- Construction cable jointing and pulling locations to enable the sequenced installation of cables and to meet electrical performance requirements; and
- Construction of trenchless cable crossings through HDD or other trenchless methods. This requires drilling/boring compounds and the supply of specialist equipment such as drills, tunnel boring machines and associated consumables.

5.7.1.4.1 Cable Installation

278. The Onshore Export Cables would be pulled through pre-installed ducts. There may be occasions where direct lay is required in certain ground conditions or if an obstruction is identified. Cable ducts are generally laid in trenches and installed in trenchless crossing bores and then the cables are pulled through. The cables installed onshore for the Projects generally include the onshore transmission cables, fibre optic communications cables, Distributed Temperature Sensing (DTS), Distributed Acoustic Sensing (DAS) systems cables, and Earthing Continuity Cables. An example of trench construction is included in **Plate 5-10**.

Plate 5-10 Example of Open Trench Technique, Sofia offshore wind farm (2022)

279. Jointing Bays would be constructed at intervals along the Onshore Export Cable Corridor to allow pulling and / or joining of the cables. Typically, the Jointing Bays would be located every 750m to 1.5km.

280. The final number of cable duct trenches required is dependent on the final Development Scenario and actual dimension of trenches would not be confirmed until the detailed design stage for the Projects. The majority of the Onshore Export Cable Route would require two trenches as shown in the indicative cross section in **Plate 5-9**. At trenchless crossing locations the number of trenches may increase to the maximum of four to allow adequate cable spacing for a deeper burial depth, as shown in **Plate 5-11**. Each trench would contain up to two HVDC cables and one fibre optic and earthing cable. Permanent easement for the onshore cable corridor is shown in **Table 5-27**. At complex trenchless crossings the permanent easement would be determined at the detailed design stage based on the final cable depth.

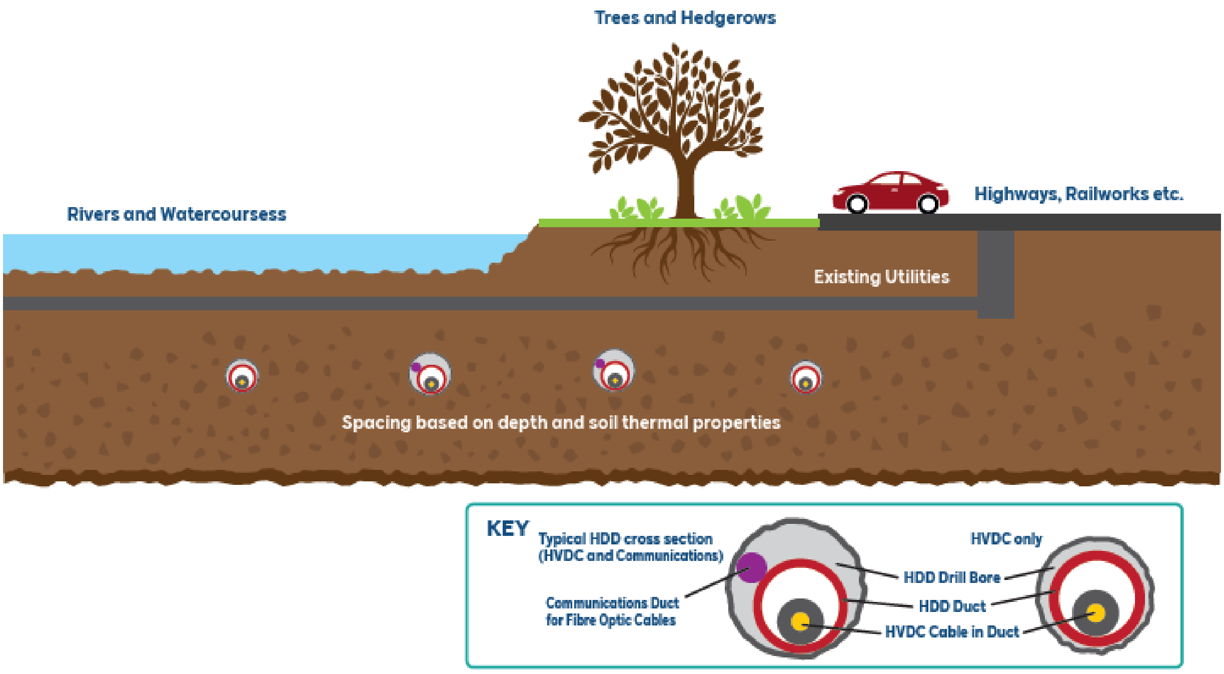

Plate 5-11 - Trenchless Crossing e.g. HDD beneath roads rivers or other infrastructure

281. Trenches would only be excavated following stripping and stockpiling of topsoil. Subsoil from trenching activities would be stored in separate stockpiles to topsoil. Cement Bound Sand (CBS) is generally used as bedding material for the cable ducts in trenches, other suitable materials such as concrete, sand or natural soils may also be used. At some TCCs CBS or concrete batching plants may be established to support the works along the Onshore Export Cable Corridor. This will depend on the delivery logistics strategy, site sensitivity and the location of neighbouring receptors. If used, such temporary batching plants would consist of material storage bins, conveyor systems and silos (typically up to approximately 17m in height).

5.7.1.4.2 Haul Road

282. A single temporary Haul Road is proposed running along the Onshore Export Cable Corridor to allow access to the Onshore Export Cable Corridor, cable corridor construction compounds, the Landfall Zone and the Substation Zones. This single Haul Road would serve both Projects.

283. For a Sequential Development Scenario it is assumed that the Haul Road would be in place for the duration of the works.

284. Construction of the temporary Haul Road (and other temporary and permanent hardstanding required for the development) would include placement of suitable graded imported aggregate material onto a prepared sub-soil, potentially with a reinforcing geogrid(s) and / or a geotextile separator. The thickness of the Haul Road will vary along the cable route and is dependent on the underlying ground conditions. The particular make-up requirements would be confirmed at detailed design stage following intrusive ground investigation along the proposed Haul Road alignment. The average thickness of temporary Haul Roads has currently been estimated to be 0.35m. Where possible and economical, the use of geogrids to strengthen the road will be considered to reduce the thickness and hence the required volume of imported material. Where appropriate and where this is a suitable available source(s) of materials, the use of clean recycled aggregates (as an alternative to primary aggregates) will be considered by the construction contractor prior to construction.

285. The Haul Road and access roads would likely cross over watercourses and drainage ditches and therefore crossings would be required. The methodology of the temporary Haul Road crossings would be determined during the post-consent detailed design stage and may include installation of flume culverts or temporary bridges. These crossing designs would need to be agreed with the Environment Agency, Internal Drainage Board (IDB) and Lead Local Flood Authority (LLFA), as required. All crossings are detailed in the **Obstacle Crossing Register** in **Volume 7, Appendix 5-2 (application ref: 7.5.5.2)**.

286. A Haul Road width of 5m has been identified to allow for access along the Onshore Export Cable Corridor, allowance for 3m wide lay-by every c. 150m along the Haul Road has been made to allow for two-way movements along the Haul Road. The Haul Road has been designed with passing places to allow for all vehicle movements, including abnormal loads e.g. the delivery of cable drums.

287. When cable duct installation is completed the Haul Road would be removed and the ground reinstated using the stored topsoil. However, some sections of Haul Road would need to be retained or reinstated to maintain access for the subsequent cable pulling stage. The Haul Road along the majority of the cable route may need to be retained until completion of cable pull and potentially until commissioning of the project to allow for access to areas of identified faults etc to install an additional Jointing Bay. This is discussed further in section 5.7.1.4.2.

5.7.1.4.3 Construction Access

288. The intention of the accesses is to allow construction traffic to access and egress from the public highway on to the onshore cable corridor(s). The Haul Road crossings would allow construction traffic to cross the public highway (but not take direct access), thereby allowing access to be taken from a more suitable location. The Haul Road crossings and access road locations are as shown on **Volume 7, Figure 5-3 (application ref: 7.5.1)**.

289. With the exception of the accesses to the Onshore Converter Station(s), all accesses would be temporary and upon completion of construction would be removed and land reinstated to its former state. Access(es) to the Onshore Converter Station(s) would be permanent and remain in-situ for the life of the Project.

290. Generally, accesses have been located where there are existing field accesses or where works would have the least impact upon surrounding hedges and trees. However, this is not possible in all locations. The location of the accesses, crossings and associated visibility splays have been agreed with East Riding of Yorkshire Council.

291. The access footprint comprises a metalled area (asphalt/concrete) that will be used by traffic. In order to allow the accesses to be constructed and subsequently removed, a working area of approximately 10m has also been included around the accesses and crossings. This working area is intended to provide space within which to construct the accesses and crossing, however there would be no permanent infrastructure located within these areas. It is not proposed that any trees or hedges within these working areas would be removed.

292. To allow construction traffic to egress safely from each of the proposed accesses and crossings, visibility splays have been provided. These splays allow drivers to see oncoming traffic and egress safely, consequently where there are obstructions to visibility splays such as hedges, these would need to be removed.

293. Where works are required to provide the visibility splays, a working area has also been shown to the rear of the splay. This working area is offset 5.0m from the back of the visibility splay and is provided to allow space to undertake the works to provide the visibility splay (e.g. to allow access for construction equipment to remove and replant hedgerows).

5.7.1.4.4 Approach to Road Widening

294. Roads may need to be widened to facilitate construction traffic movements as the existing roads are assessed to be too narrow to allow for two-way construction traffic movements.

295. In total five roads have been identified as being of substandard width requiring mitigation measures to be provided. The final form of mitigation is not defined within the DCO and instead a range of mitigation measures are outlined, in the **OCTMP (Volume 8, application ref: 8.13)** thus providing flexibility in how mitigation is delivered within the Onshore Development Area post consent. Mitigation options could include physical improvements (such as road widening, new or improved passing places) or traffic management measures (such as the use of escort/pilot vehicles or stop works signage).

296. Prior to the commencement of construction, the final form of mitigation would be formalised and agreed with East Riding Yorkshire Council through the development of the CTMP in accordance with the **OCTMP (Volume 8, application ref: 8.13)** which has been provided with the DCO application. Where road/junction widening or new/improved passing places are proposed, they would be contained within the public highway and the technical approvals for the designs will be submitted to and agreed with East Riding Yorkshire Council under Section 278 of the Highways Act 1980.

297. All road/junction widening is proposed to be temporary and following completion of construction would be removed and the road reinstated to its former state.

5.7.1.4.5 Jointing Bays

298. The number of Jointing Bays (JB) required would be dependent on the lengths of cable sections being used, the location of obstacle crossings requiring trenchless crossing, and a number of factors including topography, bends within the cable route, and the maximum pulling tension of the cable. Additional pulling pits may also be required to assist in pulling of cables where constraints are present. The location of the pulling pits would be identified by way of cable pulling assessment during the detailed design of the project. A pulling pit would require a temporary area of hard standing or cable drum/winch near the pulling pit. They may also require some temporary anchors to secure the winch and temporary pipe supports / rollers.

299. JBs generally comprise a cast in situ concrete slab base and backfilled with CBS and/or sand and natural soil arisings. The JBs may also have concrete blockwork walls and pre-cast concrete roof sections and, if required, the walls and roof would generally only be added after pulling and jointing of the cables. The JBs are generally buried at a depth to allow land to return back to normal uses such as agricultural land.

300. However, each JB is usually accompanied by a Link Box to allow testing and monitoring of cable joints. The Link Boxes are generally much smaller in footprint than the JBs however these are generally at a much shallower depth with a manhole inspection cover at the surface. The number of manhole covers is provided in **Table 5-27**.

5.7.1.4.6 Construction and Temporary Drainage

301. The contractor would further develop the **Outline Drainage Strategy (Volume 8, application ref: 8.12)** to produce a Pre and Post Construction Land Drainage scheme to detail works required where the Projects intercepts land drainage during construction. Pre-construction drainage would be installed at the edge(s) of the Onshore Export Cable route Corridor. Post construction drainage would be installed following the completions of the works providing restoration of drainage capacity in temporary works areas.

302. The Construction Drainage Scheme will ensure that existing land drainage is maintained during construction and will identify specific drainage measures for each area of land based on information identified and recorded by a Land Drainage Consultant prior to construction. The Construction Drainage Scheme will be developed in consultation with landowners, the Lead Local Flood Authority (East Riding of Yorkshire Council), the Environment Agency and relevant Internal Drainage Board.

303. The construction drainage scheme will include measures to ensure that existing land drainage is reinstated and/or maintained. Further details in regard to the outline operational drainage strategy for the Onshore Converter Station(s) and onshore cable corridor are presented within the **Outline Drainage Strategy (Volume 8, application ref: 8.12)** which has been prepared as part of the DCO application.

304. During the onshore construction works, drainage ditches and watercourses are expected to be encountered along the onshore cable corridor and these have been assessed and included within **Volume 7, Chapter 20 Flood Risk and Hydrology (application ref: 7.20)**. The assessment includes details on how watercourses and drainage routes are to be managed where interactions with the works are recognised. Further details on minor watercourse crossings are provided in section 5.7.1.6.4.

305. Land drains are likely to be encountered in the excavation of trenches and Jointing Bays. Land drains generally consist of small diameter (100-150mm) vitrified clay or plastic pipes to drain specific parts of a plot of land. Often no records are available for land drainage layout locations, or where they are available, they are not fully accurate.

306. Prior to construction commencing, a pre-condition drainage survey would be undertaken to identify specific land drainage along the cable route, to identify any areas of problem drainage and identify the existing land drainage, outfalls and other drainage features. This survey would feed into the pre-construction drainage design.

307. Generally, during installation of existing land drains, trenches are backfilled with the material that had been excavated to allow placement of the drain, and therefore during excavation it is difficult to identify the presence of an existing land drain before excavating through it. If a land drain is severed during construction, it would be temporarily reconnected to maintain hydrological conditions in the surrounding fields.

308. All drains would be cross connected immediately; temporary cross connections can be removed for short periods to allow access. Severed land drains would be reinstated following export cable installation and prior to backfilling for reinstatement through agreement with the landowner.

309. Onsite drainage would be designed to make best use of existing land drainage. The **OCoCP (Volume 8, application ref: 8.9)** considers the requirement to divert surface water away from the location of excavations and the construction footprint of cable trenches and Joining Bay and transition bay construction. The diversion of existing surface water drains is also accounted for within the **OCoCP (Volume 8, application ref: 8.9)**. The **Outline Drainage Strategy (Volume 8, application ref: 8.12)** identifies measures to adequately mitigate the risk of surface water flooding to and from the development and the incorporation of sustainable drainage system techniques in meeting the criteria for water quality.

5.7.1.4.7 Hedgerows and Trees

310. Where removal of hedgerow is proposed the Applicants are committed to only clearing hedgerow for the minimum width required to allow construction of trenches and Haul Road, this would be 15m for an In Isolation Development Scenario and 20m for a Concurrent and/or Sequential Development Scenario. Displaced sub-soil and topsoil would be stockpiled elsewhere within the Onshore Development Area. This area of potential hedgerow loss would increase within the onward cable corridor to 24m for an In Isolation Development Scenario and 34m for a Concurrent and/or Sequential Development Scenario as the corridor is wider.

311. Trees are present within the Onshore Export Cable Corridor and the Applicants have committed to micrositing of the Haul Road and cable trenches around these within the Order Limits where conditions allow to retain these trees.

5.7.1.4.8 Soil Management

312. Stripped topsoil and excavated subsoil would be stored separately within the Onshore Export Cable Corridor. The area to be used for storing the topsoil would be cleared of vegetation and any waste arising from the development (e.g. building rubble and fill materials). Topsoil would also be stripped from any land to be used for storing subsoil.

313. 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.

314. A Soil Management Plan (SMP) outlining the best practice techniques, which contractors would be obliged to comply with would also be produced by the contractor which would also set out procedures for the appropriate handling of soils during the construction works. At this stage, an **Outline Soil Management Plan, Appendix A** of the **OCoCP (Volume 8, application ref: 8.9)** has been submitted as part of the DCO application. This was informed by an Agricultural Land Classification Survey (ALC) within the Substation Zone, where there would be permanent loss of agricultural land. ALC surveys for the Onshore Export Cable Route and the Landfall Zone will be completed in 2024 to inform the final SMP. Assumptions about Best and Most Versatile Land (BMV) are set out in **Volume 7, Chapter 21 land Use (application ref: 7.21)**.

5.7.1.5 Cable Pull

315. Cables would either be pulled through the pre-installed ducts or directly laid in certain circumstances. Trenches would not need to be reopened, and the cable pull would take place from Jointing Bays located along the cable corridor.

316. Typically, this would be achieved by accessing the Onshore Export Cable Corridor directly from the existing accesses (i.e. the existing road network where it crosses the Onshore Export Cable Corridor or from other accesses such as existing farm tracks, where possible.

317. For the sequential construction scenario, some sections of the Haul Road would need to be retained or reinstated following the duct installation works to allow access to more remote joint locations for the subsequent cable pulling stage. At this stage it is unknown exactly what proportion of the Haul Road would need to be retained. As a worst case it is assumed that the Haul Road along the whole extent of the cable route may need to be retained until completion of the cable pull and potentially until commissioning of the Projects to allow for access to areas of identified faults etc to install an additional Jointing Bay.

318. During the cable pull and jointing works cable drums would be delivered by HGV low loader to the open Jointing Bay locations and a winch attached 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 Jointing Bay.

5.7.1.6 Crossing Methods

319. All crossings are listed within the Obstacle Crossing Register provided in **Volume 7, Appendix 5-2 (application ref: 7.5.5.2)** to this chapter. The crossing methodology will be finalised at the detailed design stage, where there is currently an option for either an open cut or a trenchless crossing option the worst case has been selected in the EIA. For example, in the **Volume 7, Chapter 20 Hydrology ad Flood Risk (application ref: 7.20)** open cut crossings are considered the worst case assessment.

5.7.1.6.1 Trenchless Crossings

320. Trenchless crossing techniques can be used to avoid physical obstacles and environmental constraints by drilling underneath them for cable installation.

321. There are a number of potential trenchless techniques which may be used such as Horizontal Direction Drill (HDD), microtunneling, auger boring, pipe jacking, pipe ramming and others. The type of trenchless crossing would be determined during detailed design; however HDD technique is likely to be a conservative case in terms of area required and likely impacts associated with the construction activities. HDD is described below. Further details on other potential trenchless crossing techniques are provided in section 5.7.1.6.2.

322. As an example of a trenchless crossing technique, HDD initially involves the construction of a shallow, inclined, narrow diameter directionally drilled open hole beneath the obstacle/constraint. The initial hole may be enlarged by one or more reaming passes until it has reached the diameter required to pull the duct through. The method does not normally require the construction of deep temporary supported pits or shafts either side of the obstacle, however, relatively small 'entry' and 'exit' pits are generally required, as shown on **Plate 5-12**.

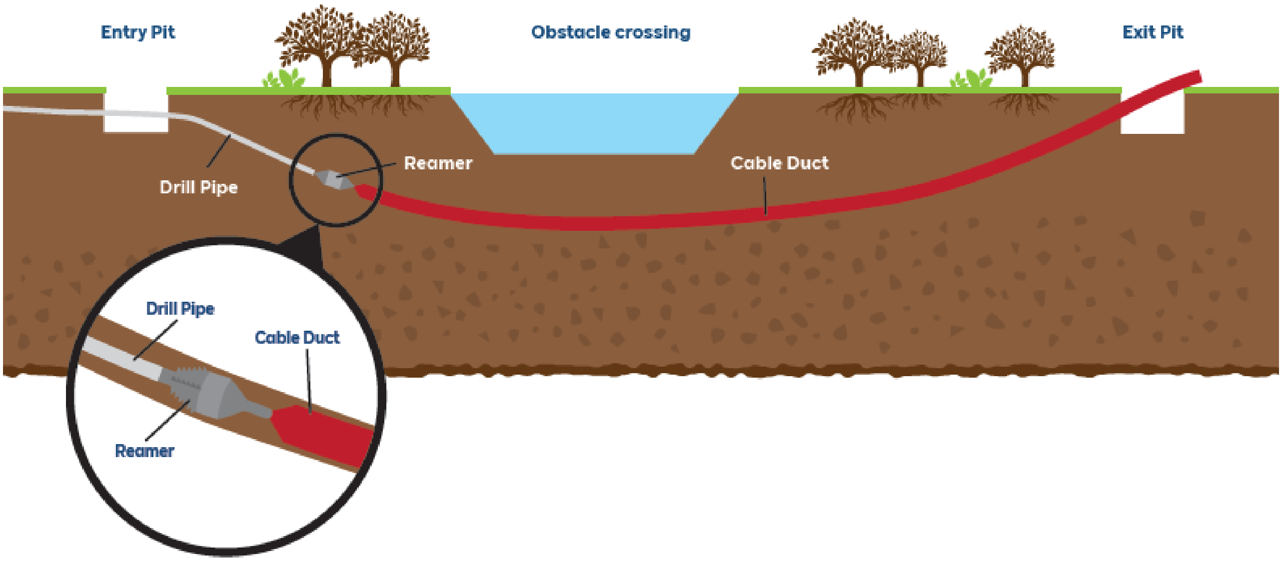

Plate 5-12 Illustrative section of Horizontal Directional Drilling technique for laying Onshore Export Cables beneath an obstacle crossing (a water course)

323. Trenchless crossing construction compounds would be required at the entry and exit pit either side of the trenchless crossing. Compounds at the entry pit side of the trenchless crossing may require all the following facilities and equipment during the drilling process: trenchless crossing (e.g. HDD) rig and drill pipe racks, driller's cabin, power packs/generators, mud pump, bentonite storage, water tanks, mixing tank, water treatment/recycling plant, mud recycling unit, stores/workshop, tool laydown area, fuel storage, offices, canteen and welfare. The drilling compound would also provide areas for vehicle parking and a laydown and turning area for plant and material deliveries. The exit compounds have less significant works than the entry compounds. As such facilities required at compounds at the exist pit side of the trenchless crossing would be limited to stores/workshop, tool laydown area, drill pipe rock and office/welfare with these facilities shared for the many trenchless crossings.

324. Each trenchless crossing construction compound would have an indicative dimension of up to 60m x 40m but may vary due to site specifics. The total minimum and maximum number of trenchless crossing compounds, depending on the Development Scenario and final number of trenchless crossings for the Projects, is shown in **Table 5-27.** Further details on the likely crossing methodology to be used can be found within **Volume 7, Appendix 5-2 Obstacle Crossing Register (application ref: 7.5.5.2).** Each crossing methodology has not currently been committed.

325. Some trenchless crossing works are likely to require 24 hour working. This would depend on the trenchless crossing length and location. For the majority of cases where this may be required, works would be managed within the temporal limits of night working. This consists of night working not exceeding 10 or more days in any 15 consecutive days and / or for a total number of days exceeding 40 in any 6 consecutive months).

5.7.1.6.2 Other Potential Trenchless Techniques for Crossings

326. It should be noted that the indicated HDD technique is likely to be a conservative case in terms of area required for construction and permanent easement. A list and brief description of other available trenchless techniques is provided below. These may be selected at the post-consent, detailed design stage depending on the particular circumstances and ground and groundwater conditions.

327. Microtunneling is a pipe-jacking operation that is remotely controlled and guided which applies continuous support to the excavation face to balance groundwater and earth pressures by means of mechanical or fluid pressure. The applied pressure at the excavation face is the main feature of microtunneling and distinguishes it from traditional open-shield pipe-jacking. Microtunneling requires jacking and reception pits or shafts at the opposite ends of each drive. These are sunk and then the tunnel is driven between the two, with lining segments added Sequentially from the jacking pit or shaft.

328. Auger boring is a technique for forming a bore from a launch shaft to a reception shaft by means of a rotating cutting head. The cut spoil is moved back to the drive shaft by means of a helical auger in a steel casing. As the auger head progresses, the casing is jacked-forward. Depending on the equipment used, there is limited capacity for steering the drive.

329. Pipe ramming is a trenchless technique for installation of permanent steel pipe casings through which cables could then be installed. Pipe ramming is carried out generally horizontally, from a launch shaft to a reception shaft.

330. Pipe jacking is similar to pipe ramming and is a trenchless technique for installation of permanent steel pipe casings through which cables could then be installed. Pipe jacking is carried out generally horizontally, from a launch shaft to a reception shaft.

5.7.1.6.3 Minor Road Crossings and Public Rights of Way (PRoW)

331. Where the Onshore Export Cable Corridor crosses minor roads, tracks and public rights of way, open cut trenching methods may be used in combination with traffic management. Where appropriate, single lane traffic management would be utilised during installation with signal controls to manage traffic movement. Where the width of the road does not permit single lane traffic management, alternative methods such as temporary road closure or diversion could be required. Where standard traffic management techniques are not deemed to be suitable it may be necessary to revert to a trenchless crossing solution. The proposed crossing method for each road crossing is provided in the **Obstacle Crossing Register (Volume 7**, **Appendix 5-2 (application ref: 7.5.5.2)**).

332. The approach for each crossing would be agreed with East Riding of Yorkshire Council prior to works beginning. Temporary closures or diversions would only be required for the duration of time that duct installation takes place in that location, up to 3 months. Temporary crossings of the Onshore Export Cable Corridor could then be installed to allow the public including walkers, cyclists and horse riders continued access, where the Haul Road is required to remain in service crossings may be manned, during peak construction periods. Where there are less traffic movements, appropriate signage would be provided along the PRoW to ensure the user is aware of the works and any temporary diversion within the Onshore Development Area. The crossings would be managed to allow safe operation. Re-instatement of the trench would broadly follow the same process described for the cable duct installation; however, the PRoW surface would be reinstated to a specification agreed with East Riding of Yorkshire Council. An **Outline PRoW Management Plan** has been developed as part of the DCO, this forms **Appendix C** of the **OCoCP (Volume 8, application ref: 8.9)**.

5.7.1.6.4 Minor Watercourse Crossings

333. Where minor watercourses such as field drains are to be crossed, the approach would be open cut combined with temporary damming and diverting of the watercourse, or trenchless crossing methods are also being considered. The suitability of the methods would be agreed at detailed design.

334. 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 across the dammed section to effectively maintain flow across the dammed section, diversion of drains may also be considered. The cable trenches would then be excavated within the dammed section but ensuring that watercourse bed materials are stored separately to subsoils. Ducts would typically be installed below the channel bed to avoid impacts to the active channel bed. Reinstatement of the trench would be conducted to the pre-construction depth of the watercourse, taking care to reinstate the channel bed material and subsoils in the correct order. The dams would then be removed. Temporary dam and divert would only be required for the duration of time that duct installation takes place in that location.

335. The Haul Road could also require culverting or temporary bridging in these locations to allow continued access up and down the working corridor. These would remain in place for the duration that the Haul Road is required, in consultation with IDB and the LLFA where appropriate.

336. Where trenchless crossings are proposed all works would be kept minimum 20m from any 'main river' or from toe of flood embankment. Entry and exit points would also be kept a minimum of 9m from banks of any watercourse and landward toe of any defences. Material storage areas and soils stockpiles would be kept a sufficient distance away from all watercourses to ensure there is no risk of surface water becoming blocked with debris or risk of collapse of the bank of the watercourse.

337. A Surface Water Management Plan and Drilling Fluid Break Out Management Plan would be prepared for the Projects prior to construction by the Contractor for agreement with relevant stakeholders. This Surface Water Management Plan would outline proposals for maintenance of existing surface water flows and proposals for how construction drainage is to be dealt with. Further detail is provided in the **OCoCP (Volume 8, application ref: 8.9)**.

5.7.1.7 Reinstatement

338. For the In Isolation and Concurrent Scenarios, whilst the completion of the overall cable installation works can be expected to take up to 33 months in total, discrete works at any location would be take a considerably shorter period as would be expected of a linear project.

339. All land / habitats within the Onshore Development Area would be subject to temporary losses. In each Development Scenario, the Projects are committed to a rolling reinstatement between the Jointing Bays within two years of the start of construction.

340. The remaining Haul Road, Satellite Temporary Construction Compounds and TJB Compound at the Landfall Zone and the Jointing Bays along the Onshore Export Cable Corridor would be reinstated within six years after the initial loss, for a Sequential Scenario, and four years for an In Isolation or Concurrent Scenario. Habitats within the Onshore Substation Zone would be replaced with a combination of artificial sealed surfaces for the Onshore Converter Stations and associated infrastructure with areas of habitat creation within the remainder of the Onshore Substation Zone. Further detail is provided in the **Outline Landscape Management Plan (Volume 8, application ref: 8.11)** and the Outline Ecological Management Plan **(Volume 8, application ref: 8.10)**.

341. Further detail in regards to the implication of this commitment on the Projects' **Biodiversity Net Gain Strategy** can be found in **Volume 7, Appendix 18-10 (application ref: 7.18.18.10)**.

5.7.1.8 Construction Compounds

342. TCCs are required to support the Onshore Export Cable Corridor installation. This would include several Satellite Temporary Construction Compounds and two Main Temporary Construction Compounds per project along the Onshore Export Cable Corridor. In addition, there would be the TJB Compound and Satellite Temporary Construction Compound within the Landfall Zone, and up to two Substation Zone Temporary Construction Compounds associated with the Onshore Substation Zone (as shown in **Volume 7, Figure 5-3 (application ref: 7.5.1)**.

343. Two Main Temporary Construction Compounds would be required, regardless of the Development Scenario, to support the cable duct installation and cable pulling works. The final location of these is not yet confirmed and a number of options are being considered within the Onshore Development Area. These would operate as hubs for the onshore construction works and would house the central offices, welfare facilities, and stores, as well as acting as staging posts and secure storage for equipment and component deliveries.

344. The location of the TCC's are presented on **Volume 7, Figure 5-3 (application ref: 7.5.1)**. The size of the Main Temporary Construction Compounds would be up to 100m x 100m, but this may vary due to site specifics. In order to minimise disruption to the local road network the Applicants have identified the most suitable accesses to and from the construction compounds and in some cases, this is via the Projects' Haul Road as shown on the **Access to Works Plan (Volume 2, application ref: 2.10) and Volume 7, Figure 5-3 (application ref: 7.5.1)**.

345. The construction works would also require a series of Satellite Temporary Construction Compounds that would operate as support bases for the onshore construction works as the cable work fronts pass through an area. They may house portable offices, welfare facilities, concrete or CBS batching plant, localised stores, as well as acting as staging posts for localised secure storage for equipment and component deliveries.

346. Each Satellite Temporary Construction Compound (up to approximately 15 in total) would be approximately 75m x 75m in size with direct access into the construction easement.

347. Other works compounds include: the Substation Zone Temporary Construction Compounds, the TJB Compound, the emergency beach access compound (only used in the event of an emergency) and each trenchless crossing, which would require its own compound, referred to as cable route trenchless crossing entry and exit compounds.

348. The Substation Zone compounds may include, but not be limited to the following equipment, which will be detailed by the Contractor prior to construction:

- Site portacabins for office use (single), approximately 7m x 3.5 m and 3m in height;
- Site portacabins for office use (double stacked), approximately 7m x 3.5m and 5.5m in height;
- Site portacabins for office use (triple stacked), approximately 7m x 3.5m and 8.5m in height;
- Cement Bound Sand Batching Plant (five silos) approximately 17.5m in height;
- Controlled Environmental Storage approximately 50m x 10m and 6m in height;
- Bunded fuel tank (30,000L), approximately 7m x 3.5m and 3m in height;

- Water storage tank (20,000L) approximately 3m x 3m and 4m in height;
- Cable drums, approximately 4.5m in height; and
- General Waste Skips, approximately 1.8m in height.

349. **Table 5-28** Table details the construction compound parameters for the different Development Scenarios. Different numbers of TCC's would be required depending on the Development Scenario. **Volume 7, Appendix 5-3 (application ref: 7.5.5.3)** includes an indicative layout of a Main and Satellite Temporary Construction Compound.

Table 5-28 Onshore Temporary Construction Compound Maximum Parameters

Temporary Construction Compound	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Number of Main Temporary Construction Compounds	2	2	2
Number of Satellite Temporary Construction Compounds along the Onshore Export Cable Corridor (including Landfall Zone)	15	15	15
Number of Substation Zone Temporary Construction Compounds within the Onshore Substation Zone	1[10]	2[11]	2
Total area per Substation Zone Temporary Construction Compounds (m^2)	30,000	30,000	30,000
Total area per 1 Main Temporary Construction Compound (m^2)	10,000	10,000	10,000
Total area per Satellite Temporary Construction Compound (m^2)	5,625	5,625	5,625

[10] This would be located within the footprint of the Western Convertor Station in an In Isolation Scenario as the Western Convertor Station would not be required. The other Substation Zone TCC's identified on **Volume 7, Figure 5-4 (application ref: 7.5.1)** would not be required in an In Isolation Scenario.
[11] As identified on **Volume 7, Figure 5-4 (application ref: 7.5.1).** The Western Convertor Station TCC would not be used in a Concurrent or Sequential Scenario.

Temporary Construction Compound	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Trenchless Crossing Compounds (Onshore Export Cable Corridor)	Min 41 and up to maximum of 147 entry compounds Min 41 and up to maximum of 147 exit compounds	Min 82 and up to maximum of 294 entry compounds Min 82 and up to maximum of 294 exit compounds	Min 82 and up to maximum of 294 entry compounds Min 82 and up to maximum of 294 exit compounds
Trenchless crossing compound dimensions (Onshore Export Cable Corridor) (m)	Up to 60x40 - including two drills	Up to 60x40 for - including two drills	Up to 60x40 for - including two drills
TJB Compound (Landfall Zone)	1	1	1
TJB Compound Dimensions (Landfall Zone) (m)	110x75	190x75	190x75

5.7.1.9 Operation and Maintenance

350. Maintenance of the Onshore Export Cable Corridor is expected to be minimal. It is anticipated that approximately one visit to each cable Jointing Bay would be required per year by two personnel. During operation, periodic testing of the cable is likely to be required (every two to five years). This would require access to the Link Boxes at defined inspection points along the Onshore Export Cable route. This would involve attendance by up to three light vehicles, such as vans, in a day at any one location. The vehicles would gain access using existing field accesses and side accesses as agreed with landowners to reach the relevant sections of the cable.

351. Lighting during Onshore Export Cable Corridor operation and maintenance activities along the Onshore Export Cable Corridor are expected to be minimal. External lighting would be directional and limited to essential security and safety requirements. External works would usually be scheduled during daylight hours. If night working is required, then portable directional task lighting would be deployed.

5.7.1.10 Decommissioning

352. No decision has been made regarding the final decommissioning policy for the Onshore Export Cables, as it is recognised that industry best practice, rules and legislation change over time. It is anticipated that the onshore electrical cables would be left in-situ with ends cut, sealed and buried to minimise environmental effects associated with removal. However, given the likelihood of the cables being inside ducts, there remains a possibility to remove and recycle the cables, leaving the ducts in the ground. Access would be needed at Jointing Bays to enable this.

353. The decommissioning methodology would be finalised immediately prior to decommissioning and would depend on the requirements of the onshore decommissioning plan approved by the local planning authority secured through the requirement in the DCO.

5.7.2 Onshore Substation Zone / Onshore Converter Stations

354. The DBS East and DBS West HVDC Onshore Converter Stations would be either Air Insulated (AIS) or a gas insulated (GIS) switchgear design. AIS and GIS are both types of electrical switchgear used in power systems, but they differ in their construction, insulation method, and application.

355. GIS uses a dielectric gas at moderate pressure for phase-to-phase and phase-to-ground insulation. GIS currently uses sulphur hexafluoride (SF_6) gas as the insulating medium. The components are enclosed in metal-enclosed, sealed enclosures where the SF_6 gas provides superior insulation and arc-quenching properties (i.e. preventing electricity 'jumping/transferring' through the air). GIS is more compact and occupies much less space because the gas-insulated components are enclosed in a metal casing, allowing for a more compact design. A building up to 15m tall would be required to house GIS which would sit alongside the 24m high HVDC valve hall.

356. AIS uses air as the insulating medium. The components such as circuit breakers, isolators, and busbars are exposed to air, and the air serves as the dielectric (insulating) medium to prevent electrical arcs and shorts. AIS typically requires more space as the air-insulated components need sufficient clearance and spacing between them to prevent electrical faults. The individual items of AIS equipment vary in height. However, as a consequence of air clearances required, the overall aggregate profile height (excluding lightning masts) may be in the region of 12.5m.

357. In both options the largest building would be the Valve Hall which would be up to 24m in height.

358. The parameters set out in **Table 5-29** are based on the AIS design, which represents a worst case spatially and forms the worst case from a Landscape and Visual Impact perspective. However, both AIS and GIS solutions remain under consideration and will be confirmed at the detailed design stage.

359. The Onshore Substation Zone is of sufficient size to accommodate the maximum footprint required for both DBS East and DBS West Onshore Converter Stations (as shown in **Volume 7, Figure 5-2 (application ref: 7.5.1)**).

360. The Onshore Converter Stations would be constructed to accommodate the connection of both DBS East and DBS West to the transmission grid. The permanent footprint of one HVDC converter station would be up to 64,000m^2. The permanent footprint of two HVDC converter stations would be up to 129,000m^2. Indicative Layouts are included in **Volume 7, Appendix 5-3 (application ref: 7.5.5.3)**.

361. The Onshore Substation Zone may include:

- Control building;
- GIS building (if required);
- External fire barriers;
- Static var compensator (SVC) building (if required);
- Valve halls;
- Transformers;
- Lightning protection masts (up to 10)
- Palisade fencing
- Switchgear;
- Shunt reactors;
- Emergency diesel generators;
- Service buildings;
- Spare part building
- Cooling systems;
- Earth mat
- Harmonic filters if required; and
- Access roads – for operation and maintenance access to equipment.

362. The largest structures within the Onshore Substation Zone listed above would be the valve hall with an approximate height of 24m. Other tall features within the Onshore Substation Zone would be the lightning protection masts at a maximum height of 27m above ground level. An example of the Onshore Converter Stations viewed from Coppleflat Lane, Bentley, is included in **Plate 5-13**.

363. The valve hall building contains specialist electrical equipment to convert the power from HVDC to HVAC for export along the Onward Cable Corridor to the proposed Birkhill Wood National Grid Substation. The electrical equipment requires a carefully controlled environment (i.e. a climate controlled, clean room) to function safely, necessitating the valve hall building to be designed so that it is weathertight and meets airtightness standards.

364. The valve hall contains valves assembled in rows and the number of rows dictates the height of the building and its footprint, the maximum height of 24m. Suitable operational working clearances are required around the electrical equipment inside the building. An indicative example of the inside of a valve hall is included in **Plate 5-14**.

365. The valve hall also mitigates the spread of electromagnetic disturbances outside of the building by acting as a faraday cage. The building roof design also needs to accommodate adequate drainage falls for such a large area. Process safety requirements for high energy equipment also include need for access control and safety features as part of the enclosure.

Plate 5-13 Example of the Onshore Converter Stations' built form after construction on the left, and 10 years after the planting is established on the right. View from Coppleflat Lane, Bentley (2023)

Plate 5-14 Indicative Image of the Inside of a Valve Hall

5.7.2.1 Onshore Substation Zone Parameters

366. **Table 5-29** shows the main construction parameters for the Onshore Substation Zone. This is based on the worst-case scenario using AIS switchgear design (refer to para 5.7.2).

Table 5-29 Onshore Substation Zone Construction Maximum Parameters

Onshore Substation Zone	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Operational compounds for HVDC converter station (m)	244 x 264 (HVDC Converter)	244 x 264 (HVDC Converter) plus 244 x 264 (HVDC Converter)	244 x 264 (HVDC Converter) plus 244 x 264 (HVDC Converter)
Area of converter station(s) (m^2)	64,000	129,000	129,000
Total construction area (m^2)	94,000	189,000	189,000
Building height (m)	24	24	24
Height of lightning masts (m)	27	27	27

Onshore Substation Zone	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently	DBS East and DBS West Sequentially
Total construction compound area (m^2)	30,000	60,000	60,000
Number of construction compounds	1	2	2
Duration of works at the Onshore Substation Zone (years)	4	4	6
Operational duration (years) (approximate)	30	30	32

5.7.2.2 Onshore Substation Zone Construction Method

367. Prior to the converter stations construction commencing, establishment would largely comprise the set-up of TCC's and mobilisation of plant for the site preparation work. The construction compound would generally include offices for the management of construction, messing and washroom facilities, car parking, and storage. Site preparation works includes the following:

- Setting out survey;
- Installation of temporary security fencing;
- Topsoil stripping and stockpiling;
- Land forming and earthworks to form level platform as required, indicative cut and fill diagrams are included in **Volume 7, Appendix 5-3 (application ref: 7.5.5.3)**;
- Installation of the temporary and permanent accesses;
- Installation of utilities and services; and
- Installation of temporary and permanent drainage.

5.7.2.2.1 Foundations

368. The foundation requirements would be based on the electrical, mechanical and structural requirements for the proposed Onshore Converter Stations as well as ground conditions at the proposed converter station locations.

369. Foundations in favourable ground conditions would generally be conventional shallow foundations (pads and strips). Where unfavourable ground conditions are present ground improvement, or a piled solution may be required.

370. Where groundwater levels are high some dewatering of excavations for foundations may be required.

371. Ground investigation would be needed at the (up to) two new Onshore Converter Stations sites prior to detailed design to confirm the ground conditions prior to foundation design based on the anticipated loads.

5.7.2.2.2 Installation Works

372. The techniques used for the installation of the mechanical and electrical plant and equipment related to the Onshore Converter Stations is anticipated as follows:

- Within the converter station buildings – a combination of mobile plant and lifting apparatus and / or temporary or permanent gantry cranes within the building.
- External transformers – the transformers are anticipated to require specialist lifting equipment to transfer them from road transport into their installed position. This is likely to comprise a temporary gantry crane.
- Other external plant and equipment – installation using mobile plant and lifting apparatus.

5.7.2.3 Drainage

373. A surface water drainage system would be required for the operational converter stations and would be designed to meet the technical requirements set out in the National Planning Policy Framework (NPPF) through the use of infiltration techniques. These would be accommodated within the Onshore Development Area and surface water discharge rates controlled to prevent any increase in flood risk to surrounding land from present day levels. More details are provided within the **Outline Drainage Strategy (Volume 8, application ref: 8.12)** submitted with the DCO application.

374. Some form of surface water attenuation would be required with sufficient capacity to retain a peak rainfall event (100-year event + climate change) with controls to ensure that water discharge back to the surrounding area matches the existing greenfield runoff rates, discharging into the closest watercourse or sewer connection. The full specification for the water

attenuation and drainage system would be addressed as part of detailed design post-consent.

375. Foul drainage would be collected through a mains connection to an existing local authority sewer system if available or septic tank located within the development boundary. The specific approach would be determined during the detailed design phase with consideration for the availability of mains connection and the number of visiting hours for site attendees during operation.

5.7.2.4 Screening

376. An **Outline Landscape Management Plan (Volume 8, application ref: 8.11)** has been developed for the combined Development Scenario, reflecting the form and scale of the proposals, and the assessed landscape and visual effects. This has been developed in consideration of biodiversity units to maximise the net gain associated with the Projects. Further information is provided in **Volume 7, Chapter 23 Landscape and Visual Impact Assessment (application ref: 7.23),** the **Outline Landscape Management Plan (Volume 8, application ref: 8.11)** and **Volume 7, Appendix 18-10 Biodiversity Net Gain Strategy (application ref: 7.18.18.10)**, secured through Requirement 32 of the **draft DCO (Volume 3, application ref: 3.1)**. This includes woodland and hedgerow planting to screen key views, and to help to integrate the new development into the landscape. Species selected are appropriate to the local environment and of local provenance. Species would be planted in an organic layout which seeks to mimic the canopy layers found in the wider countryside.

5.7.2.5 Operations and Maintenance

377. Operational construction lifetime is expected to be 30 years for a Concurrent and In Isolation Scenario and 32 years for a Sequential Scenario to accommodate the lag in completion of the construction for the two Projects.

378. The Onshore Converter Stations would not be manned; however, access would be required periodically for routine maintenance activities, estimated at an average of one visit per week. Monitoring of the Onshore Converter Stations would be done remotely using CCTV technology and other remote monitoring equipment. The security fencing installed during construction would remain in place. Certain areas of the Onshore Substation Zone would have permanent light fittings; however, these lights would only be used when required for unscheduled maintenance or emergency repair purposes. Lighting during onshore operation and maintenance activities is expected to be minimal. External lighting would be directional and limited to essential security and safety requirements. There would be no continuous lighting. A detailed assessment of lighting requirements would be defined at detailed design. Lighting details are also included in the **Design and Access Statement** (**Volume 8, application ref: 8.8**).

379. External works would usually be scheduled during daylight hours. If night working is required, then portable directional task lighting would be deployed. Unscheduled maintenance or emergency repair visits would typically involve a very small number of vehicles, typically light vans. Infrequently, equipment may be required to be replaced, then the use of an occasional HGV may be utilised, depending on the nature of the repair. Inspection and minor servicing may be required for the electrical plant, but it is anticipated that the Onshore Converter Stations would require minimal scheduled maintenance and operation activities.

5.7.2.6 Decommissioning

380. No decision has been made regarding the final decommissioning plan for the Onshore Converter Stations, as it is recognised that industry best practice, rules and legislation change over time. The decommissioning methodology would be finalised immediately prior to decommissioning and would depend on the requirements of the onshore decommissioning plan approved by the local planning authority secured through the requirement in the DCO.

381. The Onshore Converter Station may be used as a Substation or Converter Station site after decommissioning of the Projects or it may be upgraded for use by another offshore wind project. This would be subject to a separate planning application.

382. Should the Onshore Converter Station need to be decommissioned fully, it is anticipated that a full EIA would be carried out ahead of any decommissioning works being undertaken if required by regulations at the time. The programme for decommissioning is expected to be similar in duration to the construction phase of five years to seven years. 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 services equipment;
- Demolition of the buildings and removal of fences; and
- Landscaping and reinstatement of the site.

5.7.3 Onward Cable Connection to the proposed Birkhill Wood National Grid Substation

383. A further section of buried Onshore Export Cable is required to connect the Projects onshore cable from the Onshore Converter Stations with the proposed Birkhill Wood National Grid Substation. The HVDC export cables will enter the substation site and connect to the converter station buildings. The electrical power will pass through the buildings and into the equipment in the yard, which will convert it from HVDC to HVAC. It will exit the site via underground 400 kV HVAC cables which will connect to the proposed Birkhill Wood National Grid Substation. This section of cabling would be similar in design to the onshore cabling, but must be HVAC at 400kV, and will have minimum of four circuits for an In Isolation Scenario, and eight for a Concurrent and Sequential Scenario, installed with a 20m and 34m permanent easement within a 53.5 and 100m cable corridor respectively as referenced in **Table 5-30.** An illustrative section of Onward Cable Connection is provided in **Plate 5-15.**

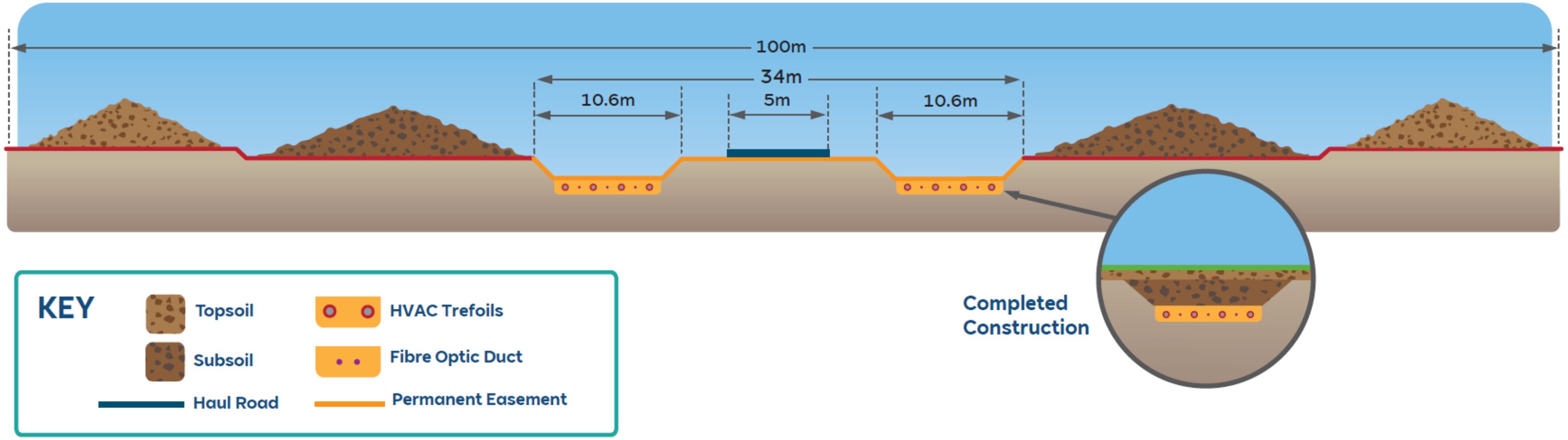

Plate 5-15 Illustrative section of Onward Cable Connection to the proposed Birkhill Wood National Grid Substation, Including Power Cores and Ducts, Construction Haul Road and Proposed Topsoil Laydown Areas Either Side

384. The Onward Cable Connection to the proposed Birkhill Wood National Grid Substation extends approximately 2.5km South East from the Onshore Substation Zone.

385. The cable corridor splits part way along the route to form a northern and southern route, each accommodating one of the Projects cabling, as shown on **Volume 2, Figure 5-3 (application ref: 7.5.1)**. This is due to the presence of the Ineos pipeline and the existing A1079, which restricts the working area available for the Projects cabling to be co-located. The cable route reconverges at the proposed Birkhill Wood National Grid Substation. Should an In Isolation Scenario be taken forward only the northern route of the Onward Cable Connection to the proposed Birkhill Wood National Grid Substation would be utilised.

386. The proposed Birkhill Wood National Grid Substation is not part of the Projects and therefore not part of the DCO application. National Grid will seek separate planning permission under the Town and Country Planning Act 1990 (TCPA) for the proposed Birkhill Wood National Grid Substation, submission of the planning application is planned for late 2024, with a decision expected in 2025 and the earliest commencement of construction works in 2026. The Projects require the new Substation to be granted planning permission and be fully constructed by National Grid, prior to connection, the earliest proposed connection date is 2029. National Grid will be the owner of the proposed Birkhill Wood National Grid Substation. Connection to the National Grid substation itself would be completed by National Grid or their appointed contractors. The development of the proposed Birkhill Wood National Grid Substation is considered as a cumulative development as construction of both Projects would take place at the same time, further detail is provided in **Volume 7, Appendix 6-1 (application ref: 7.6.6.1).** The Applicants are in regular discussions with National Grid and will seek to collaborate with them as their planning proposals develop.

387. **Table 5-30** shows the main construction parameters for the Onward Cable Connection.

Table 5-30 Onward Cable Connection to the Proposed Birkhill Wood National Grid Substation Construction Maximum Parameters

Onward Cable Connection	DBS East or DBS West In Isolation	DBS East and DBS West Concurrently or Sequentially
Number of export circuits	4x400kV	8x400kV
Technology	HVAC	HVAC
Number of Earth/Link Boxes	35	70
Distance from Onshore Substation Zone to proposed Birkhill Wood National Grid Substation (km)	2.5	2.5
Cabling from project substation to National Grid Substation	Buried	Buried
General cable corridor permanent easement swathe (m)	20	34
Cable corridor construction swathe (m)	53.5	100
Cable construction compound dimensions (m)	75x75	75x75
Permanent easement (m)[12]	20	34

[12] At trenchless crossings the permanent easement width would be located within the Onshore Development Area and determined by the depth of the trenchless crossing at the detailed design stage.

5.7.4 Maintenance Port and Facilities

388. The maintenance port and facilities will be located on the East coast of the UK and it is assumed that all direct labour will be resident within the area. It is likely that the existing facilities at the Grimsby Port will be utilised (and expanded where necessary) as the base for operations management of the Projects, as this will yield synergies and enable effective coordination with the existing operations team at the RWE Grimsby Hub.

5.7.5 Onshore Decommissioning

389. A decommissioning plan for the Onshore Export Cable Corridor would be produced and submitted following permanent cessation of commercial operation of the onshore works in accordance with the requirements set out in the **draft DCO (Volume 3, application ref: 3.1)**.

5.8 Construction Programme

5.8.1 Offshore Construction

390. A high-level indicative construction programme including the offshore works is presented in **Table 5-31**, **Table 5-32** and **Table 5-33** depending on the Development Scenario. The earliest any construction works would start is 2026. If built sequentially, construction of the first Project would be completed within 5 years, with construction of the second Project being completed within 7 years. Therefore, the maximum construction period over which the construction of both Projects could take place is seven years, as described in section 5.1.1.

391. It should be noted that the construction programme is dependent on numerous factors including consent timeframes and funding mechanisms. The final design of the Projects (including for example the number and type of turbines, Onshore Converter Stations, offshore platforms, cables, etc.) would also affect the construction programme, as well as weather conditions once construction starts. As such, details of the construction programme are indicative at this stage in order to provide a reasonable and realistic basis for undertaking the environmental assessments.

392. Offshore (seaward of mean low water) working hours during construction are assumed to be twenty-four hours a day and seven days a week.

5.8.2 Onshore Construction Programme

5.8.2.1 Pre-Construction Works

393. Prior to the commencement of the onshore construction works, it is anticipated that a number of pre-construction works would take place after grant of consent. The main pre-construction activities are noted below and would be applicable to the Onshore Substation Zone and works to install the Onshore Export Cables:

- 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 cable corridor and at the substation, which requires an understanding of the existing agricultural drainage environment;
- Pre-construction utilities diversions (temporary and permanent);
- Hedge and tree removal – hedge 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 great crested newt fencing; and
- Archaeological mitigation – pre-construction activities agreed with Historic England and Humber Historic Environment Services.

5.8.2.2 Main Works

394. A high-level indicative construction programme including the onshore and offshore works is presented in **Table 5-31**, **Table 5-32** and **Table 5-33** depending on the Development Scenario. The programme illustrates the likely duration of the major installation elements, and how they may relate to one another in the three potential Development Scenarios, i.e. either DBS East or DBS West In Isolation, DBS East or DBS West built Concurrently, and DBS East or DBS West build Sequentially. The final construction programme would not be confirmed until detailed design.

395. Normal onshore construction (landward of mean low water) would usually only take place between:

- 0700 hours and 1900 hours Monday to Saturday, with no activity on Sundays or bank holidays. Noisy construction works would primarily occur during these hours, as per Requirement 19 of the **draft DCO (Volume 3, application ref: 3.1).**

396. Outside of these hours some onshore construction work may be required for essential activities including but not limited to:

- Continuous periods of operation, such as concrete pouring, drilling, and pulling cables through ducts;
- For internal fitting out works associated with the Onshore Converter Stations;
- For the delivery of abnormal loads to the connection works, which may cause congestion on the local road network;
- The testing or commissioning of any electrical plant installed as part of the onshore infrastructure;
- Security monitoring; and
- Activity necessary in the instance of an emergency where there is a risk to persons, the environment, delivery of electricity or property.

5.8.2.3 Construction Programme Considerations for the Concurrent and Sequential Development Scenarios

397. The following assumptions have been made when developing the concurrent construction scenario and indicative construction programme onshore:

- Landfall ducts will be installed for both Projects during the first phase of construction in a Sequential and Concurrent Scenario;
- There will be a single Haul Road to service both Projects;
- Onshore Export Cable Corridor ducting will be installed for both Projects in full during the first phase of onshore construction in a Sequential Scenario; and
- Onshore Export Cables will be pulled separately for each Project.

398. In addition to the above assumptions for the concurrent construction scenario, the following has been considered when developing the sequential construction scenario and indicative construction programme onshore:

- The first Project would install the landfall and onshore cable ducts for the second Project. The first Project would reinstate the ducted sections within 2 years;
- The Haul Road may either be removed and the land reinstated following completion of works for the first Project or retained to allow access to Jointing Bays for the second Project. This would depend on the final Jointing Bay locations; this retention may only be for parts of the cable corridor but extents are unable to be defined at this stage;
- The first Project would either fully reinstate the TCC's or retain for use by the second Project;
- If removed following the construction of the first Project, the Haul Road and some of the TCC's would need to be constructed at the commencement of the second Project;
- The first Project would also complete all earthworks, drainage and permanent access for the second converter station;
- Within the Onshore Substation Zone where no further works are required, i.e. working areas around permanent access / drainage basins etc may be able to be reinstated as part of the first project with full reinstatement completed following completion of the second Project; and
- The second Project will only require works along the cable route to construct Jointing Bays and pull cables through the ducts followed by full reinstatement. There may be up to a 21 month lag between the completion of cabling works for the first Project and the start of cabling works for second Project.

Table 5-31 Indicative Construction Programme – DBS East or DBS West Built In Isolation or Concurrently

Programme Assumption for:	**Example, 2026**				**2027**				**2028**				**2029**				**2030**			
1. In Isolation build of DBS East or DBS West **2. Concurrent build of DBS East and DBS West**	**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**
Onshore																				
Enabling works, construction of accesses / permanent access road / TCC / drainage and Onshore Converter Station(s) platforms	■	■	■	■																
Construction of structures, installation of electrical equipment etc				■	■	■	■	■	■	■	■									
Commissioning of Onshore Converter Station(s)									■	■	■	■	■	■	■	■				
Reinstatement works at Onshore Converter Station															■	■				
Onshore Export Cable Corridor construction		■	■	■	■	■	■	■	■	■	■	■								
Landfall Trenchless Crossing and TJB construction					■	■	■	■	■	■										
Offshore																				
Seabed preparation including UXO/boulder clearance, sandwave levelling etc.		■	■	■	■															
Wind Turbine Generator foundations installation						■	■	■	■	■	■									
Array cables installation							■	■	■	■	■	■	■	■	■	■				
HVDC Offshore Converter Station(s) installation & commissioning									■	■	■	■	■	■	■	■				
Offshore Export Cable installation									■	■	■	■	■	■	■	■				
Wind Turbine Generator installation										■	■	■	■	■	■	■	■	■	■	
Wind Turbine Generator commissioning											■	■	■	■	■	■	■	■	■	■
First Power											▲									

Table 5-32 Indicative Construction Programme – DBS East and DBS West Built With Offshore Phased Approach

Programme Assumption for:	**Example, 2026**				**2027**				**2028**				**2029**				**2030**				**2031**			
1. Phased build of DBS East and DBS West	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**				**Phased Build**			
	Q1	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Onshore																								
Enabling works, construction of accesses / permanent access road / TCC / drainage and Onshore Converter Station(s) platforms	■	■	■	■																				
Construction of structures, installation of electrical equipment etc				■	■	■	■	■	■	■	■													
Commissioning of Onshore Converter Station(s)									■	■	■	■	■	■	■	■								
Reinstatement works at Onshore Converter Station															■	■								
Onshore Export Cable Corridor construction		■	■	■	■	■	■	■	■	■	■	■												
Landfall Trenchless Crossing and TJB construction					■	■	■	■	■	■														
Offshore																								
Seabed preparation including UXO/boulder clearance, sandwave levelling etc.		■	■	■	■					■	■	■	■											
Wind Turbine Generator foundations installation						■	■	■	■	■				■	■	■	■	■						
Array cables installation							■	■	■	■	■				■	■	■	■	■					
HVDC Offshore Converter Station(s) installation & commissioning									■	■	■	■	■	■	■	■								
Offshore Export Cable installation									■	■	■	■	■	■	■	■								
Wind Turbine Generator installation										■	■	■	■					■	■	■	■			
Wind Turbine Generator commissioning											■	■	■	■					■	■	■	■		
First Power											▲ Phase 1								▲ Phase 2					

Table 5-33 Indicative Construction Programme – DBS East and DBS West Built Sequentially

Programme Assumption for:	**Example, 2026**				**2027**				**2028**				**2029**				**2030**				**2031**				**2032**			
1. Sequential build of DBS East and DBS West (2-year lag)	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Year 5**				**Year 6**				**Year 7**			
2. Onshore civils works completed in parallel	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Onshore																												
Enabling works, construction of accesses / permanent access road / TCC / drainage and Onshore Converter Station(s) platforms																												
Construction of structures, installation of electrical equipment etc																		**Project 2 – electrical equipment**										
Commissioning of Onshore Converter Station(s)																					**Project 2 – commissioning**							
Reinstatement works at Onshore Converter Station																							**Project 2 - reinstatement**					
Onshore Export Cable Corridor construction															**Project 2 – recovery and uncapping of previously installed ducts, Project 2 Jointing Bay construction. cable pulling & reinstatement**													
Landfall Trenchless Crossing and TJB construction															**Project 2 – TJB Construction and cable pulling**													
Offshore																												
Seabed preparation including UXO/boulder clearance, sandwave levelling etc.																												
Wind Turbine Generator foundations installation																												
Array cables installation																												
HVDC Offshore Converter Station(s) installation & commissioning																												
Offshore Export Cable installation																												
Wind Turbine Generator in-stallation																												
Wind Turbine Generator commissioning																												
First Power																												

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