Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 1

Chapter 4 – Project Description (Revision C) (Tracked)

Revision C
Deadline 5
June 2023
Document Reference: 6.1.4.1
APFP Regulation: 5(2)(a)

China Resources
Better Life Together

Masdar
A MUBADALA COMPANY

equinor

Title: **Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects Environmental Statement** **Chapter 4 - Project Description (Revision C) (Tracked)**
PINS Document no.: 6.1.4.1
Revision: ~~B~~C
Document no.: C282-RH-Z-GA-00024

Date:	Classification
~~May~~ June 2023	**Final**

Prepared by:	
Royal HaskoningDHV	
Approved by:	Date:
Sheery Atkins, Equinor	~~May~~ June 2023

Table of Contents

Table of Tables

Table of Plates

Volume 2

Figure 4.1 Project location overview
Figure 4.2 SEP and DEP Offshore Sites
Figure 4.3 SEP and DEP Offshore Sites with Order Limits
Figure 4.4 Landfall
Figure 4.5 Offshore SEP and DEP Grid Option Scenarios - up to one OSP in the DEP North array area and one OSP in the SEP wind farm site
Figure 4.6 Offshore SEP and DEP Grid Option Scenarios - one OSP in the DEP North array area and one OSP in the SEP wind farm site
Figure 4.7 Offshore DEP in isolation development scenarios
Figure 4.8 Offshore SEP in isolation development scenario
Figure 4.9 Offshore cable corridor pre-sweeping locations
Figure 4.10 Onshore project area
Figure 4.11 Onshore substation

Volume 3

Appendix 4.1 Crossing Schedule

Glossary of Acronyms

AfL	Agreement for Lease
BEIS	Business, Energy and Industrial Strategy
CAA	Civil Aviation Authority
CBS	Cement Bound Sand
COMAH	Control of Major Accident Hazards
CSCB	Cromer Shoal Chalk Beds
CSIMP	Cable Specification, Installation and Monitoring Plan
CTV	Crew Transfer Vessel
DCO	Development Consent Order
DEP	Dudgeon Offshore Wind Farm Extension Project
DML	Deemed Marine Licence
DOW	Dudgeon Offshore Wind Farm
DP	Dynamic Positioning
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEP	Food Enterprise Partnership
GBS	Gravity Base Structures
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HV	High Voltage
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
IPMP	In-Principle Monitoring Plan
km	Kilometres
kV	Kilovolt
LAT	Lowest Astronomical Tide
LV	Low Voltage
MCA	Maritime and Coastguard Agency
MCZ	Marine Conservation Zone
MGN	Marine Guidance Notice
MoD	Ministry of Defence

MW	Megawatts
NPPF	National Planning Policy Framework
NSIP	Nationally Significant Infrastructure Project
Ofgem	Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
O&M	Operations and Maintenance
PEIR	Preliminary Environmental Information Report
PLGR	Pre-Lay Grapnel Run
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SCADA	Supervisory Control and Data Acquisition
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SOW	Sheringham Shoal Offshore Wind Farm
SF6	Sulphur Hexafluoride
SVC	Static Var Compensator
TCE	The Crown Estate
THLS	Trinity House Lighthouse Service
TP	Transition Piece
TSHD	Trailer Suction Hopper Dredger
UPS	Uninterruptible Power Supply
UXO	Unexploded Ordnance

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
Grid option	Mechanism by which SEP and DEP will connect to the existing electricity network. This may either be an integrated grid option providing transmission infrastructure which serves both of the wind farms, or a separated grid option, which allows SEP and DEP to transmit electricity entirely separately.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable corridor which would house HDD entry or exit points.
Infield cables	Cables which link the wind turbine generators to the offshore substation platform(s).
Integrated grid option	Transmission infrastructure which serves both extension projects.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Interlink cables	Cables linking two separate project areas. This can be cables linking:

	1) DEP South array area and DEP North array area 2) DEP South array area and SEP 3) DEP North array area and SEP 1 is relevant if DEP is constructed in isolation or first in a phased development. 2 and 3 are relevant where both SEP and DEP are built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Integrated Grid Option	Transmission infrastructure which serves both extension projects.
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 at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore scoping area	An area that encompasses all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, and allows sufficient room for receptor identification and environmental surveys. This has been refined following further site selection and consultation.
Offshore substation platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.

Offshore Temporary Works Area	An Offshore Temporary Works Area within the offshore Order Limits in which vessels are permitted to carry out activities during construction, operation and decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Onshore cable corridor	The area between the landfall and the onshore substation sites, within which the onshore cable circuits will be installed along with other temporary works for construction.
Onshore export cables	The cables which would bring electricity from the landfall to the onshore substation. 220 – 230kV.
Onshore Substation	Compound containing electrical equipment to enable connection to the National Grid.
Order Limits	The area subject to the application for development consent, including all permanent and temporary works for SEP and DEP.
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR.
Section 36 Consent	Consent granted under section 36 of the Electricity Act 1989.
Separated grid option	Transmission infrastructure which allows each project to transmit electricity entirely separately.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
Study area	Area where potential impacts from the project could occur, as defined for each individual EIA topic.

The Applicant	Equinor New Energy Limited.
Transition joint bay	Connects offshore and onshore export cables at the landfall. The transition joint bay will be located above mean high water.
Trenchless crossing technique	Installation of the onshore cable using Horizontal Directional Drilling (HDD) technique. This involves drilling from underneath one side of a specific feature to another, e.g. a road.

4 PROJECT DESCRIPTION

4.1 Introduction

1. This chapter of the Environmental Statement (ES) provides a description of the key components of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP), as well as details of how the wind farms will be constructed, operated, maintained and decommissioned. The details provided inform and underpin the assessments that have been undertaken and presented in the Environmental Statement (ES). Chapters 6 to 29 should be referred to for details of the worst-case scenarios that apply to each assessment topic.
2. SEP and DEP will each have a maximum export capacity greater than 100 megawatts (MW). The SEP and DEP wind farm sites are 15.8 kilometres (km) and 26.5km from the coast for SEP and DEP respectively at their closest point (**Figures 4.2** and **4.3**).
3. SEP and DEP will be connected to shore by offshore export cables installed to the landfall at Weybourne, on the north Norfolk coast. From there, the onshore export cables travel approximately 60km inland to a new high voltage alternating current (HVAC) onshore substation near to the existing Norwich Main substation. The onshore substation will be constructed to accommodate the connection of both SEP and DEP to the transmission grid.
4. The key offshore components comprise:
   - Wind turbines;
   - Offshore substation platform/s (OSP);
   - Foundation structures for wind turbines and OSP/s;
   - Infield cables;
   - Interlink cables; and
   - Export cables from the wind farm sites to the landfall.
5. The key onshore components comprise:
   - Landfall and associated transition joint bay/s;
   - Onshore export cables installed underground from the landfall to the onshore substation and associated joint bays and link boxes;
   - Onshore substation and onward 400 kilovolt (kV) connection to the existing Norwich Main substation;
   - Trenchless crossing zones (e.g. Horizontal Directional Drilling (HDD));
   - Construction and operational accesses; and
   - Temporary construction compounds.

4.1.1 Project Development Scenarios

6. As set out in **Chapter 1 Introduction**, whilst SEP and DEP have different commercial ownerships and are each Nationally Significant Infrastructure Projects (NSIPs) in their own right, a single application for development consent is being made for both wind farms, and the associated transmission infrastructure for each. A single planning process and Development Consent Order (DCO) application is intended to provide for consistency in the approach to the assessment, consultation and examination, as well as increased transparency for a potential compulsory acquisition process.

7. The Applicant is seeking to coordinate the development of SEP and DEP as far as possible. The preferred option is a development scenario with an integrated transmission system, providing transmission infrastructure which serves both of the wind farms, where both Projects are built concurrently. However, given the different commercial ownerships of each Project, alternative development scenarios such as a separated grid option (i.e. transmission infrastructure which allows each Project to transmit electricity entirely separately) will allow SEP and DEP to be constructed in a phased approach, if necessary. Therefore, the DCO application seeks to consent a range of development scenarios in the same overall corridors to allow for separate development if required, and to accommodate either sequential or concurrent build of the two Projects.

8. Reasons for the requirement to retain separate and phased (sequential) development scenarios alongside more coordinated approaches are further described in the **Scenarios Statement** [APP-314].

9. The range of development scenarios considered for SEP and DEP can be broadly categorised as:
   - In isolation – where only SEP or DEP is constructed;
   - Sequential – where SEP and DEP are both constructed in a phased approach with either SEP or DEP being constructed first; or
   - Concurrent – where SEP and DEP are both constructed at the same time.

10. Whilst SEP and DEP are the subject of a single DCO application (with a combined Environmental Impact Assessment (EIA) process and associated submissions), the assessment considers both Projects being developed in isolation, sequentially and concurrently, so that mitigation is specific to each development scenario.

11. Under each scenario where SEP and DEP are both constructed it is possible that the electrical infrastructure could be integrated as described above which would offer benefits to the operation of the electrical infrastructure system.

12. An integrated transmission system would also offer the opportunity to reduce from two OSPs (one for SEP, one for DEP) to a single OSP serving both wind farms (located in SEP).

13. **Table 4.1** provides a summary of the development scenarios.

Table 4.1: Development Scenarios

Development scenarios	OSP option
The construction of SEP or DEP only, where the other Project does not proceed to construction	1 OSP only
SEP and DEP sequential	2 OSPs, one for SEP and one for DEP
	1 OSP (located in SEP)
SEP and DEP concurrent	2 OSPs, one for SEP and one for DEP
	1 OSP (located in SEP)

~~14. In the concurrent development scenario there will need to be collaboration between the two Projects to optimise construction logistics and to share certain temporary works such as the haul road and construction compounds. This applies to a concurrent build regardless of whether the transmission systems are integrated. The extent of coordination will be determined post consent.~~

14. In several development scenarios there will need to be collaboration between the two Projects to optimise construction logistics and to share certain temporary works such as the haul road and construction compounds. This applies to a concurrent build, or may apply to a sequential build if there is an overlap in construction programmes, regardless of whether the transmission systems are integrated. The extent of coordination will be determined post consent and governed by a Cooperation Agreement. In the event of the scenarios outlined above (concurrent build or sequential build if there is an overlap in construction programmes), collaboration between the two Projects is secured via Requirement 33 (Onshore collaboration) of the **draft DCO (Revision H)** [document 3.1].

15. Each of the development scenarios offer a range of benefits, with the preferred option (integrated transmission system built concurrently) particularly benefitting the planning and construction of the Projects, being likely to reduce the overall environmental impact and disruption to local communities, and responding to concerns regarding the lack of a holistic approach to offshore wind development in general. For example, the preferred option would only require one haul road for construction activities, half the number of work fronts, and a smaller onshore substation.

4.1.1.1 Development Scenario Options

16. Within the broad development scenarios there are also a number of alternative development options. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. **Table 4.2** describes the development options and how they have been considered within the assessment presented in the ES.

Table 4.2: Development Options

Development option	Consideration in the ES worst-case scenarios
Either SEP is constructed first and installs the ducts for DEP, or DEP is constructed first and installs the ducts for SEP	This option would result in an overall shorter construction duration than the sequential scenario (separate transmission systems), and would result in lower overall peaks during construction than the

Development option	Consideration in the ES worst-case scenarios
	concurrent scenario (separate transmission systems). As it does not reflect the maximum peak effects or maximum duration of effects it has not been assessed as a specific scenario but is covered by the envelope of parameters considered.
Either SEL or DEL constructs on behalf of both itself and the other project an integrated onshore substation and connection to National Grid's Norwich Main Substation (all other onshore and offshore works are constructed either concurrently or sequentially)	This option would result in an overall smaller onshore substation footprint than the sequential scenario (separate transmission systems), and the concurrent scenario (separate transmission systems). As it does not reflect the maximum parameters it has not been assessed as a specific scenario but is covered by the envelope of parameters considered.

4.1.1.2 Design Options

17. The EIA is being undertaken on the basis of a 'Rochdale Envelope' approach as described in **Chapter 5 EIA Methodology** [APP-091]. The consent will therefore be granted on the basis of a range of parameters to allow flexibility in the final detailed design of the Projects. A key design decision for DEP is whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only. This will be determined based on a number of technical and commercial factors such as wind yield, wake losses and ground conditions. The DCO application is based on the possibility of using either both DEP North and DEP South array areas, or the DEP North array area only.

18. **Table 4.3** provides a summary of how this design option has been considered within the EIA.

Table 4.3: Design Option

Design Option	Consideration in the ES worst-case scenarios
DEP North array area only	Each offshore EIA topic considers the option of the DEP North and DEP South array areas both being used; and the DEP North array area only being used. The worst-case scenario will be different for different topic assessments, e.g. for Shipping and Navigation the worst-case scenario is full build out across the whole of the DEP North and DEP South array areas; for Ornithology the worst-case scenario may be the build out in the DEP North array area only with a higher density of turbines there.

19. The development scenarios, including the associated configurations of export and/or interlink cables, are illustrated in **Figures 4.5** to **4.8**.

20. The EIA considers the appropriate realistic worst-case associated with the different development scenarios and options, and presents the results accordingly. The information provided in this chapter, and each topic specific ES chapter, is designed to clearly show how the project design envelope would differ depending on which scenario may be taken forward.

21. In summary, the following principles set out the framework for how SEP and DEP may be developed:

- SEP and DEP may be constructed at the same time, or at different times;
- If built at the same time both SEP and DEP could be constructed in four years;
- If built at different times, either Project could be built first;

- If built at different times the first Project would require a four-year period of construction and the second Project a four-year period of construction;
- If built at different times, the duration of the gap between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
- Taking the above into account, the maximum construction period over which the construction of both Projects could take place is eight years.

22. The impact assessments for onshore topics therefore consider the following development scenarios and sub-options in determining the worst-case scenario for each topic:
    - Build SEP or build DEP in isolation;
    - Build SEP and DEP sequentially with a gap of up to four years between the start of construction of each Project – reflecting the maximum duration of effects; and
    - Build SEP and DEP concurrently – reflecting the maximum peak effects.
23. The impact assessments for the offshore topics consider the following development scenarios and sub-options in determining the worst-case scenario for each topic:
    - Build SEP or build DEP in isolation – therefore one OSP only; and
    - Build SEP and DEP concurrently or sequentially – with either two OSPs, one for SEP and one for DEP, or with one OSP only to serve both SEP and DEP.
24. For each of these scenarios it has been considered whether the build out of both the DEP North and DEP South array areas, or the build out of the DEP North array area only, represents the worst-case for that topic.

4.1.2 Flexibility and the Project Design Envelope

25. The project design envelope described in this chapter provides a minimum and maximum extent for each parameter. The detailed design of SEP and DEP will be developed and refined within the consented project design envelope prior to construction, with the final design lying between the minimum and the maximum extent of the consent. This approach to the EIA, known as the 'Rochdale Envelope' approach is further described in **Chapter 5 EIA Methodology** [APP-091].
26. As such, the information presented in this chapter outlines the options and flexibility required along with the range of potential design and activity parameters upon which the subsequent impact assessment chapters are based.
27. The need for flexibility in the consent is a key aspect of any large infrastructure project which will take some years to develop, but is particularly significant for offshore wind projects where technology continues to evolve quickly. The project design envelope must therefore provide sufficient flexibility to enable the Applicant and its contractors to use the most up to date, efficient and cost-effective technology and techniques in the construction, operation, maintenance and decommissioning of SEP and DEP.
28. Key aspects of SEP and DEP for which flexibility in the project design envelope is required include:

- Wind turbine capacity, including parameters such as maximum rotor diameter, 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 above (**Section 4.1.1**).

29. This chapter outlines the full range of parameters for all aspects of SEP and DEP, including where flexibility is required.

4.1.3 Site Description

4.1.3.1 Offshore

30. The SEP and DEP wind farm sites are located in the Greater Wash region of the southern North Sea, with the closest point to the coast being 15.8km from the SEP wind farm site and 26.5km from the DEP wind farm site (**Figure 4.2** and **Figure 4.3**). The offshore Order Limits include the SEP and DEP wind farm sites as defined by The Crown Estate (TCE) Agreement for Lease (AfL) areas noting that an additional offshore temporary works area has been implemented since AfL award (see **Section 4.4.8**). The DEP wind farm site comprises two distinct areas: The DEP North array area and the DEP South array area. The offshore Order Limits include the offshore cable corridors that either connect the wind farm sites together (interlink cable corridors) or connect the wind farm sites to the landfall (export cable corridors).

31. The offshore Order Limits also include the area of the existing Dudgeon Offshore Wind Farm (DOW), as shown on **Figure 4.3**. DOW has been included alongside a provision in the **Draft DCO (Revision H)** (document reference 3.1) to amend the Section 36 Consent for DOW (reference 12.04.09.04/227C) to enable the release of environmental 'headroom'. This possibility arises as a result of DOW not having been built out to its full consented capacity, meaning that there is a difference between the consented parameters (such as number of turbines and total rotor swept area) and the as built parameters. Further details of the relevant DCO provisions are contained within the **Explanatory Memorandum (Revision D)** [REP2-013].

32. It should be noted that the DCO does not provide for any additional works to be undertaken within the existing DOW boundary; its inclusion is solely to enable the release of headroom. For this reason, the assessments set out in this ES are focussed on the authorised development as described in the **Draft DCO (Revision H)** (document reference 3.1) and shown on the **Onshore (Revision C) and Offshore (Revision B) Works Plans** [REP2-004and PDA-003]. Where the matter of headroom is of relevance to the assessments, specifically ornithology, both consented and as built parameters have been considered such that the worst-case has been addressed. Further details with regard to the assessment approach for ornithology are provided in **Chapter 11 Offshore Ornithology** [APP-097].

33. Water depths at the SEP and DEP wind farm sites range from 14m below Lowest Astronomical Tide (LAT) in the northwest of the SEP wind farm site to 36m in the northwest of the DEP North array area. The sea bed gradient across both wind farm sites is generally relatively flat (i.e. less than 1°), although steeper gradients are associated with areas of sand waves, particularly in the northwest of the DEP North and DEP South array areas.

34. Water depths along the interlink cable corridors are between 10m and 35m. Again, the sea bed is relatively flat, other than in areas of sand waves which are found predominantly at the northern end of the SEP to DEP North array area corridor and between DEP South and DEP North array areas, on the south west side of DOW.

35. Water depths along the export cable corridor are between 25m and 27m in the area closest to the SEP wind farm site, shallowing to about 16m near the eastern tip of the Sheringham Shoal sand bank and then decreasing progressively to 0m at the coast. The 5m contour is typically 200-300m from the coast.

36. The geology of SEP and DEP generally consists of Holocene deposits overlying a series of Pleistocene sands and clays, with a bedrock of Upper Cretaceous Chalk. The chalk is only exposed (outcropping) at the sea bed within the landward 500m of the offshore export cable corridor, beyond which and out to the Sheringham Shoal sand bank, it is sub-cropping beneath alternating zones of thin gravelly sand/gravel and Holocene sand. As such, the predominant surface sediment types across the offshore sites are medium and coarse sands and gravels, and outcropping chalk in the landward 500m of the export cable corridor.

37. Up to 11km of the offshore export cable corridor passes through the Cromer Shoal Chalk Beds (CSCB) Marine Conservation Zone (MCZ) (see **Figure 8.8** of **Chapter 8 Benthic Ecology** [APP-121]).

4.1.3.2 Onshore

38. The offshore export cable makes landfall at Weybourne beach, to the west of Weybourne cliffs. A transition joint bay would be installed below ground inland from the coast to connect the offshore and onshore cables. From here the onshore cable corridor extends south for approximately 60km and would connect to a new onshore substation south of Norwich.

39. Through its approximately 60km length, the onshore cable corridor crosses the following Main Rivers: River Bure, River Wensum (upstream of Norwich), River Tud, River Yare, River Tiffey and Intwood Stream. In addition, the following A roads and railways are crossed from landfall to the onshore substation: The Street (A149), the North Norfolk Railway line between Holt and Sheringham, Cromer Road (A148), the A1067, the A47 between Hockering and Easton, the A11 near Ketteringham and the Norwich to Ely Mainline.

40. The SEP and DEP onshore site is primarily rural and agricultural in nature with pockets of woodland and small settlements in proximity to the cable corridor. The nearest settlements to the works are Weybourne at the landfall, and Swardeston at the substation. The onshore cable corridor passes in proximity to a small number of settlements including Little Barningham and Attlebridge.

41. The proposed onshore substation lies within an area of arable fields enclosed by woodland belts, adjacent to the existing Norwich Main substation. The Norwich to Ipswich railway line and A140 road is located to the east of the proposed substation. The substation site lies within a larger area of arable farmland to the north, west and south, with fields typically enclosed by hedgerows, trees and woodland, interspersed with villages.

42. The onshore site selection process has sought to avoid settlements, sensitive habitats and other technical and environmental constraints where possible (see **Chapter 3 Site Selection and Assessment of Alternatives** [APP-089]). Where sensitive features were unavoidable, for example crossing large rivers, rail lines and traffic sensitive roads these would be undertaken using trenchless crossing techniques, e.g. HDD.

43. A main construction compound is located approximately half way along the cable corridor close to Attlebridge. This would be the location for offices, welfare and storage to facilitate the onshore construction works. Additional works compounds would be located at the landfall and onshore substation, as well as a small number of secondary compounds along the cable corridor.

4.2 Consultation

44. The Applicant has undertaken an extensive programme of community and stakeholder consultation to inform the EIA process and the design of SEP and DEP. The **Consultation Report** [APP-029] provides an overview of the consultation undertaken in the context of the wider EIA process, with details of how the Applicant has taken account of the comments received also provided in each assessment topic chapter of the ES where relevant.

45. Full details of the consultation process including wider community consultation are also presented in the **Consultation Report** [APP-029], submitted as part of the DCO application.

46. Key project design decisions that have been made by the Applicant as a result of the consultation process and feedback received to date include:

- The intention to coordinate the development of SEP and DEP as far as possible with the preferred option of developing the integrated electrical infrastructure system (providing transmission infrastructure which serves both of the wind farms) which would be constructed concurrently, as detailed in **Section 4.1.1**. This benefits the planning and construction of the electrical infrastructure system, is likely to reduce overall levels of environmental impact and disruption, and helps to respond to any concerns regarding the lack of a holistic approach to offshore wind development.
- The removal of the 14MW wind turbine option from the envelope, reducing the total maximum number of wind turbines across SEP and DEP from 56 to 53.
- An increase in the minimum air gap from 26m to 30m to reduce impacts on ornithology through a reduction in predicted collision risk.

- Selection of the landfall at Weybourne with an export cable corridor through the western portion of the MCZ. This avoids the Wash and North Norfolk Coast Special Area of Conservation (SAC) and reduces the overall length of the export cable corridor.
- Commitment to bury the export cables as far as possible and to no more than 100m of external cable protection per export cable in the MCZ (for unburied cables (i.e. up to 1,200m^2), excluding that required at the HDD exit point (i.e. up to 600m^2). This reduces the extent of any longer-term impacts on the MCZ.
- Commitment to not using loose rock type external cable protection systems in the MCZ. This facilitates the possibility of removal on decommissioning.
- Should a plough be selected as the appropriate burial tool for the SEP and DEP export and/or interlink cables, a non-displacement type will be used to minimise environmental impact.
- Use of long HDD at the landfall (exiting approximately 1,000m from the coastline) in order to avoid works such as trenching on the beach and cliffs and the complete avoidance of the sensitive outcropping chalk feature in the nearshore section of the MCZ.
- The location of the new onshore substation in proximity to the existing Norwich Main substation to minimise the proliferation of industrial infrastructure within the landscape.
- Commitment to not route heavy goods vehicles for construction along the B1145 through Cawston.
- Locating the main construction compound away from Oulton / Cawston, which are already subject to increased traffic levels from other offshore wind farm projects.

47. **Table 4.4** summarises the key consultation comments that relate specifically to the development of the project description, and the Applicant's responses to these. Further details on how the Applicant has had regard to consultation feedback received are set out in the **Consultation Report** [APP-029] and in each individual topic chapter within the ES.

Table 4.4: Summary of Key Consultation Responses Related to the Development of the Project Description

Reference	Comment made	Response and where addressed in the ES
Scoping Opinion – general points		
2.3.1	The ES should include the following: a description of the Proposed Development comprising at least the information on the site, design, size and other relevant features of the development; and a description of the location of the development and description of the physical characteristics of the whole development, including any requisite demolition works and the land-use requirements during construction and operation phases.	These points are addressed throughout this chapter.
2.3.2	The maximum technical capacity (i.e. electrical output) of the individual wind turbines and of the Proposed Development as a whole should be confirmed within the ES.	The capacity of SEP and DEP is discussed in **Section 4.1** and of individual turbines in **Section 4.4.2**.
2.3.3	The Inspectorate notes that timely refinement of options will support a more robust assessment of likely significant effects and increase certainty for those likely to be affected.	The Applicant has noted the need to refine the options in a timely manner, as reflected in this chapter. A summary of the project design envelope and flexibility required is provided in **Section 4.1.2**.
2.3.4	Construction programme.	Further information on the construction programme is provided in **Section 4.7** of this chapter.
2.3.5	The ES should specify the anticipated working hours for construction. Any need for unsocial hours of working should be detailed.	These are provided in **Section 4.7** of this chapter.
2.3.6	The ES should provide a full description of the nature and scope of [operation and maintenance] activities, including the types of activity, their frequency, and how works will be carried out for both the onshore and offshore elements of the Proposed Development.	Operation and maintenance activities are described in **Section 4.4.11** (offshore) and **4.6.1.7** and **4.6.2.5** (onshore).
2.3.7	The anticipated operational lifespan of the Proposed Development… should be clearly and consistently defined within the ES to provide a clear indication of the likely duration of operational impacts.	The operational lifespan / design life of SEP and DEP is 40 years, as stated in **Table 4.5** and **Section 4.4.11** of this chapter. This is

Reference	Comment made	Response and where addressed in the ES
		reflected in the topic assessment chapters where relevant.
2.3.8	The ES should include the rationale in support of the assessment of potential significant effects during the decommissioning phase, including a description of anticipated decommissioning activities. Where there is uncertainty around the impacts of decommissioning this should be clearly explained along with the implications for the assessment of significant effects.	Decommissioning activities are described in **Section 4.4.13** (offshore) and **4.6.1.8** and **4.6.2.6** (onshore). Potential impacts relating to the decommissioning works are considered throughout the topic assessment chapters.
Scoping response – offshore		
2.3.9	The ES should clearly describe the different permutations of the Proposed Development that would arise should both, or just one of SEP/DEP, be constructed. This should include a clear description of the electrical infrastructure that would be installed in each circumstance. Figures to depict the arrangements for these alternative options would aid in this understanding.	The project development scenarios are described in **Section 4.1.1** of this chapter, including an explanation of how consideration of these has been incorporated into the assessments. **Figures 4.5 to 4.8** show the differences between the development scenarios in terms of the interlink and export cable configurations. Differences between the scenarios are clearly described throughout this chapter. Each topic assessment chapter also describes the differences relevant to the topic/assessment in question. Assessments have been undertaken for the Projects 'in isolation' as well as both Projects being built including, for the latter, consideration of whether a concurrent or sequential development scenario is the worst-case.
2.3.10	Section 1.5.6.2 of the Scoping Report identifies the need for sea bed preparation for foundations. Any requisite sea bed preparation for the array cables, the interlink cables and the export cable route should also be described and any resultant likely significant effects assessed within the ES. Should sea bed preparation involve dredging, the ES should identify the quantities of dredged material and identify the likely location for disposal.	Sea bed preparation requirements in relation to the wind turbine foundations are described in **Section 4.4.3**, in relation to the subsea cables in **Section 4.4.7.4.1** and the HDD exit pit works in **Section 4.5**. This

Reference	Comment made	Response and where addressed in the ES
		includes consideration of disposal where relevant and all these matters are reflected in the topic assessment chapters as appropriate.
2.3.11	The ES should identify the worst-case footprint of sea bed disturbance that would arise from all offshore construction activities, for example sea bed clearance/preparation, and vessel jack up and anchoring. The maximum footprints of all permanent components should also be identified.	Both temporary and permanent sea bed footprints are discussed throughout this chapter and a summary for the offshore works is provided for ease of reference in **Section 4.4.1**. Footprints are also presented in the worst-case scenario tables included in each topic assessment chapter, as relevant.
2.3.12	The ES should quantify the anticipated worst-case amount of scour and cable protection (including for cable crossings) that would be utilised for the Proposed Development, including for the export cables.	Scour protection in relation to foundations is addressed in **Sections 4.4.3** and **4.4.4.1**. Cable protection including at cable crossings, as well as at the HDD exit pit is described in **Section 4.4.7.7** and **Section 4.5**.
2.3.13	The Scoping Report identifies a number of wind turbine foundation options which could be used for the Proposed Development...The Applicant should ensure that the ES clearly identifies and assesses the worst-case scenario for the different environmental aspects and matters that could be significantly affected.	The wind turbine foundation options are described in **Section 4.4.3** of this chapter. The worst-case scenario differs according to the receptor and impact in question (for example the greatest sea bed footprint of a gravity base system foundation vs the underwater noise generated by piling of monopile foundations) – this is clearly identified in each topic assessment chapter.
2.3.14	The Inspectorate expects the ES to confirm the maximum length of both array and interlink cables so that the likely significant effects of these elements can be understood.	The maximum length of export, array (termed infield) and interlink cables is clearly described in **Section 4.4.7**, for each development scenario.

Reference	Comment made	Response and where addressed in the ES
2.3.15	Paragraph 141 of the Scoping Report states that the maximum hammer size for pile driving would be 4500kJ. The ES should also describe the maximum diameter of piles should they be used.	Maximum hammer energy and pile diameters are described in **Section 4.4.3**. The maximum hammer energy for monopiles is now 5,500kJ. Further detail in relation to the impacts of underwater noise and the underwater noise modelling study is provided in **Chapter 9 Fish and Shellfish Ecology** [APP-095] and **Chapter 10 Marine Mammal Ecology** [APP-096].
Scoping response – onshore		
2.3.16	The Scoping Report states that the cable corridor is 500m wide, however the scale on the figures indicates a greater width than this. The Inspectorate acknowledges that the final cable corridor will be refined for the application. The Applicant should ensure that the project description within the ES and any figures reflect one another appropriately.	See **Section 4.6.1**
2.3.17	The Scoping Report identifies the need for jointing bays and link boxes up to every 300m. The ES should identify a worst-case scenario for the number of jointing pits and link boxes.	The worst-case total number of link boxes and joint bays is detailed in **Section 4.6.1.2**.
2.3.18	The Scoping Report states that the Proposed Development may incorporate balancing equipment/storage infrastructure, such as a battery which would be housed within the footprint of the onshore substation. The ES should include sufficient detail to describe such equipment in order to provide confidence that any potential effects have been assessed in the ES	Balancing/storage infrastructure is no longer included with the proposals and therefore does not form part of the application for development consent.
2.3.19	The Scoping Report has identified the need for access roads to the onshore substation. The ES should identify whether new routes, either temporary or permanent, are required to access the onshore cable corridor and/or the temporary compounds. The likely significant effects of all temporary and permanent accesses should be included in the assessment scope.	The onshore substation will require a permanent operational access. The accesses required for construction have been identified and are considered further within **Chapter 24 Traffic and Transport** [APP-110].
2.3.20	Given the length of the onshore cable, there is the potential for numerous points at which the cable will need to cross roads, railways, watercourses, gas, water and electrical infrastructure. The ES should identify the locations and type of all such crossings. Where commitments are made within the ES to use a specific method as mitigation (e.g. trenchless techniques at sensitive locations), the Applicant should ensure that such commitments are adequately secured.	A crossing schedule is included as **Appendix 4.1** of this Chapter.

Reference	Comment made	Response and where addressed in the ES
2.3.21	The Scoping Report states that the onshore substation may connect to the existing Norwich Main substation through either an overhead connection or an underground connection, depending on their proximity to one another. The Inspectorate expects the ES to provide greater clarity as to the necessary connection works in order to inform a meaningful assessment of likely significant effects.	The connection between the onshore substation and the existing Norwich Main will be an underground 400kV cable.
PEIR responses		
AONB_002	Landfall We are very concerned about the visual impact and physical disturbance in the AONB During and after construction. This is a sensitive area in terms of biodiversity and landscape. There could be adverse knock on effects for farmers, fishermen, tourism, local people and visitors, sensitive species, adverse visual impact from movement, traffic and lighting. As a nationally designated landscape we would have preferred Bacton and difficult to see how impact can be mitigated here.	The landfall works are temporary in nature with the landfall compound set back from the coast by approximately 150m (i.e. set back from the coastal path by 150m). The Applicant has committed to the use of a long HDD that will avoid direct disturbance to the beach and cliff areas. The main drilling works will last four months in total for the single project scenario, five months for the concurrent scenario, or two separate periods of four months (sequential scenario). Whilst there will be a construction presence during this four to five month period it will be set back from the areas most used by people and any impacts are not significant. Further details on the impacts are detailed in the following chapters: landscape (**Chapter 26 Landscape and Visual Impact Assessment** [APP-112]), tourism (**Chapter 27 Socio-economics and Tourism** [APP-113]), farming (**Chapter 19 Land Use, Agriculture and Recreation** [APP-105]), biodiversity (**Chapter 20 Onshore Ecology and Ornithology (Revsion C)** [document reference 6.1.20])

Reference	Comment made	Response and where addressed in the ES
		and traffic (**Chapter 24 Traffic and Transport** [APP-110]).
CNTSPC_002	HVAC vs HVDC • We feel strongly that HVDC is preferable to HVAC technology because it has less impact on the environment.	For longer cable systems HVDC technology usually requires the introduction of a Cable Relay Station or Booster Station along the onshore cable corridor. Should a HVDC System be adopted a Convertor Station will be required to covert the voltage from HVDC to AC near or at the National Grid Connection Point, on average a HVDC station is 10m higher than an HVAC Station. In addition the footprint of the offshore and onshore substation would increase with a DC System. Should SEP and DEP be delivered with 2No OSS as HVAC the trench configuration will be the same as HVDC however, with 1No OSS HVDC will has one trench whereas HVAC will have two although the OSS for HVDC will be much larger.
CNTSPC_004	Beach/Landfall • Equinor must honour its commitment to use HDD for bringing the cables onshore, to minimise the impact to the beach and beyond. • The North Norfolk coast, which is an AONB, depends on tourism which will be affected by any road closures and heavy construction activity. • None of the roads along this coast are suitable for HGVs, and particularly not for exceptional loads.	The Applicant has committed to the use of a long HDD at the landfall, and the DCO would not allow any other approach for undertaking the works. The landfall works will require some heavy goods vehicle movements to the landfall compound, and these have been assessed in detail in **Chapter 24 Traffic and Transport** [APP-110].

Reference	Comment made	Response and where addressed in the ES
GMPC_002	It is understood that Equinor would like to minimise the impact on the environment by developing the SEP and DEP cable corridors in tandem. However, no guarantee has been given that SEP and DEP will not be developed sequentially with a gap of up to 4 years between the start of each project. This would be a stark contradiction of the stated aim of minimising environmental disruption and is something we cannot support.	The intention is to reduce environmental impacts by delivering the Projects at the same time. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case impacts are considered the various build out scenarios have been assessed, including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
GMPC_004	In the event that the radial connection of these windfarms to the National Grid through a sub-station south of Norwich goes ahead, and after reviewing the proposed cable route, it is clear that the interests of Great Melton Parish will be severely and adversely affected. The Parish Council requires robust assurances on a number of issues affecting our parishioners and our local environment. 1. Effective communication at all times regarding all aspects of the project that may affect our parishioners, our local environment, its wildlife and businesses within the parish. 2. Consultation regarding the exact cable route, within the 200m corridor through the parish, so as to minimise the negative impact on our parishioners. 3. Assurances that wildlife and the environment in which it thrives will be minimally impacted. This will require but is not limited to: a. Trenching that is created without disturbing hedgerows, waterways and woodland and has a minimal impact on footpaths. b. Respect for conservation areas created within the parish. This respect refers to, but is not limited to: • the cable trenching route • the contractors employed at all stages of the project • vehicular access required at any stage of the project • equipment storage. 4. Rapid undertaking of remedial work following destruction of the environment, including but not	All affected Parish Councils have been included within the SEP and DEP community engagement exercises including two phases of consultation leading up to the application itself. The location of the final cable corridor within the 200m wide PEIR boundary was presented to the public during a targeted consultation undertaken in March 2022. Potential impacts to wildlife were a key consideration in the site selection exercise which is set out in detail within **Chapter 3 Site Selection and Alternatives** [APP-089]. Further details on the assessment and mitigation measures that SEP and DEP have committed to are set out in **Chapter 20 Onshore Ecology and Ornithology (Revision C)** [document

Reference	Comment made	Response and where addressed in the ES
	limited to: a. footpaths b. hedgerows c. woodland d. waterways e. field drainage – this should be undertaken by local specialist firms who are familiar with the land and drainage systems in place. 5. A commitment to return in future years if any remedial work is shown to have been of a poor standard. This further work should be undertaken sympathetically and to an acceptable standard. 6. Unequivocal information should be provided regarding timescales for any disruption. This includes but is not limited to: • Environmental surveys: when and for how long will pedestrian and / or vehicular access and equipment storage be required; the start and finish dates of ANY work to be undertaken in the parish with robust and swift communication regarding any delays. • Timescale for the trenching e.g. time to create 1 km of cable trenching. • Time delay and reasons for the same between cable trenching being created and environmental remedial work being undertaken. • Traffic disruption; we have a thriving cricket club and bowls club in the parish, along with established agricultural businesses, all of which rely on easy access to the facilities required. Any traffic disruption will have an adverse effect on the community living in the parish and on those who rely on the parish for recreation, employment and business activity. 7. Confirmation of future access requirements. It is understood that 'access points' are required at intervals of approx.. 500m along the cable route but no information has been provided regarding the nature of these 'access points.' Great Melton is one of the largest parishes in Norfolk and as such, may be required to accommodate a number of these 'access points'. Basic information such as whether or not they require pedestrian or vehicular access, the width and nature of access required and the long term impact on their location has not been available when questions have been raised during the webinars. 8. Clear explanations of the interaction between the cable route and the new route for the Anglian Water mains water pipe; both trenches look likely to cross within or immediately adjacent to the parish of Great Melton. 9. A guarantee that 'financial benefits' awarded to the parish as a result of any disruption will be fair and not ring fenced for projects requiring approval from Equinor. Great Melton Parish Council will resist any development that does not fully consider and minimise the impact to our parish, its parishioners, environment and wildlife.	reference 6.1.20], which includes details of reinstatement. A detailed description of SEP and DEP is set out in this chapter, which sets out the working methods and timings.

Reference	Comment made	Response and where addressed in the ES
GYBC_003	Specific Comments Broadly speaking the Council has no major objections to the proposed routing of the onshore cabling with respect of: the proposed landfall point at Weybourne; the proposed onshore cabling corridor; nor the proposed location of the onshore substation that has been offered by National Grid at Norwich Main Substation, as these all lie outside of the Council's administrative boundary. Notwithstanding this, every effort should be made to ensure that any proposed impact upon the environment are reduced or where this is not possible, suitable mitigation measures are put in place. To this effect, the Council supports Equinor's preferred approach which aims to develop both windfarm extensions and their associated infrastructure and grid connections in an integrated and holistic manner, as such an approach will reduce the likely scale and impact of the combined construction works. I hope that these comments are of use to you. If you have any queries, please do not hesitate to contact me using the contact details below.	The intention is to reduce environmental impacts by delivering the Projects at the same time in an integrated holistic manner. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case impacts are considered the various build out scenarios have been assessed, including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
HISTE_002	The Location and Design of the Projects The PEIR details that up to four HVAC electricity export cables will run from the array areas to a landfall location on the north Norfolk coast at Weybourne. We note that it is proposed that the cable will come ashore through Horizontal Directional Drilling (HDD) and run under the cliff and existing sea defences (at a depth of 3-10 metres). We note also that if "short HDD" is selected that the cable will exit on the beach above the level of Mean Low Water Spring tide level and that foreshore access will be required for an excavator, associated equipment and 4x4 support vehicles. The buried onshore cable route will extend for approximately 60km from the landfall at Weybourne to a proposed substation and National grid connection at Swardeston south of Norwich. Regarding the offshore infrastructure, the PEIR describes water depths at the Project locations as between 14m below Lowest Astronomical Tide (LAT) in the northwest of SEP to 36m in the northwest of DEP. The sea bed is described as comprising Holocene deposits overlying a series of Pleistocene sands and clays, with a bedrock of Upper Cretaceous Chalk, which is exposed at the sea bed within the landward 500m of the export cable corridor. The Wind Turbine Generators (WTGs) that could be used:	The option for "short HDD" is not included in the project envelope. The cables will exit in the subtidal.

Reference	Comment made	Response and where addressed in the ES
	• DEP will consist of between 17 and 32 WTGs, each having a rated capacity of between 14MW and 26MW with total export capacity of up to 448MW; and • SEP will consist of between 13 and 24 WTGs, each having a rated capacity of between 14MW and 26MW with a total export capacity of up to 338MW. In total between 30 and 56 WTGs could be installed with a total export capacity of up to 786MW with the Projects connected via interlink cables. A single Offshore Substation Platform (OSP) could be placed within SEP, or one OSP within SEP and a second within DEP North. A 500m wide electricity export cable corridor from the wind farm site(s) will increase to 1000m wide when close to the coast at Weybourne with up to two ducts (one per project) installed under the intertidal area and cliff by Horizontal Directional Drilling (HDD). An additional drill per project is included (four in total) in the impact assessment worst case scenarios.	
HISTE_004	Chapter 5: Project Description With regard to the offshore infrastructure, the PEIR states that at this stage foundation design is undecided for Wind Turbine Generators (WTGs), which could comprise any of the following: • Piled monopile; • Suction bucket monopile; • Piled jacket; • Suction bucket jacket; and/or • Gravity Base Structure (GBS). It is also apparent from the PEIR that the size parameters of these foundation designs will be different depending on the WTG used, as highlighted in Chapter 5, Table 5.9 (monopile foundation parameters) and Table 5.11 (Gravity Base structures foundation parameters). The Offshore Substation Platform (OSP) foundations designs are likely to be either: • Piled jacket; or • Suction bucket jacket. The description of WTGs which could be used explains that the blade tip height above Highest Astronomical Tide (HAT) could be minimum 246m or maximum 330m. We also appreciate that the wind turbine layout will not be finalised until closer to construction, given that detailed preconstruction studies inclusive of site investigations, selection of the preferred WTG design and foundation type(s). In reference to the importance of finalising the layout arrangements it is	Noted - comments are addressed in **Chapter 14 Offshore Archaeology and Cultural Heritage** [APP-100].

Reference	Comment made	Response and where addressed in the ES
	apparent that detailed analysis will be required of sea bed and sub-sea bed conditions. We therefore encourage the Applicant to plan investigation programmes which optimise the timely involvement of professional, experienced and accredited archaeological consultants, so that full consideration can be taken of known and presently unknown heritage assets. In this regard the statement made in Chapter 5, section 5.4.2.2 (Wind Turbine Layout), paragraph 54 about how environmental factors may influence the layout is important for inclusion within the EIA exercise. Section 5.4.7.4.1.2 (Pre-lay grapnel run) describes action to clear debris from the cable route and we stress at this point the importance of archaeological advice to differentiate contemporary debris/litter or geological items (e.g. boulders) from other materials which might be of archaeological interest – note Plate 5.9 (described as an “abandoned anchor”). Section 5.4.7.4.1.3 (Pre-sweeping) also demonstrates how archaeological analysis of sea bed penetrating geophysical data will be required to prevent inadvertent impact to presently unknown archaeological materials or historic sites (i.e. crashed aircraft) buried within mobile bed forms. With regards to Section 5.4.7.5, for effective Cable Burial it is essential that a detailed picture of what might exist within or under the contemporary sea bed is important. It might be the case that archaeological materials, inclusive of palaeo-environmental sequences of archaeological interest, are identified under the depth of proposed cable burial. Although not directly impacted, it is still the case that access to such materials will subsequently become impossible; this itself represents an ‘impact’ which requires assessment as part of the EIA exercise with provision made for appropriate mitigation. Section 5.4.8 (Construction vessels) describes the use of jack-up barges and anchored vessels with anticipated sea bed footprint. It is therefore a relevant matter that all assessment of risk of encountering elements of the historic environment needs to determine the presence of such material(s) within any area that sea bed impacting operations may occur.	
MMO_004	"4 Chapter 5. Project Description Observation: 4.1 The project description is clearly presented in Chapter 5 and is both to the extent that MMO would expect and in line with projects of a similar nature. Changes required:	The Applicant notes that the MMO considers that the project description is clearly presented in **Chapter 4 Project Description (Revision B)** and is both to the extent that MMO would expect and in

Reference	Comment made	Response and where addressed in the ES
	4.2 It appears there are broken cross-references in paragraph 22 in Section 5.1.3 and paragraph 39 in Section 5.3.1. 4.3 Table 5-4 assumes a 3 metre (m) disturbance width to determine the export cable installation impacted area, which to the MMO seems narrow. The MMO request that this is confirmed by the Applicant as to whether or not this includes any slumping of surrounding sand or sea bed into any temporary trenches that would be created during ploughing and/or jetting. 4.4 The MMO note that Tables 5-5 and 5-6 give the widths of cable protection as the actual width of the protection itself but do not account for potential scour around their edges: the footprint of effect may be larger than stated."	line with projects of a similar nature. Broken cross references have been amended throughout the chapter. With regard to the assumed 3 metres (m) disturbance width from export cable installation (**Table 4.5**) this has been updated to a more conservative 15m. The rationale for this has also been added to the chapter. With regard to the footprint from cable protection. The widths given here (**Table 4.6** and **Table 4.7**) describe the actual width of cable protection. Other impacts, including from scour processes are considered in **Chapter 6 Marine Geology Oceanography and Physical Processes** [APP-092], **Chapter 8 Benthic Ecology** [APP-094] **and Chapter 9 Fish and Shellfish Ecology** [APP-095].
MPC_004	4. Network reinforcements In the most recent Network Options Assessment (NOA) issued by National Grid ESO in January 2021 a new overhead transmission line has been introduced from Norwich Main to Bramford in Suffolk. This project is identified by the code name AENC. To the extent that this new proposal is due to the proposed connection of DEP & SEP at Norwich Main, it should be described in the PEIR, together with any associated expansion of the Norwich Main substation itself. This will allow local communities to see the full extent of the proposals represented by the pre-application consultation.	National Grid made a grid connection offer to the Applicant in April 2019 for connection at Norwich Main National Grid Substation, which would accommodate both SEP and DEP. This grid offer was not reliant on any future network reinforcement work. This National Grid project (now referred to as East Anglia GREEN) is currently at a relatively early stage of site selection. Options have been presented for initial

Reference	Comment made	Response and where addressed in the ES
		public consultation in June 2022. National Grid indicate that this will inform further design work and that more detail will be made available in Q2 2023 a DCO application being made in 2024/2025. The potential for cumulative impacts with SEP and DEP have been considered within the onshore impact assessments.
NE_004	Summary of Main Points After reviewing the report, we feel that there remain a number of fundamental concerns in relation to the application as currently drafted. Whilst our detailed comments are provided within the Annexes below and accompanying tables of this letter, our main concerns are as follows: 1) DEP and SEP Considered as One 'Project' within the Development Consent Order (DCO) Natural England is concerned that two projects with two owners sharing a single DCO will be problematic.	The Applicant notes that there are numerous examples of where two NSIP projects have been consented through one DCO application e.g. the Hornsea and Dogger Bank projects.
NE_005	Summary of Main Points 2) DEP and SEP Development Options and the Worst-Case Scenario (WCS) As above, the two projects are being considered under one application yet there are three array areas in spatially separated locations with potentially differing environmental impacts. Natural England is concerned that this approach has introduced confusion throughout the PEIR chapters. We have struggled to find clear statements discriminating between impacts within each array area, and from each potential construction option when the worst-case scenario (WCS) is considered for either DEP or SEP alone or DEP and SEP together. The complexity is exacerbated by the separated or integrated grid options, along with the option to construct DEP and SEP sequentially or simultaneously. As the worst-case scenario (WCS) for these options interchanges, it is difficult to evaluate realistic development option(s) based on least impact and disturbance to the environment. It is recommended the Applicant details the precise information used to consider and then identify the WCS, including information on the impacts of DEP North (DEPN), DEP South	Further detail has been added to the worst-case scenario tables in the relevant assessment chapters of the ES to make it clear which of the possible scenarios is the worst-case, and why. Calculations have been checked, amended where necessary and further details have been added to make the basis of the calculations clear. The benefits of installing infrastructure where the routes and locations are shared at the same time are noted, however the application retains the flexibility to build each Project at different times if necessary, and this has been considered accordingly in

Reference	Comment made	Response and where addressed in the ES
	(DEPS), DEP, SEP, and DEP/SEP together against the various development options. This will also inform and clarify where targeted mitigation measures are required to reduce the impacts to an acceptable level. In addition, Natural England found several inconsistencies with the calculations of the WCS and also, occasions where the calculations were difficult to follow. This occurred both within the project description and relevant thematic chapters. The inclusion of the figures used in calculations within the tables, such as the notes column, or cross referencing to the relevant table within the Project Description would be helpful to the reader to easily understand the calculations. If both DEP and SEP offshore windfarm projects are consented, Natural England re-iterates the benefits of installing infrastructure where the routes and locations are shared at the same time. This will significantly reduce the construction time and significantly reduce ecological and visual impacts for these projects.	identifying the worst-case scenarios (also see response to similar comments below).
NE_032	Volume 1 Chapter 5 Project Description Section: 5.1.1 9 / Table 5- 1 Comment: Natural England welcome the Applicant's preference to develop SEP and DEP as an integrated project. We re-emphasise that an integrated project is our preferred option to minimise any offshore or onshore environmental impacts. Further, we advise that simultaneous installation of the cable infrastructure for both the DEP and SEP projects when the first of the two proceeds will significantly lessen any ecological impacts (both offshore and onshore) where the route and/or infrastructure is shared. Recommendation: We encourage the Applicant to progress with the integrated project as the preferred option.	Noted - as confirmed in **Section 4.1.1**, the Applicant is seeking to coordinate the development of SEP and DEP as far as possible. The preferred option is a development scenario with an integrated transmission system, providing transmission infrastructure which serves both of the wind farms, where both Projects are built concurrently.
NE_033	Volume 1 Chapter 5 Project Description	

Reference	Comment made	Response and where addressed in the ES
	Section: 8 Comment: The choice between integrated or phased build will have implications in relation to the temporal and spatial scale of the impacts and their recoverability. Natural England considers that there are in fact 4 build out scenarios being considered in the Rochdale Envelope, each with their own issues and concerns · Built concurrently/simultaneously (3 years build out phase) · Built sequentially (1-year gap between end of construction of one and commencement of the other - & year build out phase) · Dudgeon Built only (3 year build out phase) · Sheringham only (3 year build out phase) Recommendation: A clear audit trail of the impacts for each thematic area from each scenario should be presented in the ES to enable interested parties to advise on accordingly, recommend mitigation measures and ensure that the DCO/dML remains fit for purpose.	**Table** 4.1 identifies the development scenarios and how they relate to the grid options. The Applicant agrees that the development/build out scenarios have implications for the scale of impacts and for this reason has carefully considered and assessed each option. This ensures that the worst-case scenario is addressed and allows mitigation to be specific to each scenario. It should be noted that the focus is on identifying and assessing the worst-case scenario (in line with the PINS s51 advice on this matter dated 21 May 2021). In this manner, differences are assessed by exception. The topic chapters of the ES detail how each scenario has been considered in relation to each assessment. Further information has been added to the topic chapters to ensure that a clear audit trail has been provided.
NE_034	Volume 1 Chapter 5 Project Description Section: 5.1.3 20 + 21 Comment: The offshore PEIR boundary includes the area of the existing DOWF. The inclusion of the DOWF in the offshore PEIR boundary reflects the intention of the Applicant to include the same in the DCO alongside a mechanism to release 'headroom' for the benefit of DEP and/or SEP. Recommendation:	Natural England's comment is noted. The Applicant considers that the intended approach to headroom as described in **Section 4.1.3.1** of the ES (unchanged from the PEIR) is appropriate. It has sought legal advice on this matter and has consulted BEIS on the appropriate mechanism. Further details of the relevant DCO provisions relating to headroom are contained within the **Explanatory Memorandum (Revision D)** [REP2-013].

Reference	Comment made	Response and where addressed in the ES
	This has legal implications that we will seek further guidance on. However, please see Natural England Response to EA1 NMC Application where we have flagged that this is not a legally sound mechanism to release head room.	
NE_035	Volume 1 Chapter 5 Project Description Section: 24 Comment: Please note that the sandwaves within DEPN are associated with Annex I sandwich terns and prey availability. Recommendation: Please see detailed comments under Benthic and Fisheries.	Noted. These issues have been addressed under the corresponding ES chapters.
NE_036	Volume 1 Chapter 5 Project Description Section: 5.2 32 Comment: Natural England agrees with the preference for long HDD at the landfall and the avoidance of the outcropping chalk feature in the nearshore portion of the MCZ. Further clarification and reassurance should be given that micro siting the cable within the remainder of the MCZ will be considered to avoid any significant impacts to any other sensitive features that may be present within the MCZ. Recommendation: Add further clarification to these key project decisions.	Noted. The Applicant highlights that the use of long HDD at the landfall is a commitment that has been made (unchanged from the PEIR) to avoid, mitigate and reduce impacts on the MCZ (and specifically the nearshore outcropping chalk feature). It also confirms that micro-siting of the offshore export cable corridor within the Order Limits will be undertaken pre-construction, based on the latest available data including pre-construction surveys. Micro-siting is referenced in **Chapter 4** (e.g. **Section 4.4.7.4.1**, unchanged from the PEIR). Further reference to micro-siting has been added to the ES chapter in relation to the export cables and the MCZ (**Section 4.4.7.4.1**).
NE_037	Volume 1 Chapter 5 Project Description Section: 5.4.1 43	The aim of the table is to provide a summary of the key elements of the offshore infrastructure. For ease of reference maximum spatial footprints of

Reference	Comment made	Response and where addressed in the ES
	Table 5-3 Comment: If the aim of the table is to present the maximum or worst-case scenario this should be added to the table description. Also, it would be helpful if the Applicant outlined the WCS for DEPN, DEPS, SEP and together options. This would not only help with understanding the impacts of each potential construction scenario, but also provide a useful reference summary table (particularly when later tables interchange depending on the WCS for each parameter). Given the complexity of the different development scenarios, this approach to providing comprehensive information for each of the development scenarios could be adopted throughout this and other chapter tables where applicable. Recommendation: We advise a more comprehensive and transparent approach to the presentation of WCS for all the development scenarios.	offshore infrastructure are included in **Table 4.6 to Table 4.9**. In general terms the Applicant has opted to reserve the presentation of worst-case scenarios relating to each assessment for the topic chapters. This is because the worst-case scenario differs according to the topic and impact under consideration. As such **Chapter 4 Project Description (Revision B)** is designed to provide a complete description of the proposed development, including minima and maxima where they apply, and how the development could be constructed, operated and decommissioned. The topic chapters provide the detail of which combination of scenarios and parameters combine to produce the worst-case scenario for each impact. The Applicant agrees that the identity and justification of worst-case scenarios must be comprehensive and transparent and further information has been added to the worst-case scenario sections of each topic chapter to ensure that this is the case.
NE_038	Volume 1 Chapter 5 Project Description Section: 5.4.1 Tables 5.4 and 5.5 Comment: The area for each turbine foundation should be included alongside the number of turbines for	**Table 4.7** provides a summary of the key elements of the foundations i.e. the totals, maxima and minima for DEP, SEP and combined. The details for individual foundations are given in the foundations section (**Section 4.4.3**), unchanged from the PEIR.

Reference	Comment made	Response and where addressed in the ES
	transparency of the total footprint calculations. The width of a gravity based foundation along with the maximum area of scour protection should be specified within Table 5.5., or a reference to a later table where calculations are made should be added Recommendation: Provide updates to the table.	
NE_039	Volume 1 Chapter 5 Project Description Section: 5.4 Table 5-4 Comment: Boulder clearance – wind farm areas & boulder clearance – export cable corridor. Both refer to boulders of up to 5m diameter. Whilst in Section 5.4.3.1 Pre-installation works. Boulder clearance – where micrositing is not possible, boulders will be relocated, these will be in the order of 5m diameter and 1m height). Table 5.4 should also state the estimated height of 1m. Recommendation: Table 5.4 should also state the estimated height of 1m, in addition to the 5m diameter.	The (renumbered) **Table 4.6** parameters are focussed on footprint, hence diameter rather than height. However, the 1m height has been added **to** the table as requested.
NE_040	Volume 1 Chapter 5 Project Description Section: 5.4.1 1.2 Table 5-5 Comment: Infield external cable protection (unburied cables) Total allowance of 1000m across both projects, up to 4m wide. Either project may use the total allowance. Recommendation: This implies that that allowance can be used on either project in isolation, or integrated, or sequential. This is a concern	The Applicant has already reduced the quantities of external cable protection as far as is possible in order to mitigate and reduce impacts. The option for either Project to use the total allowance of 1,000m increases flexibility which is required at this stage prior to detailed design studies having been undertaken, accounting for potential differences in the cable protection requirements between Projects. However, it also allows the Applicant to minimise the total applied for. The alternative might be to include 1,000m per Project i.e. 2,000m in total. The Applicant's preferred approach is to minimise the total allowance. Natural England do not specify their concern, but

Reference	Comment made	Response and where addressed in the ES
		the Applicant notes that the topic chapters provide the assessment of impacts from external cable protection, including in relation to benthic and fish ecology. In addition, further reference to the cable burial risk assessments that have been completed by the Applicant to underpin the assumptions on external cable protection requirements has been added to **Section 4.4.7**.
NE_041	Volume 1 Chapter 5 Project Description Section: 5.4.1 1.3 Table 5-6 Comment: External cable protection – unburied cables. Total allowance of 500m for the export cables (6m wide) and 1500m for the interlink cables (6m wide). Either project may use the total allowance. Please be advised that volume of any protection should also be included Recommendation: This implies that the allowance can be used on either project in isolation, or integrated, or sequential. This is a concern.	The external cable protection volumes have been added to **Table 4.22** (**Table 4.7** is only intended to provide a summary of sea bed footprint). With respect to the option for either Project to use the total allowance, refer to comment above.
NE_042	Volume 1 Chapter 5 Project Description Section: Table 5-7 Comment: The O&M requirements in relation to cable reburial and repair which have been included don't seem to align with proposals from other Offshore Wind Farm (OWF) projects and variation requests recently received from OFTOs Recommendation:	The Applicant has based its anticipated Operations & Maintenance (O&M) requirements on its own experience from its own assets, including the adjacent DOW and Sheringham Shoal Offshore Wind Farm (SOW). The Applicant considers this approach to be more appropriate than using other developers' information for other OWFs. This is because it has higher confidence in data from its own wind farms,

Reference	Comment made	Response and where addressed in the ES
	Please refer to the O&M included for Norfolk Boreas, Vanguard, EA1N and EA2, and amend accordingly.	including those that are in the same location as SEP and DEP. As explained in **Section 4.4.11** (unchanged from the PEIR), the Applicant's intention is that O&M activities will be shared with the existing assets to reduce the overall O&M effort required across all projects. As referenced in the chapter, the Applicant has included an **Outline Offshore Operations and Maintenance Plan (Revision C)** (document reference 9.9)with the DCO application to confirm the details of the O&M works.
NE_043	Volume 1 Chapter 5 Project Description Section: 5.4.2.1 49 Comment: It is stated the project design envelope includes a range of turbines from 14MW to 26MW. However, subsequent tables present the maximum/WCS for 18+MW turbine option. Recommendation: Please clarify within the document that the parameters for the 18+MW option include the range in MW between 18MW and 26MW.	Updated - note added to **Table 4.10** to make this clear.
NE_044	Volume 1 Chapter 5 Project Description Section: 5.4.3 Plate 5-3 Comment: Point 60 states that three foundation types are under consideration for the wind turbines at DEP and SEP: monopiles, GBS and jackets. However, Plate 5-3 shows GBS, jacket with piles, suction bucket and monopile.	The foundation types are monopiles, GBS and jackets. Monopiles and jackets may be fixed to the sea bed in different ways, for example suction buckets or pile/s. This is described in **Sections 4.4.3** and **4.4.4.1**, unchanged from the PEIR.

Reference	Comment made	Response and where addressed in the ES
	Recommendation: This should be clarified. Noting that impacts should be minimised as much as possible. Please also see benthic and coastal processes detailed comments.	
NE_045	Volume 1 Chapter 5 Project Description Section: 5.4.3.1 64 Comment: Given the relatively low number of boulders, it is Natural England's preference that these are micro-sited around to reduce sea bed disturbance during clearance. It is also our preference that re-locating boulders to an adjacent area of sea bed is with in an area of similar sediment type identified from geophysical surveys and avoidance of any sensitive habitats. Recommendation: Natural England recommend micro-siting to avoid the need to disturb the sea bed to remove existing boulders. If boulders are moved, then consideration should be given to their deposit location.	**Sections 4.4.3.1** and **4.4.7.4.1** have been updated to make it clear that micro siting around boulders is the preferred option, and that where relocation is required, boulders will be relocated where possible to an adjacent area of sea bed with similar sediment type and avoiding any known sensitive habitats such as Annex I reef.
NE_046	Volume 1 Chapter 5 Project Description Section: 5.4.3.2.3 69 Comment: Natural England welcomes the option to use dynamical positioning (DP) for floating construction vessels thereby reducing the need for anchoring. Further detail should be shared if available Recommendation: Natural England welcome the option for dynamic position in favour of sea bed disturbance from anchoring.	Noted. At this stage the Applicant needs to retain the option to use either dynamic positioning (DP) or anchoring. Further information is not available at the time of writing, although details will be confirmed pre-construction.
NE_047	Volume 1 Chapter 5 Project Description Section: 5.4.3 2.3.2	Examples of which ground conditions are more likely to be unsuitable for pile driving have been added to **Section 4.4.3.2.3.2.**

Reference	Comment made	Response and where addressed in the ES
	74 Comment: The ground conditions where pile driving would not be suitable should be explained here for clarity. Recommendation: Please expand with further detail.	
NE_048	Volume 1 Chapter 5 Project Description Section: 5.4.3 2.4 77 Comment: d50=200 to 400 should read d50 = 200 to 400mm (units are missing here) Recommendation: It would be useful if the D50 value could be included as a row or footnote to Table 5-9	Units have been added to the text.
NE_049	Volume 1 Chapter 5 Project Description Section: 5.4.3.2.1 Table 5-9 Comment: Not clear where the figures for 'Maximum footprint on the sea bed per foundation (excl. scour protection) (m2), have come from, i.e. 1784 and 2702m2. Recommendation: The source for these figures needs to be clarified.	These figures describe the maximum footprint of each monopile foundation, excluding scour protection. They are derived from the Applicants' knowledge of what is currently and expected to be available on the market for the turbines under consideration.
NE_050	Volume 1 Chapter 5 Project Description Section: 5.4.3.1 Table 5-11 Comment:	Clarification has been added to **Table 4.12.**

Reference	Comment made	Response and where addressed in the ES
	Maximum scour protection volume per foundation, including gravel bed (m3) (gravel and rock) for 14MW & 18+MW are 35,785 and 63,617m2, respectively. These are calculated from the Maximum area of scour protection per foundation (incl. structure footprint area) (m2) since 14,314 and 25,447, respectively, multiplied by 2.5m height. Recommendation: There is no mention where the 2.5 multiplier has come from. We note the reference in 5.4.3.3.2 Sea bed Preparation which refers to a gravel pad of between 1.5-3m height and 60m in diameter.	
NE_051	Volume 1 Chapter 5 Project Description Section: 5.4.3.3.1 Table 5-11 Comment: Indicative volume of gravel footing per foundation (m3) – this appears to come from A = irr2h = ir23.52h where h has been assumed to be 2m, but there is no explanation for where this has come from. Recommendation: This needs to be clarified.	Clarification has been added to **Table 4.12.**
NE_052	Volume 1 Chapter 5 Project Description Section: 5.4.3.3.4 Table 5-11 Comment: Indicative maximum volume of gravel for sea bed preparation purposes per foundation (m3) this would appear to have been calculated from the Maximum footprint for sea bed preparation 1735m2 x gravel height 5.5m. However, Section 5.4.3.3.2, Bullet Point 3 describes dredging up to 5m depth and back filling with gravel up to 1m in height above the mudline (which appears to suggest a gravel height of 5m + 1m) – this does not equate. Recommendation: This needs to be clarified.	These values have been checked and updated (**Table 4.13**).

Reference	Comment made	Response and where addressed in the ES
NE_053	Volume 1 Chapter 5 Project Description Section: 5.4.3.3.4 Point 90 Comment: Section 5.4.3.3.4, states that the maximum diameter, area, and volume requirements for scour protection per foundation are provided in Table 5-15. However, Table 5-15 describes OSP piling parameters, not GBS scour protection. This also relates to the comment above), Recommendation: This needs to be clarified/amended.	Table referencing has been corrected.
NE_054	Volume 1 Chapter 5 Project Description Section: 5.4.3.4 Table 5-12 Comment: It will be helpful if further detail could be added to the table for ease in understanding the calculations, or cross reference to information elsewhere within the chapter. Recommendation: Update table.	Where relevant, further information has been provided throughout to state the basis for calculations.
NE_055	Volume 1 Chapter 5 Project Description Section: 5.4.4.1.1 Table 5-14 Comment: Not clear how some of these figures have been calculated Recommendation: As above, could the breakdown of the calculations be provided please?	Where relevant, further information has been provided throughout to state the basis for calculations.
NE_056	Volume 1 Chapter 5 Project Description	As above and as confirmed in **Section 4.1.1**, the Applicant is seeking to coordinate

Reference	Comment made	Response and where addressed in the ES
	Section: 5.4.7.1 126-128 Comment: Natural England re-iterate their preference for an integrated grid option, with one OSP at SEP, thus minimising the export cable length required to 80km and resulting impacts to the sea bed. Recommendation: The Applicant should pursue the integrated option as the preferred approach.	the development of SEP and DEP as far as possible. The preferred option is a development scenario with an integrated transmission system, providing transmission infrastructure which serves both of the wind farms, where both Projects are built concurrently.
NE_057	Volume 1 Chapter 5 Project Description Section: 5.4.7.1 Table 5-16 Comment: Export cable corridor width inside MCZ to landfall (m) Approximately 1000m Recommendation: Please also refer to our response (20 April 2021) on the DEP & SEP Draft Outline In-Principle Measures of Equivalent Environmental Benefit (MEEB) Plan for CSCB MCZ. The CSCB MCZ was designated to protect a range of sea bed habitats including chalk, sand and gravel, and small areas of peat and clay. The installation of export cables through the Cromer MCZ would be detrimental to the conservation objectives of the site. However, if this cannot not be avoided, then any impacts on the protected features should be minimised.	Noted - **Chapter 8 Benthic Ecology** [APP-094], the **Stage 1 CSCB MCZA** [APP-077] and the **In-Principle MEEB Plan (Revision C)** [REP2-020] describe how the Applicant has avoided, mitigated and reduced impacts on the CSCB MCZ.
NE_058	Volume 1 Chapter 5 Project Description Section: 5.4.7.2 134 / Table 5.17 Comment: The maximum number of interlink cables at each development area are provided, however there is no explanation within the preceding paragraphs 132 to 134 as to why it is this number. This would be beneficial to add to further understand the project design.	The maximum number of interlink cables takes account of the maximum capacity of DEP and is based on a 15MW turbine scenario (up to 30 wind turbines). This results in a maximum of five wind turbines per string, with four strings from the DEP North array area and two from the DEP South array area. One additional string is added for contingency to accommodate

Reference	Comment made	Response and where addressed in the ES
	Recommendation: Please add further information for reference.	different numbers of wind turbines. This has been clarified at **Section 4.4.7.2**.
NE_059	Volume 1 Chapter 5 Project Description Section: 5.4.7.2 134 / Table 5.18 Comment: The interlink cable lengths are defined as 22, 16.5 and 22km in length, yet the calculations appear to be based on 20km and 15km lengths. Recommendation: Please clarify and amend or explain the reason for this difference.	Interlink cable lengths include a 10% contingency for final design purposes (unchanged from the PEIR, see **Section 4.4.7.2**). Therefore 22, 16.5 and 22km are the worst-case lengths and it is these numbers that have been used for the purpose of the assessment.
NE_060	Volume 1 Chapter 5 Project Description Section: 5.4.7.4.1 139 Comment: It is noted that 20 boulders are estimated to be removed and relocated within the project boundaries. It should be stated that consideration will be given to the area of re-location to ensure a similar habitat type and avoidance of any sensitive habitats. Recommendation: Clarification should be added to the re-location of the boulders.	As above, **Sections 4.4.3.1** and **4.4.7.4.1** have been updated to make it clear that micro siting around boulders is the preferred option, and that where relocation is required, boulders will be relocated where possible to an adjacent area of sea bed with similar sediment type and avoiding any known sensitive habitats such as Annex I reef.
NE_061	Volume 1 Chapter 5 Project Description Section: 5.4.7.4.1.3 144 to 146 Comment: Natural England notes the defined areas for sandwave clearance are outside of benthic designated sites. This is preferential to cable burial remedial works involving additional rock placement. However, implication to supporting habitat and prey availability for Annex I birds and marine mammals will need to be considered further.	Implications for supporting habitat and prey availability for Annex I marine mammals and birds from the works are considered in **Chapter 10 Marine Mammal Ecology** [APP-096] and **Chapter 11 Offshore Ornithology** [APP-097] respectively. Pre-sweeping works are addressed as appropriate by a **Disposal Site Characterisation Report (Revision B)**

Reference	Comment made	Response and where addressed in the ES
	Recommendation: A sandwave/sea bed levelling plan should be included in the Deemed Marine Licences. Further detail should be added to clarify that the sandwave clearance disposal sites will be of similar habitat ensuring that the location does not coincide with any sensitive habitats.	[REP1-019] and an **Outline CSCB MCZ Cable Specification, Installation and Monitoring Plan (CSIMP)** [APP-291]. Both are submitted as part of the DCO application. The Applicant expects a condition for the final CSIMP to be submitted and approved prior to the start of construction to be included in the Deemed Marine Licenses. This section has been updated to make it clear that the disposal activities will be carried out where possible in an adjacent area of sea bed with similar sediment type and avoiding any known sensitive habitats such as Annex I reef.
NE_062	Volume 1 Chapter 5 Project Description Section: 5.4.7.5 149 Comment: Natural England welcomes the intention to submit an outline Cable Specification, Installation and Monitoring Plan for CSCB MCZ. Recommendation: To be provided as part of Application submission	As confirmed above, an **Outline CSCB MCZ CSIMP** [APP-291] is submitted as part of the DCO application and has been consulted on with stakeholders at the pre-application stage.
NE_063	Volume 1 Chapter 5 Project Description Section: 5.4.7.4.1.3 Table 5-20 Comment: Not clear how some of these figures have been calculated	Pre-sweeping corridor lengths have been added to **Table 5-20** and an explanation of the volume calculations has been added to the table (dredge volume has been calculated using the bathymetry data collected by the site specific surveys).

Reference	Comment made	Response and where addressed in the ES
	Recommendation: A breakdown of the calculations needs to be provided.	
NE_064	Volume 1 Chapter 5 Project Description Section: 5.4.7.6 162 Comment: "Since it is not possible to bury the infield cables in close proximity to the wind turbines and OSP/s due to the scour protection that will be installed, the cables would be surface laid with cable protection on the approach to each foundation" Is it possible to define the proximity to each turbine requiring cable protection? It is noted this will be within the defined footprint and will not increase sea bed habitat loss. Recommendation: Further information should be added.	This corresponds to the dimensions of the scour protection, which have been provided for the different foundation types in **Section 4.4.3**.
NE_065	Volume 1 Chapter 5 Project Description Section: 5.4.7.7.3 169 Comment: "An allowance is made for external cable protection where an adequate degree of protection has not been achieved from the burial process." How did the applicant arrive at this figure? Can reassurance be provided that this allowance will be adequate? Recommendation: Provide further rationale for the external cable protection allowance figures as part of the application in the form of a cable burial risk assessment	The Applicant has completed a cable burial risk assessment for both the interlink and the export cables. Further details have been added where relevant.
NE_066	Volume 1 Chapter 5 Project Description Section: 5.4.7.7.3.1 Point 170 Comment: External cable protection requirements in the Cromer MCZ	Noted. The **Stage 1 CSCB MCZA** [APP-077] considers the effects of cable installation including proposals for external cable protection. As noted in the application documents (e.g. **Chapter 4 Project Description (Revision B)** and the **Stage 1**

Reference	Comment made	Response and where addressed in the ES
	Recommendation: Reference should also be made here to our response to the MEEB proposal (20 April 2021). Neither DOW nor SOW required cable protection within the MCZ. Therefore, thorough consideration should be given to avoiding the need for cable protection within the CSCB MCZ. Any cable protection placed, its installation activities, and cable maintenance activities would hinder the conservation objectives of the MCZ and put pressure on the designated features (e.g. increased suspended sediments, deposition, temporary and permanent habitat loss). An MCZ Assessment should evaluate the full range of pathways between the features and all pressures due to EC installation, protection, and maintenance.	**CSCB MCZA** [APP-077]), the Applicant has given careful and detailed consideration to the requirement for external cable protection in general, and in the MCZ in particular. As a result, external cable protection has been avoided for the majority of the route and minimised to 100m per cable within the MCZ. The Applicant has also committed (unchanged from the PEIR) to the use of external cable protection types in the MCZ that will be removable on decommissioning i.e. no loose rock.
NE_067	Volume 1 Chapter 5 Project Description Section: 5.4.8 178 &192 Comment: The number of vessel movements over a potentially long period of team, may impact features of other designated sites though which they transit. Recommendation: Natural England advise best practice should be adopted by vessel users and appropriate protocols developed for use both within the construction phase and operational and maintenance phase.	Noted. Impacts from vessel movements including best practice measures and protocols where relevant are addressed in the appropriate ES chapter including **Chapter 10 Marine Mammal Ecology** [APP-096] and **Chapter 11 Offshore Ornithology** [APP-097].
NE_069	Volume 1 Chapter 5 Project Description Section: 5.4.10.3/5. 4.10.4 193 to 201 Comment: The O&M plan should detail the scenarios for cable repair and re-burial, and that as stated these would be the subject of a separate marine licence application. We welcome the inclusion of cable	Noted. The **In-Principle Monitoring Plan** is submitted with the DCO application [APP-289] and has been consulted on with stakeholders at the pre-application stage. With respect to O&M, as above, the Applicant has based its anticipated O&M requirements on its own experience from its own assets, including the adjacent SOW

Reference	Comment made	Response and where addressed in the ES
	monitoring within the in-principle monitoring plan. Recommendation: Further detail required. Please see previous points in relation to O&M activities for OWF currently in ExA and determination phases. Please note that these O&M plans have been amended since they were submitted so the latest versions should be used.	and DOW. The Applicant considers this approach to be more appropriate than using other developers' information for other OWFs. This is because it has higher confidence in data from its own wind farms, including those that are in the same location as the proposed SEP and DEP. As referenced in the chapter, the Applicant has included an **Outline Offshore Operations and Maintenance Plan (Revision C)** (document reference 9.9) with the DCO application to confirm the details of the O&M works.
NE_070	Volume 1 Chapter 5 Project Description Section: 5.4.12 209 Comment: Natural England welcomes the intention for decommissioning. However, further rationale for scour and cable protection left in-situ should be provided. If exposed, this would result in permanent habitat loss. If buried, there is rationale for leaving in-situ to avoid habitat disturbance. Recommendation: Further clarification should be provided here.	Further detail has been added to **Section 4.4.13** to clarify the proposals for the decommissioning of external cable protection.
NE_072	Volume 1 Chapter 5 Project Description Section: 5.5.2 230 Comment: It is Natural England's preference that from the HDD exit point, cables are buried to avoid permanent loss of habitat from cable protection, thus minimising impact to the MCZ.	Noted. Both options need to be retained in the envelope pending completion of the detailed design studies. This has been clarified in the text at **Section 4.5.2.**

Reference	Comment made	Response and where addressed in the ES
	Recommendation: At the HDD exit point, cables should be buried thus minimising habitat loss within the MCZ.	
NE_073	Volume 1 Chapter 5 Project Description Section: 5.5.2 238 / Table 5-29. 245 Table 5-30 Comment: Natural England re-emphasise that, if both projects are consented, but proposed to be built sequentially, the Applicant should pursue their commitment that any infrastructure along the shared cable routes should be installed simultaneously. This will minimise any ecological impact to the MCZ and visual impacts to the North Norfolk AONB from the infrastructure installation. Recommendation: The Applicant should seek to provide confirmation that works along the shared routes will be undertaken when construction of the first of the two projects begins.	The Applicant notes the recommendation. The development scenarios and need for flexibility is detailed in the **Scenarios Statement** [APP-314].
NE_074	Volume 1 Chapter 5 Project Description Section: 5.6.1.3 249 Comment: As above, with the anticipated time frame of 24 months (single project or concurrent) and a further 24 months if sequential, Natural England advise the Applicant to pursue their commitment that any shared cable routes should be installed simultaneously. This will minimise any ecological and visual impact along with disturbance to the community and infrastructure. Recommendation: See above comments/recommendations	The Applicant notes the recommendation. The development scenarios and need for flexibility is detailed in the **Scenarios Statement** [APP-314].

Reference	Comment made	Response and where addressed in the ES
NE_075	Volume 1 Chapter 5 Project Description Section: 5.7.1 Plates 5-23 and 5-24 Comment: If both DEP and SEP OWF projects are consented, Natural England re-iterate the benefits of installing infrastructure where the routes and locations are shared so that when construction of the first project begins, the second is installed simultaneously. This will significantly reduce the construction time and significantly reduce ecological and visual impacts for these projects. Recommendation: See above comments/recommendations	The Applicant notes the recommendation. The development scenarios and need for flexibility is detailed in **Scenarios Statement** [APP-314].
NE_677	Annex 12 All Other Matters Natural England has general comments in regards to monitoring that are provided below to help inform the In Principle Monitoring Plan (IPMP) to be submitted at the time of the Application. Table 12.1 - In Principle Monitoring Plan Comments General Comment General Comment Natural England has concerns that SEP and DEP may be operational at different times which would have an effect on post-construction monitoring i.e. when would post-construction monitoring begin? Does the post-construction monitoring start when the last project becomes operational, or the first one? What if there are long periods of time (i.e. years) between this? Recommendations Natural England advises that a good IPMP should: 1. Provide a brief background/overview of the proposed OWF project at the start of the	Noted – this approach has been reflected in the **Offshore In-Principle Monitoring Plan (IPMP)** submitted with the DCO application [APP-289].

Reference	Comment made	Response and where addressed in the ES
	document, which will be updated as the project design is refined, to ensure that the monitoring remains fit for purpose. 2. Clearly set out what the uncertainties, residual concerns, and evidence gaps to be monitored. 3. Provide outlines of questions/hypotheses that should be answered/tested through monitoring. 4. Provide the reader of the IPMP with an indication – albeit in-principle at this consenting stage – of where the project considers their monitoring should be focussed (the 'what') and what this should achieve (the 'why') 5. The IPMP should provide the framework for the monitoring i.e. outline numbers of surveys, timings and duration, but other topic-specific monitoring documents should provide the finer details regarding how the monitoring will be carried out e.g. Ornithological Monitoring Plan (OMP). 6. The above should be clearly presented, for instance, with a table summarising the proposed in-principle monitoring for each topic. The inclusion of 'headline reasons for monitoring' and 'monitoring proposal' within the tables are helpful. 7. Where appropriate, the IPMP should identify potential routes to achieving strategic level monitoring in collaboration with others i.e. ORJIP in order to address project specific concerns. 8. The IPMP should commit to looking for opportunities to maximise monitoring outputs through working with other developers/ projects/stakeholders. 9. There should be alignment with any monitoring associated with compensatory measures needed by the project. For example, there is a requirement for Hornsea Project 3 to design and deliver monitoring of the compensatory measures in the Kittiwake Implementation and Monitoring Plan (KIMP) in addition to the ornithology monitoring included with their IPMP. 10. But most of all, the IPMP should be focussed on monitoring options which are most likely to provide the required evidence to better understand the uncertainties in the impact assessment. 'Monitoring for monitoring's sake' should be avoided, and in some instances lessons should be learnt from monitoring at other projects rather than just repeating studies.	

Reference	Comment made	Response and where addressed in the ES
NG_002	National Grid infrastructure within / in close proximity to the order boundary: Electricity Transmission National Grid Electricity Transmission has high voltage electricity overhead transmission lines and a high voltage substation cables within the onshore scoping area. The overhead lines and substation form an essential part of the electricity transmission network in England and Wales. Substation • Norwich Main Substation Overhead Lines • 4VV 400kV Norwich Main to Walpole 1 and 2 • 4YM 400kV Bramford to Norwich Main 1 and 2 • PGG 132kV Norwich Main to Norwich Trowse 3 • PHC 132kV Norwich Main to Norwich Trowse 1	These assets have been taken into account in the site selection and project design of SEP and DEP.
NG_003	The following points should be taken into consideration. Electricity Infrastructure: ▪ National Grid's Overhead Line is protected by a Deed of Easement/Wayleave Agreement which provides full right of access to retain, maintain, repair and inspect our asset Statutory electrical safety clearances must be maintained at all times. Any proposed buildings must not be closer than 5.3m to the lowest conductor. National Grid recommends that no permanent structures are built directly beneath overhead lines. These distances are set out in EN 43 – 8 Technical Specification for "overhead line clearances Issue 3 (2004) available at: http://www.nationalgrid.com/uk/LandandDevelopment/DDC/devnearohl_final/appendixIII/appIII-part2 ▪ If any changes in ground levels are proposed either beneath or in close proximity to our existing overhead lines then this would serve to reduce the safety clearances for such overhead lines. Safe clearances for existing overhead lines must be maintained in all circumstances. ▪ Further guidance on development near electricity transmission overhead lines is available here: http://www.nationalgrid.com/NR/rdonlyres/1E990EE5-D068-4DD6-8C9A-4D0B06A1BA79/31436/Developmentnearoverheadlines1.pdf ▪ The relevant guidance in relation to working safely near to existing overhead lines is contained within the Health and Safety Executive's (http://www.hse.gov.uk/) Guidance Note GS 6 "Avoidance of Danger from Overhead Electric Lines" and all relevant site staff should make sure	The Applicant is seeking crossing agreements with National Grid where any National Grid asset is to be crossed. The Applicant is also liaising with National Grid on the protective provisions which are included within the **Draft DCO (Revision H)** (document reference 3.1) to benefit National Grid.

Reference	Comment made	Response and where addressed in the ES
	that they are both aware of and understand this guidance. ▪ Plant, machinery, equipment, buildings or scaffolding should not encroach within 5.3 metres of any of our high voltage conductors when those conductors are under their worse conditions of maximum "sag" and "swing" and overhead line profile (maximum "sag" and "swing") drawings should be obtained using the contact details above. ▪ If a landscaping scheme is proposed as part of the proposal, we request that only slow and low growing species of trees and shrubs are planted beneath and adjacent to the existing overhead line to reduce the risk of growth to a height which compromises statutory safety clearances. ▪ Drilling or excavation works should not be undertaken if they have the potential to disturb or adversely affect the foundations or "pillars of support" of any existing tower. These foundations always extend beyond the base area of the existing tower and foundation ("pillar of support") drawings can be obtained using the contact details above ▪ National Grid Electricity Transmission high voltage underground cables are protected by a Deed of Grant; Easement; Wayleave Agreement or the provisions of the New Roads and Street Works Act. These provisions provide National Grid full right of access to retain, maintain, repair and inspect our assets. Hence we require that no permanent / temporary structures are to be built over our cables or within the easement strip. Any such proposals should be discussed and agreed with National Grid prior to any works taking place. ▪ Ground levels above our cables must not be altered in any way. Any alterations to the depth of our cables will subsequently alter the rating of the circuit and can compromise the reliability, efficiency and safety of our electricity network and requires consultation with National Grid prior to any such changes in both level and construction being implemented.	
NG_005	The following points should be taken into consideration. Gas Infrastructure ▪ National Grid has a Deed of Grant of Easement for each pipeline, which prevents the erection of permanent / temporary buildings, or structures, change to existing ground levels, storage of materials etc. Pipeline Crossings: • Where existing roads cannot be used, construction traffic should ONLY cross the pipeline at previously agreed locations. • The pipeline shall be protected, at the crossing points, by temporary rafts constructed at ground level. The third party shall review ground conditions, vehicle types and crossing frequencies to determine the type and construction of the raft required. • The type of raft shall be agreed with National Grid prior to installation.	The Applicant is seeking crossing agreements with National Grid where any National Grid asset is to be crossed. The Applicant is also liaising with National Grid on the protective provisions which are included within the **Draft DCO (Revision H)** (document reference 3.1) to benefit National Grid.

Reference	Comment made	Response and where addressed in the ES
	• No protective measures including the installation of concrete slab protection shall be installed over or near to the National Grid pipeline without the prior permission of National Grid. • National Grid will need to agree the material, the dimensions and method of installation of the proposed protective measure. • The method of installation shall be confirmed through the submission of a formal written method statement from the contractor to National Grid. • Please be aware that written permission is required before any works commence within the National Grid easement strip. • A National Grid representative shall monitor any works within close proximity to the pipeline to comply with National Grid specification T/SP/SSW22. • A Deed of Consent is required for any crossing of the easement Cable Crossings: • Cables may cross the pipeline at perpendicular angle to the pipeline i.e. 90 degrees. • A National Grid representative shall supervise any cable crossing of a pipeline. • Clearance must be at least 600mm above or below the pipeline. • Impact protection slab should be laid between the cable and pipeline if cable crossing is above the pipeline. • A Deed of Consent is required for any cable crossing the easement. • Where a new service is to cross over the pipeline a clearance distance of 0.6 metres between the crown of the pipeline and underside of the service should be maintained. If this cannot be achieved the service shall cross below the pipeline with a clearance distance of 0.6 metres.	
NG_006	General Notes on Pipeline Safety: • You should be aware of the Health and Safety Executives guidance document HS(G) 47 "Avoiding Danger from Underground Services", and National Grid's specification for Safe Working in the Vicinity of National Grid High Pressure gas pipelines and associated installations - requirements for third parties T/SP/SSW22. • National Grid will also need to ensure that our pipelines access is maintained during and after construction. • Our pipelines are normally buried to a depth cover of 1.1 metres however; actual depth and position must be confirmed on site by trial hole investigation under the supervision of a National Grid representative. Ground cover above our pipelines should not be reduced or increased. • If any excavations are planned within 3 metres of National Grid High Pressure Pipeline or, within 10 metres of an AGI (Above Ground Installation), or if any embankment or dredging works are proposed then the actual position and depth of the pipeline must be established on site in the presence of a National Grid representative. A safe working method agreed prior to any work	The Applicant is seeking crossing agreements with National Grid where any National Grid asset is to be crossed. The Applicant is also liaising with National Grid on the protective provisions which are included within the **Draft DCO (Revision H)** (document reference 3.1) to benefit National Grid.

Reference	Comment made	Response and where addressed in the ES
	taking place in order to minimise the risk of damage and ensure the final depth of cover does not affect the integrity of the pipeline. • Excavation works may take place unsupervised no closer than 3 metres from the pipeline once the actual depth and position has been confirmed on site under the supervision of a National Grid representative. Similarly, excavation with hand held power tools is not permitted within 1.5 metres from our apparatus and the work is undertaken with NG supervision and guidance.	
NG_007	General Notes on Pipeline Safety: • You should be aware of the Health and Safety Executives guidance document HS(G) 47 "Avoiding Danger from Underground Services", and National Grid's specification for Safe Working in the Vicinity of National Grid High Pressure gas pipelines and associated installations - requirements for third parties T/SP/SSW22. • National Grid will also need to ensure that our pipelines access is maintained during and after construction. • Our pipelines are normally buried to a depth cover of 1.1 metres however; actual depth and position must be confirmed on site by trial hole investigation under the supervision of a National Grid representative. Ground cover above our pipelines should not be reduced or increased. • If any excavations are planned within 3 metres of National Grid High Pressure Pipeline or, within 10 metres of an AGI (Above Ground Installation), or if any embankment or dredging works are proposed then the actual position and depth of the pipeline must be established on site in the presence of a National Grid representative. A safe working method agreed prior to any work taking place in order to minimise the risk of damage and ensure the final depth of cover does not affect the integrity of the pipeline. • Excavation works may take place unsupervised no closer than 3 metres from the pipeline once the actual depth and position has been confirmed on site under the supervision of a National Grid representative. Similarly, excavation with hand held power tools is not permitted within 1.5 metres from our apparatus and the work is undertaken with NG supervision and guidance.	The Applicant is seeking crossing agreements with National Grid where any National Grid asset is to be crossed. The Applicant is also liaising with National Grid on the protective provisions which are included within the **Draft DCO (Revision H)** (document reference 3.1) to benefit National Grid.
NFU_002	2. HVAC Cables The NFU has noted that it has been stated that the decision is to go HVAC and that the cables may be either installed in ducts or trenches as highlighted in the Project Description. The NFU would like to understand why the cables cannot be HVDC and it believes that the cables should be installed using ducts. This would then enable the cables if they were built in stages to be pulled through the ducts. The benefits of HVDC are clear. Our clients feel that every effort should be made to enable an HVDC solution to be adopted to minimise the onshore impacts including environmental, land out	For longer cable systems HVAC technology usually requires the introduction of a cable relay station or booster station along the onshore cable corridor. The inclusion of this element often represents a greater overall environmental impact compared to options that do not require the booster station. SEP and DEP can be delivered using HVAC technology without the need for a booster

Reference	Comment made	Response and where addressed in the ES
	of production and the wider social and economic issues. The cost of an HVDC system must not be the deciding factor on the selection of the technology chosen.	station (due to the relatively short length of cables offshore) and as such there is no significant difference in terms of environmental impact when comparing the buried cable systems alone. SEP and DEP cables would be installed in ducts.
NFU_004	4. Onshore cable corridor parameters It has been stated in the Table 5.30, paragraph 245 in the Project Description that the scheme could either have cables laid in isolation for Sep and Dep or concurrent or sequential. To reduce the impact on agricultural land and farm businesses the NFU believes that it is imperative that the cables are laid concurrent. The impact due to the time it will take to lay the cables in isolation or sequential is too long. Two periods of 24months for construction to lay the cables will have far to great an impact and inconvenience on the running of the agricultural businesses. This is also exacerbated by the fact that the haul road and compound sites would be taken up and laid again when the second project started a year later. It is stated in the Chapter 21: Agriculture, that the maximum construction time could be 7 years if the projects are built independently. The impact of a linear scheme with land being out of production for 7 years is too great. The NFU would not want to see the Sep and Dep scheme receiving a DCO to construct over this time frame.	The intention is to reduce environmental impacts by delivering the Projects at the same time. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case impacts are considered the various build out scenarios have been assessed, including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
NFU_010	10. Joint Bays It is stated that joint bays will be at least 1m below the ground. The NFU would like to see joint bays being 1.2m below the ground surface to reduce interference with agricultural operations.	The Applicant has now committed to a joint bay depth of at least 1.2m below ground.
NNDC_007	5.7 Construction Programme In respect on onshore, you have indicated that pre-construction works are expected to take place from 2024. The main pre-construction activities are noted below and would be applicable to the onshore substation and works to install the onshore export cables: 8 • 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	The intention is to reduce environmental impacts by delivering the Projects at the same time. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case

Reference	Comment made	Response and where addressed in the ES
	substation, which requires an understanding of the existing agricultural drainage environment; • 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 Norfolk Historic Environment Services. You have indicated that the earliest construction start date for the main works is expected to be 2025 and the latest is 2028. In terms of hours of working you have indicated that onshore construction (landward of mean low water) would normally only take place between: • 0700 hours and 1900 hours Monday to Friday, and 0700 hours to 13.00 hours on Saturdays. Outside of these hours you have indicated that 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; and • Delivery of abnormal indivisible loads that may otherwise cause congestion on the local road network. NNDC would be happy to work with Equinor to agree a Code of Construction Practice and Construction Hours so that construction activities are appropriately managed in the wider public interest. The indicative construction programmes are noted. Whilst it is understood that project progression will be dependent on funding commitments, NNDC would again strongly suggest that both SEP and DEP are completed together as a single project so as to reduce the period for construction disruption. Consideration also should be given to ducting both projects at the same time to further reduce the construction disturbance and reduce the risk of damage to any mitigation planting and biodiversity net gain to be delivered.	impacts are considered the various build out scenarios have been assessed, including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
NNDC_034	Other Matters In the presentation of the project and consideration of cumulative impacts, NNDC would welcome the provision of mapping data to show the location of DEP and SEP together with routes for Ørsted Hornsea Project Three and relevant parts of Vattenfall Norfolk Vanguard and Vattenfall Norfolk Boreas. Consideration of these projects together including construction compounds and traffic routes will be important matters to assess in the event that all projects occur across similar and overlapping construction timeframes.	A figure showing the location of projects considered within the cumulative impact assessment is included in **Chapter 5 EIA methodology** (**Figure 5.1**) [APP-118].

Reference	Comment made	Response and where addressed in the ES
OHPT_002	1.2 Landfall 1.2.1 We note the offshore cable route and landfall locations are in close proximity to Hornsea Three. Further discussion on planned works will be needed and Orsted welcomes sight of further information and assessment (including close consideration of overlap in project programmes) and is keen to engage with Equinor further on these points.1.2.2 We note the large onshore PEIR cable corridor boundary area at the cable landfall location overlaps with the onshore Order limits of Hornsea Three. There are several areas of potential impact to Hornsea Three, for example, the potential for Equinor to locate 'temporary works' over Hornsea Three's laid cables and suggest Equinor's landfall design must be refined to avoid causing a material impact to Hornsea Three so that the location of both permanent, and where possible temporary activities are moved further to the east away from the Hornsea Three onshore landfall area. 1.2.3 With regard to interactions with Hornsea Three's accesses around the landfall area, Equinor's landfall connection works also interact with Hornsea Three's landfall access to the beach. Here, Hornsea Three has both temporary and permanent access rights, from Weybourne Road and into the area shown as 'Temporary works (contingency)' on Equinor's PEIR Onshore Works Plans. 1.2.4 Orsted welcomes further amendments and consultation on boundary refinements including clarity on planned work in this area to ensure effective cooperation and no material impact to any Hornsea Three Project pre-construction, construction or operational activities will take place.	The Order Limits at the landfall have been refined since PEIR. The only areas where SEP and DEP now overlap with Hornsea Project Three, at the landfall, is a narrow strip south of the coastal path, which is required to lay out lengths of cable duct as the HDD works progress. There would be no intrusive works required at the landfall where the SEP and DEP Order limits overlap with Hornsea Project Three. Notwithstanding this, the Applicant will continue to engage with Orsted throughout the development of SEP and DEP.
OHPT_004	East of Weston Longville 1.3.2 Equinor's onshore PEIR cable boundary is planned to cross Hornsea Three's onshore export cables, east of Weston Longville. Where the Equinor cable corridor crosses Hornsea Three's cable assets, thermal studies and crossing agreement(s) will be required. Equinor has also located temporary access tracks over Hornsea Three's cables, off Morton Lane and Church Lane in this location. In addition, Equinor's access of Church Lane intersects with one of Hornsea Three's soil storage areas, and so further discussion will be required on the possible sequencing of works at this location by both projects. This will, in turn, provide clarity on where co-operation between both projects and/or changes may be required to Equinor's final Order Limits.	Equinor is in discussion with Orsted and the Hornsea Three project team. The **Draft DCO (Revision H)** (document reference 3.1) includes Protective Provisions for the benefit of Hornsea Three. A co-operation agreement is also being sought between the parties.
OHPT_005	West of Ringland 1.3.3 Further, Equinor's onshore cable corridor overlaps with Hornsea Three's cable corridor in an area west of Ringland. Orsted suggest Equinor update their final Order Limits in this location as the current configuration in this location is likely to pose a feasibility challenge.	The final SEP and DEP Order Limits now avoid any overlap with Hornsea Project Three in the area west of Ringland.
OHPT_006	South of the A47 1.3.4 South of the A47, Orsted would like to discuss further likely interactions between Equinor's	It is of Equinor understanding that the construction access North & South of

Reference	Comment made	Response and where addressed in the ES
	cable corridor and one of Hornsea Three's main compound locations. Equally, in this location Equinor's temporary access crosses over Hornsea Three's cables heading both north and south off Church Lane, and off Broom Lane. Further discussion will be required as to the possible sequencing of works, and any further protection for Hornsea Three's cables. Currently Equinor's red line boundary overlaps with the western edge of Hornsea Three's Order Limits for a considerable length south of the A47. Orsted suggests that Equinor avoids this interaction altogether through subsequent updates to Equinor's final Order Limits.	Church Lane will be directly of the carriageway and will have no impact on HS3. Access off Broom Lane will be west and will not impact HS3. The final SEP and DEP Order Limits avoids the overlap ensuring to run alongside it.
OHPT_007	Norwich Main and Equinor's proposed substation area(s): 1.3.5 Further engagement between both projects will be required in relation to the areas where Equinor's substation site(s), 'onshore cable corridor' and 'temporary works (contingency)' overlap with Hornsea Three's 400kV connection area.	Equinor is in discussion with Orsted and the Hornsea Three project team. The **Draft DCO (Revision H)** (document reference 3.1) includes Protective Provisions for the benefit of Hornsea Three. A co-operation agreement is also being sought between the parties.
OHPT_002	1.2 Landfall 1.2.1 We note the offshore cable route and landfall locations are in close proximity to Hornsea Three. Further discussion on planned works will be needed and Orsted welcomes sight of further information and assessment (including close consideration of overlap in project programmes) and is keen to engage with Equinor further on these points.1.2.2 We note the large onshore PEIR cable corridor boundary area at the cable landfall location overlaps with the onshore Order limits of Hornsea Three. There are several areas of potential impact to Hornsea Three, for example, the potential for Equinor to locate 'temporary works' over Hornsea Three's laid cables and suggest Equinor's landfall design must be refined to avoid causing a material impact to Hornsea Three so that the location of both permanent, and where possible temporary activities are moved further to the east away from the Hornsea Three onshore landfall area. 1.2.3 With regard to interactions with Hornsea Three's accesses around the landfall area, Equinor's landfall connection works also interact with Hornsea Three's landfall access to the beach. Here, Hornsea Three has both temporary and permanent access rights, from Weybourne Road and into the area shown as 'Temporary works (contingency)' on Equinor's PEIR Onshore Works Plans. 1.2.4 Orsted welcomes further amendments and consultation on boundary refinements including clarity on planned work in this area to ensure effective cooperation and no material impact to any Hornsea Three Project pre-construction, construction or operational activities will take place.	The Order Limits at the landfall have been refined since PEIR. The only areas where SEP and DEP now overlap with Hornsea Project Three, at the landfall, is a narrow strip south of the coastal path, which is required to lay out lengths of cable duct as the HDD works progress. There would be no intrusive works required at the landfall where the SEP and DEP Order Limits overlap with Hornsea Project Three. Notwithstanding this, the Applicant will continue to engage with Orsted throughout the development of SEP and DEP.

Reference	Comment made	Response and where addressed in the ES
OPC_004	2. The Location of the Main Construction Compound a) Has the current consultation made clear yet where the Main Construction Compound will be located? Oulton Parish Council note that the proposed Main Construction Compound site in Oulton is mapped as being on an agricultural field which has a boundary next to a constructed solar farm, an agricultural business, and a poultry unit. This contradicts the statement by Equinor that the site was positively considered because of the existing hardstanding. In fact hardstanding would have to be constructed. It is also directly adjacent to Hornsea Three's proposed Main Construction Compound, as well as near to residential properties, in particular one property (The Old Railway Gatehouse) which will be continuously and directly impacted by all of the proposed projects in this area. Any construction compound would have a significant adverse environmental impact with the loss of agricultural land. Oulton "Airfield" is not on the brownfield register: it is arable land in an agricultural area, which has been consistently farmed since the second World War. The title of 'RAF Oulton air base' gives the impression of a recent use as an airfield, when it was only operational during WW2 and now forms part of a historical connection with the history of Blickling Hall (National Trust) and the Estate – which is a Conservation Area. It is also an undesignated heritage asset.	The main construction compound will be located near Attlebridge on the A1067 (Fakenham Road). This decision was relayed to local communities in November 2021 and also a part of a targeted consultation exercise undertaken in January 2022.
SWARDPC_007	3. Onshore Cables 3.1 General Although most documentation and presentations refer to onshore cables being ducted there are still several places in the PEIR where reference is made to cables being simply buried in trenches without ducts. As Chapter 5.6.1.3.252 clearly refers to ducts we assume this is the proposed method of onshore cable installation. On that basis it is imperative that, should SEP and DEP be built at different times, the ducts for the second project are installed at the same time as those for the first project. This would provide some mitigation for the timescale of disruption caused by the trenching activity and would just leave less invasive "cable pulling" to be carried out for the installation of the second project if not carried out concurrently.	The intention is to reduce environmental impacts by delivering the Projects at the same time. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case impacts are considered the various build out scenarios have been assessed,

Reference	Comment made	Response and where addressed in the ES
		including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
SWARDPC_008	3. Onshore Cables 3.2 Crossing 153 (B1113) This road crossing is detailed in Appendix 5.1 as being possibly Open Cut or Trenchless (using Horizontal Directional Drilling – HDD). Given the high traffic volumes along this road, the disruption to local businesses and residents if this road is closed (given the 26+ minute proposed diversion) and the temporary cessation of a critical twice-hourly bus service between Mulbarton and Norwich, this crossing must be categorised as requiring Trenchless (HDD) installation. Due to the length of the proposed diversion, closing this road would result in extremely high levels of "rat running" through surrounding narrow lanes which are not appropriate for the traffic levels using this road at all times of day. There is no indication as to how long a road might be closed for open cut trench cable laying but, given the width and number of trenches required, and the need to reinstate a road bed up to 11/2 metres deep, this could be a significant period. It also appears that trenching across a road rather than using HDD results in the loss of at least 20 metres of hedging on either side of the road. The other alternative to closing the road or using HDD mentioned in the PEIR would be to temporarily widen the road (presumably just on one side) to allow open trenching to just beyond the centre of the widened road with single-lane, light-controlled traffic movement using the remainder of the widened road. This would obviously require much more than 20 metres of hedge to be removed and would still cause lengthy holdups and considerable "rat running" through nearby narrow country lanes (as previously noted) during peak times with traffic volumes on the B1113 of more than 800 vehicles an hour.	The Applicant has committed to cross the B1113 using trenchless crossing techniques.
SWARDPC_010	3. Onshore Cables Conclusion HDD must be the preferred method of crossing both the B1113 and Hickling Lane albeit for different reasons. The remaining crossings within the parish (148-152, 154-157) are probably manageable if open trenched, providing adequate signage and advance notice is provided and the work is completed as expeditiously as possible.	The Applicant has committed to cross the B1113 using trenchless crossing techniques.

Reference	Comment made	Response and where addressed in the ES
VWP_004	Onshore Export Cable Corridor Crossing We understand from the PEIR documentation that the DEP/SEP onshore development footprint remains unchanged from that set out in the Scoping Report, i.e. a 45-60m wide onshore cable corridor, but that a much wider study area (up to 600m wide) at the crossing of Norfolk Vanguard and Norfolk Boreas, has been presented at PEIR to allow for greater flexibility when developing options for routing in this area. VWPL have engaged with Equinor to understand proposals for this underground cable crossing. It is VWPL's understanding that Equinor propose to install the DEP/SEP cables underneath the Norfolk Vanguard and Norfolk Boreas cables at an indicative depth of 10m and a crossing angle of 90 degrees using a HDD method. VWPL will continue to engage with Equinor regarding the cable crossing, particularly with respect to advancing discussions regarding a crossing agreement. The DEP/SEP onshore cable route crosses the Norfolk Vanguard and Norfolk Boreas onshore cable route approximately 1km to the north-east of Cawston with a crossing of the B1149 (by DEP/SEP) close to the B1145/B1149 junction. Equinor should be mindful of construction traffic commitments made by Norfolk Vanguard and Norfolk Boreas along both the B1149 and B1145, as well as cumulatively with Hornsea Project Three, when they are developing their plans in this location, and VWPL welcomes the commitment in the DEP/SEP PEIR to avoid routing any construction traffic along the B1145 through Cawston.	The Applicant is mindful of the commitments made by Norfolk Vanguard and Norfolk Boreas along the B1149 and B1145. The reported traffic numbers from these projects along with Hornsea Project Three have been incorporated into the traffic cumulative impact assessment, which is presented in **Chapter 24 Traffic and Transport** [APP-110].
VWP_005	Construction Access The DEP/SEP PEIR boundary overlaps with a construction access required by Norfolk Vanguard and Norfolk Boreas. This access is required to undertake a trenchless crossing of the B1149 and represents the only means of access to the east of the B1149 to undertake the trenchless crossing outside of the wider duct installation programme. This access is also required for cable pulling operations for both Norfolk Vanguard and Norfolk Boreas post duct installation. VWPL therefore require assurances that the proposed routing of the DEP/SEP cables would not impact the construction programmes for either Norfolk Vanguard or Norfolk Boreas; both at this construction access and across the onshore cable route. We note in Chapter 5 Project Description that up to two main construction compounds and eight secondary compounds will be required for the DEP/SEP construction works, but that these have not yet been identified. However, there is a main compound site selection report included within the PEIR documentation that identifies four potential options for the main compound including RAF Oulton which is accessed from The Street at Oulton, and additionally Chapter 22 Air Quality	The Applicant will work with Vattenfall during the construction of these projects to programme works to ensure that there is no conflict with the Norfolk Vanguard and Norfolk Boreas construction. The main construction compound is near Attlebridge on the A1067 (Fakenham Road). The option at RAF Oulton was dropped following feedback during the site selection consultation exercise.

Reference	Comment made	Response and where addressed in the ES
	identifies a number of locations for secondary compounds including one on the B1149 south of Oulton. It is not clear whether these compound locations have been factored into the construction traffic derivation numbers presented in Chapter 26 Traffic and Transport of the PEIR. Equinor will need to demonstrate that positioning works compounds along the B1149 and along The Street at Oulton will not conflict with commitments made on both these routes by Norfolk Vanguard and Norfolk Boreas, in combination with Hornsea Project Three.	
WLPC_002	1. The route of the trenching for the cables. We are fully supportive of the initial proposal from the government to investigate a ring main solution which would avoid the digging of multiple trenches across Norfolk and all the associated environmental damage. However, as you made clear in the meetings the proposed timescales of the ring main will not meet those of your project. Therefore, our concern is to minimise the impact of the construction of the cable corridor on the residents and natural environment of our Parish. The proposed route through the parish follows a similar route to that of the Hornsea project and so we have the negative impact of both projects. They are on different timescales and so the noise and disruption could continue for several years. We see from the report that there will be access points to the construction route but are not clear exactly where these will be. We want these to only be from the main roads at each end of the route through the Parish, the A47 and A 1067. Any other access points would need to be accessed by single carriageway roads which are unsuitable. We object to widening of these roads as that will mean further damage to verges, hedges and wildlife. The proposed corridor through our parish is primarily across open farmland, but it does cross some hedgerows which may have established trees in them. We want to ensure that no ancient trees that are within the 60m construction corridor are removed or damaged and that all hedges are replaced as soon as possible after completion. One specific concern on the proposed route is an ancient track that runs between the end of Weston Green Road and Ringland Lane. Lining this track are a number of ancient oak trees and established hedges. This track is adjacent to the route of the proposed Western Link Road, and will provide some screening from the new road as well as being an important wildlife habitat. We are already likely to lose some ancient woodland and trees in construction of the road and therefore we want the project to drill under this track so that no trees are destroyed. In your report	A detailed exercise has been undertaken to consider all the identified access routes based on the dimensions of those roads, the existing traffic and receptors present, and the projected construction traffic. Any routes that were deemed unacceptable based on this assessment have not been included. The location of all construction accesses is shown on **Figure 4.10** and details of all wider road network that was assessed for all construction traffic is detailed in **Chapter 24 Traffic and Transport** [APP-110]. The Applicant has committed to cross the tree lined route using trenchless crossing techniques to avoid tree losses in this location.

Reference	Comment made	Response and where addressed in the ES
	there is only mention of drilling under roads but we want this added to your list. We support your stated intention to "identify good projects that deliver a positive benefit to biodiversity". We want to ensure that we get at least our fair share of these projects in our Parish and that it is not all concentrated in other Parishes along the route, or other parts of Norfolk who are less impacted. We will actively work with you and local landowners to identify suitable projects and planting schemes as well as options for improvements to footpaths and public access. We feel strongly that our parish should at least see significant compensation for the disruption that will be caused. As with the whole length of the corridor, the construction compounds and the sub-station, we want you to ensure that your commitments in the PEIR to protect the environment and minimise disturbance in the Wensum Valley are met.	
WLPC_003	2. The potential sites for the construction compounds. 4 possible sites are proposed in your report, 2 of which are in our Parish, and one in an adjacent Parish. One site in particular gives us major cause for concern, that of Woodforde Farm. It is situated on the B1535. It is not a good road with several sharp bends on it and your report mentions the possible need for some widening if chosen, which gives an indication of its inadequacy. There are some places on its length as it stands where 2 large HGV vehicles going in opposite directions cannot pass each other easily. The B1535 is the only HGV route between the A47 and the A1067 and already takes a lot of traffic cutting between the 2 routes with significantly increased noise and disturbance for the residents. We are already concerned that the construction of the A47 widening is going to further increase the traffic on this route prior to the construction of the Western Link. The junctions to the A47 and A10657 are already congested at peak times and the traffic to the compound will only make it worse. If you select this site there will be an increase in HGV and contractor traffic to and from the site. We cannot comment on how much this would be as you stated in one of our meetings that you have not done the traffic modelling. I think this is disappointing, and a major oversight given the amount of modelling you have done on all the other routes that are crossed by construction areas. We urgently want to see the data when you have done the modelling and will then	The main construction compound will be located near Attlebridge on the A1067 (Fakenham Road). The potential site at Woodforde Farm was dropped following community feedback during the site selection consultation.

Reference	Comment made	Response and where addressed in the ES
	comment further. The Woodforde Farm site is not on the construction corridor, and of the 4 sites is the furthest from it. The route from the compound to and from the corridor will involve travel back to the A47 or the A1067. We are not clear from the plans exactly where all the access points will be and are concerned that contractor traffic will choose to use the most direct routes, which are single track local lanes totally unsuitable for construction traffic. We know that signs stating “no construction traffic” are ignored, as we have a weight limit on a number of roads in the village which are already widely ignored. The village and its roads are already a rat run and totally inadequate for the volume of traffic using them and we do not want any further increase of traffic on them. Norfolk County Council Highways are well aware of this and we are having regular meetings with them to discuss what can be done to alleviate things prior to the Western Link being built. We are in contact with them to ask for their support in objecting to this site. With regards to the 2 other sites proposed on the A1067 they are far more suitable. Of the 2 the site on the A1067 Fakenham Road at Lenwade already exists with plenty of hard standing and good HGV access and is preferred. HGV construction traffic is able to access this compound without going through Norwich or using single carriageway roads, as the Norwich southern bypass and Broadland Northway can be used. The other site the A1067 Norwich Road at Attlebridge is a more greenfield site and will mean the destruction of more of the countryside for the period of construction, and for this reason we do not support it.	
WPC_002	HVAC vs HVDC • The choice of HVAC technology will have a greater footprint and impact on habitat and biodiversity than HVDC. We therefore urge Equinor to commit to HVDC.	For longer cable systems HVAC technology usually requires the introduction of a cable relay station or booster station along the onshore cable corridor. The inclusion of this element often represents a greater overall environmental impact compared to options that do not require the booster station. SEP and DEP can be delivered using HVAC technology without the need for a booster station (due to the relatively short length of cables offshore) and as such there is no significant difference in terms of

Reference	Comment made	Response and where addressed in the ES
		environmental impact when comparing the buried cable systems alone.
WPC_005	Beach/Landfall • It is critical that Equinor sticks to its commitment to use HDD for bringing the cables onshore, to minimise the impact.	The Applicant has committed to HDD at the landfall.
WPC_018	Sandy Hill Lane • Any activity on Sandy Hill Lane would have a very significant impact on a number of businesses: Breck Farm (working farm and campsite), Weybourne Forest Lodges, Kelling Heath Holiday Park, North Norfolk Railway, Clive Hay-Smith's farm. • Trenchless technology would be the preferred method. • What would the timescale and level of disruption be if trenchless drilling is use?	The Applicant has routed the onshore cables further to the east of Sandy Hill Lane to avoid direct impacts. Sandy Hill Lane will still be required for access during the works but would not result in any road closures.
WPC_019	Weybourne Woods • Equinor claims that it will use commercial forestry firebreaks or trenchless drilling, but WPC is concerned that the width of the cable corridor required will result in fragmentation of the woodland which may make it less suitable for many of the bird species in the area (notably Firecrest, Siskin, Crossbill, Tawny Owl), as well as bat species. • How wide will the easements be through the woods? • The loss of habitat would need to be mitigated if there is a reduction in tree cover as a result of the cable laying	The proposal is to cross Weybourne Woods via two HDDs, each approximately 400m long. The only tree losses would be at the central point between the two HDDs, this would require an area of approximately 100m x 50m to be subject to tree felling to accommodate a drilling compound, and would also require a permanent easement with no replacement trees. Trees would not need to be removed outside of this small compound. The Applicant has targeted a section of the woodland for the compound that has already been the subject of some commercial tree felling to minimise trees losses. Refer to **Chapter 20 Onshore Ecology and Ornithology (Revision C)** (document reference 6.1.20) and **Chapter 26 Landscape and Visual Impact Assessment** [APP-112] for further details.
WPC_020	Reinstatement of Habitat • How quickly will habitat be reinstated after the work is done? At the Stakeholder Forum in May, Equinor stated that it expects to complete approximately 1km of cable in four weeks. Will the	The approach to construction is described in **Section 4.6.1.3** which sets out that teams will typically work on 400m long

Reference	Comment made	Response and where addressed in the ES
	habitat be reinstated immediately after the trench is dug, or will there be a time lag? Obviously, tree/hedge planting needs to be done at the correct time of year to ensure success. • With 20m wide gaps being made in hedgerows, Equinor acknowledges that there will be destruction of wildlife corridors. If the gaps are replanted with whips, it will take 5-10 years from replanting before these wildlife corridors function effectively again. Equinor should therefore plant some larger specimens to allow the hedgerows to regain their former function more quickly. • What sort of aftercare will Equinor give to reinstated habitat to ensure that it establishes successfully?	sections opening up the trench at one end, installing cables in the middle and backfilling as the works move forward. In a typical week 1km of the cable corridor would have been excavated, cable ducts installed and then backfilled. Full reinstatement may take longer to allow for the replacement of hedges in the correct season etc. Also, the haul road would need to be retained to maintain access up and down the cable corridor and this would be fully reinstated at the end of the Project. Details of hedgerow reinstatement are provided in **Chapter 20 Onshore Ecology and Ornithology (Revision C)** (document reference 6.1.20).
WPC_023	Timing There are issues with construction at almost any time of the year: • The tourist season (April-October) • The low season (November-March) • Agricultural activity (year-round) • The bird breeding season (April-August) • Migratory birds (spring and autumn) • Overwintering birds (October-March)	The timing constraints are noted.
WPC_026	Separate/Joint DCO applications • While there is much reference to Equinor's preference for consenting and constructing SEP and DEP as a single project, the regularly reiterated caveat that this may not be possible due to the different plans of the two groups of shareholders, fails to give any reassurance to those who will be on the receiving end of the disruption caused by these projects. • The failure to commit to constructing both projects at the same time also undermines faith in Equinor's assertions that it is engaging with other wind farm operators and the government's Offshore Transmission Network Review. • There is some concern that Equinor will opt to put one cable through and then sell the	The intention is to reduce environmental impacts by delivering the Projects at the same time. However, the final approach to delivering the Projects will depend on future investment decisions and Government-led auctions. This requires some flexibility in the approach to constructing the Projects which are reflected in the construction scenarios. To ensure that the worst-case impacts are considered the various build

Reference	Comment made	Response and where addressed in the ES
	infrastructure on, meaning that it is almost certainly going to be in two phases, with all the additional disruption that would entail.	out scenarios have been assessed, including the sequential scenario to ensure that should impacts be unavoidable that appropriate mitigation is identified.
Section 51 advice regarding draft application documents		
PINS, May 2022	The Environmental Statement (ES) should assess 'worst case scenarios' in terms of durations and peak activities and clarify how much shorter the overall estimated construction duration is likely to be, were a sequential option to be selected. This should include consideration of the 'sequential with pre-investment' development scenario sub-option, or clarification as to how this would fit within the worst case of the other presented scenarios. This does not appear to be made clear in the draft document (in Plate 4-24 (Indicative Construction Programme) for instance). The ES should demonstrate how less adverse the effects from "lower overall peaks" with their sequential "pre-investment" development scenario sub-option would be.	To ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. Details are provided in the Realistic Worst Case Scenario section of each assessment chapter, with notes and rationale provided to explain the basis of the scenarios identified. Where relevant, additional narrative has been provided within the impact assessments, for example to explain the difference between the concurrent and sequential scenarios. Having established the realistic worst-case scenarios in this manner, the Applicant does not consider it necessary to undertake further assessment of "less adverse effects".
PINS, May 2022	The Applicant should ensure that the project description in the ES describes in detail the different 'worst-case' scenarios for each of the potential development options to clearly demonstrate that all potential environmental effects have been fully assessed. The ES should describe and assess the impacts resulting from staggered construction and the potential for one extension project to be operational whilst the other is constructed for instance.	See above. The ES considers both the concurrent and sequential scenarios and therefore accounts for the possibility that one extension project could be operational whilst the other is under construction.

Reference	Comment made	Response and where addressed in the ES
PINS, May 2022	The offshore Order Limits include the area of the existing Dudgeon Offshore Wind Farm (DOW), as shown on Figure 4.3. DOW has been included alongside a provision in the Draft DCO (document reference 3.1) to amend the Section 36 Consent for DOW (reference 12.04.09.04/227C) to enable the release of environmental 'headroom'… as a result of DOW not having been built out to its full consented capacity. The Applicant's response to Natural England comments (NE_034) on the Preliminary Environmental Information Report (PEIR) considers that the intended approach to environmental 'headroom' described in Section 4.1.3 of the ES (unchanged from the PEIR) is appropriate. The Applicant states they sought legal advice on this matter and consulted BEIS on the appropriate mechanism. The ES should fully clarify the extent to which this matter has been fully resolved to the point that it has been relied upon as part of the assessments in the ES.	Further details of the relevant DCO provisions relating to headroom are contained within the **Explanatory Memorandum (Revision D)** [REP2-013].

4.3 Overview of the Project

48. SEP will consist of between 13 and 23 wind turbines, each having a rated electrical capacity of between 15MW and 26MW. DEP will consist of between 17 and 30 wind turbines, each having a rated electrical capacity of between 15MW and 26MW. Taken together, there will be between 30 and 53 wind turbines. The locations of the SEP and DEP wind farm sites and offshore cable corridors are shown on **Figure 4.2**.

49. Depending on the development scenario (**Section 4.1.1**), the wind farm sites will be connected to one another via interlink cables, with either a single OSP in the SEP wind farm site serving both SEP and DEP, or one OSP in the SEP wind farm site and a second in the DEP North array area. An offshore export cable corridor will link the wind farm site/s with the cable landfall at Weybourne. An onshore cable corridor will link the landfall with the grid connection point at the existing Norwich Main substation, via a new HVAC onshore substation. An HVAC transmission system will be used for the transmission of the power from the wind farm site/s to the onshore substation.

50. An overview schematic of the key onshore and offshore project infrastructure is provided in **Plate 4-1**.

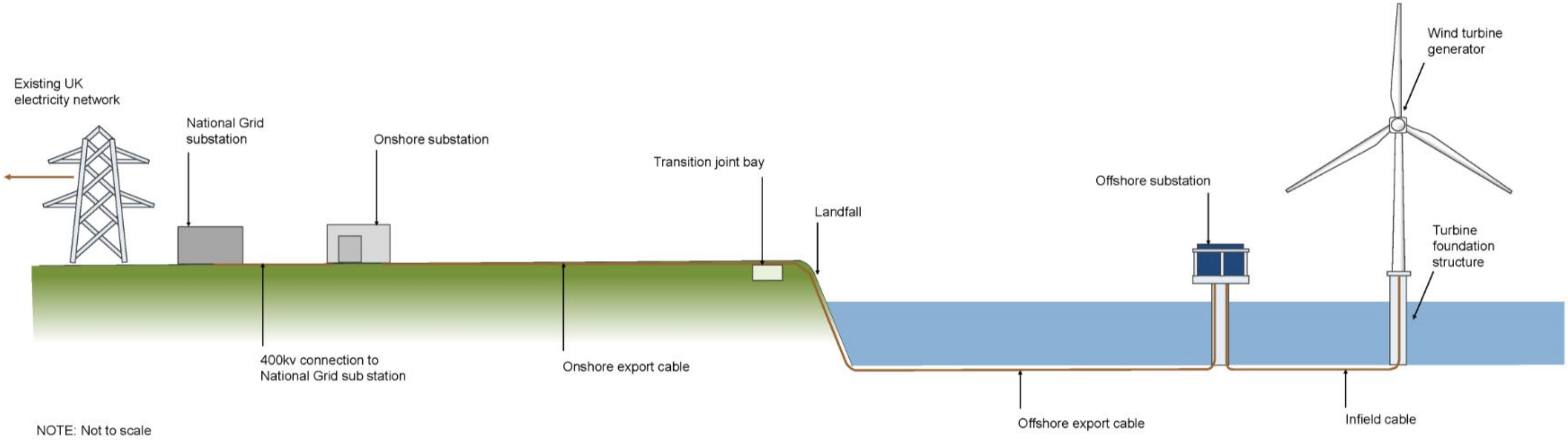

Plate 4-1: Project overview schematic (N.B. not to scale).

51. The earliest that construction could commence under any scenario is anticipated to be 2025, with the onshore construction works likely to commence first. **Section 4.7** provides an indicative construction programme for each development scenario, for both the offshore and onshore works.

4.3.1 Key Project Components

52. The following section provides an overview of the key offshore and onshore project components which are described in further detail in **Sections 4.4** to **4.6**.

53. The key offshore components are:

- Offshore wind turbines and their associated foundations;
- OSP/s and their associated foundations;
- Scour protection around foundations;
- Subsea cables comprising:
  - Offshore export cables (linking the OSP/s to the landfall)
  - Interlink cables (linking two separate project areas)
  - Infield cables (linking the wind turbine generators to the OSP/s)
  - External cable protection on subsea cables as required
  - Fibre optic communications cables integrated with the power cables
- Temporary working areas.

54. The key components at the landfall are:

- Up to two ducts (one per Project) installed under the cliff by HDD. An additional drill per Project is included (four in total) in the impact assessment worst-case scenarios where applicable, for contingency purposes in the unlikely event of HDD failure; and
- Up to two transition joint bays to house the connection between the offshore and onshore cables.

55. The key onshore components are:

- Ducts installed underground to house the electrical cables along the onshore cable corridor;
- Onshore cables installed within ducts;
- Joint bays and links boxes installed along the cable corridor;
- Trenchless crossing zones at certain locations such as some roads, railways and sensitive habitats (e.g. rivers of conservation importance);
- Temporary construction compounds and accesses;
- An onshore substation and onward 400kV connection to the existing Norwich Main substation; and
- Permanent operational substation access.

4.4 Offshore

4.4.1 Offshore Scheme Summary

56. A summary of the key elements of the offshore infrastructure is provided in **Table 4.5**. The parameters presented for SEP and DEP combined represent the maximum possible however this may be less depending on the development scenarios as described in **Section 4.1.1**.

Table 4.5: Offshore Scheme Summary

Parameter	Details		
	DEP	**SEP**	**Combined**
Lease period (years)	50	50	50
Indicative construction duration (years) (excluding landfall works)	2	2	4 (max. gap of 4 years between SEP and DEP, start to start)
Anticipated design life (years)	40	40	40
Number of wind turbines	17-30	13-23	30-53
Wind farm site area (array) (km2)	114.75	97.0	211.75
Closest point from wind farm site to coast (km)	26.5	15.8	n/a
Maximum length of export cable SEP to landfall (per cable) (km)	n/a	40	n/a
Maximum length of export cable DEP to landfall[1] (per cable) (km)	62	n/a	62
Maximum number of export cables and trenches	1 & 1	1 & 1	2 & 2
Maximum total length of all interlink cables (km)	66	n/a	154[2]
Maximum turbine rotor diameter (m)	300	300	300
Maximum tip height above Highest Astronomical Tide (HAT) (m)	330	330	330
Minimum clearance (air gap) above HAT (m)	30	30	30
Rotor swept area (km2)	1.20-1.30	0.92-1.00	2.12-2.30
Indicative minimum and maximum separation between wind turbines (inter-row) (km)	1.05-3.3	1.05-3.3	1.05-3.3
Maximum infield cable length (not incl. interlink cables) (km)	135	90	225

Parameter	Details		
	DEP	**SEP**	**Combined**
Wind turbine foundation type options	Piled monopile; Suction bucket monopile; Piled jacket; Suction bucket jacket; and Gravity base structure (GBS).		
Met masts	0	0	0
Maximum number of OSPs	1	1	2
OSP foundation type options	Piled jacket; or Suction bucket jacket.		

[1] Applies either to a DEP in isolation development scenario, or for SEP and DEP with a separate OSP in the DEP North array area.

[2] Applies to the scenario with one OSP in the SEP wind farm site and assuming only the DEP North array area is developed – see **Section 4.4.7.2** for further details.

4.4.1.1 Maximum Spatial Footprints of Offshore Infrastructure

57. The spatial footprints caused by the construction or decommissioning works (generally assessed as temporary footprints) as well as those caused for the duration of the lifetime of the wind farms during operation are summarised in the following sections. 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 up to 19 18MW wind turbines with GBS foundations at SEP and 24 18MW wind turbines GBS foundations at DEP (and all with maximum scour protection), which is the scenario with the largest overall footprint on the sea bed during operation.

58. An offshore temporary works area has been defined around the wind farm sites and offshore cable corridors (see **Figure 4.2** and **Section 4.4.8**). Sea bed disturbance from vessel anchors and jack-up vessels could occur within the offshore temporary works area however no permanent infrastructure would be installed within it.

4.4.1.1.1 Temporary Construction Footprint

59. **Table 4.6** describes the maximum temporary construction footprints in the wind farm sites and cable corridors. This includes sea bed preparation for foundation installation and cable installation.

Table 4.6: Maximum temporary construction footprints in the Wind Farm Sites and Offshore Cable Corridors. Activities with an Asterisk (*) Denote those for which the Footprint May Extend into the Offshore Temporary Works Area (see Works Plans (offshore) (document reference 2.7)). Other Activities' Footprints would not Extend into the Offshore Temporary Works Area

Activity	Worst-case scenario description	Footprint – DEP (m^2)	Footprint – SEP (m^2)	Footprint – combined (m^2)
Sea bed preparation – wind turbines	24 (DEP) and 19 (SEP) 18MW wind turbines on GBS foundations	72,457	57,362	129,820
Jack-up vessel footprint – wind turbine and OSP installation*	30 (DEP) and 23 (SEP) 15MW wind turbines and 2 OSPs.	74,400	57,600	132,000
Anchoring footprint – wind turbine and OSP installation*	30 (DEP) and 23 (SEP) 15MW wind turbines and 2 OSPs.	22,320	17,280	39,600
Sea bed preparation – OSP/s	Not required	0	0	0
Pre-lay grapnel run (PLGR) (all cables)	Up to 3m disturbance width but encompassed by footprint of cable installation works (see below).	n/a	n/a	n/a
Cable corridor pre-sweeping / sandwave levelling works	Four areas as described in **Section 4.4.7.4.3**	929,719	n/a	929,719
Anchoring footprint – export cable installation*	Seven mooring lines and an anchor footprint of up to 30m², and repositioning of the mooring lines every 500m. Export cable lengths 62km (DEP), 40km (SEP) and 102km (SEP and DEP with 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area).	26,040	16,800	42,840
Anchoring footprint – interlink cable installation*	The development scenario with the greatest overall length of interlink cabling is for SEP and DEP, with 1 OSP in the SEP wind farm site (assuming only the DEP North array area is developed). Total length of 154km. Refer to **Section 4.4.7.2** for further details.	27,720	0	64,680
Boulder clearance – wind farm sites	Clearance of an estimated 20 boulders in the SEP wind farm site and 10 across the DEP wind farm site, each of up to 5m in diameter, 1m in height and accounting for both lifting and placement.	393	785	1,178

Activity	Worst-case scenario description	Footprint – DEP (m²)	Footprint – SEP (m²)	Footprint – combined (m²)
Boulder clearance – export cable corridor	Clearance of an estimated 20 boulders in the export cable corridor/s in total, each of up to 5m in diameter, 1m in height and accounting for both lifting and placement.	393	393	786
Export cable installation	1 export cable per Project: 62km (DEP), 40km (SEP) and 102km (SEP and DEP with 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area), 15m disturbance width.	930,000	600,000	1,530,000
Interlink cable installation	The development scenario with the greatest overall length of interlink cabling is for SEP and DEP, with 1 OSP in the SEP wind farm site (assuming only the DEP North array area is developed). Total length of 154km, 15m disturbance width. Refer to **Section 4.4.7.2** for further details.	990,000	0	2,310,000
Infield cable installation	Up to 135km of infield cables at DEP and 90km at SEP, 15m disturbance width.	2,025,000	1,350,000	3,375,000

4.4.1.1.2 Wind Farm Sites Lifetime Footprint

60. **Table 4.7** describes the maximum lifetime footprints in the wind farm sites. This includes the foundations, crossings and external cable protection for unburied cables.

Table 4.7: Maximum Lifetime Footprints in the Wind Farm Sites (Excluding Offshore Temporary Works Area) (Wind Turbines, OSPs and Infield Cables)

Infrastructure	Worst-case scenario description	Footprint – DEP (m²)	Footprint – SEP (m²)	Footprint – combined (m²)
Wind turbine foundations	24 18MW wind turbines at DEP and 19 at SEP, all with GBS foundations and all with scour protection	610,726	483,491	1,094,217
OSP foundations	1 OSP at each of SEP and DEP, both on a jacket foundation with suction buckets and scour protection	4,761	4,761	9,522
Infield external cable protection (unburied cables)	Total allowance of 1,000m across both Projects, up to 4m wide. Either Project may use the total allowance.	4,000	4,000	4,000

Infrastructure	Worst-case scenario description	Footprint – DEP (m²)	Footprint – SEP (m²)	Footprint – combined (m²)
Infield external cable protection (cable crossings)	7 crossings (Durango to Waveney pipeline (3); Lancelot to Bacton pipeline (2); and Shearwater to Bacton pipeline (2)). All up to 21m wide and 100m long.	14,700	0	14,700
Total	**-**	**634,187**	**492,252**	**1,122,439**

4.4.1.1.3 Offshore Cable Corridors Lifetime Footprint

61. **Table 4.8** describes the maximum lifetime footprints in the interlink and export cable corridors. This only concerns crossings and any external cable protection that may be used, including at the HDD exit.

Table 4.8: Maximum Lifetime Footprints, Interlink Cables and Export Cables

Infrastructure	Worst-case scenario description	Footprint – DEP (m²)	Footprint – SEP (m²)	Footprint – combined (m²)
External cable protection – unburied cables	Total allowance of 500m for the export cables (6m wide) and 1,500m for the interlink cables (6m wide). Either Project may use the total allowance.	12,000	3,000 (no interlink cables for SEP in isolation)	12,000
External cable protection – cable crossings	8 export cable crossings (for up to 2 export cables for SEP and DEP crossing 2 export cables for each of DOW and Hornsea Project Three) 6 interlink cable crossings (up to 3 interlink cables from the DEP South array area crossing 2 DOW export cables). All up to 21m wide and 100m long.	21,000	8,400	29,400
External cable protection – HDD exit	Based on 100m protection of each of the export cables, 3m wide	300	300	600
Total	**-**	**33,300**	**11,700**	**42,000**

4.4.1.1.4 Temporary Operation and Maintenance Footprint

62. **Table 4.9** describes the maximum temporary footprints during operation and maintenance (O&M) in both the wind farm sites and the offshore cable corridors. This includes the use of jack-up vessels for major component replacement, cable repair and cable reburial works, should they be required.

Table 4.9: Maximum Temporary O&M Footprints in the Wind Farm Sites and Cable Corridors

Activity	Worst-case scenario description	Footprint – SEP and DEP combined (m^2)
Jack-up vessel footprints for major maintenance activities (m^2/year)	Up to 10 jack-up movements per year for each of SEP and DEP (i.e. 20 in total). Jack-up vessel with a sea bed footprint of 1,200m^2 (up to four legs/spudcans, each with a footprint of up to 300m^2).	24,000
Cable repair or replacement (m^2/10 years)	One export cable repair every 10 years, up to 800m, 3m disturbance width. One interlink cable repair every 10 years, up to 800m, 3m disturbance width. Two infield cable repairs every 10 years, up to 5km each, 3m disturbance width.	34,800
Cable reburial (m^2/10 years)	Up to 200m per export cable subject to reburial works every 10 years, up to two export cables, 3m disturbance width. Reburial of 1% of up to 154km of interlink cabling every 10 years (1.54km), 3m disturbance width. Reburial of 1% of 225km of infield cabling every 10 years (2.25km), 3m disturbance width.	12,570

4.4.2 Wind Turbines

4.4.2.1 Wind Turbine Parameters

63. The project design envelope includes a range of turbines from 15MW to 26MW capacity in order to accommodate the ongoing rapid development in wind turbine technology. Accounting for this range there could be between 13 and 23 wind turbines at SEP and between 17 and 30 at DEP. Wind turbine parameters are summarised in **Table 4.10**, with key dimensions shown on **Plate 4-2**. Parameters stated for the 18+MW option throughout this chapter include the range of possible turbines between 18MW and 26MW.

Table 4.10: Key Wind Turbine Parameters

Parameter	Minimum	Maximum
Rotor diameter (m)	235	300
Rated power (MW)	15	26
Units SEP	13	23
Units DEP	17	30
Rotor swept area DEP (km^2)	1.20	1.30
Rotor swept area SEP (km^2)	0.92	1.00
Rotor swept area total (km^2)	2.12	2.30
Tip height above HAT (m)	265	330
Lower blade above HAT (the 'air gap') (m)	30	30
Rotor cut-in/cut-out wind speed (m/s)	3 to 38	3 to 38

Parameter	Minimum	Maximum
Indicative separation distance between turbines (inter-row and in-row) (expressed as a multiplication of rotor diameter)	4.5	11
Indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) (km)	1.05	3.3

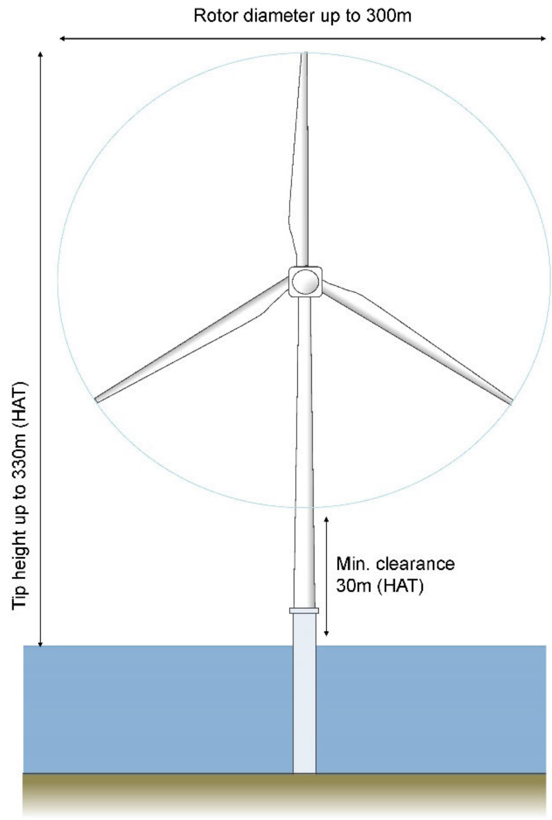

Plate 4-2: Wind turbine schematic with key maximum dimensions & minimum clearance

4.4.2.2 Wind Turbine Layout

64. The final wind turbine layout will not be finalised until completion of detailed pre-construction wind resource studies, site investigations and the selection of the preferred turbines and their foundations. A layout will be selected from within the consented parameters to optimise energy output and the foundation installation process, accounting for water depths, ground conditions, wake effects and any other constraints. A key consideration for SEP and DEP will be the relationship with the existing wind farms at SOW and DOW. The wake downstream of a turbine rotor is characterised by decreased wind speed and increased turbulence compared to the flow upstream of the rotor, and wake effects can be detected at a distance of up to 20 rotor diameters. An optimum layout will ensure that the flow in front of a wind turbine is affected as little as possible by wake effects from other wind turbines.

65. For the purposes of some ES receptor topic assessments (e.g. **Chapter 13 Shipping and Navigation** [APP-099]), an indicative wind turbine layout has been considered. **Appendix 13.1 Navigation Risk Assessment** [APP-198], sets out layout commitments informed by the Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN 654). The final wind farm layout will be submitted for approval by the MCA in consultation with Trinity House, secured by condition in the relevant deemed marine licences (DMLs) (see **Chapter 13 Shipping and Navigation** [APP-099] and **Chapter 15 Aviation and Radar** [APP-101] for further details).

4.4.2.3 Wind Turbine Installation

66. The precise details of the installation process will be confirmed prior to construction however it will follow one of the methodologies outlined below (details of the pre-installation works are given in relation to the foundations in **Section 4.4.3.1**):

- Turbine components will be loaded on to the installation vessel (typically a jack-up vessel or an anchored floating vessel) at the marshalling base port. Blades, nacelles and towers for a number of turbines are likely to be loaded separately.
- The installation vessel will then transit to the SEP and DEP wind farm sites and the components will be lifted by the vessel's crane onto the foundation or transition piece (TP) (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 will then 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 and installed by an installation vessel that remains on site throughout the installation campaign.

67. The total duration of the installation campaign/s for the wind turbines is expected to be a maximum of 6 months (this may be across different campaigns for each Project if they are developed separately).

68. 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 will make the same general movements to, from and around the wind farm sites as the installation vessels that they are supporting. See **Section 4.4.11.2** for further details of vessel types, numbers and movements.

4.4.2.4 Wind Turbine Oils, Fluids and Materials

69. 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 will be certified to the relevant standard and all wind turbines will have provision to retain any spilt fluids within the structure.

70. The required volume of oil and fluids will 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.

4.4.3 Wind Turbine Foundations

71. The following sections describe the foundation types under consideration for the wind turbines at SEP and DEP: monopiles, GBS and jackets (examples given in **Plate 4-3**), noting that monopiles and jackets may be secured to the sea bed either by piling or suction bucket), as well as details of the pre-installation works.

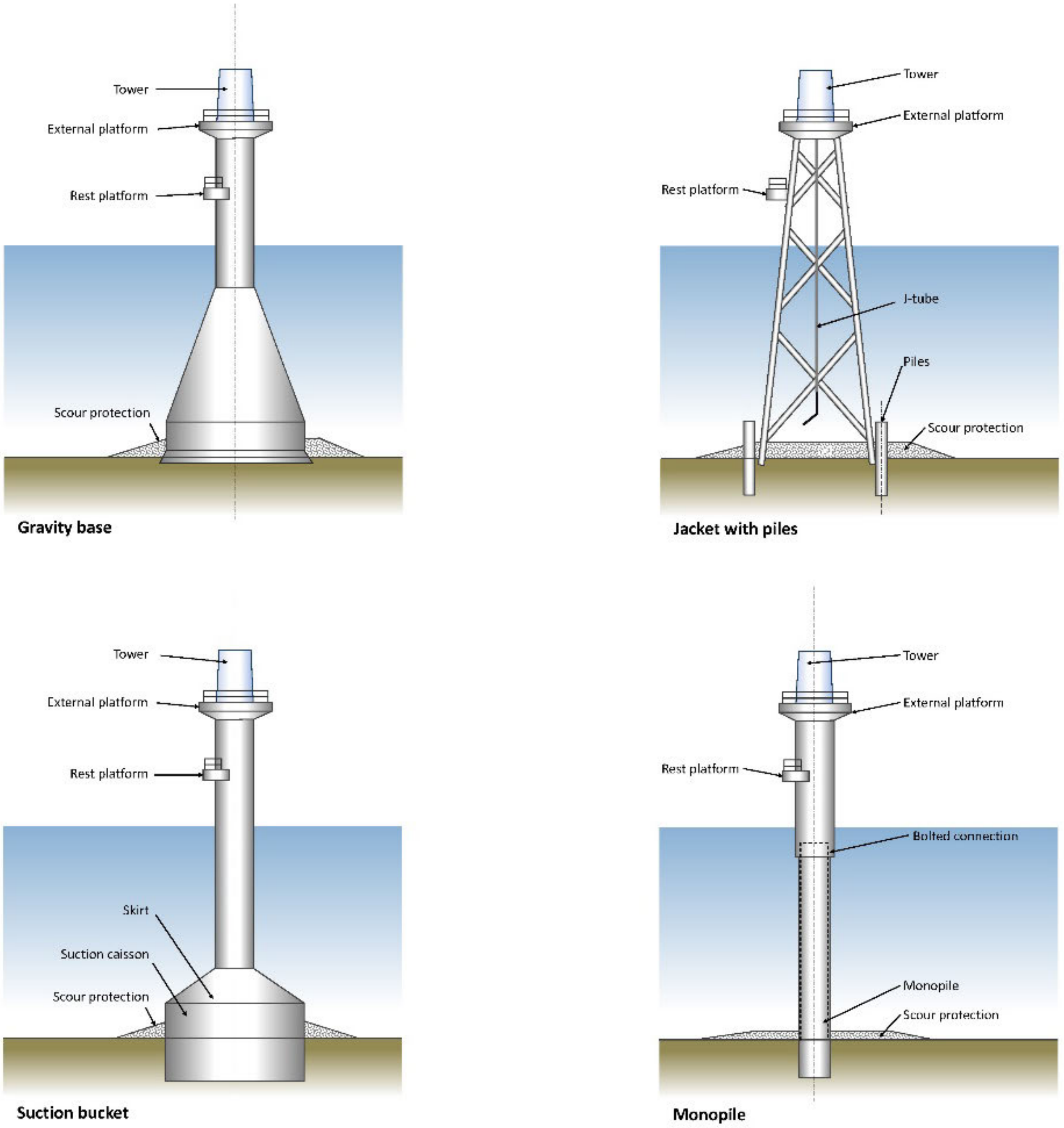

Plate 4-3: Examples of Wind Turbine Foundation Types

72. It is possible that more than one type of wind turbine foundation will be installed for SEP and DEP, 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.

73. The foundations will be manufactured at an onshore facility and most likely delivered to site as fully assembled units. 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.

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

4.4.3.1 Pre-Installation Works

75. Pre-installation works may include:

- Pre-construction surveys to confirm that the sea bed 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, sea bed preparation and for environmental monitoring purposes.
- UXO clearance requirements will be informed by the results of the pre-constructions surveys. Micro-siting will be used to avoid UXO where possible, however where this is not the case, clearance may be required to safely remove or detonate any UXO that present a hazard to the construction activities or the ongoing operation of SEP and DEP. An example of UXO from the nearby DOW is shown in **Plate 4-4**. For context, 23 historic UXO were reported as part of the post-construction monitoring for the existing DOW, comprising projectile shells, a range of air dropped bombs from 250lb up to 2,000lb and sea mines (Wessex Archaeology, 2015). Low impact techniques will be used where possible e.g. low order deflagration, noting that UXO clearance works will be the subject of a separate marine licence application/s prior to the start of construction.
- Boulder clearance – boulders that present an obstacle to the foundation installation process will be confirmed by the pre-construction surveys. The existing geophysical data suggests a relatively low number of boulders that could need to be relocated and it is likely that micro-siting around many of these will be possible. Micro-siting around boulders is the preferred option. Where this is not possible, large boulders (in the order of 5m diameter and 1m height) will be relocated to an adjacent area of sea bed within the SEP and DEP boundaries where they do not present an obstacle to the works, and where possible to an area of sea bed with similar sediment type and avoiding any known sensitive habitats such as Annex I reef. Boulder clearance will be undertaken by subsea grab. Clearance of an estimated 20 boulders in the SEP wind farm site and 10 in the DEP wind farm site, each of up to 5m in diameter, has been included in the assessments in order to be conservative. Temporary disturbance footprints are included in **Section 4.4.1.1.1** and account for both lifting and placement.
- For GBS, sea bed preparation by dredging might be required to prepare a flat area of sea bed prior to installation – see **Section 4.4.3.3.2** for further details.

Plate 4-4: Example of UXO (500lb German air dropped bomb) from DOW

4.4.3.2 Monopiles

4.4.3.2.1 Overview and Materials

76. The monopile is a large tubular structure on which a cylindrical TP can be fitted (**Plate 4-5** and **Plate 4-6**Plate 4-5: A monopile foundation being installed at DOW (Source: Equinor)

77. The pile and/or TP may be tapered or change in diameter along their length. Monopiles may be fixed to the sea bed in one of two ways: a suction bucket (caisson), or a single pile. The key parameters for monopile foundations are presented in **Table 4.11**.

78. Monopiles are fabricated from steel, with a number of secondary structures on the associated TP such as handrails, ladders, working platforms etc. that may be produced from a range of materials such as steel, concrete, aluminium, other metals and composites. The TP may be either steel or concrete.

Plate 4-5: A monopile foundation being installed at DOW (Source: Equinor)

Plate 4-6: Monopile TPs ready for mobilisation to DOW (Source: Equinor)

Table 4.11: Monopile Foundation Parameters

Parameter	15MW	18+MW
Maximum column diameter above sea surface (m)	9	14
Maximum column diameter in water column (m)	13	16
Maximum sea bed diameter (suction bucket) (m)	36	45
Max footprint per suction bucket foundation structure (m^2)	1,018	1,590
Maximum penetration (piled solution) (m)	45	50
Maximum penetration (suction bucket) (m)	18	20
Maximum pile diameter (m)	13	16
Average drill arisings per foundation (m^3)	5,973	10,053
Maximum footprint on the sea bed per foundation of scour protection (excl. foundation structure) (m^2) (assumes a suction bucket)	13,680	21,375
Maximum outer scour protection sea bed diameter (incl. foundation structure) (m) (based on 3.8 multiplied by foundation diameter and assumes a suction bucket)	137	171
Maximum area of scour protection per foundation (incl. structure footprint area) (m^2) (assumes a suction bucket)	14,698	22,966
Maximum scour protection volume per foundation (m^3) (rock) (based on scour protection depth of 3m) (assumes a suction bucket)	41,041	64,126
Maximum % requiring scour protection	100	100

4.4.3.2.2 Sea Bed Preparation

79. Monopiles would be positioned in such a way to avoid the need for sea bed preparation. If scour protection is required (see below) a filter layer would be installed prior to foundation installation to help prepare the sea bed.

4.4.3.2.3 Installation

80. Steel monopile foundations would typically be installed as follows:

- Delivery of monopile and TP to site via barge or by installation vessel. Monopiles can generally be installed with monohull floating construction vessels. Several exist in the market with the required crane capacities of 3,000 – 5,000 tonnes. Large jack-up vessels may also be used; however these have a more limited lifting capacity. It may also be possible to tow floated piles to site using tugs.
- Monopile up-ended by crane to vertical position and lowered to sea bed.

- For a piled solution, driving hammer located onto top of pile using craneage, and monopile driven to required depth. Where ground conditions are difficult, it may also be necessary to carry out drilling using drilling equipment operated from the installation vessel before completing the driving.
- Lifting of TP onto top of monopile using craneage from installation vessel, levelling of TP and grouting of connection.
- Installation of scour protection.

81. A recent development for floating construction vessels is the possibility for installation using dynamic positioning (DP), although this is dependent on suitable water depth and ground conditions and at the time of writing this is not yet common practice. Operating in DP mode negates the need for anchoring operations and helps to speed up the installation process.

4.4.3.2.3.1 Pile Driving

82. 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 will be optimised to that required for successful installation. At the time of writing, 4,000kJ spreads are available although the expectation is that larger hammers in the region of 5,000kJ to 5,500kJ may become available prior to the start of construction of SEP and DEP, and may be needed for larger diameter piles. A drivability assessment will 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).

83. At this stage, the maximum hammer energy used for monopile installation is assumed to be 5,500kJ. Each piling event would commence with a soft-start at a lower hammer energy, followed by a gradual ramp-up for at least 30 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.

84. As an alternative to traditional impact piling, the feasibility of vibration piling will also be explored pre-construction. Vibration piling is not yet a proven technique for offshore wind foundations but is included in the design envelope to allow for future technology developments. Even if feasible, it is likely that it 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.

85. The key impact piling parameters are described in **Table 4.12**. Further information describing the detailed piling parameters used to inform the assessment, including the underwater noise modelling, are provided in **Chapter 9 Fish and Shellfish Ecology** [APP-095] and **Chapter 10 Marine Mammal Ecology** [APP-096].

Table 4.12: Monopile Piling Parameters for Wind Turbine Foundations

Parameter	Value
Maximum diameter (m)	16
Maximum hammer energy (kJ)	5,500

Parameter	Value
Indicative pile depth (m)	45
Total worst-case piling time per foundation (hr) (including soft-start and ramp-up, excluding possible breakdown, drive-drill-drive, refusal, etc.)	4

4.4.3.2.3.2 Pile Drilling

86. Whilst pile driving is the most likely installation method, in the event that ground conditions prove to be unsuitable for piling, monopiles may be drilled, or both drilled and driven, into the sea bed. Unsuitable ground conditions are more likely to be associated with, for example, high density chalk or chalk rock, Botney Cut Formation (e.g. sand-rich or organic-rich sandy mud channel infills), and Egmond Ground Formation (very dense fine sand). Such ground conditions will be avoided where possible, to be confirmed through pre-construction survey and the drivability assessment.

87. As a worst-case, it is estimated that up to 5% of the wind turbine locations could need drilling i.e. up to two for each of SEP and DEP. For a 15MW turbine, requiring a drill diameter of 13m and a drill penetration depth of 45m, the amount of monopile drill arisings would be approximately 5,973m^3 per foundation, or a total of 23,892m^3 for SEP and DEP combined.

88. 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 sea bed in the immediate vicinity of each foundation (see **Chapter 6 Marine Geology, Oceanography and Physical Processes** [APP-092] for further details).

4.4.3.2.4 Scour Protection

89. Monopiles normally require rock installation for scour protection, although the exact requirements will not be confirmed until prior to the start of construction. Purpose made vessels are used to accurately install rock, which is normally completed using a fall-pipe lay system.

90. Scour protection would likely consist of two gradings of quarried rock: one for the filter layer and one for the armour layer. Rock for the outer armour layer would typically be well graded with d_{50} = 200mm to 400mm (i.e. half the stones would be less than a specified median (200mm to 400mm diameter) and half would be greater).

91. Other scour protection systems including frond systems and grouted mattresses are under development in the market and, subject to availability at the time of construction, would be evaluated for the actual design case taken forward.

92. The maximum diameter, area and volume requirements for scour protection per foundation are provided in **Table 4.11**.

4.4.3.3 Gravity Based Structures

4.4.3.3.1 Overview and Materials

93. GBS foundations typically comprise the base itself, a lower conical section and an upper cylindrical section. The shape and size can vary widely, with buoyant structures being significantly larger in size. Buoyant structures offer the advantage of being able to be floated or semi-floated to the wind farm sites with the assistance of a barge or pontoon.

94. GBS might also use a skirt at their base that penetrates the sea bed, adding stability. The penetration could vary from around 0.1m to 5m. Under base grouting may also be used to strengthen the soil beneath the foundation and to fill small voids between the foundation and the sea bed.

95. The key parameters for GBS foundations are presented in **Table 4.13**.

96. GBS are generally fabricated from steel reinforced concrete, ballasted with marine aggregate (sand). Secondary structures such as handrails, ladders, working platforms etc. may be produced from a range of materials such as steel, concrete, aluminium, other metals and composites.

Table 4.13: GBS Foundation Parameters

Parameter	15MW	18+MW
Maximum column diameter at water level (m)	11	14
Maximum diameter of GBS shaft at the sea bed (m)	30	40
Maximum sea bed diameter (base plate) (m)	45	60
Maximum penetration below mud line (m)	6	6
Maximum footprint on the sea bed per foundation (excl. scour protection) (m^2)	1,590	2,827
Maximum outer scour protection diameter at sea bed (incl. foundation structure) (m)	135	180
Maximum area of scour protection per foundation (excl. foundation structure) (m^2)	12,723	22,619
Maximum area of scour protection per foundation (incl. foundation structure) (m^2)	14,313.80	25,446.90
Maximum scour protection volume per foundation, including gravel bed (m^3) (gravel and rock) (assumes a conservative 2.5m height based on filter and armouring layer at the shallowest locations)	35,785	63,617
Maximum % GBS requiring scour protection	100	100
Maximum diameter of gravel footing per foundation (m)	47	62
Indicative volume of gravel footing per foundation (m^3) (assumes a conservative 2m height, based on very soft top layer of soil)	3,470	6,038
Maximum dredge volume for sea bed preparation, up to 5m depth (m^3)	7,952	14,137
Maximum footprint for sea bed preparation (m^2)	1,735	3,019

Parameter	15MW	18+MW
Indicative maximum volume of gravel for sea bed preparation purposes per foundation (m^3)	1,590	2,827
Maximum total volume of sea bed preparation per foundation (m^3)	9,543	16,964.60

4.4.3.3.2 Sea Bed Preparation

97. The size and weight of the GBS foundation combined with the natural variability of the sea bed within the wind farm sites result in three scenarios for potential sea bed preparation works, as follows:
    - No sea bed preparation;
    - Place a gravel pad of between 1.5m and 3m in height and 60m in diameter (bedding layer); or
    - Dredge up to 5m depth and back fill with gravel up to 1m above mudline (levelling layer).
98. Where required, dredging works are likely to be carried out using a trailer suction hopper dredger (TSHD), with the gravel installed by a dynamically positioned fall pipe vessel. Dredged sediment will be deposited in the near vicinity of each foundation, all within the SEP and DEP disposal sites (see **Disposal Site Characterisation Report (Revision B)** [REP1-019] for further details) and where possible in an area of similar sediment type and avoiding any known sensitive habitats such as Annex I reef. Sediment may either be released at or near the sea surface, or at the sea bed using a fall pipe.
99. Dimensions and volumes are given in **Table 4.13**.

4.4.3.3.3 Installation

100. GBS would be delivered to site via one of two methods, depending on the foundation design:
    - Transported to site by barge and installed by heavy lift crane (either a jack-up vessel or floating vessel); or
    - For floating types, towed to site and sunk via ballasting.
101. The overall installation methodology would typically be as follows:
    - Where necessary, undertake sea bed preparation activities as described above;
    - Transport GBS to site;
    - Mobilise heavy lift floating crane (if foundation is a non-buoyant solution);
    - Lift foundation from barge and lower to prepared area of sea bed, or adjust buoyancy of floating foundation and sink to prepared area of sea bed;
    - Install backfill as necessary; and
    - Install scour protection (details below).

4.4.3.3.4 Scour Protection

102. As described for monopiles, GBS will normally require rock installation for scour protection, although the exact requirements will not be confirmed until prior to the start of construction. For the purpose of the assessment, it is assumed that 100% of GBS will require scour protection as a worst-case. The installation methodologies and type of scour protection systems that might be used are as described in **Section 4.4.3.2.4**.

103. The maximum diameter, area and volume requirements for scour protection per GBS foundation are provided in **Table 4.13**.

4.4.3.4 Jackets

4.4.3.4.1 Overview and Materials

104. If jacket foundations are used for the wind turbines, each will have up to four legs with the footing for each leg secured to the sea bed with either a single pin pile, one suction bucket, a jack-up foot or with up to two screw piles. In the case of a single pin pile solution, the piles may be either driven or drilled, or a combination of the two.

105. The key parameters for jacket foundations are presented in **Table 4.14**.

106. Jackets are primarily fabricated from steel. Secondary structures such as handrails, ladders, working platforms etc. may be produced from a range of materials such as steel, concrete, aluminium, other metals and composites.

Table 4.14: Jacket Foundation Parameters (Wind Turbines)

Parameter	15MW	18+MW
Jacket width at LAT (m)	28	35
Maximum overall width of jacket at tower interface (m)	23	30
Maximum height of foundation main access platform floor above HAT (m)	22	22
Maximum sea bed footprint per jacket (m^2) (based on 4 suction buckets, 18m to 20m diameter), excl. scour protection	1,018	1,257
Maximum number of pin piles per jacket	4	4
Average drill arisings per jacket (m^3) (based on 3m to 4m drill diameter and 50m to 60m depth)	1,414	3,015
Maximum scour protection diameter at sea bed level, per leg (based on a suction bucket or piled design and including the foundation structure) (m)	12	14
Maximum area of scour protection per jacket (m^2) (based on a suction bucket or piled design)	3,054	3,770
Maximum sea bed footprint per jacket (m^2) (based on a suction bucket or piled design), incl. scour protection	4,072	5,027
Maximum scour protection volume per jacket (m^3) (rock) (based on 3m depth)	9,161	11,310

4.4.3.4.2 Sea Bed Preparation

107. Jacket foundations would be positioned in such a way to avoid the need for sea bed preparation. If scour protection is required (see below) a filter layer would be installed prior to foundation installation to help prepare the sea bed.

4.4.3.4.3 Installation

108. As described above, jacket foundations may be fixed to the sea bed either with pin piles (driven and/or drilled, or screw piles), jack-up footings or suction buckets. The key impact piling parameters for pin piles are described in **Table 4.15**, with further details presented in **Chapter 9 Fish and Shellfish Ecology** [APP-095] and **Chapter 10 Marine Mammal Ecology** [APP-096].

109. As described for monopiles, the feasibility of vibration piling will also be explored pre-construction, but at the time of writing remains an unproven technique for offshore wind foundations and therefore the worst-case scenario for assessment purposes is impact piling.

110. Whilst considered unlikely, in the event of drilling being required due to unsuitable ground conditions for pile driving, the jacket pin piles may be drilled or drilled-driven into the sea bed. For this purpose, it is estimated that up to 5% of the wind turbine locations could need drilling i.e. up to two for each at SEP and DEP. For a 15MW turbine, requiring a drill diameter of 3m and an average drill penetration depth of 50m, the amount of pin pile drill arisings would be approximately 1,414m^3 per jacket, or a maximum total of 5,656m^3 for SEP and DEP combined.

111. As with monopiles, 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 sea bed in the immediate vicinity of each foundation (see **Chapter 6 Marine Geology, Oceanography and Physical Processes** [APP-092] for further details).

112. Jackets are most likely to be installed using floating monohull construction vessels, with the jackets either transported and lifted directly from the vessel deck, or transported to site by barge and lifted into place by a crane vessel.

Table 4.15: Jacket Foundation Piling Parameters (Wind Turbines)

Parameter	18+ MW
Maximum pin pile diameter (m)	4
Maximum hammer energy (kJ)	3,000
Indicative pin pile depth (m)	60
Total worst-case piling time per pin pile (hr.) (including soft-start and ramp-up, and excluding possible breakdown, drive-drill-drive, refusal, etc.)	3
Total piling time per jacket (hr.) (up to 4 pin piles each)	12

4.4.3.4.4 Scour Protection

113. Scour protection may be required around the base of the foundations to protect against localised erosion of the sea bed.

114. The types of scour protection that could be used include:

- Rock or gravel placement;
- Concrete mattresses;

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

115. The installation method will depend on the scour protection system selected. Rock would be placed by dynamically positioned fall pipe vessel, whilst the other options would be more suited to the use of a smaller crane vessel or similar.

116. The maximum diameter, area and volume requirements for scour protection per jacket are provided in **Table 4.14**.

4.4.4 Offshore Substation Platform/s

117. The infield (array) cables from each string of turbines will be brought to an OSP, located appropriately to optimise the infield, interlink and export cable lengths. At the OSP, the generated power will be transformed to a higher AC voltage of up to 220kV.

118. There will be up to two OSPs, depending on how SEP and DEP are developed, as described in **Section 4.1.1**. In the case that two OSPs are constructed there will be one located in each extension area, one in the DEP North array area and one in the SEP wind farm site. In the case that one OSP is constructed it will be located in the SEP wind farm site. The location of the OSP/s will be confirmed during the detailed design process, accounting for the wind turbine layout, but will be within the Order Limits (excluding offshore temporary works area) of each wind farm site.

The basic OSP design will 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:

- High voltage (HV) power transformers;
- HV switchgear and busbars;
- Substation auxiliary systems and low voltage (LV) distribution;
- Instrumentation, metering equipment and control systems;
- Standby generators;
- Shunt reactor(s);
- Auxiliary and uninterruptible power supply (UPS) systems;
- Navigation, aviation and safety marking and lighting;
- Systems for vessel access and/or retrieval;

- Potable water supply;
- Black water separation;
- Storage (including stores, fuel, and spares); and
- Communication systems and control hub facilities.

119. It is likely that only a minor platform crane will be required and no helideck, although the design may allow for ‘lift-off’ (i.e. of equipment) by helicopter.

120. Indicative maximum design parameters (based on the scenario with a single larger OSP serving both SEP and DEP) are a topside weight up to 4,000Te, topside width up to 40m and length up to 70m (**Table 4-16**). The indicative maximum topside height is 50m above HAT. An example OSP (from DOW) is shown **Plate 4-7**.

Table 4-16: Indicative OSP Maximum Design Parameters

Parameter	Value
Topside weight (Te)	4,000
Topside width (m)	40
Topside length (m)	70
Topside height (m above HAT)	50

Plate 4-7: DOW OSP being mobilised for installation (Source: Equinor)

4.4.4.1 Offshore Substation Platform Foundations

4.4.4.1.1 Overview and Materials

121. The OSP foundation type will be a jacket, as installed, for example, at DOW (**Plate 4-8**). The jacket will have up to four legs and will be secured to the sea bed with either up to two piles at each leg, or one suction bucket (caisson) at each leg. In the case of a piled solution, the piles may be either driven or drilled, or a combination of the two. The key OSP foundation parameters are detailed in **Plate 4-8**: OSP Jacket at DOW (Source: Equinor)

122. **Table 4.17**.

Plate 4-8: OSP Jacket at DOW (Source: Equinor)

Table 4.17: OSP Foundation Parameters

Parameter	Value
Jacket width (m)	30
Jacket length (m)	30
Maximum sea bed footprint per OSP (m^2) (based on a jacket design, 12m diameter), including scour protection and the footprint of the jacket legs	4,761
Maximum number of piles per jacket	8
Average drill arisings per OSP (m^3) (based on 1 pile per OSP requiring drilling)	425

Parameter	Value
Maximum sea bed footprint per OSP (m^2) (based on a suction bucket design), including scour protection and the footprint of the suction buckets)	4,225

123. The jacket foundation will 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.

124. Some of the equipment at the OSP 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 will be monitored and filtered, top-up may be required);
- Engine oil;
- Glycol;
- Sewage and grey water;
- Lead acid contained within batteries; and
- SF6.

125. The OSP design will include self-contained bunds to collect any possible oil spill. Transfer of oil/fuel between the OSP and service vessels will follow best practice procedures, with additional procedures in place should there be a spill to the marine environment.

126. Any oil spillage would be collected in a separate oil waste tank. Both oil waste and other wastes (waste water etc.) would be brought to shore in a secure container and disposed of according to industry best practice procedures.

127. All other waste streams would be processed on the OSP or transferred to shore as required.

4.4.4.1.2 Installation

128. Topside installation may be by any of the following methods:

- Crane vessel (or vessels working together) in a single lift;
- Crane vessel (or vessels working together) in separate lifts of deck and sub-modules;
- Rail-skid transfer from a large jack-up; or
- Self-installing.

129. The jacket foundation legs may be fixed to the sea bed either with piles or suction buckets. Piling of the jacket would be as described for the wind turbine foundations (**Section 4.4.3.4**), with the key parameters (worst-case) described in **Table 4.18**. Sea bed preparation is not considered necessary for the OSP jacket foundations.

130. As with the other piled foundation solutions and whilst considered unlikely, in the event of drilling being required, the OSP jacket pin piles may be drilled or drilled-driven into the sea bed. For this purpose, it is assumed that drilling may be required for both OSPs, but only at one pile per OSP. In this manner, the amount of pin pile drill arisings would be approximately 425m^3 per OSP, or a total of 850m^3 for SEP and DEP combined (i.e. two OSPs).

131. 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 sea bed in the immediate vicinity of each foundation (see **Chapter 6 Marine Geology, Oceanography and Physical Processes** [APP-092] for further details).

Table 4.18: OSP Piling Parameters

Parameter	Value
Maximum pile diameter (m)	3.5
Maximum hammer energy (kJ)	3,000
Indicative pile depth (m)	60
Total piling time per pin pile (hr.) (including soft-start and ramp-up, excluding possible breakdown, drive-drill-drive, refusal, etc.)	3
Total piling time per jacket (hr.) (up to 8 piles each)	24

4.4.4.1.3 Scour Protection

132. Scour protection may be required around the base of the foundations to protect against localised erosion of the sea bed. The types of scour protection that could be used and installation methods are as described for the wind turbine jacket foundations (**Section 4.4.3.4**). In the case of a piled solution, a radius of scour protection of up to 12m may be required for each leg, equating to a total area of up to 4,761m^2 (including foundation structure) for all four legs. For a jacket foundation with suction buckets, a radius of scour protection of up to 11.5m may be required for each leg, equating to a total area of up to 4,225m^2 (including foundation structure) for all four legs.

4.4.5 Underwater Noise

133. A number of activities during the construction, operation and decommissioning of SEP and DEP will result in 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 **Appendix 10.2 Underwater Noise Modelling Report** [APP-192].

4.4.6 Navigation Lighting Requirements and Colour Scheme

134. With respect to lighting and marking, the wind turbines and OSP topsides will be designed and constructed to satisfy the requirements of the Civil Aviation Authority (CAA), MCA, Trinity House Lighthouse Service (THLS), and the Ministry of Defence (MoD) as required.

135. Further details including reference to the relevant guidance and regulations is presented in **Chapter 13 Shipping and Navigation** [APP-099] and **Chapter 15 Aviation and Radar** [APP-101].

136. The colour scheme for nacelles, blades and towers is expected to be RAL 7035 (light grey) and foundation steelwork RAL 1023 (traffic yellow) from HAT up to a minimum of 15m, to be determined by the relevant requirements and guidance at the time.

4.4.7 Electrical Infrastructure – Offshore Cables

137. The electrical transmission system will collect the power produced at the wind turbines and transport it to the UK electricity transmission network. The transmission system will be constructed and the ownership will 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).

138. The electrical cables that make up the offshore transmission system include:

- Offshore export cables (linking the OSP/s to the landfall); and
- Interlink cables (linking two separate wind farm areas).

139. Additionally, infield cables link the wind turbine generators to the OSP/s.

140. Each type of offshore cabling is described in the following sections.

4.4.7.1 Offshore Export Cables

141. There will be up to two HVAC offshore export cables, with each forming a circuit consisting of a 3-core power cable with an integrated fibreoptic cable. The power cable voltage will be between 220kV and 230kV, with an indicative external cable diameter of 235mm to 300mm.

142. The length of the export cables depends on the development scenario in question (**Section 4.1.1**) with lengths depending on scenario in **Table 4.19**). In the event of one OSP in the SEP wind farm site, the export cable length will be up to 40km (per cable), measured from the OSP to landfall. As such, for SEP in isolation there would be one 40km export cable between SEP and the landfall. For SEP and DEP in a one OSP scenario, there would be up to two export cables between SEP and the landfall giving a maximum total length of 80km. With a single OSP in the SEP wind farm site, the cables connecting the SEP and DEP wind farm sites would be interlink cables, which are described in **Section 4.4.7.2**.

143. For DEP in isolation, the maximum length of export cable measured from an OSP in the DEP North array area to landfall is 62km. For the SEP and DEP two OSP scenario with a separate OSP in the DEP North array area, one export cable would run from the DEP North array area to the landfall (62km) and a second export cable would run from the SEP wind farm site to the landfall (40km). Therefore, the maximum total length of export cables in this scenario would be 102km.

144. The offshore export cable/s make landfall at Weybourne, where they will be connected to the onshore cables in transition joint bays, having been installed under the intertidal zone by HDD. The landfall works are described in **Section 4.5**.

145. Each offshore export cable will be installed in a separate trench with a spacing of up to 100m between the cables, where two export cables are installed in parallel. For the purpose of the DCO application and EIA, an offshore export cable corridor which includes a temporary works area either side (see **Section 4.4.8** and **Figure 4.2**) has been defined in order to encompass both cables and the adjacent area of sea bed that may be subject to temporary works such as anchoring or the use of jack-up vessels. As such, the offshore Order Limits are designed to provide sufficient space for the cable trenches (including the potential need to micro-site the offshore export cable corridor around any sensitive features that are confirmed at the pre-construction stage), as well as all temporary works and any future operation and maintenance activities such as cable reburial or repairs (details in **Section 4.4.11**). The offshore export cable corridor is up to approximately 2,500m wide but funnels out to up to approximately 3,200m on approach to the landfall and through the CSCB MCZ. However, the area within which the export cables will be installed is up to 1,000m wide, funnelling out to approximately 1,700m wide on approach to the landfall and through the CSCB MCZ. The greater width of offshore export cable corridor on approach to landfall is designed to provide greater flexibility in the detailed routeing/micro-siting of the export cable/s at the pre-construction stage.

146. Future operation and maintenance activities such as jack-up vessel leg placement or vessel anchoring for cable reburial or repairs (details in **Section 4.4.11**) may occur anywhere within the offshore Order Limits.

147. There is no planned jointing of cables along the offshore export cable corridor as the required length of cable can be manufactured without the need for offshore joints and can be loaded onboard several installation vessels in the market with sufficient cable loading capacity.

Table 4.19: Offshore Export Cable Corridor

Parameter	Details			
	DEP in isolation	**SEP in isolation**	**SEP & DEP – 1 OSP in the SEP wind farm site**	**SEP & DEP – 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area**
Maximum length of export cable measured from OSP to landfall (per cable) (km)	62	40	40	SEP: 40 DEP: 62
Maximum length of export cable measured from OSP to landfall (all cables) (km)	62	40	80	102
Export cable corridor width outside MCZ (m)	Up to approximately 2,000			
Export cable corridor width inside MCZ to landfall (m)	Up to approximately 3,200			
Maximum number of export cables	1	1	2	2

Parameter	Details			
	DEP in isolation	**SEP in isolation**	**SEP & DEP – 1 OSP in the SEP wind farm site**	**SEP & DEP – 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area**
Maximum number of trenches	1	1	2	2
Spacing between cables in trenches (m)	n/a	n/a	Up to 100	Up to 100
Export cable operating voltage (kV)	220 – 230			

4.4.7.2 Interlink Cables

148. In the event that one OSP is constructed for SEP and DEP (in the SEP wind farm site), interlink cables will connect the DEP North array area to the SEP wind farm site, and possibly also the DEP South array area to the SEP wind farm site. If DEP is developed in isolation, an OSP will be constructed in the DEP North array area, and interlink cables would connect the DEP South array area to the DEP North array area, assuming that both DEP North and DEP South array areas are developed. The maximum number of interlink cables takes account of the maximum capacity of DEP and is based on a 15MW turbine scenario (up to 30 wind turbines). This results in a maximum of five wind turbines per cable circuit (string), with four strings from the DEP North array area and two from the DEP South array area. One additional string is added for contingency to accommodate different numbers of wind turbines (see further discussion below). Cable circuits (strings) will be optimised according to the electrical load they are required to carry, with up to three different cable dimensions being used. They will be integrated with fibre optic cables. Interlink cable parameters for each development scenario are set out in **Table 4.20**. All interlink cable lengths include a 10% contingency for final design purposes (i.e. to account for the final layout of the arrays and OSP).

149. The interlink cable voltage could be up to 132kV AC, with an indicative external cable diameter of between 110mm and 180mm. They will be integrated with fibre optic cables.

150. Each interlink cable will be installed in a separate trench with a spacing of up to 100m between the cables. For the purpose of the DCO application and EIA, interlink cable corridors including a temporary works area either side (**Section 4.4.8**) have been defined in order to encompass the interlink cables and the adjacent area of sea bed that may be subject to temporary works such as anchoring or the use of jack-up vessels (see **Figure 4.2**). As with the export cables, the Order Limits therefore provide sufficient space for the installation works, temporary works and any future operation and maintenance activities such as cable reburial or repairs (details in **Section 4.4.11**). The interlink cable corridors are between approximately 1,500 and 2,500m wide which includes an offshore temporary works area buffer of 750m either side of the area in which interlink cables will be installed. The width of the interlink cable corridors varies to account for the number of cables (**Table 4.20**).

151. For each development scenario in **Table 4.20**, the number of interlink cables includes an extra cable for contingency purposes with the maximum total number of interlink cables for any one scenario being seven. As such, under a one OSP scenario where both the DEP North and South array areas are developed, there could be:

- Up to five cables (22km in length each) between the DEP North array area and the SEP wind farm site; and
- Up to three cables (16.5km in length each) between the DEP South array area and the SEP wind farm site.

152. If the contingency is in the DEP North array area, the DEP South array area has only two cables (i.e. 5 + 2 = 7). If the contingency is in the DEP South array area, the DEP North array area has only four cables (i.e. 4 + 3 = 7).

153. The worst-case for assessment purposes is for the extra contingency cable to be from the DEP North array area, as this is the longer cable corridor. Therefore the maximum length of all interlink cables for a one OSP scenario where both the DEP North and South array areas are developed is 143km (five 22km cables from DEP North array area plus two 16.5km cables from DEP South array area). For a one OSP scenario where only the DEP North array area is developed there could be up to seven 22km long interlink cables with a total maximum length of 154km.

Table 4.20: Interlink Cable Parameters

Parameter	Details
General interlink cable parameters	
Maximum length of interlink cable from DEP North array area to the SEP wind farm site (per cable) (km)	22
Maximum length of interlink cable from DEP South array area to the SEP wind farm site (in the event of no separate OSP in the DEP North array area) (per cable) (km)	16.5
Maximum length of interlink cable from the DEP South array area to the DEP North array area (per cable) (km)	22
Interlink cable corridor width – DEP South array area to DEP North array area (m)	Up to 1,600
Interlink cable corridor width – DEP North array area to SEP wind farm site (m)	Up to 2,500

Parameter	Details
Interlink cable corridor width – DEP South array area to SEP wind farm site (m)	Up to 2,000
Maximum number of trenches	Up to 1 trench per cable
Spacing between interlink cables in trenches (m)	Up to 100
Maximum interlink cable voltage (kV)	110
SEP in isolation	
No interlink cables required for SEP in isolation	
DEP in isolation (interlink cable corridor required between the DEP North and South array areas if the DEP South array area is built out)	
Maximum number of interlink cables required	3
Total maximum length of all interlink cables (km)	66
Two OSP scenario where both the DEP North and South array areas are developed	
Same as for DEP in isolation	
Two OSP scenario where only the DEP North array area is developed	
No interlink cables required for this scenario (export cables only)	
One OSP scenario where both DEP North and South array areas are developed	
Maximum number of interlink cables from the DEP North array area to the SEP wind farm site	5
Maximum number of interlink cables from the DEP South array area to the SEP wind farm site	3
Total maximum length of all interlink cables (km)	143
One OSP scenario where only the DEP North array area is developed	
Maximum number of interlink cables from the DEP North array area to the SEP wind farm site	7
Total maximum length of all interlink cables (km)	154

4.4.7.3 Infield (Array) Cables

154. Infield cables link the wind turbine generators to the OSP/s. Cable system design will be based on radial strings from the OSP/s and connecting multiple turbines per string. The number of infield cables will be equal to the number of turbines, whilst the length of each cable, and string, will depend on the distance between the turbines and the distance between the first turbine on the string and the OSP (**Table 4.21**).

155. The infield cables will be up to 132kV AC, with an indicative external cable diameter of between 110mm and 180mm. Cable circuits (strings) will be optimised according to the electrical load they are required to carry, with up to three different cable dimensions being used. They will be integrated with fibre optic cables.

156. Each infield cable will be installed in its own trench, with the maximum length of infield cables being 225km (90km at SEP, 90km in the DEP North array area and 45km in the DEP South array area).

Table 4.21: Infield Cable Parameters

Parameter	Details		
	DEP	SEP	Combined
Maximum length of infield cables (km)	135 (90 in the DEP North array area and 45 in the DEP South array area)	90	225
Maximum number of infield circuits (strings)	6	6	15
Number of infield cables per circuit	Up to 6	Up to 6	Up to 6
Maximum infield cable voltage (kV)	132	132	132

4.4.7.4 Cable Installation Methods

4.4.7.4.1 Pre-lay Works

157. Pre-construction surveys, UXO clearance and boulder clearance (where required) will be undertaken as described for the foundations (**Section 4.4.3.1**).

158. The estimated sea bed footprint resulting from boulder clearance is included in **Section 4.4.1**. The existing geophysical data suggests a relatively low number of boulders that could need to be relocated and it is likely that micro-siting around many of these will be possible, as the preferred option. However, clearance of an estimated 20 boulders for both SEP and DEP in the export cable corridor, each of up to 5m in diameter, has been included in the assessments in order to be conservative. All boulders would be relocated within the SEP and DEP wind farm sites or offshore cable corridors (excluding temporary works areas) by subsea grab and where possible to an area of sea bed with similar sediment type and avoiding any known sensitive habitats such as Annex I reef.

4.4.7.4.2 Removal of Existing Out of Service Cables

159. The disused Stratos telecommunications cable makes landfall near Weybourne and is inside the offshore export cable corridor as it approaches the landfall (see **Chapter 16 Petroleum Industry and Other Marine Users** [APP-102] for details).

160. Where the cable corridor crosses any such cable, depending on the length of cable and burial depth, these will either be recovered from the sea bed 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 sea bed by clump weights.

4.4.7.4.3 Pre-Lay Grapnel Run

161. 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 (e.g. **Plate 4-9**). A survey vessel would be used to undertake a pre-lay grapnel run (PLGR) to clear all such identified debris.

162. The width of sea bed disturbance along the PLGR is estimated to be up to 3m, which would be encompassed by the 15m width maximum footprint of cable installation works – see **Section 4.4.7.5.4** for further details.

Plate 4-9: Example of sea bed debris (an abandoned anchor) found in the DOW wind farm site (Source: Equinor)

4.4.7.4.4 Pre-Sweeping / Sand Wave Levelling

163. Areas of mobile sea bed (typically manifest either in sand waves 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 cases this could result over time in the cable being left 'free-spanning' over the sea bed. 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.

164. In order to prevent this, cables can be placed where possible in the troughs of sand waves to the reference sea bed level, which would minimise the potential for cables becoming unburied. However, where this is not possible, the alternative is to dredge the top of the sand waves prior to installation down to the sea bed reference level. This process is termed pre-sweeping (also referred to as sea bed levelling) and would be completed before the cable is laid on the sea bed.

165. Analysis of the SEP and DEP geophysical data collected in 2020 has identified four areas that may require pre-sweeping, as shown on **Figure 4.9** and described in **Table 4.22**. These include:

- a portion of the interlink cable corridor from SEP, as it joins the DEP North array area;
- an adjacent area within the DEP North array area;
- a portion of the interlink cable corridor between the DEP North and DEP South array areas, as it exits the DEP North array area; and
- an area within the DEP South array area.

166. The area affected by the works will vary between 50m and 100m in width depending on the cable corridor in question and the number of cables. The sea bed footprint and volume of sediment affected due to pre-sweeping is described in **Table 4.22**, with a total sea bed footprint of 929,719m^2 across all four areas and a total volume of up to 376,400m^3. Dredge volume has been calculated using the bathymetry data collected by the site specific surveys. Dredged sediment will be deposited within the SEP and DEP disposal sites (see **Disposal Site Characterisation Report (Revision B)** [REP1-019] for further details) and where possible in an area of similar sediment type and avoiding any known sensitive habitats such as Annex I reef. Sediment may either be released at or near the sea surface, or at the sea bed using a fall pipe.

Table 4.22: Cable Corridor Pre-Sweeping Footprints and Volumes

Area ID and location	Pre-sweep corridor length (m)	Pre-sweep corridor width (m)	Sea bed footprint (m^2)	Dredge volume (m^3)
Area 1: SEP wind farm site to the DEP North array area interlink	3,374.95	100	337,495	144,200
Area 2: DEP North to DEP South array areas interlink	2,387.82	50	119,391	44,300
Area 3: DEP South array area	3,019.35	100	301,935	171,700
Area 4: DEP North array area	3,417.96	50	170,898	16,200
Total	**12,200.08**	**-**	**929,719**	**376,400**

4.4.7.5 Cable Burial

167. 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 sea bed. Typical burial depth for SEP and DEP cables, excluding in areas of sand waves, is expected to be between 0.5m to 1.5m (or up to 1m for the export cables), although in challenging ground conditions the target depth of burial may not be achieved. In this event, the installation of external cable protection would be considered.

168. Cable burial requirements for the purpose of the environmental assessment have been informed through the completion of cable burial risk assessments (Pace Geotechnics; 2021, 2020) which have been undertaken by the Applicant at an early stage to inform the design and EIA processes on advice from relevant stakeholders. These studies have drawn on the data and lessons learnt from the cable burial process for the nearby SOW and DOW. The burial requirements will be finalised based on an assessment of the risks posed to SEP and / or DEP in specific areas, following the completion of detailed pre-construction geotechnical and geophysical investigations and the subsequent finalisation of the cable burial risk assessment prior to the start of construction. Geotechnical investigations (vibrocores and cone penetrometer testing) have been undertaken in 2021 across the wind farm sites and cable corridors to provide further data to help inform the cable installation campaign.

169. Specifically in relation to the export cable corridor, an **Outline CSCB MCZ CSIMP** [APP-291] is submitted alongside the DCO application. The **Outline CSCB MCZ CSIMP** demonstrates how the proposed export cable installation works in the MCZ will be controlled by the DCO and explains the key assumptions that underpin the assessments, such as the amount of external cable protection that might be required (**Section 4.4.7.7**).

170. Burial of the offshore cables will be through any combination of ploughing, jetting or mechanical cutting; however infield cable burial is more likely to be undertaken by jetting or mechanical cutting. The dimensions of the cable trenches (where applicable) and the overall sea bed footprint affected by the burial process will depend on the installation method. Details are provided in **Section 4.4.7.5.4** below and summarised in **Section 4.4.1**.

171. The export cables will be installed in separate installation campaigns as the installation vessel can only install one cable at a time (bundle lay is not possible with HVAC cables).

4.4.7.5.1 Ploughing

172. A plough uses a forward blade to cut through the sea bed, 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 sea bed 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 sea bed taking power from a surface vessel. The plough inserts the cable into the sea bed as it moves. Indicative dimensions of a large plough are 15m x 6.5m x 7m.

173. There are two types of plough: displacement and non-displacement. The difference is important in terms of understanding the effect on the sea bed. 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.

174. By contrast, a non-displacement plough (**Plate 4-10**) is designed to trench and bury the cable in a single pass, consequently causing less disturbance on the sea bed 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.

Plate 4-10: Example of a non-displacement plough (Source: Equinor)

175. A non-displacement plough was used with very good results for the installation and burial of the nearby DOW export cables. In environmental terms, the year 1 post-construction monitoring report for Dudgeon (MMT, 2019) has demonstrated very little temporary impact to the sea bed along the export cable corridor. This experience has been taken into account, alongside the outcomes of the SEP and DEP export cable burial risk assessment (Pace Geotechnics, 2020). As a result, should a plough be selected as the appropriate burial tool for SEP and DEP, a non-displacement type will be used to minimise environmental impact.

176. The rate of burial using a plough depends on factors including bathymetry, ground conditions and the required towing tension. An indicative burial rate by ploughing is 150-300m/h.

177. There may be locations where other methods to bury and protect the cable are required even where ploughing is used as the primary burial tool e.g. for any jointing loops, corner areas and where ploughing would be unable to negotiate obstacles or cable crossings.

4.4.7.5.2 Jetting

178. Jetting uses high powered jets of water to fluidise the sea bed 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 sea bed, 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.

179. Indicative dimensions of a large jetting tool are 5m x 4.2m x 3m. An indicative burial rate by jetting is 150-450m/h.

4.4.7.5.3 Mechanical Cutting

180. 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. This is a challenging and time-consuming process (indicative burial rate is 30-80m/h) and while it will not be used as the primary burial method, it may be required for particular sections where the other methods are not feasible.

4.4.7.5.4 Trench Sizes

181. The maximum temporary disturbance width for export, interlink and infield cable installation and burial would be up to 15m. This assumes a conservative 30-degree trench side slope (based on burial in sand) and 1.5m burial depth for all cables, which could result in an estimated 5.2m wide trench with 4.5m spoil heaps either side (i.e. 5.2m + 4.5m + 4.5m = 14.2m). A 15m temporary disturbance width is therefore assessed for cable installation and burial, encompassing the pre-grapnel run, footprint of the burial tool on the sea bed, trenching works and any spoil that may be generated at either side of the trench.

182. The footprint for pre-sweeping (where required) would be additional to this, as described in **Section 4.4.7.4.3**.

4.4.7.6 Infield Cable Installation

183. Since it is not possible to bury the infield cables in close proximity to the wind turbines and OSP/s due to the scour protection that will be installed, the cables would be surface laid with cable protection on the approach to each foundation. An allowance of up to 1,000m of cable protection (total across both SEP and DEP) is included for this purpose, although it would be entirely within the footprint of the foundation scour protection.

184. Each section of cable will be laid from the cable lay vessel either from a static coil or a revolving carousel, turntable or drum. The cable will 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. A typical methodology for installing the cable into a J-tube is:

- Mobilisation of a specialist cable installation vessel to site.

- A DP operated vessel will take up station adjacent to a wind turbine foundation. The cable end will be connected to a pre-installed messenger wire at the wind turbine foundation. The messenger wire will 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 will 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 will 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 will in principal be similar to the first end, except for overboarding of the last end of the cable from the installation vessel that will 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.

4.4.7.7 External Cable Protection

4.4.7.7.1 Need for External Cable Protection

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

- Where an adequate degree of protection has not been achieved from the burial process. This may as a result of challenging grounds conditions, or unforeseen circumstances with the burial process, such as break down of the burial tool/s.
- Where the infield cables approach the wind turbines and OSP/s, as described above in **Section 4.4.7.6** (N.B the corresponding footprint is within the allowance described for scour protection and therefore is not included in **Table 4.23** below).
- At cable crossings (**Section 4.4.7.7.5**).
- At the HDD exit pits (**Section 4.4.7.7.6**).
- In the event that cables become unburied as a result of sea bed mobility during the operation of the wind farms or (where necessary) in the event of making a cable repair (discussed in **Section 4.4.11.3**). If these works were required, they would be the subject of a separate marine licence application and therefore are not included in the project design envelope.

186. In all cases, the amount of external cable protection will be minimised as far as is possible. It should be noted that none has been used on either of the existing SOW and DOW export cable corridors, with the exception of the HDD exit location at DOW. At SOW, where satisfactory burial depth of the export cables was not achieved in the first instance, remedial work was performed by additional passes of the trenching tools. Ploughing performed on the DOW export cables was considered to be satisfactory without any remedial work. The sea bed footprints of external cable protection requirements for SEP and DEP are summarised in **Section 4.4.1** and **Table 4.23.**

4.4.7.7.2 Types of External Cable Protection

187. 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.
- Uraduct shell or similar – a protective shell fixed around the cable. Generally used for short spans at crossings or near offshore structures where there is a high risk from falling objects. Uraduct does not provide protection from damage due to fishing trawls or anchor drags.

188. It is possible that external cable protection systems may be available on the market that are manufactured from non-plastic material and would be recoverable where necessary after the lifetime of the wind farm. Selection of the appropriate system for use at SEP and DEP will be completed at the pre-construction stage once the requirements are better understood.

189. Protection systems may be placed alone or in combination with other types and may be secured to the sea bed where necessary.

4.4.7.7.3 Unburied Cables

190. An allowance is made for external cable protection where an adequate degree of protection has not been achieved from the burial process (see **Section 4.4.7.5** for further details of how these quantities have been estimated). The external cable protection is assumed to have a width on the sea bed of up to 6m for the export and interlink cables and 4m for the infield cables. A total allowance of up to 500m is assumed for the export cables, 1,500m for the interlink cables (1,000m for the DEP North array area and 500m for the DEP South array area) and 1,000m for the infield cables.

4.4.7.7.4 External Cable Protection Requirements in the CSCB MCZ

191. The use of external cable protection creates a footprint on the sea bed for the lifetime of the Projects, dependent on the subsequent need and/or ability to remove the cable protection on decommissioning (see below). As above, the amount of external cable protection will be minimised as far as is possible across the offshore sites. Given the sensitivity of the MCZ, the allowance for external protection within the MCZ boundaries has been further restricted by the Applicant as follows (**Table 4.23**):

- For unburied cables, no more than 100m of external cable protection per export cable, up to 6m in width (i.e. up to 200m (equalling 1,200m^2) within the total allowance of 500m for the export cables).
- At the HDD exit pit transition zone, no more than 100m of external cable protection per export cable, up to 3m in width (i.e. up to 200m (equalling 600m^2) in total for two cables).
- No use of loose rock type systems.

192. All external cable protection used within the MCZ will be designed to be removable on decommissioning, although the requirement for removal will be agreed with stakeholders and regulators at the time. Details describing the feasibility of, and commitment to, removing external cable protection is provided with the **Outline CSCB MCZ CSIMP** [APP-291], which takes account of a Natural England study on the decommissioning of cable protection, published in March 2022 (Peritus International Limited, 2022).

4.4.7.7.5 Cable Crossings

193. Potential crossings include (see **Chapter 16 Petroleum Industry and Other Marine Users** [APP-102] for details):

- The Lancelot to Bacton gas export pipeline (PL876) (together with the Bacton to Lancelot chemical pipeline (PL877)); and the Shearwater to Bacton gas pipeline (PL1570), all of which run parallel to each other and traverse the DEP South array area.
- The Durango to Waveney gas production pipeline traversing the DEP North array area.

- Export cables for the existing DOW which also make landfall at Weybourne. The proposed SEP and DEP offshore export cables cross and then route to landfall to the east of these cables.
- The DOW export cables will also be crossed further offshore by interlink cables, either those connecting the DEP South array area to an OSP in the SEP wind farm site (in a SEP and DEP scenario), or interlink cables from the DEP South array area to the DEP North array area.
- The offshore export cable corridor for the consented Hornsea Three OWF crosses the SEP and DEP offshore export cable corridor approximately 14km from the coast, making landfall at Weybourne to the west of the SEP and DEP landfall. As such, in the event that Hornsea Three is constructed, the SEP and DEP offshore export cables would also need to cross the Hornsea Three offshore export cables.

194. The maximum width and length of cable protection for crossings is 21m and 100m, respectively. The maximum height of cable crossings will be 1.7m and all crossings will be designed to be overtrawlable. The sea bed footprint of cable crossings is summarised in **Section 4.4.1** and **Table 4.23.**

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

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

4.4.7.7.6 HDD Exit Pits Cable Protection

196. Where the offshore export cables exit onto the sea bed from the HDDs at the landfall, 100m of cable protection may be placed in the transition zone along each of the cables, from the HDD duct sections on the sea bed to the start position for cable burial. Rock bags are considered to be suitable for this purpose and, as explained above, loose rock will not be used in this location as it is within the CSCB MCZ. The design of the cable protection in this location will also take account of the need to restrict any reduction in water depth to less than 5% on account of navigational risks. Further details on the HDD works are provided in **Section 4.5**.

4.4.7.7.7 Summary of Potential Cable Protection Requirements

197. A summary of all potential cable protection requirements is provided in **Table 4.23.**

Table 4.23: Cable Protection Summary

Cables	Maximum number of crossings	Crossing protection (m^2 / m^3)	Protection of unburied cable (m^2 / m^3)	Protection of unburied cable notes	Total (m^2 / m^3)
Export	8 (for up to 2 export cables for SEP and DEP crossing 2 export cables for each of DOW and Hornsea Project Three)	16,800 / 11,520	3,000 / 1,125	Based on 500m protection in total of the export cables, 6m wide, which includes up to 200m in the MCZ	19,800 / 12,645
Export (HDD exit)	n/a	n/a	600 / 225	Based on 100m protection of each of the export cables, 3m wide	600 / 225
Interlink	6 (up to 3 interlink cables from the DEP South array area crossing 2 DOW export cables)	12,600 / 1,146	9,000 / 2,250	Based on 1,500m protection, 6m wide	21,600 / 3,396
Infield	7 (Durango to Waveney pipeline (3); Lancelot to Bacton pipeline (2); and Shearwater to Bacton pipeline (2))	14,700 / 1,306	4,000 / 1,000	Based on 1,000m protection, 4m wide	18,700 / 2,306
Total	**-**	**44,100 / 13,972**	**16,600 / 4,600**	**-**	**60,700 / 18,572**

4.4.8 Offshore Temporary Works Area

198. In April 2022, the Applicant conducted a targeted consultation exercise following the addition of an offshore temporary works area to the SEP and DEP wind farm sites and offshore cable corridors. The offshore temporary works area is shown on **Figure 4.2** and consists of a 750m buffer either side of the area in which the offshore export and interlink cables will be installed and a 200m buffer around the area in which wind turbines, OSPs and infield cables will be installed.

199. The offshore temporary works area has been defined such that the offshore Order Limits encompass both the area in which permanent installations will be placed (with adequate allowance for micro-siting around sensitive features, as required), plus the adjacent area of sea bed that may be required for temporary works only. See the **Works Plans (Offshore) (Revision B)** [PDA-003 for details].

200. Temporary works could occur during the construction, operation and decommissioning phases and includes vessel anchoring and the use of jack-up vessels that will have a temporary works footprint, including for the purpose of foundation and wind turbine installation, cable installation and maintenance activities. The temporary works footprints assessed in this ES are unchanged from those parameters assessed in the PEIR. No anchoring or use of jack- up vessels will be undertaken where the subtidal chalk or subtidal rock (Habitat class: A3 – Infralittoral rock) associated with outcropping chalk features in the inshore area of the Cromer Shoal Chalk Beds MCZ are reported (Benthic Habitat Mapping for SEP & DEP 6.3.8.5 Appendix 8.5) and subsequently confirmed by pre-construction survey.

201. The Applicant is committed to post consent survey coverage of the offshore temporary works area involving a suite of geophysical, geotechnical and benthic surveys which will identify any sensitive features that may need to be avoided in consultation with the relevant stakeholders.

4.4.9 Construction Vessels

202. A variety of vessels will be used during the construction phase, although the exact number and specification will not be known until much closer to the time of construction. Similarly, whilst it is expected that both SEP and DEP will be operated from the O&M port at Great Yarmouth, as with the existing DOW, the construction port/s will not be confirmed until nearer the start of construction.

203. In order to inform the environmental impact assessment, **Table 4.24** 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 vessel will be on site at the same time.

204. A total of 1,196 vessel movements is estimated during construction of both SEP and DEP on a worst-case basis (assuming the Projects are constructed sequentially).

Table 4.24: Construction Vessels (transit to and from port equates to two movements)

Vessel type	Indicative maximum number on site at any one time (SEP or DEP in isolation)	Indicative maximum number on site at any one time (SEP & DEP)	Indicative maximum number of vessel movements (SEP or DEP in isolation)	Indicative maximum number of vessel movements (SEP & DEP)
Rock bulk vessel	2	2	4	8
Filter layer vessel	1	2	4	8
Foundation installation spread	1	2	25	50
TP Installation	1	1	25	50
Scour vessel	1	2	4	8

Vessel type	Indicative maximum number on site at any one time (SEP or DEP in isolation)	Indicative maximum number on site at any one time (SEP & DEP)	Indicative maximum number of vessel movements (SEP or DEP in isolation)	Indicative maximum number of vessel movements (SEP & DEP)
WTG installation spread	1	2	25	50
Commissioning vessels	1	2	90	180
Accommodation vessels	1	1	4	6
Infield cable vessels	1	2	8	16
HDD construction vessels (landfall construction) – two vessels for excavation and backfilling	2	2	8	8
Export cable vessels	1	2	2	4
OSP installation vessels	1	1	4	8
Other vessels – three to four vessels operational on a daily basis during construction and commissioning	2	4	400	800
Total	**n/a**	**n/a**	**603**	**1,196**

205. Where they are used, jack-up barges and anchored vessels will have a sea bed footprint (**Table 4.25**) (these footprints are also incorporated in **Section 4.4.1**). 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 up to four legs/spudcans, each with a footprint of up to 300m^2.

206. In the case of monohull floating construction vessels with anchoring, it is likely to be a wire line system with drag/fluke anchors, with up to 12 lines per location. The footprint of each anchor would be up to 6m in width (approximately 30m^2), with an anchor line length of up to 1,000m. There would usually be one anchor pattern per foundation, although re-setting of anchors is sometimes required in the event that they do not hold position (two assumed as a worst-case).

Table 4.25: Construction Vessel Footprints (Foundation, Wind Turbine and OSP Installation)

Parameter	Jack-up	Anchors
Number of legs/anchors	4	12
Footprint area per placement (m^2)	1,200	360
Max. number of operations per foundation installation	n/a	2
Max. number of operations per wind turbine installation	2	n/a
Max. number of wind turbine and OSP locations	53 +2 OSPs	53 +2 OSPs
Total footprint (m^2)	**132,000**	**39,600**

207. Anchoring may also be used by the interlink and export cable installation vessel where a simultaneous lay and plough methodology is used. Assuming a typical anchor spread with up to seven mooring lines and an anchor footprint of up to $30m^2$, and repositioning of the mooring lines every 500m, the maximum footprint for anchoring during cable installation would be up to $64,680m^2$ and $42,840m^2$ for the interlink and export cable corridors respectively, although this will vary according to the development scenario in question (**Table 4.26** and **Table 4.27**).

Table 4.26: Anchoring Footprint for Interlink Cable Installation

Development scenario	Interlink cable length (all cables) (km)	Anchoring footprint (m^2)
SEP and DEP – 1 OSP in the SEP wind farm site (assuming both the DEP North and DEP South array areas are developed)	143	60,060
SEP and DEP – 1 OSP in the SEP wind farm site (assuming only the DEP North array area is developed)	154	64,680
SEP and DEP – 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area (assuming both the DEP North and DEP South array areas are developed)	66	27,720
DEP in isolation (assuming both the DEP North and DEP South array areas are developed)	66	27,720

Table 4.27: Anchoring Footprint for Export Cable Installation

Development scenario	Export cable length (km)	Anchoring footprint (m^2)
DEP in isolation	62	26,040
SEP in isolation	40	16,800
SEP and DEP – 1 OSP in the SEP wind farm site	80	33,600
SEP and DEP – 1 OSP in the SEP wind farm site and 1 OSP in the DEP North array area	102	42,840

4.4.10 Safety Zones

208. 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 will be subject to application and approval by the Secretary of State for Business, Energy and Industrial Strategy (BEIS), prior to the start of construction. The safety zones that may be applied for are summarised in **Table 4.28**.

209. Further information on safety zones is provided in **Chapter 13 Shipping and Navigation** [APP-099] and in the **Safety Zone Statement** [APP-284].

Table 4.28: Safety Zones That May Be Applied For

Potential safety zone	Details
Construction	Up to 500m around each wind turbine foundation or OSP whilst under construction.
Commissioning	Up to 50m around each wind turbine foundation or OSP where construction has finished but where some work may be ongoing e.g. a wind turbine that is incomplete or in the process of being tested before commissioning.
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 OSP when it is being decommissioned.

4.4.11 Offshore Operation and Maintenance

210. The ongoing operation of the wind farms over the SEP and DEP design life of 40 years will require a number of operation and maintenance activities. A key characteristic of the operation of SEP and DEP is the intention that both will be operated from the existing SOW and DOW O&M base at Great Yarmouth (see **Section 4.4.11.6** for further details). Shared vessels, personnel and facilities offer a considerable benefit in optimising (and ultimately reducing) the overall O&M effort required across all projects. For example, fewer support vessels and fewer overall vessel movements would be required as opposed to a scenario where all projects were operated entirely independently. If it is not possible to use Great Yarmouth, a suitable alternative location for the O&M base will be selected.

211. An **Outline Offshore Operations and Maintenance Plan (OOMP) (Revision C)** (document reference 9.9) is provided with the DCO application, which provides details of the anticipated activities and how they will be controlled by the DCO.

4.4.11.1 General Maintenance Activities

212. A programme of monitoring and scheduled maintenance will 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.

213. Operational control of the wind farms will be through a Supervisory Control and Data Acquisition (SCADA) system, which will connect each turbine to the onshore control room. This system will enable the remote control of individual turbines, as well as remote interrogation, information transfer and data storage.

214. Surveys including geophysical survey (most typically multibeam echosounder and/or side scan sonar) and through the use of ROVs will be performed at regular intervals throughout the operational lifetime of the wind farms. A typical geophysical survey programme for asset integrity purposes would involve survey of foundations and subsea cables at least every two years, although the work programme will be adapted to focus on areas of greatest interest, for example in areas of greatest sea bed mobility.

215. Typical general maintenance activities include:

- Wind turbine service;
- Oil sampling and/or change;
- UPS battery change;
- Service and inspections of wind turbine safety equipment, nacelle crane, service lift, HV system, blades;
- Foundation inspection and repair;
- Cable repair and replacement;
- Cable remedial reburial;
- Cable crossing inspection and repair; and
- Unplanned and planned corrective work.

216. Subsea cables are designed for the lifetime of the Projects, however reactive repairs or remedial cable reburial work may be required, which are addressed in **Sections 4.4.11.3** and **4.4.11.4**.

217. Large components (e.g. wind turbine blades or OSP transformers) are not expected to need replacement frequently during the operational phase, although failure of these components is possible. In this event, 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 10 jack-up movements per year for each of SEP and DEP (i.e. 20 in total). Assuming a jack-up vessel with a sea bed footprint of 1,200m^2 (up to four legs/spudcans, each with a footprint of up to 300m^2), this would lead to a total footprint of up to 24,000m^2 per year.

4.4.11.2 Vessel Operations

218. Vessel visits to the wind farms will be required each year to allow for scheduled and unscheduled maintenance activities. As discussed above, both SEP and DEP will be operated from the existing SOW and DOW O&M base at Great Yarmouth, sharing vessels and facilities. The existing SOW and DOW vessel provision consists of one service operation vessel (SOV) and one smaller crew transfer vessel (CTV) (shown in grey in **Table 4.29**). Taking account of the existing spare capacity in terms of onboard facilities and capability for technician drop-offs, it is anticipated that two extra support vessels would be sufficient. These could be CTV, daughter craft onboard the SOV or both. **Table 4.29** provides a breakdown of the maximum number of vessels that may be required at any one time and the anticipated maximum number of vessel movements per year during operation. One vessel movement can be either from port to site or vice versa. For example: the CTV vessels, which must return to port after completing the task on site will consequently generate two vessel movements per operational day: one - port to site, two - site to port. The large O&M vessel (SOV) will in normal operation remain offshore only to return to port on a two week rotation-schedule for crew change, (de)mobilisation, or maintenance related activities.

Table 4.29: Maximum Anticipated Trips to the Wind Farms During Operation

Vessel type	Indicative maximum number of vessels required at any one time (SEP or DEP in isolation)	Indicative maximum number of vessels required at any one time (SEP & DEP)	Indicative maximum number of vessel movements (SEP or DEP in isolation)	Indicative maximum number of vessel movements (SEP & DEP)
Large O&M vessel (SOV) (SOW and DOW)	1	1	60/year(*)	60/year(*)
Small O&M vessel (CTV) (SOW and DOW)	1	1	600/year(*)	600/year(*)
Small O&M vessel (CTV)	2	2	604/year (although majority (600) will be small O&M vessel (CTV)	1,206/year (although majority (1,200) will be small O&M vessel (CTV)
Lift vessel	1	1	2/year(**)	4/year(**)
Cable repair vessel	1	1	2/10 years(**)	4/10 years(**)
Survey vessel	1	1	2/year(**)	2/year(**)

(*) These vessels are currently in operation at the Sheringham and Dudgeon sites and, as such, are not contributing any additional movements

(**) These vessels will typically arrive on site directly without a port call in Norfolk

4.4.11.3 Cable Repair or Replacement

219. Based on current knowledge and technology the estimated rate of cable failure for SEP and DEP is approximately one failure for every 1,000km of cable per year. On this basis, the assessment considers the following potential cable repair works across SEP and DEP (including replacement where necessary):

- One export cable repair every 10 years (including one in the CSCB MCZ);
- One interlink cable repair every 10 years; and
- Two infield cable repairs every 10 years (N.B. for short infield cables, replacements are a more likely operation).

220. The basic methodology for carrying out a cable repair will 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 sea bed footprint of cable repair and replacement works is summarised in **Table 4.30** below.

221. The section of cable to be repaired will 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.

222. For infield cables, the entire length of a cable (likely to be between 0.2km and 5km subject to turbine spacing) could require replacement and therefore 5km has been assumed as the worst-case. For the longer interlink and export cables, an extended cable loop ('bight') of up to 250m (depending on the water depth) would be surface laid onto the sea bed close to and to one side of the original cable, prior to the cable being protected as described above. The 250m may represent the maximum distance of the bight from the original cable corridor. As the cable has to be cut up to 200m of the cable ends pulled out of a trench, there will be up to 800m of reburial of the cables after omega repair. For these operations it is assumed that a DP vessel will be used.

223. In the event that external cable protection is required, up to a total of 700m of cable would need to be protected for each cable repair, allowing for a new cable of 300m to be inserted after a cut with the corresponding two repair joints. As up to 200m of laid cable must be taken out of the trench in two directions after the cable cut, the total cable length that may be subject to external cable protection after an omega repair (per cable) is 800m, with a berm width of up to 4m. However as described in **Section 4.4.7.7.1**, if this were required during operation it would be the subject of a separate marine licence application and therefore is not included in the project design envelope. Additionally, in order to limit the amount of external cable protection located within the MCZ as far as possible, the Applicant has made the commitment to attempt to rebury any cables which do become exposed within the MCZ during operation, prior to installation of any external cable protection (as stated in the **Outline CSCB MCZ CSIMP** [APP-291]).

4.4.11.4 Cable Reburial

224. In the event that cables become exposed due to the natural movement of the sea bed over the lifetime of the Projects, it may be necessary to undertake remedial reburial work to ensure that the cables are adequately protected and without the need to resort to the use of external cable protection measures such as rock placement (described in **Section 4.4.7.7**). The need for reburial work will be informed by an ongoing programme of geophysical surveys (as described in **Section 4.4.11.1**) as well as cable burial risk assessment. Cable burial risk assessments have been completed for the interlink and export cables (Pace Geotechnics; 2021, 2020) and will be updated prior to the start of construction.

225. The following reburial requirements have been estimated based on the worst-case scenario that no pre-sweeping is undertaken and all cables are buried under the sea bed level as described in **Section 4.4.7.5**. If undertaken, pre-sweeping would minimise the likelihood of reburial works being required in areas of sand waves and/or high sea bed mobility.

- Estimated export cable reburial at 10-year intervals:
  - Up to 0.1km per cable within the CSCB MCZ; and
  - Up to 0.1km per cable outside the CSCB MCZ.
- Reburial of 1% of the infield cabling is estimated every 10 years.
- Reburial of 1% of the interlink cabling is estimated every 10 years.

226. The sea bed footprint of cable reburial works is summarised in **Table 4.30** below.

227. An **Offshore IPMP** [APP-289] is submitted with the DCO application which outlines the proposed monitoring, the details of which would be agreed post consent with the relevant Regulators and Statutory Nature Conservation Bodies (SNCBs). The requirements for certain post-construction surveys are included in the DCO/DMLs.

4.4.11.5 Cable Repair, Replacement and Reburial Sea Bed Footprint Summary

228. **Table 4.30** summarises the sea bed footprints in relation to cable repair, replacement and reburial works. The footprints are based on a maximum temporary disturbance width of 3m. Overall totals are not provided as the impacts would occur at different times over the 40-year lifetime of the wind farms.

Table 4.30: Cable Repair (and/or Replacement) and Reburial Sea bed Footprints

Activity	Details	Footprint SEP or DEP in isolation (m^2 / 10 years)	Footprint SEP and DEP (m^2 / 10 years)
Export cable repair	One export cable repair every 10 years (SEP and DEP) Up to 800m, 3m disturbance width	2,400	2,400
Interlink cable repair	One interlink cable repair every 10 years Up to 800m, 3m disturbance width	SEP: N/A DEP: 2,400	2,400
Infield cable repair	Two infield cable repairs every 10 years Up to 5km each, 3m disturbance width	15,000	30,000
Export cable reburial	Up to 200m per export cable subject to reburial works every 10 years Assumes up to two export cables, 3m disturbance width	600	1,200
Interlink cable reburial	Reburial of 1% of interlink cabling every 10 years. 3m disturbance width	SEP: N/A DEP: 1,980 for up to 66km of interlink cables	4,620 for up to 154km of interlink cables
Infield cable reburial	Reburial of 1% of infield cabling every 10 years 3m disturbance width	SEP: 2,700 for 90km infield cables	6,750 for 225km infield cables

Activity	Details	Footprint SEP or DEP in isolation (m^2 / 10 years)	Footprint SEP and DEP (m^2 / 10 years)
		DEP: 4,050 for 135km infield cables	

4.4.11.6 Operations & Maintenance Port

229. As described above, the intention is that both SEP and DEP will be operated from the existing SOW and DOW O&M base at Great Yarmouth. O&M needs in terms of laydown areas and facilities are expected to be minimal compared to requirements during the construction phase and will be sufficiently provided for through the existing base.

230. The base includes a purpose designed building and control room on the river harbour quayside, opened in July 2016, from where all operational and maintenance activities are planned and co-ordinated (**Plate 4-11**). The base is currently home to approximately 80 permanent employees including engineers, control room operatives, marine co-ordinators, planners and support staff. The building also includes a large warehouse facility for storing spare parts and for receiving goods and equipment associated with the support of the vessels used to access the wind farm.

231. Turbine technicians board the vessels from the base to make the journey to the wind farm site/s. A marine coordination team monitors the movement of vessels and personnel offshore, and is in constant communication with the vessels in the field. All maintenance and repair work on the wind farm network is controlled through the Work Release System, and the issue of Safety Documents acts as the official sanction for work to be undertaken. The Work Release System is operated by the control room engineers, who are responsible for responding to faults on the electrical network so that maximum generation can be restored as soon as is practically possible. It is expected that SEP and DEP will be integrated with this same system.

Plate 4-11: Existing SOW and DOW O&M base at Great Yarmouth (Source: Equinor)

4.4.12 Repowering

232. 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 40-year design life of the wind farms. 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.

233. 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.

4.4.13 Offshore Decommissioning

234. At the end of the operational life of the wind farms, SEP and DEP will be decommissioned, in line with TCE AfL requirements. Under the Energy Act (2004), a decommissioning programme must be submitted to and approved by BEIS as secured through Requirement 8 of the **Draft DCO (Revision H)** (document reference 3.1), a draft of which will be submitted prior to the start of construction. It is expected that the decommissioning plan and associated programme will subsequently be updated during the lifetime of SEP and DEP to reflect any changes to regulatory requirements, best practice and new technologies.

235. As such, the scope of the decommissioning works would be determined by the relevant legislation and guidance at the time. It is anticipated that all structures above the sea bed or ground level will be completely removed, including all of the wind turbine components and the parts of the foundations above sea bed level. Removal of some or all of the infield, interlink and export cables may be undertaken, although scour and cable protection would likely be left in-situ other than where there is a specific condition for its removal. With respect to external cable and scour protection it is noted that Natural England consider that exposed material left in-situ would result in permanent habitat loss (it has been assessed as such in the relevant chapters of this ES), however where buried, that there may be rationale for leaving it in-situ to avoid habitat disturbance.

236. The decommissioning sequence will generally be the reverse of construction and will involve similar types and numbers of vessels and equipment. The anticipated techniques for the various foundation types are as described below.

237. It is anticipated that offshore decommissioning would take up to approximately one year for each of SEP and DEP.

4.4.13.1 Foundations

238. Piled foundations (jackets and monopiles) would be cut approximately 1-2m below sea bed level following localised jetting or suction around the base of the pile to clear surface sediments and/or scour protection and provide access to the cutting tools. Complete removal of piles from the sea bed is not considered to be reasonably practicable at this time, as there is currently no proven, cost-effective technology for their removal. The size of the piles, the penetration depth into the sea bed and the weight makes it technically extremely challenging to remove the entire structure, involving safety risks to personnel and significant disturbance to the sea bed due to the excavation work that would be required.

239. Gravity base foundations would be decommissioned by removal of their ballast and either floating them (for self-floating/buoyant designs) or lifting them off the sea bed. This process may need to be preceded by the clearance of sea bed sediments and/or scour protection and grout from the base of the foundation by jetting and/or suction. If a deep skirt has been used around the perimeter of the foundation, the skirt may require cutting. For the removal of ballast, consideration would be given to the options for disposal or re-use of the ballast material.

240. Suction buckets would include similar steps to clear sea bed sediments and/or scour protection from around the base of the foundation. Depending on the precise design, decommissioning may include removal of ballast or the adding of buoyancy aids; connection of pumping equipment to the suction bucket valves; and controlled pumping of water into caisson chambers. The suction bucket would then be expected to rise to the surface as the internal pressure overcomes the side wall friction. Some manipulation from craneage on a suitable vessel may be required as part of this process.

241. For all foundation types, a heavy lift DP vessel or jack-up crane would then be used to lift the foundation onto a barge for transport to shore.

4.4.13.2 Cables

242. There is no existing statutory requirement for removal of decommissioned cables. Furthermore, removal of buried cables is technically difficult and in cases it is possible that if attempted, the removal works would cause significantly greater environmental disturbance than leaving them in situ. Techniques are likely to be similar to those considered for the installation, in a reverse process to expose and remove them. Once the cables are exposed, grapples would likely be used to pull the cables onto the decks of cable removal vessels. The cables would then be cut into manageable lengths and returned to shore for recycling.

243. Cables that are not buried i.e. are exposed are more likely to be removed to ensure they do not become hazards to other activities such as shipping and fishing. Detailed survey and engineering studies will be required at the time of decommissioning in order to determine which cables are exposed (or are at risk of future exposure), and therefore the most appropriate course of action.

244. With this in mind it is expected that most infield, interlink and export cables will be cut at the ends and left in situ. However, for the purpose of the DCO application, it has been assumed as a worst-case that all cables will be removed during decommissioning, though any external cable protection will be left in situ. The area of sea bed impacted during the removal of the cables could therefore be equal to the area impacted during the installation of the cables.

245. At the landfall the export cables will have been installed in ducts by the HDD process. To minimise environmental disturbance the preferred option is to leave these cables buried in place with the cable ends cut, sealed and securely buried.

4.5 Landfall

4.5.1 Background

246. The offshore export cables make landfall at Weybourne, at a location to the west of Weybourne beach car park in proximity to the Muckleburgh Military Collection. The offshore export cables will be connected to the onshore export cables in transition joint bays, having been installed under the intertidal zone by HDD (**Figure 4.4**). This technique has been selected by the Applicant in order to avoid any impact on the features of the MCZ in this area. Chalk is known to outcrop on the sea bed close to shore, where it forms one of the key interest features of the site (see **Chapter 6 Marine Geology, Oceanography and Physical Processes** [APP-092] and **Chapter 8 Benthic Ecology** [APP-094] for further details). As described below, the HDD process will allow the complete avoidance of the nearshore outcropping chalk feature.

247. A Ground Investigation campaign (involving boreholes) was undertaken in 2021 at the landfall providing a high degree of confidence in the feasibility of HDD at this location. In addition, the Applicant's previous installation campaigns for both SOW and DOW made landfall in proximity to this location and also used HDD to successfully install two export cables per Project. As a result, whilst other cable installation projects have needed to consider other construction methodologies at the landfall, for example involving open cut trenching and the creation of cofferdam structures on the beach, these alternative options have been discounted at an early stage for SEP and DEP.

248. The onshore landfall area comprises the landfall compound (approximately 75m x 75m (5,750m^2)), located to the west of Weybourne beach car park. This area will include the transition joint bays, located approximately 150m inland from the beach frontage (beyond any areas at risk of natural coastal erosion). The wider narrow corridor identified parallel to the beach frontage (refer to **Figures 4.4** and **4.10**), provides space adjacent to the beach for onshore duct preparation. The Muckleburgh Military Collection offers existing, private access to the landfall area.

249. The landfall area at Weybourne was chosen as the result of a site selection process, considering environmental and technical constraints. The site selection process is described in **Chapter 3 Site Selection and Assessment of Alternatives** [APP-089].

250. One HDD duct will be required for the installation of each of the SEP and DEP export cables. As such, up to two drills will be undertaken for the landfall works. An extra drill per Project has been allowed for contingency (i.e. up to four drills in total to install two ducts). Each drill will be launched from a compound inland, drilled under the beach and intertidal area, and will exit out at sea.

4.5.2 Landfall Works

251. A temporary onshore compound will be required to accommodate the drilling rigs, ducting and welfare facilities (**Plate 4-12**). The temporary landfall compound will be set back approximately 150m inland from the beach and would be up to 75m long by 75m wide. Each drill would start from the landfall compound, travel beneath the beach, and will exit in the subtidal zone at a suitable water depth. The drill will be of sufficient depth below the coastal shore platform to have no effect on coastal erosion.

Plate 4-12: Example of an onshore landfall compound (DOW) with drilling rig (left of shot) in operation (Source: Equinor)

252. A pilot hole will be drilled from an onshore entry pit and advanced in stages until the required length is reached and the boring head is near to punch out. The drill head would be guided by sensors, potentially tracking a wire placed above ground/sea bed. Approximately 600-700m^3 of drilling fluid per bore hole (a combination of water and natural clays such as bentonite) will be used to lubricate the drilling process and cool the drill head. Drilling fluid will be recycled where possible, with fluid pressures monitored throughout the process to minimise the potential for breakout of the drilling fluid. An action plan will be developed, and procedures adopted during the drilling activity to respond to any drilling fluid breakout. Final punch-out is undertaken after the hole has been widened to final dimeter, reamed, and cleaned. A small amount of drill fluid (up to 25m^3 total for two HDD ducts, or 50m^3 including the two contingency drills) may be discharged into the sea during punchout at the exit point.

253. Once the pilot hole is completed, it would be enlarged through several passes with reamers until the necessary diameter for duct installation is achieved. The HDD will exit in the subtidal, approximately 1,000m from the coastline (up to 1,150m from the onshore entry point). The HDD 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 will be required to be performed on the beach that may require short periods of restricted access. For example, use of a temporary seawater pipe and pump to supply seawater to the landfall compound for use with the drilling fluid, as well as the use of vehicles to transport the ducting across the beach. Any areas subject to short-term restricted access would be agreed in advance with the Countryside Access Officer at Norfolk County Council prior to construction.

254. The ducts would typically be floated into position at the offshore exit point via barges. The ducts would then be flooded with water and pulled from the direction of the onshore entry pit into the reamed drill holes. Alternatively, the ducts could be welded in sections onshore and pushed from the onshore side. The onshore landfall area includes a narrow strip of land adjacent to the beach of approximately 1,000m to allow for onshore duct preparation. This area makes use of existing vehicle tracks within the Muckleburgh Estate.

255. Once the ducts have been installed, they will be protected with bellmouth structures as shown in **Plate 4-13**. The offshore export cables will then be installed at a suitable time, 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 transition pit.

256. At the HDD exit point in the subtidal there is a requirement for a transition zone between where the ducts exit the sea bed and the point at which it is possible for the burial tool to start the process of burying the cables. There are two options for the transition zone and both options need to be retained in the project envelope pending detailed design studies. The first option would involve the excavation of an initial trench up to 20m wide, 30m long and 1m deep (600m^3 excavated material, allowing for up to two cables), with a further transition zone trench of up to 50m in length, 1m wide and up to 1m deep per cable (100m^3 excavated material in total), at the end of which the burial tool would be able to take over the cable burial process. With this option there would be no requirement for external cable protection. This option also provides some flexibility should the Projects be restricted in terms of any potential reduction in navigable water depth (the water depth at this location is expected to be approximately 8.5m, although the exact location and corresponding depth will not be confirmed until prior to the start of construction).

257. Alternatively, rock bags or concrete half shells would be used for cable protection purposes in the transition zone. This is considered to be the best option from an engineering perspective, provided that any restrictions on the reduction of water depth can be met. Rock bags have been used successfully by Equinor for the same purpose at DOW. In this event, external cable protection would be required along up to 100m of each of the cables i.e. a total length of 200m for both cables. The cable protection would likely be in the form of removable 8 tonne rock bags (**Plate 4-14** and **Plate 4-15**), up to 3m wide and 0.8m high (accounting for the cables underneath), although some settling into the sea bed after installation would be expected to reduce this over time. The sea bed footprint of the installed rock bags would therefore be up to 600m^2, for both cables. Loose rock type systems will not be used in order to facilitate the possibility of removal on decommissioning (see **Section 4.4.7.7**).

Plate 4-13: Example of bellmouth used to protect the duct ends at the HDD exit point (Source: Equinor)

Plate 4-14: Example illustration of rock bags used for cable protection in the transition zone

Plate 4-15: Rock bag installation (Source: Equinor)

258. A jack-up barge vessel with backhoe excavator (**Plate 4-16**) would be used for the excavations and/or installing any necessary external cable protection. All excavated sea bed sediments will be temporarily stored alongside the works location and within the export cable corridor (i.e. sidecast), prior to being backfilled after cable installation (for a period of up to approximately nine months for SEP and DEP). The sea bed footprint of the deposited material is estimated to be up to approximately 400m^2. Alternatively, the excavated sediment could be stored on a barge.

259. Assuming a jack-up barge vessel with four legs, each with a 4m^2 spudcan, the total sea bed footprint for each jacking-up operation would be up to 16m^2. Up to 16 movements may be required (SEP and DEP) which would result in a total sea bed footprint during construction of 256m^2.

Plate 4-16: Example of a jack-up barge with backhoe excavator (Source: Equinor)

260. Surface lay of the export cables in the transition zone is not considered a viable option, primarily as it would not provide the necessary level of cable protection in the shallow nearshore environment. However it would also be necessary to secure or 'pin' the cables to the sea bed in some manner to prevent their movement in the shallow water depths and the presence of unconsolidated surface sediments in this area would not support this.

261. A typical programme for preparation of the export cable installation at the landfall would involve mobilisation, drilling of the two boreholes, preparation of the ducts, towing the ducts to the exit point, duct installation and excavation of the transition zone over a period of approximately five months. Upon completion of the duct installation, the onshore landfall compound would be demobilised, including the removal of drilling rigs and welfare facilities from the site.

262. The cable pull-in would then be undertaken, followed by backfilling at the HDD exit and jointing of the subsea and onshore cables in the onshore transition joint bay over a period of approximately five months. During the cable pull phase of works, the transition joint bay(s) (see **Section 4.5.2.1**) would be re-excavated and exposed allowing cables to be pulled through the pre-installed ducts and jointed. The cables would then be tested, the transition joint bays backfilled, and landfall area would then be reinstated.

263. The process outlined here effectively describes the process for both an in isolation scenario (one Project) and the concurrent scenario. If the Projects were built sequentially this process may be repeated for the second Project, this will depend on gap between construction time. In the sequential scenario synergies between the Projects would be explored, for example the second Project reusing the landfall compound from the first Project. However, should there be a gap between the two construction exercises it is assumed that land would be reinstated after completion of the first Project and a new landfall compound would be installed at the start of the second Project.

4.5.2.1 Transition Joint Bays

264. The offshore and onshore cables will be jointed together in one or two underground transition joint bays located onshore within the landfall compound. This would comprise an excavated area of up to 52m x 20m (for the worst-case SEP and DEP sequential scenario) with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

265. Following cable pulling and jointing activities, the joints would be buried to a depth of up to 3m using stabilised backfill, pre-excavated material or a concrete box. The remainder of the transition joint bay will be backfilled with the pre-excavated material and returned to the pre-construction condition, so far as is reasonably possible.

4.5.2.2 Landfall Parameters

266. **Table 4.31** shows the main construction parameters for the landfall works.

Table 4.31: Landfall Construction Onshore Parameters

Landfall worst-case parameters			
	SEP or DEP in isolation	**SEP and DEP – concurrent**	**SEP and DEP – sequential**
Number of HDD drills	Up to 2	Up to 4	Up to 4
Number of HDD drill rigs in operation at any one time	1	1	1
Approximate size of HDD temporary works compound area (m)	75 x 75	75 x 75	2 x (75 x 75)
Number of transition joint bays	1	2	2
Approximate size of transition joint bay(s) (length x width) (m)	26 x 10	2 x (26 x 10) if adjacent to each other or 26 x 12 if combined	2 x (26 x 10) adjacent to each other
Depth of transition joint bay(s) (m)	Up to 3	Up to 3	Up to 3
Transition joint bay link box dimensions (length x width x depth) (m)	2.6 x 2 x 1.5	2.6 x 2 x 1.5	2.6 x 2 x 1.5
Approximate quantities of excavated material (m^3)	2,200 + 1,050 = 3,250	2,200 + 1,250 = 3,450	4,400 + 2,100 = 6,500
Approximate length of HDD (m)	1,150	1,150	1,150
Approximate distance to transition joint bay from shoreline (m)	150	150	150

4.6 Onshore

4.6.1 Onshore Cable Corridor

4.6.1.1 Location

267. The location of the onshore cable corridor is presented in **Figure 4.10** and is 60m wide, increasing to a width of 100m for trenchless crossings. The width of the cable corridor increases where the Order Limits intersect the Food Enterprise Partnership (FEP) Phase 2 Site to allow for greater flexibility and micro siting. This increase does not affect the approximate working easement, and as such impacts presented in the ES remain the same, regardless of the increase in cable corridor width (see **Table 4.32** for details of the cable corridor width and approximate working easement).

268. From the landfall at Weybourne, the onshore cable corridor travels south, crossing the A149, and the North Norfolk Railway line between Holt and Sheringham and continuing south to cross Cromer Road (A148) to the east of High Kelling. South of North Norfolk Railway line the cable corridor crosses through a commercial woodland (Weybourne Wood), which will be crossed by two trenchless crossings to minimise tree losses in this location.

269. The cable corridor continues south passing the villages of Oulton and Cawston and crossing the River Wensum near Attlebridge and then crossing the A47 between Hockering and Easton. From this point the onshore cable corridor heads south east crossing the A11 near Ketteringham before reaching the preferred onshore substation site just south of the existing Norwich Main substation.

4.6.1.2 Onshore Cable Corridor Parameters

270. **Table 4.32** shows the main construction parameters for the onshore cable corridor.

Table 4.32: Onshore Cable Corridor Construction Parameters

Onshore cable corridor route worst-case parameters			
	SEP or DEP in isolation	**SEP and DEP– concurrent**	**SEP and DEP– sequential**
Onshore cable corridor length	60km	60km	60km for each Project
Number of circuits	1	2	2
Number of cables per circuit	1 circuit: 3 x HVAC + 1 fibre optic	2 circuits, each circuit: 3 x HVAC + 1 fibre optic	2 circuits, each circuit: 3 x HVAC + 1 fibre optic
Onshore haul road length	55km	55km	55km for each Project *
Number of simultaneous work fronts	Up to 10	Up to 10	Up to 10 for each Project
Total number of temporary construction compounds	1 main compound. 8 secondary compounds	1 main compounds. 8 secondary compounds	1 main compound. 8 secondary compounds for each Project *
Size of main compound	30,000m^2	30,000m^2	30,000m^2
Size of secondary compounds	2,500m^2 (two of these secondary compounds may be up to 7,500m^2 to accommodate batching of cement bound sand (CBS))	2,500m^2 (two of these secondary compounds may be up to 7,500m^2 to accommodate batching of cement bound sand (CBS))	2,500m^2 (two of these secondary compounds may be up to 7,500m^2 to accommodate batching of cement bound sand (CBS))
Cable corridor width	45m	60m	60m
Cable corridor width within and adjacent to the FEP Phase 2 site	Up to 110m	Up to 110m	Up to 110m
Approximate working easement	27m	38m	45m

Onshore cable corridor route worst-case parameters			
	SEP or DEP in isolation	**SEP and DEP–concurrent**	**SEP and DEP–sequential**
Cable corridor width at trenchless crossings	Up to 100m	Up to 100m	Up to 100m
Cable corridor width at trenchless crossings within and adjacent to the FEP Phase 2 site	Up to 130m	Up to 130m	Up to 130m
No. trenches	1	2	2
Depth of trenches	Up to 2m	Up to 2m	Up to 2m
Minimum depth of cable after burial	1.2m	1.2m	1.2m
Approximate width at surface of trench	3m	3m	3m
Approximate width at base of trench	0.85m	0.85m	0.85m
Approximate volume of trench excavated material (including joint bays)	198,000m^3	396,000m^3	396,000m^3
Approximate volume of excavated material for off-site disposal	4,200m^3	8,400m^3	8,400m^3
Trenchless crossings compound size	1,500 - 4,500m^2	1,500 - 4,500m^2	1,500 - 4,500m^2
Typical jointing bay and link box frequency	Every 1000m	Every 1000m	Every 1000m
Total No. jointing bays and link boxes	60	120	120
Jointing bay dimensions (length x width x depth)	Up to 16m x 3.5m x 2m	Up to 16m x 3.5m x 2m	Up to 16m x 3.5m x 2m
Depth to top of jointing bay (m)	> 1.2m	> 1.2m	> 1.2m
Link box (length x width x depth) if below ground	Up to 2.6m x 2m x 1.5m (plus an above ground marker post at each location)	Up to 2.6m x 2m x 1.5m (plus an above ground marker post at each location)	Up to 2.6m x 2m x 1.5m (plus an above ground marker post at each location)

*The SEP and DEP sequential programme would have up to a one-year gap between the completion of onshore works for the first Project and the start of the onshore works for the second Project.

4.6.1.3 Onshore Export Cable Installation

271. The onshore cable duct will be installed in sections of up to 1km at a time, with a typical construction presence of up to four weeks along each 1km section.

272. Topsoil would be stripped from the section of the onshore cable corridor to be worked on and stored within the working width. The cable trench(es) would then be excavated, typically utilising tracked excavators. The excavated subsoil would be stored separately from the topsoil, and both will be managed to minimise soil erosion.

273. The cable duct installation works are a continuous activity with each work front progressing a section at a time. In any given location once the cable ducts have been installed the trench will be backfilled and the work front will continue moving onto the next section. This would minimise the amount of land being worked on at any one time. However, the haul road will need to be retained throughout much of the cable corridor to maintain access to each work front.

274. The installation of the onshore ducts and cables is expected to take up to 24 months (single Project in isolation) 26 months (two Projects concurrently); or two separate periods of 24 months for the two Projects sequentially scenario. Construction may be carried out by up to ten teams (one per 1km section) along the export cable corridor at the same time. Each team typically working on a 400m length of the corridor on any given day, and within that length the extent of open trenches would typically be between 50-100m on any given day, with the trench being excavated at one end and backfilled at the other as works progress along that section.

275. The onshore cable corridor will contain the HVAC onshore export cables and associated fibre optic cables buried underground within ducts for both SEP and DEP. The onshore export cables will require trenches to be excavated, within which ducts will be installed to house the cable circuits.

276. The onshore cable corridor width of 45m (single Project) or 60m (two Projects) would also include a haul road to deliver equipment to the installation site from construction compounds, storage areas for topsoil and subsoil and drainage. The working easement is expected to be narrower (approximately 27m for a single Project, 38m for two Projects concurrent, and approximately 45m for two Projects sequential) than the width of the Order Limits. This will allow room for micro-siting during detailed design, and for onward connection to the existing surface water drainage network for the proposed construction drainage. The typical working widths are presented on **Plate 4-17**, **Plate 4-18** and **Plate 4-19** below.

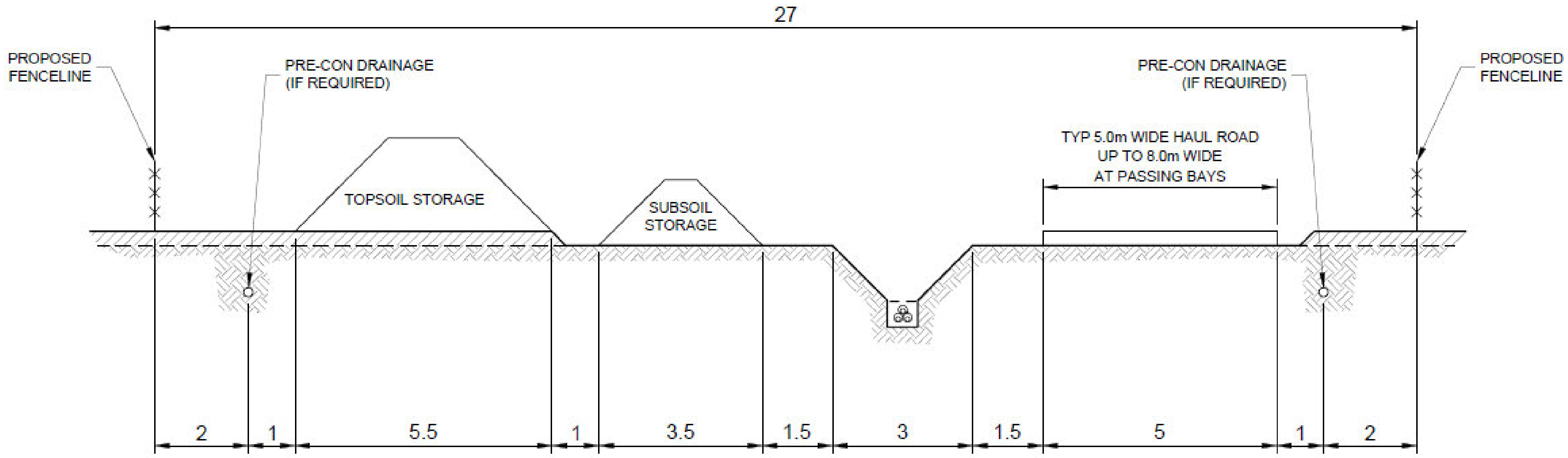

Plate 4-17: Typical working easement for a single Project – this allows for micro-siting within the 45m Order Limits

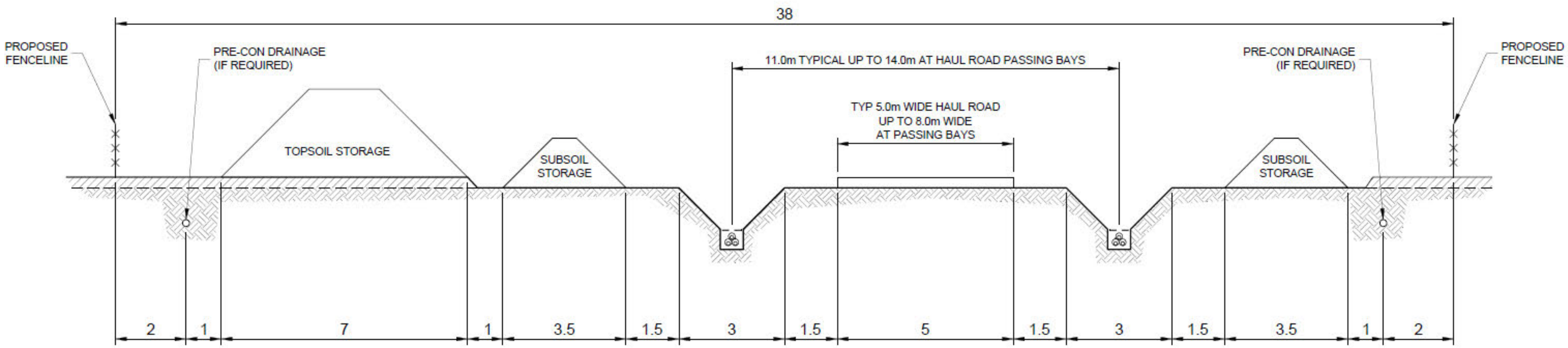

Plate 4-18: Typical working easement for two Projects (concurrently) – this allows for micro-siting within the 60m Order Limits

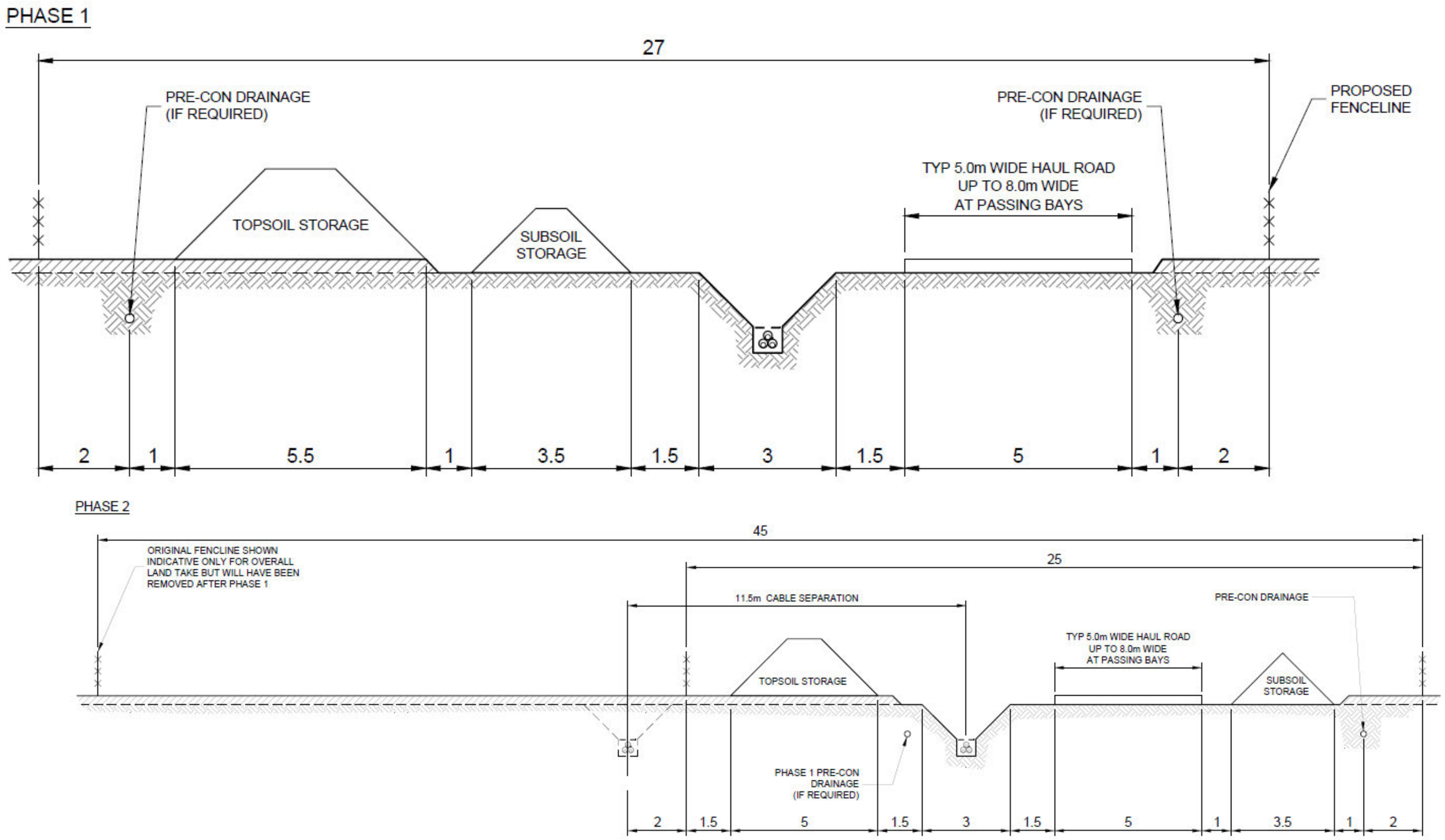

Plate 4-19: Typical working easement for two Projects (two phases sequentially) – this allows for micro-siting within the 60m Order Limits

277. The primary cable installation method will be open cut trenching, with cable ducts installed within the trenches and backfilled with soil. Cables would then be pulled though the pre-laid ducts at a later stage in the construction programme.

278. A trench approximately 2m deep and up to 3m wide would be excavated for each circuit.

279. To minimise the impacts of crossing sensitive features such as hedgerows and watercourses, the working width would be reduced to the haul road and cable trenching areas only (approximately 20m).

280. Ducts would be buried to a minimum depth of 1.2m and installed using two methods:

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

4.6.1.3.1 Hand Laying Method

281. Ducts would be palletised and manoeuvred along the easement using a telehandler (or equivalent). Operatives in the trench would lay zip ties in the base of the trench following the profile of the trench base and sides at predetermined intervals ahead of the ducts being laid (**Plate 4-20**). Ducts are then laid out alongside the trench prior to lifting and lowering into the trench. The ducts would then be jointed together in the trench.

Plate 4-20: Example of hand laying ducts within open trench (Source: Equinor)

4.6.1.3.2 Ducting Trailer Method

282. For longer sections of ducting a ducting trailer or trenching machine (**Plate 4-21**) may be used. This enables the ducts to be joined on the trailer platform and lowered directly into the trench as the tractor moves the trailer forward. The ducts are zipped tied into the correct formation prior to leaving the working platform. The use of the duct trailer or duct machine minimises the need for personnel to work in the trench.

Plate 4-21: Example of cable trenching machine (Source: Equinor)

4.6.1.3.3 Duct Surround and Backfill

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

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

285. Once the ducts are encased in stabilised backfill (typically covering depth of 100mm above the ducts) a compaction plate would be used until the required level of compaction is achieved. The trench would then be backfilled in stages using the subsoil stored at the side of the trench and compacted using suitable compaction plant. Following construction, subsoiling will be undertaken and then the stored topsoil would be replaced on top of the backfilled subsoil to reinstate the trench to pre-construction condition, so far as reasonably possible (**Plate 4-22**).

Plate 4-22: Example of backfilled trench following duct installation. End of duct visible in foreground awaiting joint bay construction and cable pulling (Source: Equinor)

4.6.1.3.4 Trenchless Crossings

286. Where it has not been possible for the onshore cable corridor to avoid crossing constraints such as major transport routes (road and rail) or large rivers then alternative crossing methodologies will be required which are described in **Section 4.6.1.5**.

4.6.1.3.5 Haul Road

287. The haul road would provide safe access for construction vehicles along the onshore cable corridor, between construction compounds and the work fronts. This will minimise the amount of vehicle movements between work areas on the existing road network. The haul road would be up to 5m wide (and up to 8m wide at passing bay locations) and as a worst-case it is assumed it may be required along the full length of the cable corridor. Speed limits on the haul road are expected to be limited to 20mph.

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

289. Where the cable corridor crosses an open ditch or drain, and access for the haul road is required, an appropriately sized culvert may be installed within the ditch and the haul road would be installed over the top of the culvert to maintain access along the cable corridor either side of the ditch. The culvert would be installed in the channel bed so as to avoid upstream impoundment and would be sized to accommodate reasonable 'worst-case' water volumes and flows. These culverts may remain in place for the duration of the cable duct installation and subsequent cable pull, i.e. 24 months total for SEP or DEP in isolation, or 26 months for SEP and DEP concurrent scenario.

290. For the SEP and DEP sequential scenario the culverts from the first Project may be removed following the completion of construction and reinstated at the start of the second Project, depending on the gap between the two onshore construction exercises.

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

292. When cable duct installation is completed the haul road would be removed and the ground reinstated using the stored topsoil. Some sections of haul road may need to be retained or reinstated to maintain access for the subsequent cable pulling stage (**Section 4.6.1.4**).

293. For the sequential scenario, as a worst-case, it is assumed that the haul road for the first Project would be completely removed and then reinstated at the start of the second Project.

4.6.1.3.6 Joint Bays

294. Joint bays would be required along the route of the onshore export cables to connect sections of cable. Joint bays would be installed at least 1.2m below ground and would be of a similar design to the transition joint bay described for the landfall. The joint bays would be formed on completion of the duct installation before the cables are installed and would typically be up to 16m long and 3.5m wide.

295. Joint bays will be constructed with a concrete raft floor, and either battered sides or sheet piled, and with a containerised enclosure. Earth mats will be installed within the joint bays which will consist of four earth rods driven into the ground and connected via earth tape to provide a low resistive connection to earth. The joint bays will be backfilled with CBS to ensure that the cables are stabilised from future thermo-mechanical movement. Following CBS backfill subsoil and topsoil would be reinstated above the joint bay.

296. All excavation and reinstatement activities for the joint bays would be conducted in the same manner as that described above for the cable trenching activities. At joint bay locations a proportion of the originally excavated soils would be surplus and may require removal from site. Adoption of a CL:AIRE (Contaminated Land: Applications in Real Environments) Industry Code of Practice will be developed to manage the re-use and disposal of excavated soils on site.

4.6.1.3.7 Link Boxes

297. One link box per circuit is required in proximity (within 10m) to the jointing bay locations to allow the cables to be bonded to earth to maximise cable ratings, as described above. The link boxes would require periodic access by technicians for inspection and testing during operation. Where possible, the link boxes would be located close to field boundaries and in accessible locations. Link boxes, similar to joint bays, are typically constructed from concrete and buried below ground with an above ground marker post to locate them, and a secured metal access panel at ground level. The below ground dimensions would be up to 2.6m x 2m x 1.5m.

298. Link boxes would not be required at all jointing bay locations but as a worst-case it is assumed that they could be required up to a frequency of one every 1000m. The number and placement of the link boxes would be determined as part of the detailed design. Where possible, the link boxes would be located close to field boundaries and in accessible locations.

4.6.1.3.8 Construction Drainage

299. Surface water drainage will be installed along the edge of the working width to intercept surface water, to minimise water within the trench and to ensure the construction works do not increase the risk of flooding to surrounding land.

300. The cable corridor may require parallel drainage channels to intercept drainage within the working width. Additional drainage channels will be installed to intercept water from the cable trench. This will be discharged at a controlled rate into local ditches or drains via temporary interceptor drains. Depending upon the precise location, water from the channels will be infiltrated or discharged into the existing drainage network.

301. Detailed construction drainage will be developed post-consent by a specialist drainage contractor, taking into account existing land drainage and will include details of header drains, outfall locations and cross-easement interconnections (if applicable). A soakaway drainage pit / outfall may be required if no suitable outfall to a nearby watercourse is possible.

302. Post-construction agricultural drainage will be reinstated including the replacement of any drains that were damaged during the construction process.

4.6.1.3.9 Soil Management

303. Stripped topsoil and excavated subsoil will be stored separately within the onshore 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.

304. 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.

4.6.1.4 Cable Pull

305. Cables would be pulled through the pre-installed ducts later in the construction programme (refer to **Section 4.7**). Trenches would not need to be reopened, and the cable pull would take place from jointing bays located approximately every 1000m along the cable corridor.

306. Typically, this would be achieved by accessing the onshore cable corridor directly from the existing accesses (i.e. the existing road network where it crosses the cable corridor or from other accesses such as existing farm tracks) where possible. Sections of the haul road would need to be retained following the duct installation works or be reinstated to allow access to more remote joint locations. On this basis, it would be possible to reinstate sections of the haul road immediately following duct installation where access to the joint locations is possible from the existing road network. However, at this stage it is unknown exactly what proportion of the haul road would need to be retained and as a worst-case it is assumed that 100% of the haul road would remain in place throughout the cable pulling works.

307. During the cable pull and jointing works cable drums would typically be delivered by HGV low loader, tractor and drum trailer to the open joint bay locations and a winch would be 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 joint bay.

308. The cable pulling and jointing process would take approximately eight weeks per 800m length of cable. However, any one joint bay could be open for up to 16 weeks to allow its neighbouring joint bay to be opened and the cables pulled from one pit to the next, dependant on the level of parallel work being conducted.

4.6.1.5 Crossing Methods

309. All crossings are listed within a crossing schedule provided as **Appendix 4.1** to this chapter.

4.6.1.5.1 Trenchless Crossings

310. Major crossings, such as major roads, river and rail crossings will be undertaken using trenchless crossings techniques.. The term Trenchless crossing technique is an umbrella term covering multiple methodologies; however, in the context of the Project, where trenchless crossing techniques are referred to in the ES and assessed as a design and construction parameter, these are HDD only. The HDD process involves drilling underneath the feature being avoided. The process uses a drilling head to drill a pilot hole along a predetermined profile based on an analysis of the ground conditions and cable installation requirements. This pilot hole is then widened using larger drilling heads until the hole is wide enough to fit the cable ducts. Bentonite is pumped to the drilling head during the drilling process to remove drill cuttings and to stabilise the hole and ensure that it does not collapse. Once the HDD drilling has taken place the ducts are pulled through the drilled hole. When crossing main rivers or Internal Drainage Board (IDB) maintained watercourses the cable entry and exit pits will be at least 9m from the banks of the watercourse, and the cable will be at least 2m below the channel bed.

4.6.1.5.2 Minor Road Crossings

311. Where the onshore cable corridor crosses minor roads, tracks and public rights of way, open cut trenching methods are proposed 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 and 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 crossing schedule (**Appendix 4.1** of this chapter).
312. The approach for each crossing would be agreed with the relevant authority 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 (no more than 1-2 weeks for a minor road crossing). Temporary crossings of the onshore cable corridor could then be installed to allow public access to continue where the haul road is required to remain in service. The crossings would be managed to allow safe operation.
313. Re-instatement of the trench would broadly follow the same process described for the cable duct installation in **Section 4.6.1.3**; however, the road surface would be reinstated to a specification agreed with the local highway authority.

4.6.1.5.3 Minor Watercourse Crossings

314. Where minor watercourses, which are not maintained by IDB, such as field drains, are to be crossed, the approach will be open cut trenching combined with temporary damming and diverting of the watercourse. The suitability of this method would be agreed at detailed design.

315. 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. The cable trenches would then be excavated within the dammed section in the manner described in **Section 4.6.1.3** but ensuring that watercourse bed materials are stored separately to subsoils. Ducts would typically be installed to 2m below the channel bed to avoid impacts to the active channel bed and a concrete capping will be installed over the ducts to protect the circuits from mechanical damage. 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 order that they were removed. 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 (typically no more than 1-2 weeks for a minor watercourse crossing).
316. 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.

4.6.1.6 Construction Compounds

317. Temporary construction compounds are required to support the onshore cable installation. This will include eight secondary compounds and one main compound. In addition, the landfall and substation works would have their own dedicated construction compounds.
318. The main construction compound will be up to 30,000 m^2 and is required to support the cable duct installation and cable pulling works. It would operate as a hub for the onshore construction works and would house the central offices, welfare facilities, and stores, as well as acting as a staging post and secure storage for equipment and component deliveries.
319. The construction works will also require eight secondary construction compounds that will 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, localised stores, as well as acting as staging posts for localised secure storage for equipment and component deliveries.
320. Each secondary compound would be approximately 2,500m^2 in size with direct access into the construction easement. Two of the secondary compounds would be up to 7,500m^2 to provide additional space for CBS batching.
321. Other works compounds include the substation construction compound at approximately 10,000m^2 and the landfall compound at approximately 5,750m^2. Each trenchless crossing will also require its own compound ranging in size between 1,500m^2 - 4,500m^2.
322. Where there is no existing hard standing construction compounds would be constructed by stripping topsoil and laying a geotextile membrane or similar directly on top of the subsoil which will have stone spread over the top of it to a depth of approximately 350mm.
323. For the sequential scenario, as a worst-case, it is assumed that the construction compounds for the first Project would be completely removed and then reinstated at the start of the second Project.

4.6.1.7 Operations and Maintenance

324. There is no ongoing requirement for regular maintenance of the onshore cables following installation, however access to the onshore export cables would be required to conduct emergency repairs, if necessary. Access to each field parcel along the cable corridor would be from existing field entry points where possible or accessing the cable corridor from road crossings.

4.6.1.8 Decommissioning

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

4.6.2 Onshore Substation

326. The onshore substation site is located in arable land south of the existing Norwich Main substation (**Figure 4.11**). The site is located approximately 250m south of Norwich Main, immediately west of the Norwich to Ipswich rail line, and approximately 600m north of the nearest village (Swainsthorpe).

327. The onshore substation will be an air insulated (AIS) switchgear design where the HV equipment is installed outdoors with open air terminations. Air is acting as dielectric medium between the phase conductors.

328. The substation site is of sufficient size to accommodate the maximum footprint required for both SEP and DEP. If only one Project comes forward the substation will be up to 3.25ha in size. If both Projects are taken forward a single substation will be constructed to accommodate both connections and will be up to 6ha in size in the concurrent build out scenario and sequential scenario.

329. A new permanent operational access will be required to access the onshore substation. This access will share part of the existing access to National Grid's Norwich Main substation. A new section of this existing access will continue south between the Norwich Main site (to the west) and the rail line (to the east). The permanent access road will be 6m wide and designed to provide operation and maintenance access throughout the operational life of the substation.

330. The substation will include:

- Control building;
- Static var compensator (SVC) building if required;
- Transformers;
- Switchgear;
- Shunt reactors;
- Harmonic filters if required;
- Access roads – for operation and maintenance access to equipment;
- Associated connections between equipment via busbar and cabling, including lightning protection and buried earthing system;

- Adjacent areas for identified landscape screening;
- Drainage and any required flood risk management measures; and
- 400kV buried cable connection to the existing Norwich Main substation

331. The largest structures within the onshore substation listed above will be the control building and SVC building with an approximate height of 15m. The main electrical equipment (transformers etc.) will not exceed a height of 15m. The tallest features within the onshore substation site will be the lightning protection masts at a height of 30m above ground level.

4.6.2.1 Onshore Substation Parameters

332. **Table 4.33** shows the main construction parameters for the onshore substation.

Table 4.33: Onshore Substation Construction Parameters

Onshore substation	Worst-case parameters		
	SEP or DEP in isolation	**SEP and DEP– concurrent**	**SEP and DEP– sequential**
Operational compound (excluding access)	Up to 3.25ha	Up to 6ha	Up to 6ha
Substation control / switchgear building	30m long x 14m wide x 15m high	50m long x 25m wide x 15m high	2 x (30m long x 14m wide x 15m high)
Maximum building height	Up to 15m		
Lightning protection masts	Up to 30m		
All other external equipment	Up to 15m		
Operational access road width	6m		
Construction compound	Up to 1ha		

4.6.2.2 Onshore Substation Construction Method

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

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

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

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

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

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

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

340. The 400kV cables from the onshore substation to the existing Norwich Main substation would be typically installed within ducts. This method will require a trench to be excavated between the onshore substation and Norwich Main (approximately 850m in length) for the cables to be laid before being reinstated. Should any sensitive features be located along the route from the preferred substation location to the existing substation at Norwich Main then trenchless crossings may also be required. The working width, trench depth, trenchless crossing width, and other dimension for the 400kV installation would be the same as those described for the main cable duct installation (**Section 4.6.1.3**).

4.6.2.3 Drainage

341. A surface water drainage system would be required for the operational substation and would be designed to meet the technical requirements set out in the National Planning Policy Framework (NPPF), through either the use of infiltration techniques or through connection to the existing sewer network, which can both be accommodated within the area of development. Discharge rates from the surface water drainage system would be controlled to prevent any increase in flood risk to surrounding land from present day levels.

342. 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.

4.6.2.4 Screening

343. The onshore substation site benefits from existing hedgerows and woodland blocks within the local area. Additional planting to further screen the substation is also proposed (refer to **Chapter 26 Landscape and Visual Impact Assessment** [APP-112]).

4.6.2.5 Operations and Maintenance

344. The onshore substation would not be manned; however access would be required periodically for routine maintenance activities, estimated at an average of one visit per week. Normal operating conditions would not require lighting at the onshore substation, although low level movement detecting security lighting may be utilised for health and safety purposes. Temporary lighting during working hours will be provided during maintenance activities only.

4.6.2.6 Decommissioning

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

346. A full EIA will be carried out ahead of any decommissioning works being undertaken. The programme for decommissioning is expected to be similar in duration to the construction phase of 48 months (based on both Projects being decommissioned at the same time). The detailed activities and methodology for decommissioning will 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.

347. The decommissioning methodology cannot be finalised until immediately prior to decommissioning but would be in line with relevant policy at that time.

4.7 Construction Programme

4.7.1 Offshore Construction

348. A high-level indicative construction programme including the offshore works is presented in **Plate 4-23**, **Plate 4-24** and **Plate 4-25** below. The earliest any construction works would start is assumed to be 2025, however there would be a two-year period of onshore construction prior to the start of offshore construction. Offshore construction works would require up to two years per Project (excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. If built at the same time, offshore construction could be completed in two years. Accounting for the development scenarios described in **Section 4.1.1**, there could be a gap of up to three years between the completion of offshore construction works on the first Project and the start of offshore construction works on the second Project.

349. It should be noted that the construction programme is dependent on numerous factors including consent timeframes and funding mechanisms. The final design of SEP and DEP (including for example which development scenario is taken forward, the number and type of turbines, OSP/s, cables, etc.) will 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.

350. Offshore (seaward of mean low water) working hours during construction are assumed to be 24/7.

4.7.2 Onshore Construction

4.7.2.1 Pre-Construction Works

351. Pre-construction works are expected to take place from 2024. The main pre-construction activities are noted below and would be applicable to the onshore substation 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;
- 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 Norfolk Historic Environment Services.

4.7.2.2 Main Works

352. A high-level indicative construction programme including the onshore works is presented below. The programme illustrates the likely duration of the major installation elements, and how they may relate to one another in the three potential build out scenarios, i.e. either SEP or DEP in isolation, SEP and DEP built concurrently, and SEP and DEP build sequentially.

353. The earliest construction start date for the main works is expected to be 2025 and the latest is 2028.

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

- 0700 hours and 1900 hours Monday to Friday, and 0700 hours to 1300 hours on Saturdays, with no activity on Sundays or bank holidays.

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

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

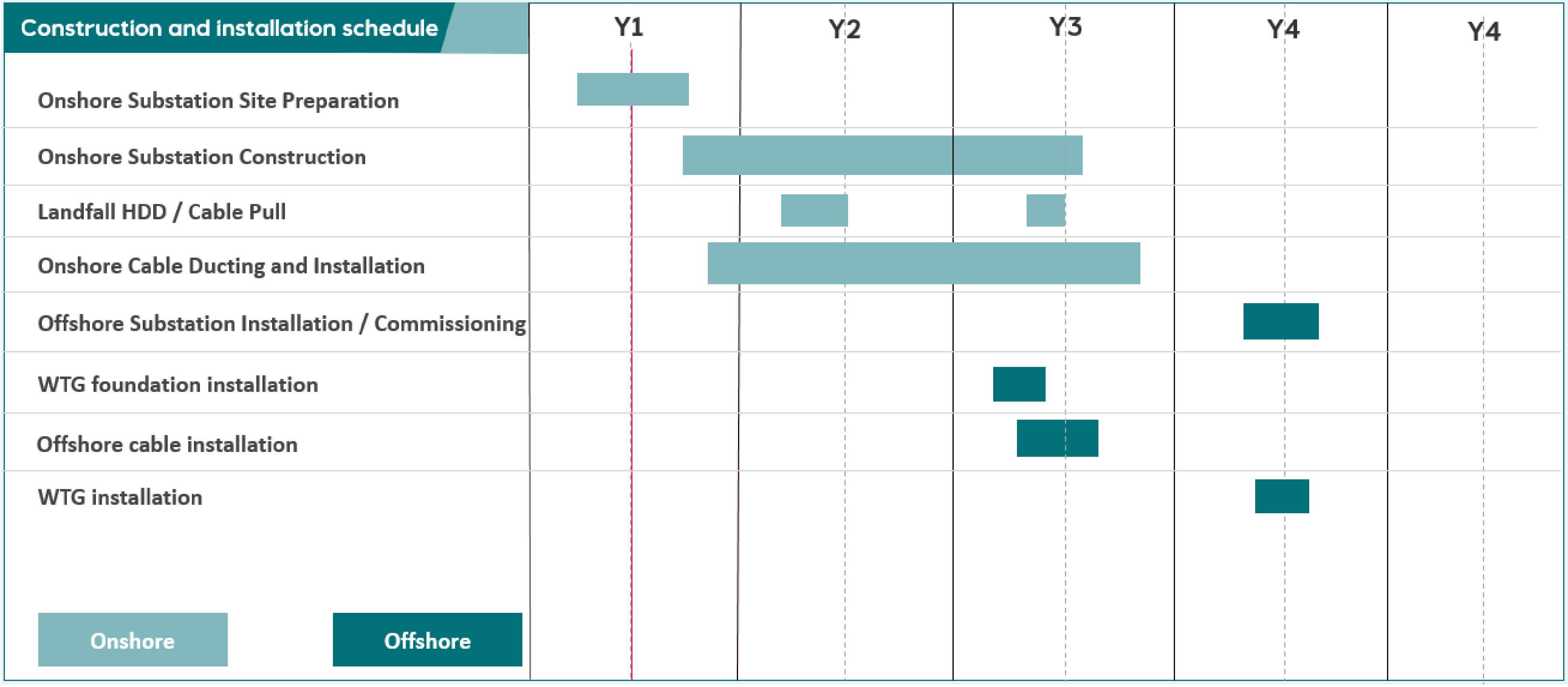

Plate 4-23: Construction Programme – SEP or DEP built in isolation

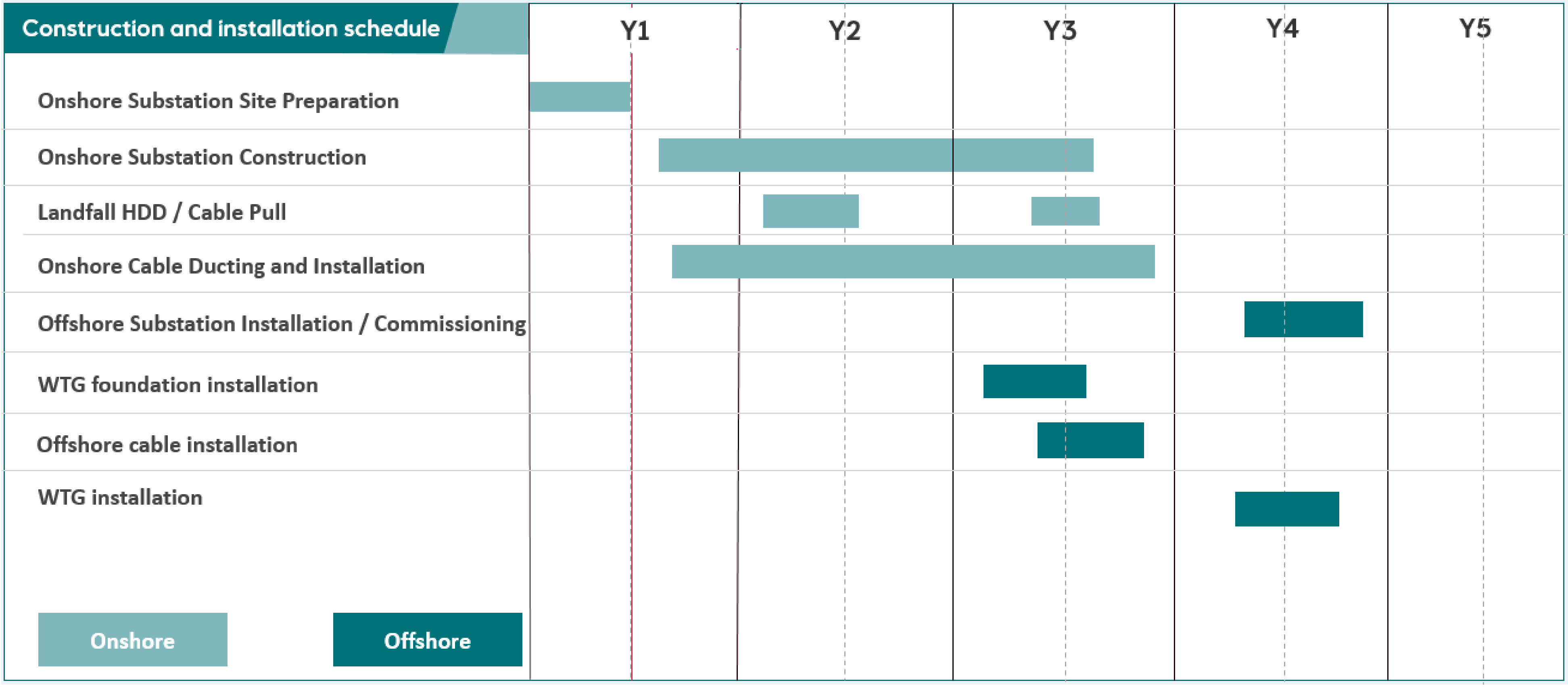

Plate 4-24: Construction Programme – SEP or DEP built concurrently

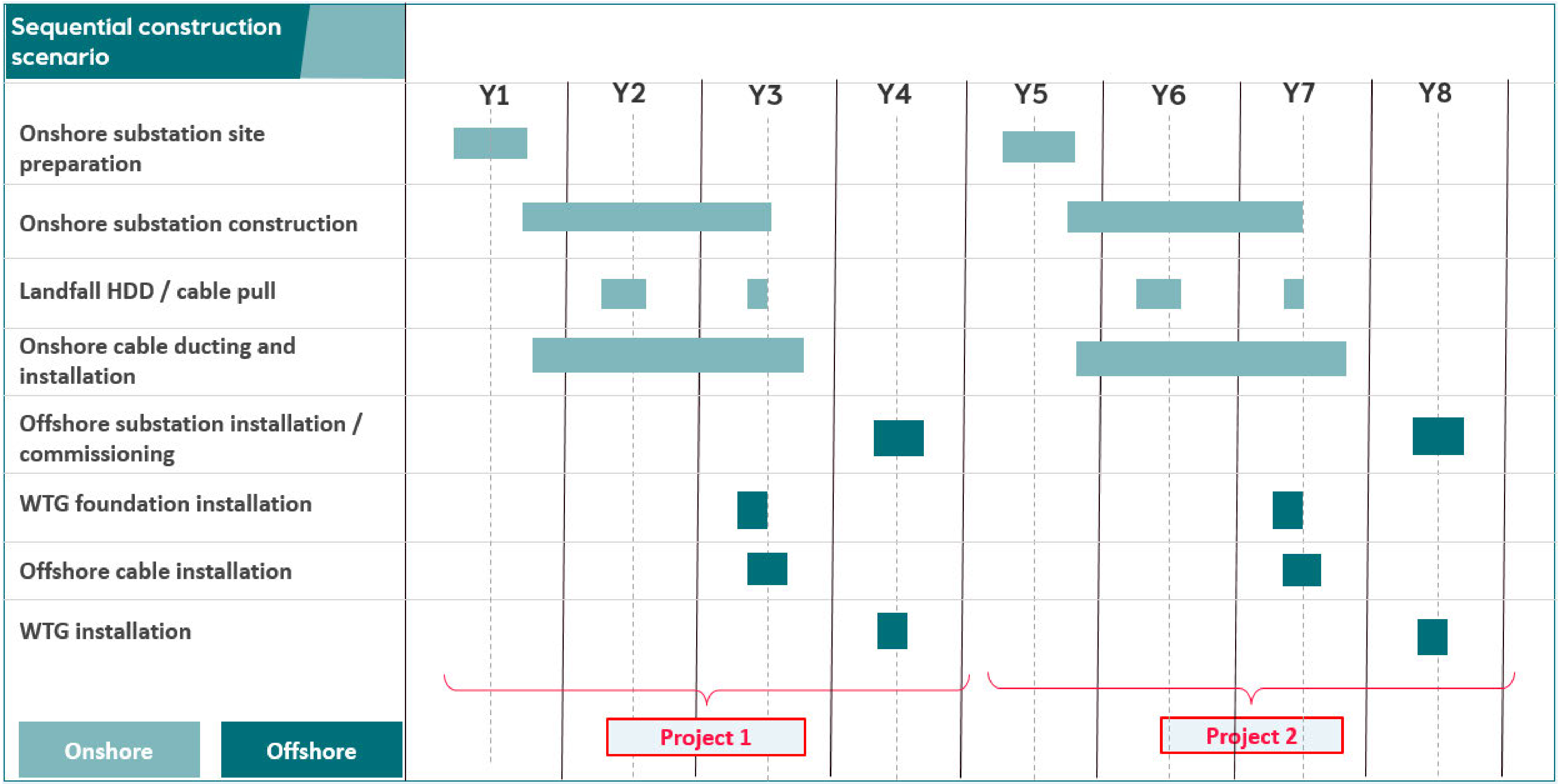

Plate 4-25: Indicative Construction Programme – SEP and DEP built sequentially with up to a 4-year gap between construction start dates

4.7.3 Major Accidents and Disasters

356. The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the EIA Regulations 2017) require the Applicant to consider significant risks to the receiving communities and environment, for example through major accidents or disasters. Similarly, significant effects arising from the vulnerability of the proposed development to major accidents or disasters should be considered. Relevant risks are covered in the topic chapters within this ES.

357. A major accident, as defined in the Control of Major Accident Hazards (COMAH) Regulations 2015 (as amended), means "*an occurrence (including in particular, a major emission, fire or explosion) resulting from uncontrolled developments in the course of the operation of any establishment and leading to serious danger to human health or the environment, immediate or delayed, inside or outside the establishment and involving one or more dangerous substances*".

358. Offshore wind developments have an intrinsically low risk of causing major accidents. The turbines, blades towers and foundation bases of OWFs have an excellent safety record with a very low failure rate and are positioned many kilometres offshore away from populated areas and the public. On the rare occasion that offshore turbine blades have been lost into the sea or damage has been caused to a turbine by a fire within the nacelle, this has resulted without injury. The performance of each turbine is constantly monitored through the SCADA system sending performance data through to a central, partly automated monitoring and control centre. As a result a problem can be quickly detected and pre-prepared safety management action plans rapidly enacted.

359. Whilst exposed power cables on the sea bed can pose a snagging risk to shipping and fishing vessels, the offshore cables will be buried where possible to protect the cables and remove the snagging risk. This is discussed in detail in **Chapter 12 Commercial Fisheries** [APP-098] and **Chapter 13 Shipping and Navigation** [APP-099], which also discusses the risk that the increased vessel movement to and from the site may pose to navigational safety during construction and operational phases.

360. The buried cables onshore and offshore pose very little risk to the public as they are designed to 'trip out' automatically should any failure in insulation along the cable be detected.

361. The risk of substation fires is historically low; however, substation fires can impact the supply of electricity and create a localised fire hazard. The highest appropriate levels of fire protection and resilience will be specified for the onshore substation to minimise fire risks. The onshore substation is also located away from populated areas.

362. The small quantities of lubricants, fuel and cleaning equipment required within the Project will be stored in suitable facilities designed to the relevant regulations and policy design guidance.

363. The offshore wind industry strives for the highest possible health and safety standards across the supply chain. However, there have been incidents including a small number of worker fatalities during the construction and operation of OWFs. Risks to the public onshore and sea users offshore during construction have been minimised through the use of controlled construction sites onshore and vessel safety zones offshore.

364. Safety zones are temporary exclusion areas enacted during construction, allowing the Applicant and its contractors to control vessel movements to enable safe construction works to proceed.

365. Onshore, controlled or closed construction sites will be operated where construction works are undertaken, in sections where access is strictly controlled during periods when the works are ongoing.

366. The Applicant recognises the importance of the highest performance levels of health and safety to be incorporated into the Projects. There is a commitment to adhere to a high level of process safety, from design to operations and for all staff, contractors and suppliers to have a high level of safety awareness and knowledge of safety and safe behaviour. The Applicant will enact a Code of Conduct for suppliers, contractors and subcontractors. They must all comply with the Code as well as health and safety legislation. The Applicant will ensure that employees have undergone necessary health and safety training.

367. With a commitment to the highest health and safety standards in design and working practices enacted, none of the anticipated construction works or operational procedures is expected to pose an appreciable risk of major accidents or disasters.

368. In conclusion, the risk of ‘major accidents and/or disasters’ occurring associated with any aspect of the Projects, during the construction, operation and decommissioning phases is negligible.

References

Maritime and Coastguard Agency (2021). MGN 654 and Annexes – Offshore Renewable Energy Installations Safety Response.

MMT (2019). Environmental Survey Report. Dudgeon OWF - ST18692 Environmental Post Construction Survey Report. Ref: 102952-EQU-MMT-SUR-REP-ENVIRONREVISION A.

Pace Geotechnics (2021). UK Extension Project Sheringham Shoal to Dudgeon NW and SE Cable Burial Risk Assessment. Report No: PACE-EQU-C1105/RPT02.

Pace Geotechnics (2020). UK Extension Project Export Cable Burial Risk Assessment. Report No: PACE-EQU-C1105/RPT01.

Peritus International Ltd. 2022. Scour and Cable Protection Decommissioning Study. NECR403. Natural England.

The Crown Estate (2019). Record of the Habitats Regulations Assessment Undertaken under Regulation 63 of The Conservation of Habitats and Species Regulations 2017 and Regulation 28 of The Conservation of Offshore Marine Habitats and Species Regulations 2017. 2017 Offshore Wind Extensions Plan. 28 August 2019.

Wessex Archaeology (2015). Dudgeon Offshore Wind Farm Archaeological Assessment of UXO Survey Results April–May 2015. Report Ref. 69684.02.

Maritime and Coastguard Agency (2021). MGN 654 and Annexes – Offshore Renewable Energy Installations Safety Response.