MORGAN OFFSHORE WIND PROJECT: GENERATION ASSETS

Environmental Statement

Volume 1, Chapter 3: Project description

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3.1	Underwater sound technical report
3.2	Sulphur hexafluoride report

Glossary

Term	Meaning
Applicant	Morgan Offshore Wind Limited.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement.
Geophysical surveys	Surveys of the seabed which collect data on seabed form and boulder mapping.
Geotechnical surveys	Surveys of the seabed which collect data on underlying seabed geology and rock layers.
Helicopter refuge area	A defined area clear of any surface infrastructure.
Hydrodynamics	Physical processes of water movement (e.g. ocean currents).
Licensing Authority	A relevant authority, department or other agency of the Government that issues a licence (for example the Marine Management Organisation).
Lines of orientation	Lines on roughly the same bearing through the Morgan Array Area.
Maximum design scenario (MDS)	The MDS represents the parameters that make up the realistic worst case scenario. This is selected from a range of parameters and may be different for different receptors and activities.
Micrositing allowance	Radius of the circle around the offshore surface structure position within which the final infrastructure position can be located.
Morgan Array Area	The area within which the wind turbines, foundations, inter-array cables, interconnector cables, scour protection, cable protection and offshore substation platforms (OSPs) forming part of the Morgan Offshore Wind Project: Generation Assets will be located.
Morgan Offshore Wind Project: Generation Assets	This is the name given to the Morgan Generation Assets project as a whole (includes all infrastructure and activities associated with the project construction, operations and maintenance, and decommissioning).
Nominal offshore surface structure position	Offshore surface structure position given in the Design Plan (submitted post-consent to Marine Management Organisation (MMO) in consultation with Maritime and Coastguard Agency (MCA) and Trinity House)
Offshore substation platform (OSP) topside	The topside of an offshore substation is the section that is located above the sea surface and houses the electrical equipment.
Project Design Envelope (PDE)	The PDE sets out the design assumptions and parameters from which the realistic MDSs are drawn for the Morgan Generation Assets Environmental Impact Assessment (EIA). Also known as the Rochdale Envelope approach.
Search and rescue (SAR) access lane	A defined lane which allows search and rescue operations to transit safely along a line of orientation through the Morgan Array Area.
Tolerance allowance	Radius of the circle around the nominal offshore surface structure position within which the target wind turbine position can be located.
Unexploded Ordnance	Remains of explosive devices that did not detonate when they were deployed.

Acronyms

Acronym	Description
AfL	Agreement for Lease
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CBRA	Cable Burial Risk Assessment
CTV	Crew Transfer Vessels
DCO	Development Consent Order
dMLs	Deemed marine licences
EIA	Environmental Impact Assessment
FLCP	Fisheries Liaison And Co-Existence Plan
HSE	Health, Safety and Environment
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ICPC	International Cable Protection Committee
JUV	Jack-Up Vessel
LAT	Lowest Astronomical Tide
MMO	Marine Management Organisation
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
NPS	National Policy Statement
OEMP	Offshore Environmental Management Plan
OSP	Offshore Substation Platform
OTNR	Offshore Transmission Network Review
PDE	Project Design Envelope
PEIR	Preliminary Environmental Information Report
SAR	Search and Rescue
SOV	Service Operation Vessel
UXO	Unexploded Ordnance

Units

Unit	Description
cd	Candela
dB	Decibel
µPa	Micro Pascal (10^{-6})
kHz	Kilohertz

Unit	Description
kJ	Kilojoules
kV	Kilovolts
kg	Kilograms
km	Kilometres
km^2	Kilometres squared
m	Metres
m^3	Metres cubed
m^2	Metres squared
mm	Millimetres
nm	Nautical miles
MW	Megawatt
%	Percentage

3 Project description

3.1 Introduction

3.1.1.1 Morgan Offshore Wind Limited (the Applicant), a joint venture of bp Alternative Energy Investments Ltd. (hereafter referred to as bp) and Energie Baden-Württemberg AG (hereafter referred to as EnBW) who is developing the Morgan Offshore Wind Project: Generation Assets (hereafter referred to as the Morgan Generation Assets). The Morgan Generation Assets is a proposed wind farm located in the east Irish sea.

3.1.1.2 As the Morgan Generation Assets is an offshore generating station with a capacity greater than 100 MW located wholly in English waters, it is a Nationally Significant Infrastructure Project (NSIP) as defined by Section 15(3) of the Planning Act 2008 (as amended) (the 2008 Act). As such, there is a requirement to submit an application for a Development Consent Order (DCO) to the Planning Inspectorate to be decided by the Secretary of State (SoS) for Energy Security and Net Zero. Marine licences are required before carrying out any licensable marine activity under the Marine and Coastal Access Act 2009. For the Morgan Generation Assets, marine licences will be deemed under the DCO for licensable activities in English waters.

3.1.1.3 The Morgan Offshore Wind Project (consisting of both Morgan Generation Assets and Morgan Transmission Assets) and the Morecambe Offshore Windfarm (developed by Morecambe Offshore Wind Farm Ltd a joint venture between Cobra Instalaciones Servicios, S.A. and Flotation Energy plc) were scoped into the Pathways to 2030 workstream under the Offshore Transmission Network Review (OTNR). Under the OTNR, the National Grid Electricity System Operator is responsible for conducting a Holistic Network Design Review to assess options to improve the coordination of offshore wind generation connections and transmission networks. The output of this process concluded that the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm should work collaboratively on a coordinated grid connection at Penwortham in Lancashire.

3.1.1.4 A coordinated grid connection for the Morgan Offshore Wind Project and the Morecambe Offshore Windfarm will be delivered as part of a separate transmission assets application for consent. The project description set out within this chapter of this Environmental Statement provides an outline description of the Morgan Generation Assets.

3.1.1.5 The parameters required for the construction, operations and maintenance and decommissioning phases of the Morgan Generation Assets are based on the design information and the current understanding of the receiving environment.

3.1.1.6 The Applicant has, through the Environmental Impact Assessment (EIA) process (i.e. from Scoping, statutory consultation on the Preliminary Environmental Information Report (PEIR) and non-statutory consultation throughout the pre-application phase of the Morgan Generation Assets), refined the proposed envelope, made design and construction commitments and provided more detailed realistic Maximum Design Scenarios (MDSs) where available. The refined parameters are presented in this Environmental Statement and Draft DCO (Document Reference C1). The final Morgan Generation Assets project design will be selected after development consent has been granted, in line with the parameters stated in the project description within this Environmental Statement and the DCO and deemed marine licences (dMLs) as granted.

3.2 Project design status

3.2.1.1 The Project Design Envelope (PDE) approach (also known as the Rochdale Envelope approach) will be adopted for the EIA of the Morgan Generation Assets, in accordance with industry good practice. The PDE sets out the design assumptions and parameters from which the realistic MDSs are drawn for the Morgan Generation Assets EIA. Information on the National Policy Statements (NPSs) is presented in Volume 1, Chapter 2: Policy and legislative context of the Environmental Statement. Further information on the PDE approach is presented in Volume 1, Chapter 5: EIA methodology of the Environmental Statement.

3.2.1.2 The Morgan Generation Assets design envelope has been prepared to include flexibility to accommodate further project refinement during detailed design, post consent. Offshore wind is a continually evolving industry with a constant focus on safety, increased efficiency and cost reduction, therefore improvements in technology and construction methodologies occur frequently and an unnecessarily prescriptive approach could preclude the adoption of new technology and methods. Consequently, this chapter sets out a series of MDS parameters, which sit within the limits of the design envelope.

3.2.1.3 This project description does not refer directly to the generation capacity of the wind turbines but rather their physical dimensions and construction methods. Subsequently, the EIA assessments are not linked directly to the overall capacity of the Morgan Generation Assets or individual wind turbine capacity, but rather the physical dimensions of the wind turbines such as the maximum tip height and rotor diameter.

3.3 Overview of the Morgan Generation Assets

3.3.1 Morgan Generation Assets Boundary/Morgan Array Area

~~3.3.1.1~~3.3.1.0 The Morgan Generation Assets boundary also known as the Morgan Array Area, is presented in Figure 3.1 below. The Morgan Generation Assets consist of the following:

- Wind turbines, foundations, inter-array cables, Offshore Substation Platform (OSPs), scour protection, cable protection and interconnector cables.

3.3.2 Agreement for Lease area

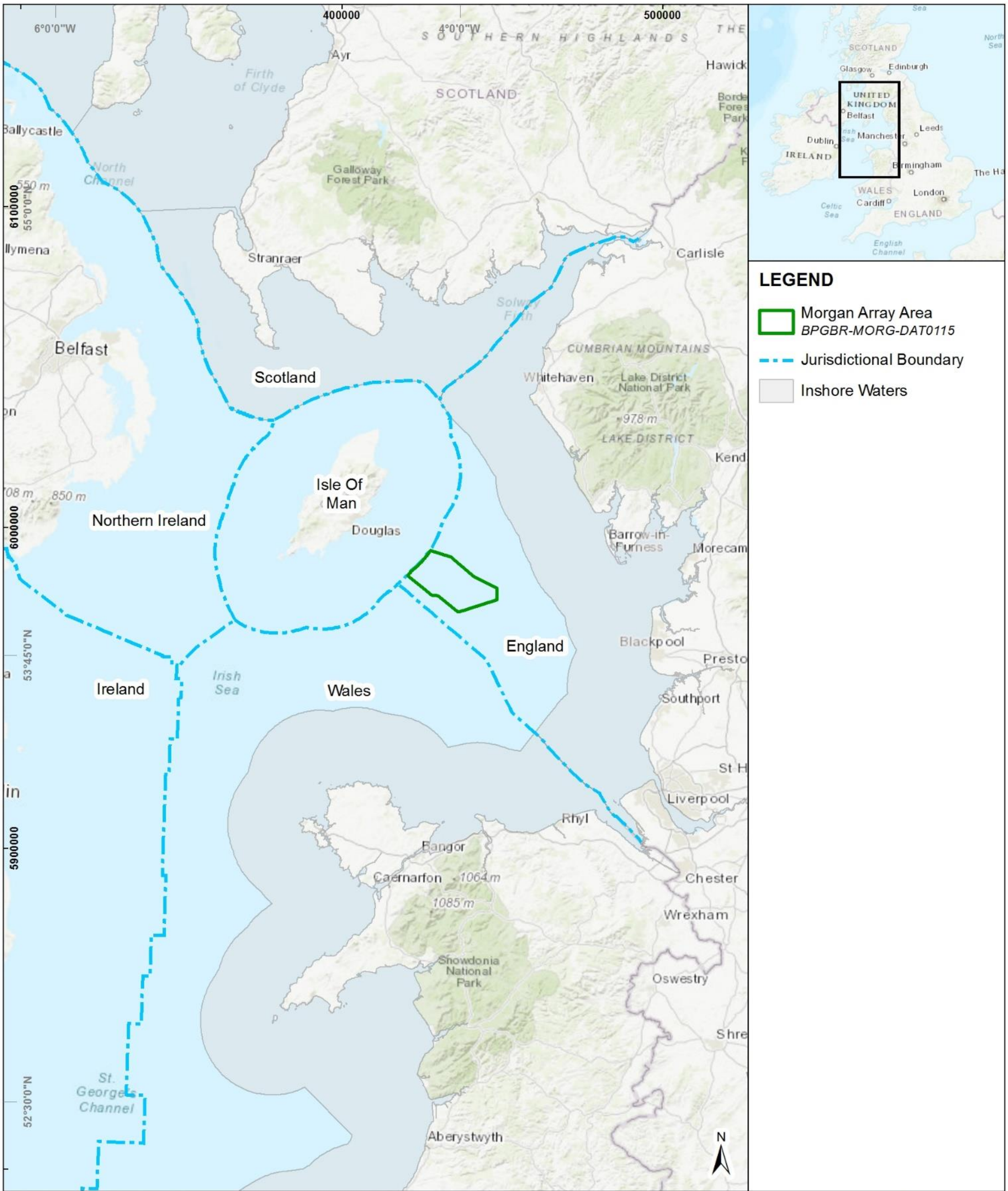
3.3.2.1 The Applicant entered into a wind farm Agreement for Lease (AfL) for the Morgan Offshore Wind Project in early 2023. The AfL for the Morgan Potential Array Area covered approximately 322.2 km^2 and located in the east Irish Sea, 58.8 km (31.7 nm) from the Anglesey coastline, 36.3 km (19.6 nm) from the northwest coast of England, and 22.22 km (12 nm) from the Isle of Man (when measured from Mean High Water Springs (MHWS)).

3.3.2.2 Subsequent to the identification of the AfL site, the Morgan Generation Assets has refined the area for development down from the AfL area (which was consulted upon in the statutory consultation) to the Morgan Array Area, an area of approximately 280 km^2 which is presented within this Environmental Statement. The Morgan Array Area (as shown in Figure 3.1) is 58.5 km (31.6 nm) from the Anglesey coastline, 37.13 km (20.1 nm) from the northwest coast of England, and 22.22 km (12 nm) from the Isle of Man (when measured from MHWS). The Morgan Array Area provided at PEIR has been minimised, where possible, to reduce potential impacts on several receptors including (as set out in Volume 1, Chapter 4: Site selection and consideration of alternatives), but not limited to, those associated with the following chapters:

- Volume 2, Chapter 6: Commercial fisheries of the Environmental Statement
- Volume 2, Chapter 7: Shipping and navigation of the Environmental Statement
- Volume 2, Chapter 10: Seascape, landscape and visual resources of the Environmental Statement
- Volume 2, Chapter 13: Socio-economics of the Environmental Statement
- Volume 2, Chapter 14: Human health assessment of the Environmental Statement.

3.3.2.3 Full details of the potential impacts which have been reduced following the Morgan Array Area boundary change are included in detail within each of these chapters and Volume 1, Chapter 4: Site selection and consideration of alternatives .

3.3.2.4 The infrastructure within the Morgan Array Area including the wind turbines, OSPs, foundations, inter-array cables, scour protection, cable protection and interconnector cables is referred to as the Generation Assets throughout this Environmental Statement. The term Morgan Generation Assets is also used throughout this Environmental Statement to refer to all works associated with construction, operations and maintenance and decommissioning of the Morgan Array Area.



Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

Data Sources: Client

Project Name: MORGAN OFFSHORE WIND PROJECT

0 5 10 20 nm
0 5 10 20 30 40 50 km

Drawing Number: RPSE-MG-ES-INT-001-00

Drawing Title: PROJECT OVERVIEW

Geodetic Information:
Datum: ETRS 1989
Projection: ETRS 1989 UTM Zone 30N
Scale@160mmx220mm: 1:2,000,000

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Figure 3.1: Project overview - Morgan Array Area location.

3.3.3 Project infrastructure overview

3.3.3.1 The Morgan Generation Assets will be located in the east Irish Sea and will include up to 96 wind turbines. The maximum proposed number of turbines has been reduced from 107 and the minimum separation distance between turbines has been increased from that proposed in the PEIR (see section 3.5.6).

3.3.3.2 The final capacity of the Morgan Generation Assets will be based on the available technology at the time of construction and constrained by the design envelope of the wind turbines presented in this chapter. The offshore infrastructure will also include up to 60 km of interconnector cables and 390 km of inter-array cables.

3.3.3.3 The key components of the Morgan Generation Assets are shown in Figure 3.2 and the key parameters are presented in Table 3.1.

3.3.3.4 The Applicant intends to commence construction of the Morgan Generation Assets in 2026, with the project fully operational by 2030 in order to contribute to the UK Government's renewable energy targets.

Table 3.1: Key parameters for the Morgan Generation Assets.

Parameter	Value
Morgan Array Area (km^2)	280
Average water depth (m Lowest Astronomical Tide (LAT))	-38.27
Maximum number of wind turbines	96
Maximum blade tip height above LAT (m)	364
Maximum number of OSPs	4
Maximum length of inter-array cables (km)	390
Maximum length of interconnector cables (km)	60

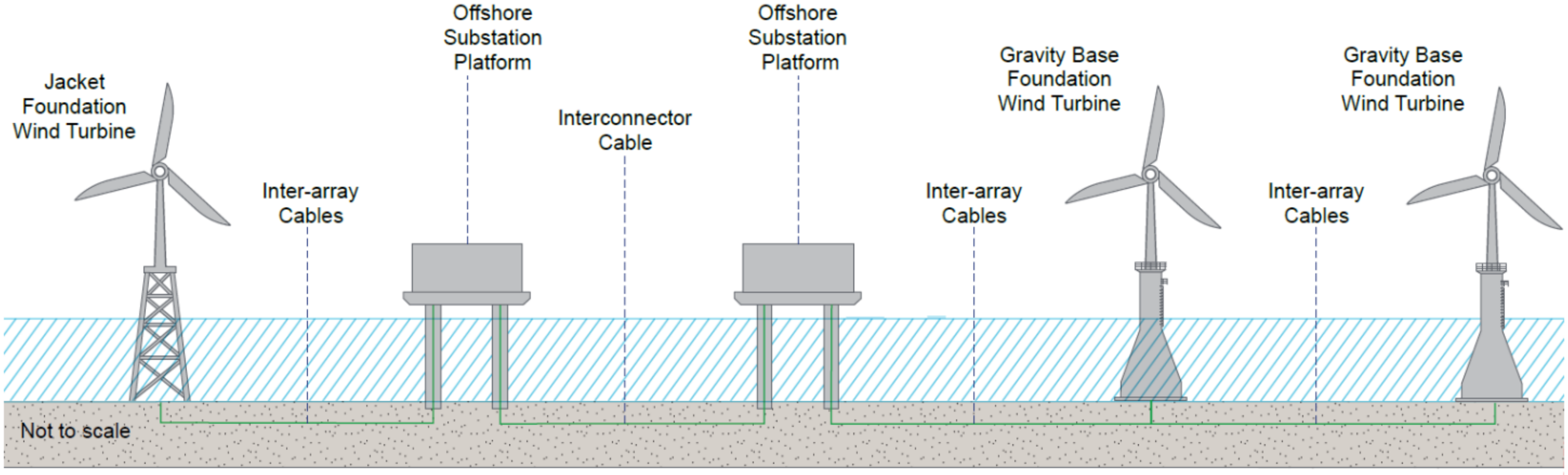

Figure 3.2: Key components of the Morgan Generation Assets infrastructure.

3.4 Consultation

~~3.4.1.1~~3.4.1.0 Consultation is an important part of the EIA process and has been carried out with both statutory and non-statutory stakeholders from the initiation of the project (pre-scoping) throughout the pre-application phase (i.e. Scoping Report, statutory consultation on the PEIR, and non-statutory consultation throughout the pre-application phase). A summary of the key matters raised during consultation activities undertaken specific to the project description is presented in Table 3.2 below, together with how these comments have been considered in the design of the Morgan Generation Assets.

~~3.4.1.2~~3.4.1.1 Wider consultation on the Morgan Generation Assets with stakeholders and local communities is described in Volume 1, Chapter 1: Introduction of the Environmental Statement. Topic-specific consultation is presented in the relevant topic chapter of the Environmental Statement (Volume 2, Chapters 1 to 15 of the Environmental Statement).

Table 3.2: Summary of key matters raised during consultation activities undertaken for the Morgan Generation Assets relevant to the project design.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
June 2022	The Marine and Coastguard Agency (MCA) – Scoping Opinion	The turbine layout design will require MCA agreement prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue aircraft operating within the site.	Development and adherence to a Design Plan will be prepared in accordance with the layout principles, which will be agreed with the Marine Management Organisation (MMO), in consultation with the MCA and Trinity House As per Volume 4, Annex 7.1: Navigational risk assessment of the Environmental Statement and section 3.5.6.
June 2022	MCA – Scoping Opinion	If cable protection measures are required e.g. rock bags or concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum	No more than 5% reduction in water depth (referenced to Chart Datum) will occur at any point on the inter-array cable and interconnector cable routes without prior written approval from the Licensing Authority (the MMO). The depths of water in the Morgan Array Area are more than 20 m therefore a greater than 5% reduction in water depth is unlikely.
June 2022	MMO – Scoping Opinion	Dredge and disposal arising from the preparation and installation of foundations or the clearance of sandwaves under construction activities should be addressed in the final project design.	A dredging and disposal site characterisation for the disposal of seabed preparation material will be presented in a dredging and disposal site characterisation report as part of the Application. Seabed preparation activities including dredging and disposal are presented in section 3.5.4.
June 2022	Natural England – Scoping Opinion	The scour and cable protection solutions that result in no, or minimal, environmental impact to the seabed should be considered.	Several types of scour and cable protection are being considered and the parameters for these are presented in section 3.5.9. The potential impacts of these options are assessed within the relevant topic chapters of this Environmental Statement. Should consent be granted, the final choice and detailed design of the scour protection and cable protection will be made once the final design of the Morgan Generation Assets is complete.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
July 2022	The Planning Inspectorate - Scoping Opinion	Request for clarification regarding how the realistic worst case scenario related to the MDS. The Environmental Statement should assess the worst case that could potentially be built out in accordance with the Authorised Development of the DCO being applied for.	A further description of the PDE approach has been provided in Volume 1, Chapter 5: Environmental Impact Assessment methodology of the Environmental Statement. The approach allows EIA to be conducted on the basis of a realistic 'worst case' scenario (i.e. the maximum project design parameters) which is selected from a range of design values. The term 'maximum design scenario' will be used throughout the Environmental Statement. The worst case that could potentially be built out will be selected on a topic-by-topic and impact-by-impact basis and assessed.
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should present a summary table of all the foundation types under consideration.	An overview of the foundation options for wind turbines and OSPs are presented in Table 3.10.
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should provide further detail on the proposed pre-construction activities and seabed preparation activities.	The pre-construction site investigation surveys and seabed preparation activities required are described in section 3.5.2 and 3.5.4 respectively. The assumptions around the number and type of Unexploded Ordnance (UXO) considered in the assessment are also presented in section 3.5.3. Any likely significant effects have been assessed in the relevant topic chapters.
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should identify the likely site for disposal of drill arisings and include an assessment of effects from these activities.	Drill arisings will be disposed of in the vicinity of the source. This is described in Table 3.11 and paragraph 3.5.8.7, and assessed in the relevant topic chapters (Volume 2, Chapters 1 to 15 of the Environmental Statement).
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should provide a full description of the nature and scope of operational and maintenance activities, including types of activity, frequency, and how works will be carried out.	A description of offshore operational and maintenance activities for which consent is sought under the DCO are presented in section 3.7.
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should describe additional equipment associated with offshore wind farms, such as meteorological masts and buoys.	Buoys are covered under a separate marine licence and forms part of the PDE presented in Volume 1, Chapter 3: Project description of the Environmental Statement. Met masts aren't included within the project design envelope.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should present the scour protection parameters for each foundation type.	The maximum design parameters for each foundation type including scour protection parameters are presented in section 3.5.8.
July 2022	The Planning Inspectorate - Scoping Opinion	The Environmental Statement should explain why target burial depths may not be achievable and provide detail on the cable protection measures to be employed.	The maximum design parameters for inter-array and interconnector cables including cable protection measures and burial depths are presented in section 3.5.9 and section 3.5.10 respectively.
June 2022	The Planning Inspectorate - Scoping Opinion	The location of the port and operations and maintenance base to be used should be identified and any potentially significant effects should be assessed.	A single port or multiple ports in the UK could be used to support primary elements of operations and maintenance. This point is considered further within Volume 2, Chapter 13: Socio-economics of the Environmental Statement, noting that a final decision is still to be made on port locations.
May 2023	MCA – Section 42 consultation response	The turbine layout design will require MCA agreement prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue aircraft operating within the site. As such, MCA will seek to ensure all structures are aligned in straight rows and columns, including any platforms. Any additional navigation safety and/or Search and Rescue requirements, as per MGN 654 Annex 5, will be agreed at the approval stage.	The Applicant has committed to two lines of orientation in the layout of structures within the Morgan Array Area to address potential impacts on search and rescue and shipping and navigation (see Table 3.7). Agreement with the MCA will be reached prior to construction which will minimise the risk to airborne Search and Rescue operations operating within the Morgan Array Area (see Table 3.7).

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
May 2023	MCA – Section 42 consultation response	The MCA is concerned with the cumulative impacts of the proposed Morgan Generation Assets, Mona Offshore Wind Project and Morecambe Offshore Windfarm projects over loss of safe navigable sea space that would increase collision risk.	The developers of the Morgan Generation Assets, Mona Offshore Wind Project and Morecambe Offshore Windfarm have recognised the potential cumulative impacts on shipping and navigation to both commercial and safety receptors. As such, a Cumulative Regional Navigational Risk Assessment (CRNRA) was undertaken collaboratively by the three projects and presented at PEIR. Following the PEIR and S42 responses, all three projects have committed to modifications to their respective array area boundaries to increase searoom and minimise the potential cumulative impacts to shipping and navigation receptors. The effects associated with these boundary changes are presented in the updated Navigational Risk Assessment (NRA) and CRNRA (Volume 4, Annex 7.1: Navigational risk assessment of the Environmental Statement) and shipping and navigation chapter (Volume 2, Chapter 7: Shipping and navigation of the Environmental Statement) submitted as part of the Application.
May 2023	MCA – Section 42 consultation response	Safety zones during the construction, maintenance and decommissioning phases are supported, however it should be noted that operational safety zones may have a maximum 50 m radius from the individual turbines. A detailed justification would be required for a 50 m operational safety zone, with significant evidence from the construction phase in addition to the baseline navigational risk assessment required supporting the case.	Application and use of safety zones will be in accordance with the Safety zone statement (Document Reference J5). These will consist of 500 m zones from the platform/wind turbines edge (at sea level) where there is active construction or major maintenance being undertaken. Applied risk controls, including safety zones, are described in Volume 4, Annex 7.1: Navigational risk assessment of the Environmental Statement.
May 2023	MMO – Section 42 consultation response	The MMO notes that within the decommissioning methodology, it is stated that the wind turbines will be cut below seabed level. As this plan involves leaving infrastructure in place, impacts should be assessed for post-decommissioning. This is because any infrastructure will remain a hazard to navigation and fishing gear, preventing future fishing activity in the area, beyond the lifespan of the windfarm.	The Applicant intends to cut piled foundations below the seabed at a level that means they will not create a hazard for fishing or shipping. This has been included in section 3.11.2.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
May 2023	MMO – Section 42 consultation response	Consent for UXO clearance is usually the subject of a separate Marine Licence application. Whether as part of the DCO application or a separate Marine Licence, the MMO expects to see supporting evidence and an appropriate assessment of impacts to fish from UXO to be presented for review.	Details of UXO clearance activities are discussed in section 3.5.3. Potential impacts associated with UXO clearance are assessed in Volume 2, Chapter 3: Fish and shellfish ecology and Volume 2, Chapter 4: Marine mammals of the Environmental Statement. The Draft DCO (Document Reference C1) submitted with the application for consent secures the requirement to provide the regulator with a UXO clearance method statement and Marine mammal mitigation protocol (Document Reference J17) for approval prior to commencement of clearance activities.
June 2023	Natural England – Section 42 consultation response	The MDS for sandwave clearance and other seabed preparation activities is exceptionally large. We advise that all efforts should be made to avoid areas of sandwaves or minimise the need for clearance by micro-routing cables.	The volume of sandwave clearance required has been refined from the PEIR to the Environmental Statement. The proportion of inter array cables requiring sandwave clearance has reduced from 50% to 40% and the sandwave clearance width along inter array ~~and interconnector~~ cables has reduced from 104 m to 80 m[1]. This subsequently reduces the sandwave clearance and seabed preparation total volume in the Morgan Array Area (inter array cables, interconnector cables and foundations) by 24% (from 24,053,910 m^3 to 18,236,920 m^3). The maximum design parameters for sandwave clearance and seabed preparation is presented in section 3.5.4.
June 2023	Natural England – Section 42 consultation response	Boulder clearance methodology and location of boulder deposition should be clearly stated within the Environmental Statement along with further details for micro-siting of cables if applicable.	Boulders may be picked up one by one and moved to the side of the Morgan Array Area or removed using a plough where boulders will be pushed out of the way. All boulders will remain in the marine environment. Further information relating to boulder clearance is presented in section 3.5.4.

[1] In the Applicant's response to Relevant Representations (PD1-017, comment ref: RR-026.D.9), the Applicant also confirmed a reduction of interconnector cable sandwave clearance width from 104 m to 80 m with associated reductions in sandwave clearance volumes from 18,236,920 m^3 to 15,694,606 m^3. This update is captured in Table 3.4 and section 3.5.4.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
June 2023	Natural England – Section 42 consultation response	Some key parameters for Morgan Generation Assets are clearly defined while others are vaguely defined due to the project requiring flexibility in design and pending further data analysis from surveys. Parameters and the MDS should be clearly defined in the final Environmental Statement.	The maximum design scenarios have been refined from the PEIR to the Environmental Statement and are clearly defined and presented section 3.4.
June 2023	Natural England – Section 42 consultation response	Natural England acknowledges that the developer will submit a UXO clearance method statement once UXO surveys are complete. Applications should provide sufficient information to assess the size and depths of craters within the Environmental Statement.	Consideration of UXO craters is included in the assessment of temporary habitat disturbance/loss in section 2.9.2 of Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. Development of, and adherence to, a UXO clearance method statement is a requirement of the dMLs in the draft DCO (Document reference C1).
June 2023	Natural England – Section 42 consultation response	MDS for boulder clearance has not been defined, it has been assumed this falls within the seabed preparation footprint. However, MDS for boulder clearance should also include consideration for the fate of removed boulders. For example, location of deposits, boulder size.	Boulders may be picked up one by one and moved to the side of the Morgan Array Area or removed using a plough where boulders will be pushed out of the way. All boulders will remain in the marine environment. Further information relating to boulder clearance is presented in section 3.5.4.
June 2023	Natural England – Section 42 consultation response	It is not clear whether secondary scour protection has been included in the project description and MDS parameters. The project description only refers to scour protection. We advise that secondary scour protection impacts are scoped in and included in the MDS parameters. If they are included within the project description, this should be clearly stated and defined.	This was scoped out of the assessment. There is a commitment to provide scour protection and the effectiveness in limiting residual or secondary scour is subject to site specific detailed design. See the Mitigation and monitoring schedule (document reference J6).
June 2023	Natural England – Section 42 consultation response	The MDS for O&M activities does not seem to include maintenance of external cable protection or remedial cable protection. We advise that these need to be considered and assessed.	Details of the potential impacts from operations and maintenance activities including cable repair are discussed in Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement. Assessment of the potential impacts is presented in sections 2.9.2 and 2.9.3 of the chapter.

Date	Consultee and type of response	Comment	Response to comment raised and/or where considered in this chapter
June 2023	Natural Resource Wales (NRW) – Section 42 consultation response	NRW (A) are concerned by the large spatial extent of sand wave clearance that is required to install the cables and infrastructure at the Morgan Generation Assets and consideration of this cumulatively with the Mona Offshore Wind Project and Morecambe Offshore Wind Farm due to their proximity to each other.	The volume of sandwave clearance required has been refined from the PEIR to the Environmental Statement. The proportion of inter array cables requiring sandwave clearance has reduced from 50% to 40% and the sandwave clearance width along inter array cables has reduced from 104 m to 80 m[2]. This subsequently reduces the sandwave clearance and seabed preparation total volume in the Morgan Array Area (inter array cables, interconnector cables and foundations) by 24% (from 24,053,910 m^3 to 18,236,920 m^3). The maximum design parameters for sandwave clearance and seabed preparation is presented in section 3.5.4.
June 2023	NRW – Section 42 consultation response	There is a significant amount of cable protection proposed for Morgan Generation Assets which will potentially lead to long term habitat loss and change of seabed substrate and supporting habitat for other receptors (i.e. marine ornithology, benthic ecology) within Welsh waters. NRW (A) strongly advise that cable protection measures are minimised as much as possible for both sites.	The MDS for cable protection has been reduced from the PEIR to the Environmental Statement. The MDS for inter-array cable installation has been refined with the length of cables requiring cable protection reduced to 39 km. This has subsequently reduced the overall area and volume of cable protection to 390,000 m^2 and 585,000 m^3 respectively. The maximum design parameters for cable protection are presented in sections 3.5.9 and 3.5.10.
June 2023	Ørsted (Mooir Vannin) – Section 42 consultation response	The project has identified indicative layout scenarios which are presented in the relevant topic specific chapters of the PEIR, noting that the final layout of the wind turbines will be confirmed at the final design phase post consent. It is not clear however which layouts have been used to inform the assessments of individual receptor chapters.	Each assessment chapter includes a table setting out the maximum design scenario parameters that have been used to inform the assessment. A summary of the MDS has been provided within each assessment chapter. See Volume 2, Chapters 1 to 15 of the Environmental Statement. Any layouts used to assess potential impacts have been identified as 'indicative layouts' and are considered to be the realistic worst case layout for that specific topic.

[2] In the Applicant's response to Relevant Representations (PD1-017, comment ref: RR-026.D.9), the Applicant also confirmed a reduction of interconnector cable sandwave clearance width from 104 m to 80 m with associated reductions in sandwave clearance volumes from 18,236,920 m^3 to 15,694,606 m^3. This update is captured in Table 3.4 and section 3.5.4.

3.5 Offshore infrastructure

3.5.1 Overview

3.5.1.1 This section describes the geophysical and geotechnical site investigation surveys as well as UXO clearance required to be undertaken before construction commences. Once these are completed, construction will commence with site preparation activities. Site preparation may include UXO clearance, boulder clearance, sandwave clearance and seabed preparation activities. This section then describes the offshore infrastructure that will be constructed within the Morgan Array Area following the completion of the site preparation activities. The offshore infrastructure will include wind turbines, OSPs, foundations, inter-array cables, interconnector cables, scour protection and cable protection. This section also describes the aids to navigation and safety practices that the Applicant will adopt.

3.5.2 Pre-construction site investigation surveys

3.5.2.1 Pre-construction site investigation surveys will be undertaken to provide detailed information on seabed conditions, morphology and geology layers, and to identify the presence/absence of any potential obstructions or hazards. Pre-construction site investigation surveys are likely to include geophysical and geotechnical surveys which will be conducted within, and in the vicinity of, the footprint of the wind turbines and OSPs and along the cable routes. Geophysical survey works will be carried out to provide detailed UXO, bedform and boulder mapping, bathymetry, topographical overview of the seabed and an indication of subsoil-layers. Geotechnical surveys will be conducted at specific locations within the Morgan Array Area.

3.5.2.2 The geophysical site investigation is anticipated to include the following activities which are commonly undertaken as best practice for offshore wind farms:

- Multi-beam echo-sounder (MBES) (200 to 400 kHz; 180 to 240 dB re 1 μPa)
- Sidescan Sonar (SSS) (200 to 900 kHz; 190 to 245 dB re 1μPa)
- Single Beam Echosounder (SBES) (200 to 400 kHz; 180 to 240 dB re 1μPa)
- Sub-Bottom Profilers (SBP) (0.5 to 12 kHz chirp, 4 kHz pinger, 100 kHz pinger; 200 to 240 chirp dB re 1μPa, 200 to 235 pinger (both) dB re 1μPa.)
- Ultra High Resolution Seismic (UHRS) (19.5 to 33.5kHz; 170 to 200dB re 1 μPa)
- Magnetometer.

3.5.2.3 The geotechnical site investigation is anticipated to include the following activities which are commonly undertaken as best practice for offshore wind farms:

- Boreholes
- Cone penetration tests (CPTs)
- Vibrocores.

3.5.3 Unexploded Ordnance clearance

~~3.5.3.1~~3.5.3.0 It is possible that UXO may be encountered during the construction of offshore infrastructure. This poses a health and safety risk where it coincides with the planned location of infrastructure and associated vessel activity and therefore it is necessary to survey for, and manage, potential UXO (pUXO). In order to identify UXO, detailed surveys of the location where infrastructure will be located are required. This work cannot be conducted before a consent application is submitted because the detailed design work needed to confirm the location of infrastructure is reliant upon the pre-construction site investigation surveys outlined in paragraph 3.5.2.1. In addition, the survey for identification of potential UXO must be undertaken within approximately one year ahead of the start of construction as UXO surveys are only valid for one year due to the potential for hydrodynamics to uncover UXO that may not be detected in pre-application surveys. The Applicant commissioned a study to establish the potential for UXO presence at the Morgan Array Area. Based on the results of this study and a conservative estimate, the design envelope for UXO clearance is described in Table 3.3. Furthermore, a range of UXO sizes is predicted with the guidance Net Explosive Quantity (NEQ) ranging between 25 kg to 907 kg with 130 kg being the most likely maximum.

Table 3.3: UXO across the Morgan Array Area.

Potential UXO constraint	Number
Potential UXO as constraints to operations	1883
Potential UXO requiring inspection	178
Percentage Potential UXO to Confirmed UXO	7.5%
Total UXO (above threat item) predicted to require clearance	13

~~3.5.3.2~~3.5.3.1 The Morgan Generation Assets will submit a UXO clearance method statement, confirmation of UXO for clearance and confirmation that clearance does not coincide with archaeology/sensitive seabed features to the MMO pre-construction once UXO surveys are complete, all of which are secured within the Draft DCO (Document Reference C1) submitted with the application for consent. UXO clearance with high order techniques is not included within the Draft DCO (S_D6_10). If UXO clearance with high order techniques is required, the Applicant will apply for this under a separate marine licence application, post-consent.

Methodology

3.5.3.2 The UXO clearance methodology will be in accordance with the latest UXO clearance guidance (Department for Environment, Food and Rural Affairs, 2025).

3.5.3.3 UXO targets identified during the pre-construction site investigation surveys will be investigated to determine if they are UXO. If they are classified as a UXO, they can either be cleared or avoided. Where possible, UXO will be avoided through micrositing of infrastructure, cleared through *in-situ* clearance or recovery of the UXO for disposal at an alternate location. The method of clearance will depend on factors such as the condition of the UXO and will be subject to the UXO clearance contractors safety assessment.

~~3.5.3.4~~ There are a number of methodologies ~~that may be used~~available to clear UXO targets, including detonation of the UXO using an explosive counter-charge placed next to the UXO on the seabed (referred to as a ‘high order’ technique) or methods that neutralise the UXO to be safe without detonation (referred to as ‘low order’ techniques). These low order techniques include ‘deflagration’ which involves the use of a small charge to ‘burn out’ the explosive material without detonation.

3.5.3.4 The use of the low order techniques will be employed where possible. The choice of techniqueThis will be– dependent on the condition of the UXO and individual circumstances. Furthermore, the Applicant will not know what condition a UXO is in until it is investigated through the pre-construction site investigation surveys. ~~Therefore, whilst the use of low-order techniques is a potentially viable solution for clearance of UXO, it is not possible to make a commitment to using them at this stage as it will not be known whether it is a feasible option.~~

3.5.3.5 UXO clearance with high order techniques is not included within the Draft DCO (S_D6_10). If UXO clearance with high order techniques is required, the Applicant will apply for this under a separate marine licence application, post-consent.

3.5.4 Site preparation activities

Boulder clearance and out of service cables

3.5.4.1 Boulder clearance is commonly required during site preparation for installation of offshore wind farm infrastructure. Boulders would pose the risk of damage and exposure to the cable as well as an obstruction risk to the foundation and cable installation equipment. Therefore, boulders may be picked up one by one and moved to the side of the construction area, for example with the inter-array and interconnector cabling this would be at least 10 m either side from the centre line of each cable, or removed using a plough where boulders will be pushed out of the way. All boulders will remain in the marine environment within the boundary of the Morgan Array Area.

3.5.4.2 The pre-application site-specific geophysical surveys have identified that boulder clearance may be required in the vicinity of the foundation locations, along the inter-array cables and interconnector cables. Boulder clearance would occur within the footprint of other installation activities therefore the footprint is not presented to prevent double counting of the seabed footprint parameters.

3.5.4.3 If the final location of the Morgan Generation Assets infrastructure crosses any out of service cables these will be removed where feasible. Any cable removal will be undertaken in consultation with the asset owner and in accordance with the International Cable Protection Committee (ICPC) guidelines (2011). Where feasible, cables will be retrieved to a vessel deck, where one end will be cut, the cable will be pulled past the crossing point, and then cut again before being pulled to the surface where it will be removed from site by the vessel.

Sandwave clearance for cables, and sandwave clearance and/or seabed preparation for foundations

3.5.4.4 In some areas within the Morgan Array Area existing sandwaves and similar bedforms may need to be removed before cables and foundations are installed. Many of the cable installation tools require a stable, flat seabed surface in order to perform as it may not be possible to bury the cable up or down a slope over a certain angle. In addition, the cables must be buried to a depth where they can be expected to stay buried for the duration of the lifetime of the Morgan Generation Assets. Sandwaves are generally mobile in nature therefore cables must be buried beneath the level where natural sandwave movement could uncover them. Wind turbine foundations need to be placed in level, pre-prepared areas of seabed. This can only be achieved by removing the existing sandwaves and similar bedforms before installation takes place.

3.5.4.5 Site-specific geophysical data from the Morgan Array Area and bathymetry data were used to identify sandwaves and it was determined that up to 40% of the inter-array cables and 60% of the interconnector cables would require sandwave clearance. Site-specific geophysical data from the Morgan Array Area and bathymetry data identified that up to 60% of foundation locations may require sandwave clearance. UXO and boulder clearance will also be required. These activities are discussed earlier in section 3.5.3 and paragraph 3.5.4.1. Additional seabed preparation may be required for gravity base foundations, including dredging of the soft sediments and piles to strengthen the seabed if required (see paragraph 3.5.8.17). If dredging is required, it would be carried out by dredging vessels using suction hoppers (dredging ships able to suck sand, clay, silt and gravel) or similar.

3.5.4.6 The MDS for sandwave clearance and seabed preparation in the Morgan Array Area is summarised in Table 3.4 below. The MDS for sandwave clearance and seabed preparation for foundations is based on the four-legged suction bucket foundation option as they have the greatest seabed preparation requirements (foundation options are further described in section 3.5.8). It should be noted that boulder clearance will occur over the same location as the sandwave clearance therefore boulder clearance represents repeat disturbance to the seabed.

3.5.4.7 The MDS for sandwave clearance width (and therefore associated sandwave clearance area) for inter-array and interconnector cables has been reduced from 104 m ~~proposed~~ in the PEIR to 80 m. In addition, the percentage of inter-array cables requiring sandwave clearance has reduced from 50% as presented in the PEIR to 40%. The reduction in sandwave clearance reduces potential impacts on several receptors including, but not limited to, those associated with the following chapters:

- Volume 2, Chapter 1: Physical processes of the Environmental Statement
- Volume 2, Chapter 2: Benthic subtidal ecology of the Environmental Statement
- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 8: Marine archaeology and cultural heritage of the Environmental Statement
- Volume 2, Chapter 9: Other sea users of the Environmental Statement.

3.5.4.8 It is expected that material subject to seabed preparation activities will be deposited in the vicinity of where it was removed. A dredging and disposal site characterisation for the disposal of seabed preparation material is presented in Morgan Array Area Site Characterisation Report (Document Reference J12) submitted with the application for development consent. The dredging site will be within the Morgan Array Area.

Table 3.4: Maximum design parameters for ~~sandwave clearance and seabed preparation~~site preparation activities in the Morgan Array Area.

Parameter	Maximum design parameters
Maximum sandwave clearance impact width – inter-array cables (m)	80
Maximum sandwave clearance impact width – interconnector cables (m)	80~~104~~
Maximum sand-wave clearance: Inter-array cables (m^3)	5,026,651

Parameter	Maximum design parameters
Maximum sand-wave clearance: Interconnector cables (m^3)	3,060,8141,253,915 518,500
Maximum sand-wave clearance and seabed preparation: Foundations (m^3)	10,149,455
Maximum sand-wave clearance and seabed preparation: Total in Morgan Array Area (sum of the inter-array cables, interconnector cables, foundations) (m^3)	18,236,92016,430,021 15,694,606 (5,026,651 + 3,060,8141,253,915 518,500 + 10,149,455)
Disused/out of service cable length removal length (m)	46,000

3.5.5 Wind turbines

Design

3.5.5.13.5.5.0 The Morgan Generation Assets will consist of up to 96 wind turbines, with the final number of wind turbines dependent on the capacity of the individual wind turbines used, and environmental and engineering survey results. Wind turbines with a range of generating capacities are being considered and are differentiated in the EIA as scenario 1 and 2 (Table 3.5). These two scenarios represent the maximum range of wind turbine numbers from minimum (68 turbines) to maximum, the final total of wind turbines could also be between these values. These scenarios have been chosen as they represent the scenario with the smallest, and greatest number of wind turbines, and the scenario with the largest, and fewest wind turbines. However, the physical parameters which form the basis of the MDS, such as maximum tip height or rotor diameter, will dictate the wind turbines that are ultimately installed, rather than be limited by the maximum power ratings of individual turbines. The wind turbines will follow the traditional wind turbine design with a horizontal rotor axis with three blades connected to the nacelle of the wind turbine. The nacelle will be supported by a tower structure which is fixed to the transition piece and foundation. An illustration of this design can be seen in Figure 3.3 and a picture of an offshore wind turbine at the EnBW Hohe See Offshore Wind Farm is shown in Figure 3.4 below. See section 3.5.8 for information relating to wind turbine foundations.

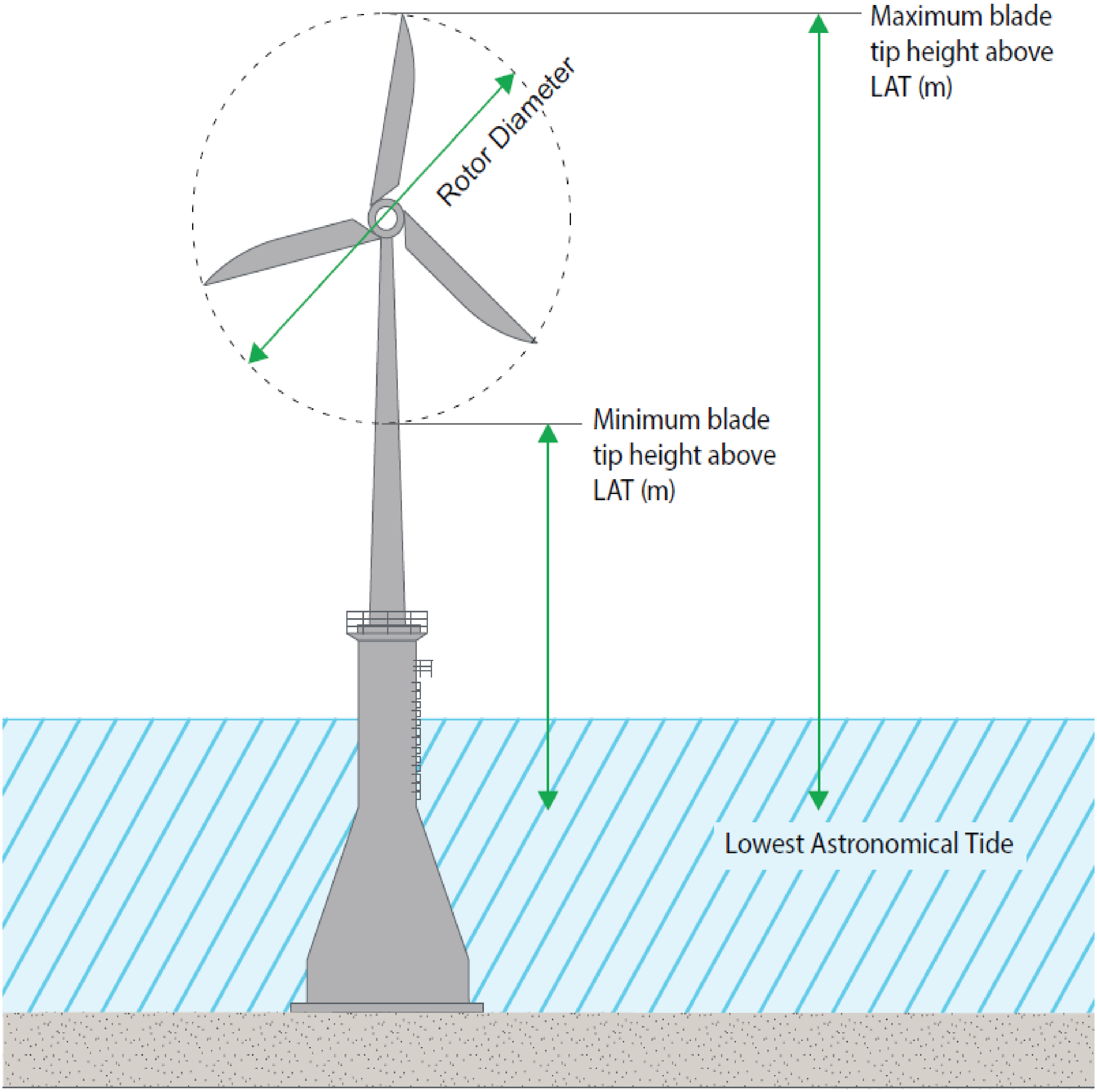

Figure 3.3: Schematic of an offshore wind turbine.

Figure 3.4: A picture of a wind turbine at the EnBW Hohe See Offshore Wind Farm in the German North Sea.

~~3.5.5.2~~3.5.5.1 The MDS for wind turbines presented in Table 3.5 shows the two scenarios (smallest and greatest number of wind turbines (scenario 1) and the largest and fewest wind turbines (scenario 2)) being considered.

Table 3.5: Maximum design parameters: wind turbines.

Parameter	Scenario 1	Scenario 2
Maximum number of turbines	96	68
Minimum height of lowest blade tip above Lowest Astronomical Tide (LAT) (m)	34	34
Maximum blade tip height above LAT (m)	293	364
Maximum rotor blade diameter (m)	250	320
Total maximum rotor swept area (m^2)	4,712,389	5,468,884

~~3.5.5.3~~3.5.5.2 The maximum blade tip height has increased from 324 m proposed in the PEIR to 364 m. The increase in the maximum blade tip height increases potential impacts on several receptors including, but not limited to, those associated with the following chapters:

- Volume 2, Chapter 10: Seascape, landscape and visual resources of the Environmental Statement
- Volume 2, Chapter 11: Aviation and radar of the Environmental Statement.

~~3.5.5.4~~3.5.5.3 When considered alongside the reduction in the Morgan Array Area and the reduced number of wind turbines, this increase in maximum blade tip height has not increased the significance of any potential effects identified in the PEIR to a level where they are considered significant in EIA terms.

Installation

~~3.5.5.5~~3.5.5.4 Generally, wind turbines are installed using the following process:

1. Wind turbine components may be collected from a port in the UK, Europe or elsewhere and loaded onto barges or dedicated transport vessels at port and transported to the array area. Generally, blades, nacelles, and towers for a number of wind turbines are loaded separately onto the vessel.
2. Wind turbine components will be installed onto the existing foundations by an installation vessel. Each wind turbine will be assembled on site. The exact methodology for the assembly is dependent on the wind turbine type and installation contractor and will be defined in the pre-construction phase. Jack-Up Vessels (JUVs) are often used to ensure a stable platform for installing the wind turbine components. JUVs are assumed to have up to six legs with an area of 350 m^2 per foot.

~~3.5.5.6~~3.5.5.5 The total duration for wind turbine construction is expected to be a maximum of 18 months within a 24 month window (Table 3.24).

~~3.5.5.7~~3.5.5.6 Each installation vessel or barge may be assisted by a range of support vessels. These are typically smaller and may comprise tugs, guard vessels, anchor handling vessels, or similar. These vessels will primarily shadow the same movements as the installation vessels they are supporting. For the purposes of the EIA, the assumptions in Table 3.6 have been made on the maximum number of installation and support vessels and the number of return trips to the Morgan Array Area from port that are required throughout wind turbine installation. These numbers have been used to inform the assessment within Volume 2, Chapter 17: Shipping and navigation of this Environmental Statement.

Table 3.6: Maximum design parameters for the wind turbines installation.

Vessel type/helicopter support	Maximum number of vessels/helicopters on site at any one time	Maximum number of return trips per vessel type/helicopter over the construction period
Installation and support vessels	4	76
Survey vessels	1	12
Crew Transfer Vessels (CTVs)	4	365
Helicopter support	2	365

3.5.6 Wind turbine and surface infrastructure layouts

~~3.5.6.1~~3.5.6.0 The layout of the wind turbines will be developed to best utilise both the available wind resource and suitability of seabed conditions, while seeking to minimise potential environmental effects and impacts on other marine users (such as fisheries and shipping and navigation). The Morgan Generation Assets will be developed on the basis of the principles set out in Table 3.7 and secured through the Draft DCO (Document Reference C1) submitted with the application for development consent.

~~3.5.6.2~~3.5.6.1 The minimum separation distance between offshore surface structures (wind turbines and OSPs) has increased from 1,000 m between rows of offshore surface structures and 875 m between each offshore structure in a row as presented in the PEIR to a minimum of 1,400 m both within and between rows. The increase in the minimum separation distance, together with the reduction in the Morgan Array Area (see section 3.3.2) and the reduction in the maximum number of turbines (see section 3.3.3), reduces potential impacts on several receptors including, but not limited to, those associated with the following chapters:

- Volume 2, Chapter 6: Commercial fisheries of the Environmental Statement
- Volume 2, Chapter 7: Shipping and navigation of the Environmental Statement
- Volume 2, Chapter 13: Socio-economics of the Environmental Statement
- Volume 2, Chapter 14: Human health assessment of the Environmental Statement.

~~3.5.6.3~~3.5.6.2 In order to inform the EIA, the Applicant has identified indicative layout scenarios which are presented in the relevant topic-specific chapters of this Environmental Statement. However, the final layout of the wind turbines will be confirmed through the Design Plan submitted to the MMO for approval in consultation with MCA and Trinity House prior to commencement of construction offshore and secured as a condition of the dMLs within the Draft DCO (Document Reference C1) submitted with the application for-development consent.

Table 3.7: Layout development principles.

Principle	Definition	How the principle is secured
Principle 1	All offshore surface structures (wind turbines and OSPs) will be located within the Morgan Array Area. No blade overfly or structural overhang is permitted, therefore all wind turbines must be positioned at least half the maximum~~a~~ rotor diameter (~~320~~i.e. 160 m) inside the boundary of the Morgan Array Area.	Location of offshore surface structures within the array area are secured in schedule 1, part 1 of the Draft DCO (Document Reference C1), within the dMLs of the Draft DCO (Document Reference C1).
Principle 2	There will be a minimum separation of 1,400 m within and between rows of offshore surface structures unless the requirements of Principles 5 and, or 6 are required to be applied. This minimum spacing is to be measured from the ~~plan~~ centre points of structures.	The minimum separation distance of 1,400 m is secured as an offshore parameter in requirement 2 of Schedule 2 of the Draft DCO, within the dMLs of the Draft DCO (Document Reference C1).
Principle 3	The final wind turbine layout will provide for two lines of orientation as a minimum.	Secured within the dMLs of the Draft DCO (Document Reference C1).
Principle 4	Search and Rescue (SAR) access lanes shall be allowed for and shall be a minimum of 500 m wide, measured from the perimeter of any offshore surface structure. In the case of wind turbines, SAR lanes will be measured from the blade tips that are transverse to the wind turbine. SAR lanes will cross the Morgan Array Area on the same bearing until the edge of the Morgan Array Area or until a Helicopter Refuge Area is reached in accordance with the recommendations for layouts in Marine Guidance Note (MGN) 654.	The minimum separation of 1,400m (Principle 2) will provide for sufficient room for SAR Access lanes. Development post-consent of a wind turbine layout in accordance with the recommendations for layout contained in MGN654 and its annexes is secured within the dMLs of the Draft DCO (Document Reference C1).
Principle 5	For all offshore surface structure positions, the tolerance allowance will be ~~2~~5 m, ~~centred on the nominal~~measured from the ~~plan~~ centre points of offshore surface structures ~~position~~ whilst still complying with Principle 4.	Secured within the dMLs of the Draft DCO (Document Reference C1).
Principle 6	For all offshore surface structures, the micrositing allowance will be 50~~100~~ m, measured from the ~~plan~~ centre points of ~~centred on the nominal~~ offshore surface structures ~~position~~ whilst still complying with Principle 4 and can be additive to the tolerance allowance of ~~2~~5 m in Principle 5. Therefore, in total the allowance for micrositing will be 5~~12~~5 m.	Secured within the dMLs of the Draft DCO (Document Reference C1).
Principle 7	Packed boundaries are permitted, that is, wind turbines on the perimeter of the Morgan Array Area maintain minimum spacing whilst internal spacing can be greater. The minimum spacing shall be compliant with Principle 2.	Not secured as MGN654 allows for layouts which include perimeter turbines with smaller spacing that internal turbines.
Principle 8	Where SAR access lanes are more than approximately 10 nm, a Helicopter Refuge Area perpendicular to the SAR Access Lanes will be included within the layout design as recommended in MGN654. The Helicopter Refuge Area shall be at least 1 nm (tip to tip) in width and allow access across the Morgan Array Area as recommended in MGN654.	Development post-consent of a wind turbine layout in accordance with the recommendations for layout contained in MGN654 and its annexes is secured within the dMLs of the Draft DCO (Document Reference C1).

Principle	Definition	How the principle is secured
Principle 9	Wind turbines will be laid out in rows with a roughly north to south orientation.	Secured within the outline fisheries liaison and co-existence plan (FLCP) submitted with the application (Document Reference J10). The dMLs of the Draft DCO (Document Reference C1) secures submission of a FLCP in accordance with the outline FLCP (Document Reference J10) prior to commencement of offshore construction.

3.5.7 Offshore substation platforms (OSPs)

~~3.5.7.1~~3.5.7.0 The OSPs will contain the equipment required to transform electricity generated at the wind turbines to a higher voltage for transportation onshore via the Morgan and Morecambe Offshore Wind Farms: Transmission Assets which is being progressed via a separate DCO application. The OSPs may also house auxiliary equipment and facilities for operating, maintaining and controlling the substation. They are likely to have one or more decks, a helicopter platform, cranes and communication antenna (Figure 3.5).

Figure 3.5: OSP at the EnBW Hohe See Offshore Wind Farm in the German North Sea.

~~3.5.7.2~~3.5.7.1 Up to four separate OSPs will be required, and they will all be located within the Morgan Array Area. The exact locations will be determined during the post-consent detailed design phase. Locations will take into account the ground conditions and the most efficient cable routing amongst other considerations. They will follow the layout principles set out in Table 3.7. The OSPs are planned to be unmanned type A according to DNVGL-ST-0145 Offshore substation standard but once commissioned will be subject to regular operations and maintenance visits.

~~3.5.7.3~~3.5.7.2 The maximum design parameters for the OSPs are presented in Table 3.8 below and a schematic of an OSP is presented in Figure 3.6.

Table 3.8: Maximum design parameters for the OSPs.

Parameter	Maximum design parameters
Maximum number of OSPs	4
Topside – maximum main structure length (m)	80
Topside – maximum main structure width (m)	60
Topside – maximum height (excluding helideck, crane or lightning protection) (LAT) (m)	70
Maximum height of lightning protection and ancillary structures (LAT) (m)	95
Topside – maximum area (m^2) (length x width)	4,800 (80 x 60)

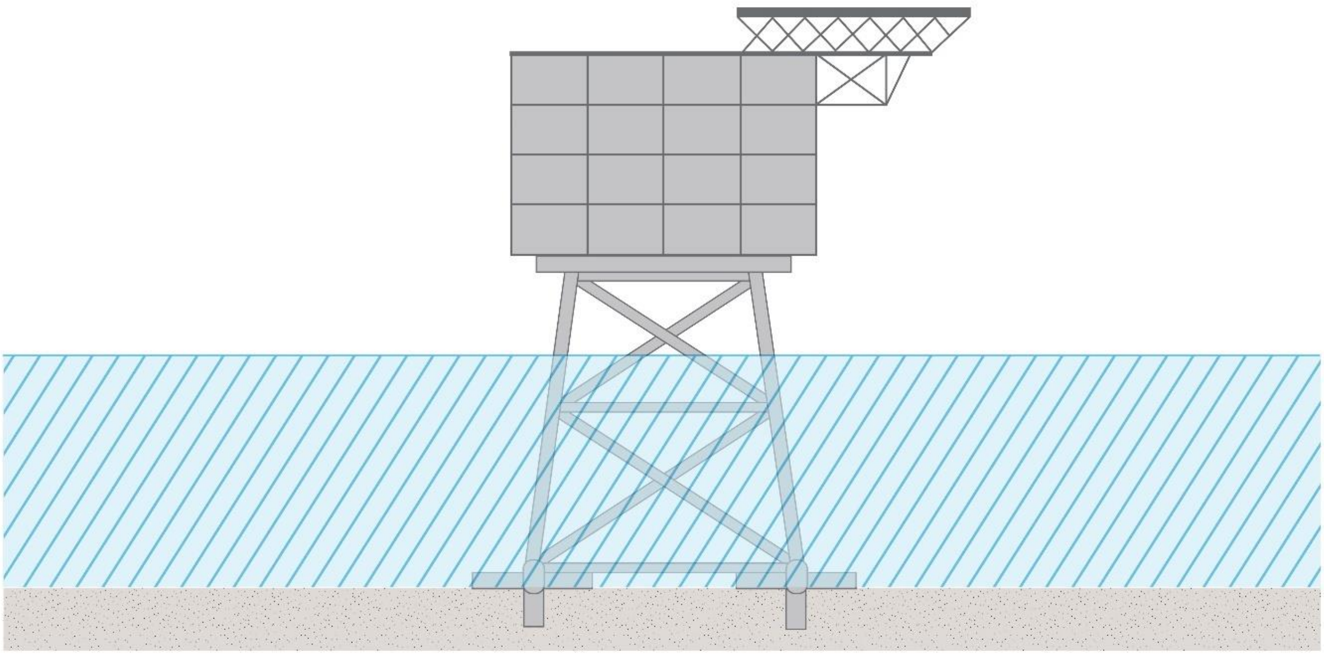

Figure 3.6: Schematic of an OSP.

~~3.5.7.4~~3.5.7.3 OSPs may have electric vessel charging equipment e.g. for service operation vessels (SOVs) or CTVs. For such a purpose, there would be one or more charging cables on one or several OSPs. It is expected that vessels would be charged through the aid of a remotely operated telescopic crane or a similar device, electric vessels would collect a power cable messenger line and then move a safe distance from the OSP(s) before fully deploying and connecting the charging cable and then commence charging operations.

Installation

~~3.5.7.5~~3.5.7.4 OSPs are generally constructed by installing the foundation structure, then the topside will be lifted from a transport vessel/barge or floated over onto the foundation. The foundation and topside may be transported on the same transport vessel/barge, or separately. The vessel requirements for OSP installation are presented in Table 3.9.

Table 3.9: Maximum design parameters for the OSP installation.

Parameter	Maximum number of vessels on site at any one time	Maximum number of return trips per vessel type over the construction period
Primary installation and support vessels	9	45
Tug/anchor handlers	2	10
Survey vessels	1	3
Seabed preparation vessels	1	2
CTVs	2	40
Scour protection installation vessels	1	1
Helicopters	2	365

3.5.8 Foundations for wind turbines and OSPs

~~3.5.8.1~~3.5.8.0 The wind turbines and OSPs will be attached to the seabed by foundation structures. The Applicant requires flexibility in foundation choice to accommodate ground conditions within the Morgan Array Area. The foundation types that are being considered for the Morgan Generation Assets are shown in Table 3.10.

~~3.5.8.2~~3.5.8.1 The PEIR included monopiles as a design option for turbines and OSPs, however monopiles have now been removed from the design envelope. The removal of monopile foundations will reduce the potential impacts on receptors associated with the following chapters:

- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 4: Marine mammals of the Environmental Statement
- Volume 2, Chapter 6: Commercial fisheries of the Environmental Statement
- Volume 3, Annex 3.1: Underwater sound technical report of the Environmental Statement.

~~3.5.8.3~~3.5.8.2 The foundations will be fabricated offsite, stored at a suitable port facility and transported to site by sea (see paragraph 3.5.5.4 *et seq*.). Specialist vessels will transport and install foundations. Scour protection (typically rock) may be required on the seabed and will be installed before and/or after foundation installation (see paragraph 3.5.8.22 *et seq*.).

Table 3.10: Foundation options for wind turbines and OSPs.

	Wind turbines	OSPs
Maximum number of structures	96	4
Pin piled three-legged Jacket	Yes	Yes
Pin piled four-legged Jacket	Yes	Yes
Pin piled six-legged Jacket	No	Yes
Suction bucket three-legged Jacket	Yes	Yes
Suction bucket four-legged Jacket	Yes	Yes
Suction bucket six-legged Jacket	No	Yes
Gravity base	Yes	Yes

Piled jacket foundations

Design

~~3.5.8.4~~3.5.8.3 Piled jacket foundations are formed of a steel lattice construction which is secured ~~to the seabed~~ by either driven and/or drilled pin piles attached to the jacket feet. The transition piece and foundation structure are fabricated as an integrated part of the jacket. The Morgan Generation Assets may use either six-legged (for OSPs only), four-legged or three-legged piled jacket foundations. An example of a pin piled jacket is shown in Figure 3.7.

~~3.5.8.5~~3.5.8.4 The seabed in some sections of the Morgan Array Area may be unsuitable for piling to be used as the installation technique. If piled jacket foundations are used for the Morgan Generation Assets, a maximum of 64 of the maximum number (96) of wind turbine foundations would be installed using driven piled jackets. The remainder (maximum 32) would be installed using non-driven piled jacket solutions, suction bucket jackets and/or gravity base foundations.

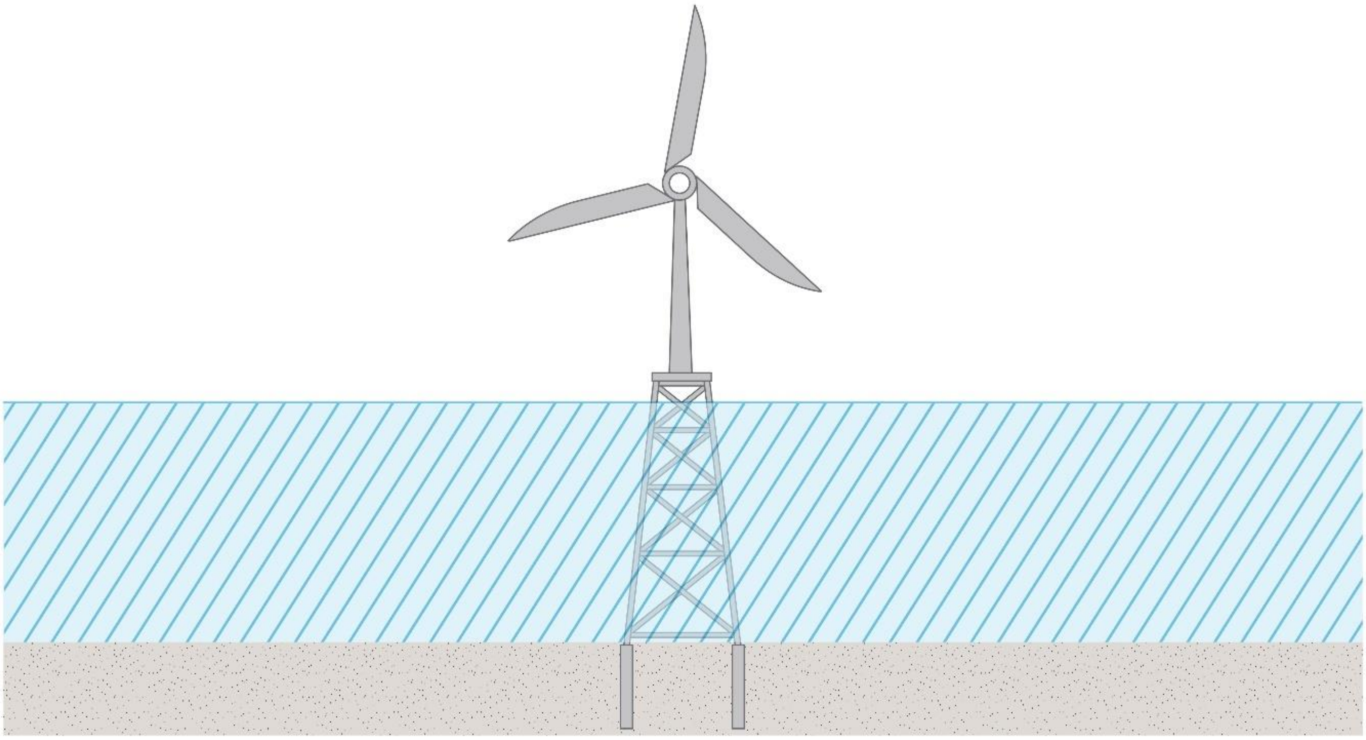

Figure 3.7: Schematic of a pin pile jacket foundation.

~~3.5.8.6~~3.5.8.5 The maximum design parameters for jacket foundations with pin piles for wind turbines are shown in Table 3.11, with the maximum design parameters for jacket foundations with pin piles for OSPs shown in Table 3.12.

Table 3.11: Maximum design parameters for jacket foundations with pin piles - wind turbines.

Parameter	Maximum design parameter
Maximum number of driven piled jacket foundations	64 of a total 96 foundation locations, with the other 32 installed using non-driven piled jacket solutions, suction bucket jackets and/or gravity base foundations
Maximum number of legs per foundation	4
Maximum number of piles per leg	1
Maximum separation of adjacent legs at seabed level (m)	50
Maximum separation of adjacent legs at LAT (m)	40
Maximum leg diameter (m)	5.5
Maximum pin pile diameter (m)	5.5
Maximum embedment depth (below seabed) (m)	75
Maximum hammer energy (kJ)	4,400 at a maximum of 16 foundation locations, with all other wind turbine foundations piling locations limited to a maximum hammer energy of 3,000 kJ
Maximum seabed area – per foundation (m^2)	85

Parameter	Maximum design parameter
Maximum seabed area – scour protection per foundation (m^2)	6,188
Maximum seabed area – total foundations and scour protection for all foundations with jacket foundations with pin piles (m^2)	284,360
Maximum scour protection volume for all foundations with jacket foundations with pin piles (m^3)	701,272
Maximum total drill arisings for all foundations with jacket foundations with pin piles (m^3)	174,892

Table 3.12: Maximum design parameters for jacket foundations with pin piles - OSPs.

Parameter	Maximum design parameter
Maximum number of jacket foundations	4
Maximum number of legs per foundation	6
Maximum piles per leg	3
Maximum separation of adjacent legs at seabed level (m)	70
Maximum separation of adjacent legs at LAT (m)	50
Maximum leg diameter (m)	5
Maximum pin pile diameter (m)	5.5
Maximum embedment depth (below seabed) (m)	75
Maximum hammer energy (kJ)	4,400
Maximum seabed area – per foundation (m^2)	428
Maximum seabed area – scour protection per foundation (m^2)	8,406
Maximum seabed area – total foundations and scour protection for all foundations (m^2)	10,622
Maximum scour protection volume for all foundations with jacket foundations with pin piles (m^3)	25,731
Maximum total drill arisings for all foundations with jacket foundations with pin piles (m^3)	37,926

Installation of piled jacket foundations

~~3.5.8.7~~3.5.8.6 The pin piles are either driven and/or drilled into the seabed relying on the frictional and end bearing properties of the seabed for support. Up to two vessels may be piling and two other vessels drilling simultaneously, with concurrent piling being undertaken at a maximum distance of 15 km between locations. Drill arisings will be disposed of in the vicinity of the source. The maximum duration for wind turbine foundation installation across the Morgan Array Area would be 12 months within a 24 month window. The modelled piling scenario (see Volume 3, Annex 3.1: Underwater sound technical report of the Environmental Statement) for pin piles assumes a maximum 6.5 hour duration per pile.

~~3.5.8.8~~3.5.8.7 The maximum hammer energy for the Morgan Generation Assets is 4,400 kJ for pin piles. The hammer energy may only be raised to 4,400 kJ at a maximum of 16 locations, with all other piling locations being limited to a maximum hammer energy of 3,000 kJ, an approach informed by pre-application geophysical and geotechnical surveys and studies. Although a maximum hammer energy of 4,400 kJ is considered as the MDS, the actual energy used when piling is likely to be significantly lower for the majority of the time. The hammer energy will only be raised to 4,400 kJ when absolutely necessary. Hammer energies will start at 320 kJ for the soft start phase and gradually increase to the optimum energy level required to install the pile, which is typically less than the maximum hammer energy.

~~3.5.8.9~~3.5.8.8 Owing to the removal of monopiles from the foundation options, the maximum hammer energy has been reduced from 5,500 kJ (monopile foundation) presented in PEIR to 4,400 kJ (piled jacked foundation) presented in this Environmental Statement. The change in maximum hammer energy will influence the potential impacts on receptors associated with the following chapters:

- Volume 2, Chapter 3: Fish and shellfish ecology of the Environmental Statement
- Volume 2, Chapter 4: Marine mammals of the Environmental Statement
- Volume 2, Chapter 6: Commercial fisheries of the Environment Statement
- Volume 3, Annex 3.1: Underwater sound technical report of the Environmental Statement.

~~3.5.8.10~~3.5.8.9 The pin piles may be installed before or after the jacket is installed on the seabed. If they are installed first, a piling template is positioned onto the seabed to guide the pin-piles to the required locations. The piles are then installed through the template, which is recovered to the installation vessel. If the pin piles are installed after the jacket has been placed on the seabed, then a piling template is not required. The transition piece may include ancillary components (e.g. boat landing facilities, ladders and a crane) as well as the connection to the wind turbine tower.

~~3.5.8.11~~3.5.8.10 The details of vessel movements and numbers of trips required for gravity base, piled jackets and suction bucket jacket foundations are presented in Table 3.13.

~~3.5.8.12~~3.5.8.11 The seabed preparation is described in section 3.5.3. The maximum design parameters for which are presented in Table 3.4.

Table 3.13: Vessel and helicopter requirements for gravity base, piled jackets and suction bucket jacket foundation installation.

Vessel type	Maximum number of vessels on site at any one time	Maximum number of return trips per vessel type over the construction period
Installation and support vessels	9	400
Tug/anchor handler	6	64
Guard vessels	1	50
Survey vessels	2	12
Seabed preparation vessels	2	12
CTVs	4	365
Scour protection installation vessels	2	40

Vessel type	Maximum number of vessels on site at any one time	Maximum number of return trips per vessel type over the construction period
Helicopters	3	365

Suction bucket jacket foundations

Design

~~3.5.8.13~~3.5.8.12 Suction bucket jacket foundations are formed with a steel lattice construction fixed to the seabed by suction buckets installed below each leg of the jacket. The suction buckets are typically hollow steel cylinders, capped at the upper end, which are fitted underneath the legs of the jacket structure. The suction buckets do not require a hammer or drill for installation. The transition piece and foundation structure is fabricated as an integrated part of the jacket structure and are not installed separately offshore. An example of a suction bucket jacket is shown in Figure 3.8. The maximum design parameters for jacket foundations with suction buckets are presented in Table 3.14.

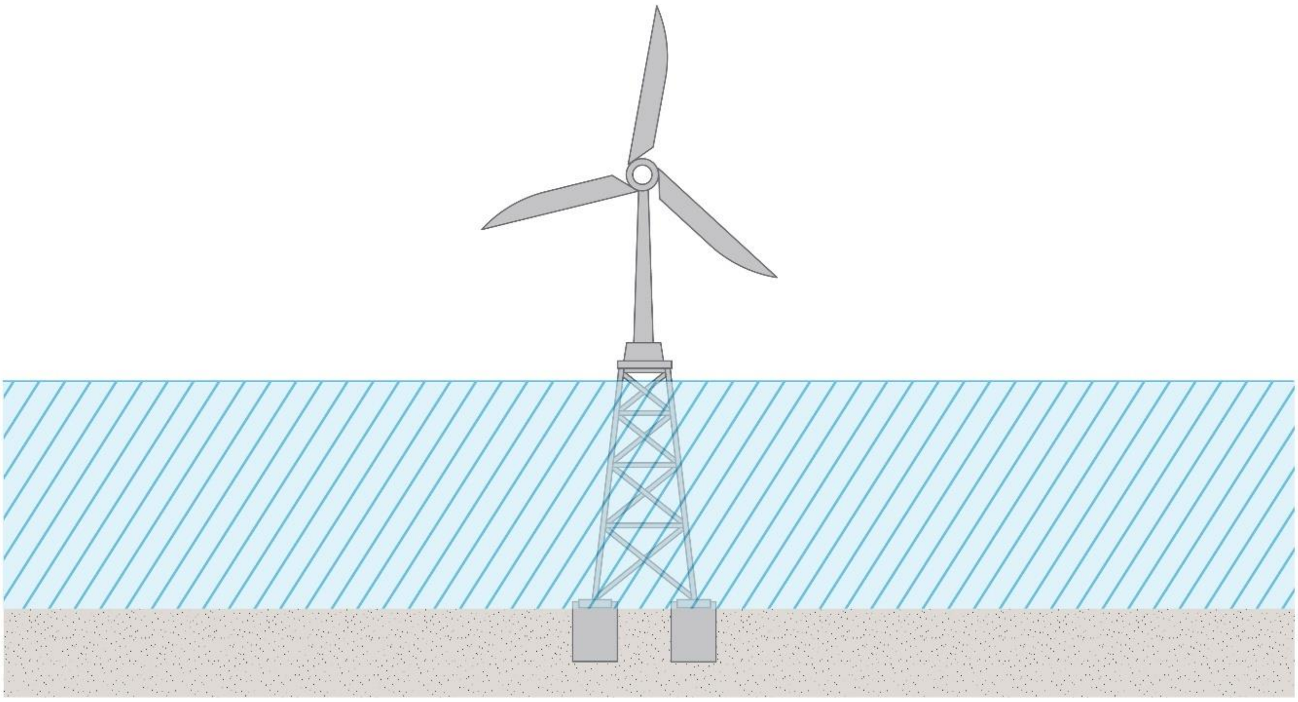

Figure 3.8: Schematic of a suction bucket jacket foundation.

Installation of a suction bucket jacket foundation

~~3.5.8.14~~3.5.8.13 The suction bucket jacket will be transported to site by sea, as described in section 3.5.5. The suction bucket jacket foundation will then be lifted by the installation vessel using a crane and lowered towards the seabed in a controlled manner. When the steel bucket reaches the seabed, a suction pump system fitted on a trunk (which is itself fitted on the bucket lid) will be powered to suck water out of each bucket. The buckets will then be pressed down into the seabed by the resulting suction force. When the bucket has penetrated the seabed to the desired depth, the pump is turned off. A layer of grout is then injected through the grouting system fitted on/or under the bucket lid to fill the air gap and ensure contact between the soil within the bucket, and the underside of the bucket lid itself.

~~3.5.8.15~~3.5.8.14 The seabed preparation is described in section 3.5.3. The vessel movements for the installation are presented in Table 3.13.

Table 3.14: Maximum design parameters for jacket foundations with suction buckets- wind turbines.

Parameter	Maximum design parameter
Maximum number of jacket foundations	96
Maximum number of legs per foundation	4
Maximum suction bucket diameter (m)	18
Maximum suction bucket depth (m)	25
Maximum separation of adjacent legs at seabed level (m)	50
Maximum separation of adjacent legs at LAT (m)	35
Maximum seabed area per foundation (m^2)	804
Maximum seabed area – scour protection per foundation (m^2)	10,012
Maximum seabed area – total foundations and scour protection for all foundations with suction bucket jackets (m^2)	735,488
Maximum scour protection volume for all foundations with suction bucket jackets (m^3)	1,701,998

Table 3.15: Maximum design parameters for jacket foundations with suction buckets - OSPs.

Parameter	Maximum design parameter
Maximum number of jacket foundations	4
Maximum number of legs per foundation	6
Maximum suction bucket diameter (m)	18
Maximum suction bucket depth (m)	25
Maximum separation of adjacent legs at seabed level (m)	70
Maximum separation of adjacent legs at LAT (m)	50
Maximum seabed area - per foundation (m^2)	1,527
Maximum seabed area – scour protection per foundation (m^2)	13,502
Maximum seabed area – total for all foundations with suction bucket jackets (m^2)	24,964

Parameter	Maximum design parameter
Maximum scour protection volume for all foundations with suction bucket jackets (m^3)	56,252

Gravity base foundations

Design

~~3.5.8.16~~3.5.8.15 Gravity base foundations are generally made of concrete with steel reinforcements, or steel alone, and consist of a base, a conical structure and a smaller cylindrical top (generally called the shaft) which can be made of steel and connected to the lower concrete conical structure. This shape provides support and stability to the wind turbine or OSP. An example of a gravity base foundation is shown in Figure 3.9. If the scenario of one OSP is taken forward, a rectangular gravity base foundation may be used (Figure 3.10). This gravity base foundation would be ballast weighted built around a rectangular support structure with up to six legs and would only be used for one OSP. Gravity base foundations could also include skirts that embed into the seabed under the weight of the structure to improve the natural stability and scour resistance of the foundation. Ancillary structures (e.g. ladders) may be attached to the gravity base foundation or the transition piece and are usually made of steel but may be made of another metal. The main structure is filled with ballast, commonly sand, rock (such as olivine), iron ore or from seabed material arising from infrastructure installation.

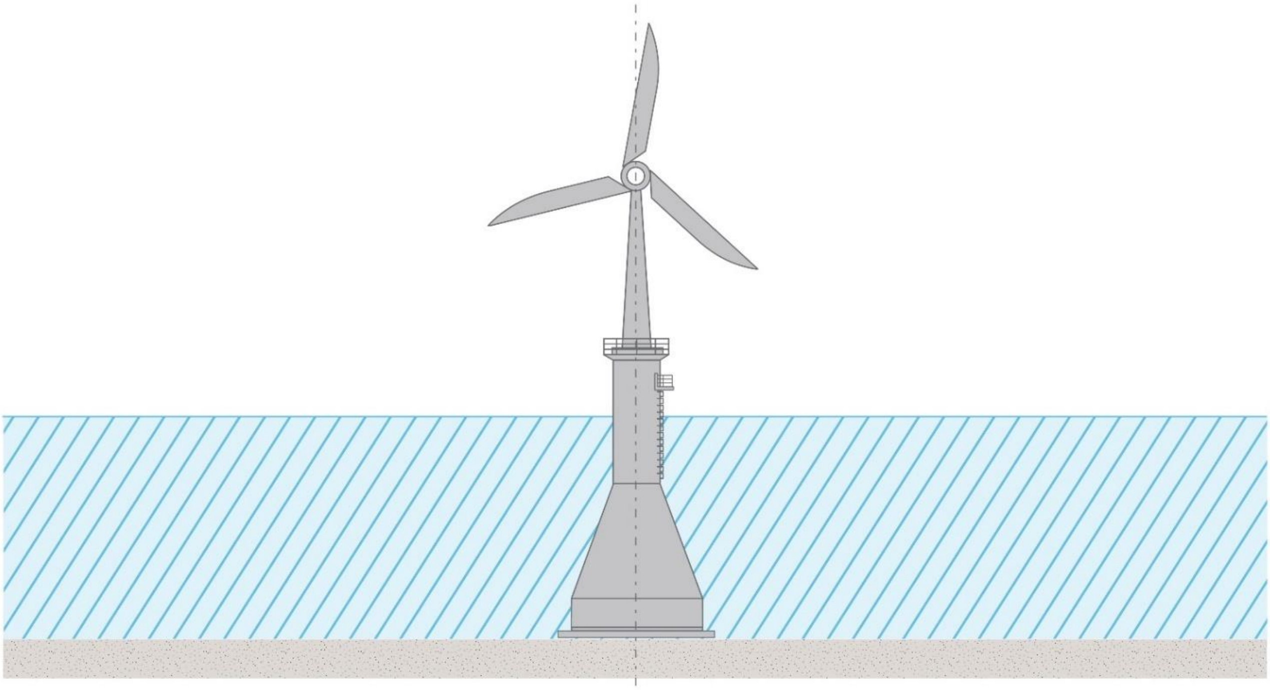

Figure 3.9: Schematic of a gravity base foundation

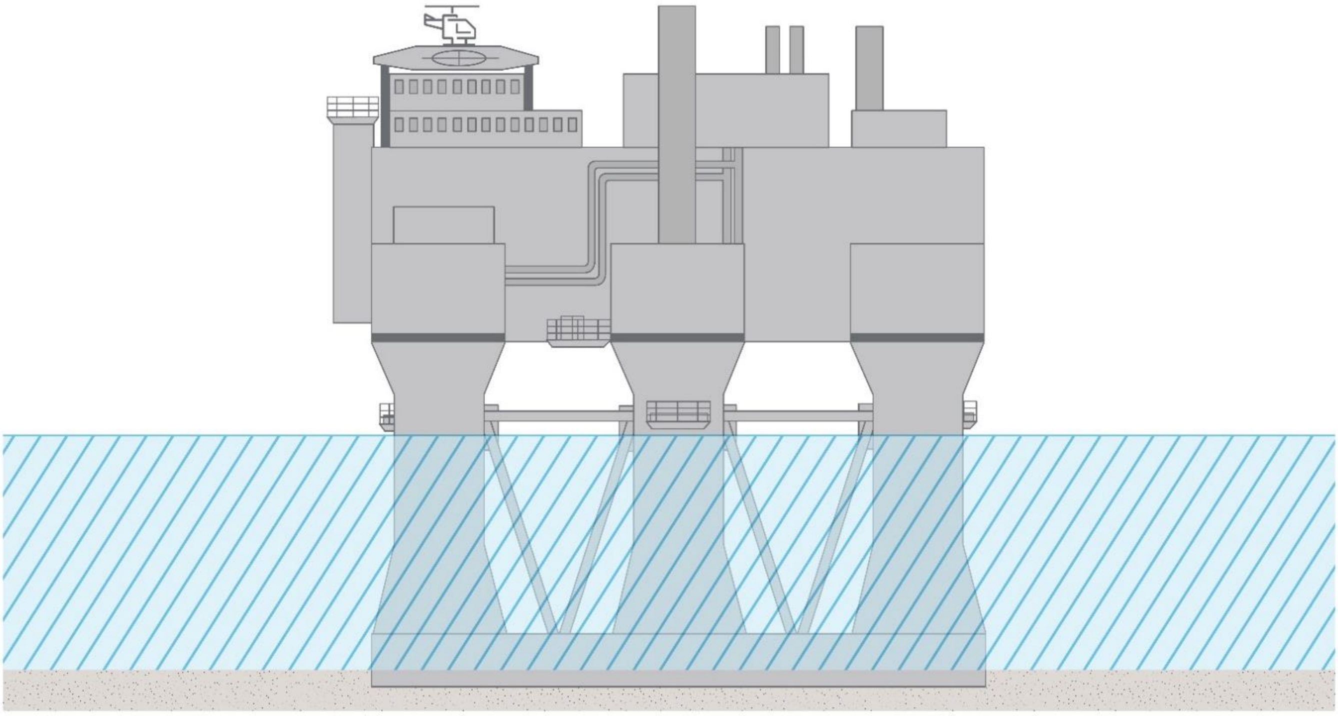

Figure 3.10: Schematic of a rectangular gravity base foundation with six legs (only used for the single OSP scenario)

~~3.5.8.17~~3.5.8.16 The maximum design parameters for gravity base foundations for wind turbines are shown in Table 3.16, with the maximum design parameters for gravity base foundations for OSPs shown in Table 3.17. In some locations, the seabed would need to be strengthened for the installation of the gravity base foundations. This can be done either with piles (Figure 3.11) or suction buckets (Figure 3.12). These systems would be completely underneath and within the footprint of the foundation. Only a maximum of ten foundations may require ground strengthening.

Table 3.16: Maximum design parameters for gravity base foundations – wind turbines.

Parameter	Maximum design parameters
Maximum total number of structures (gravity base)	96
Maximum structural diameter at sea surface (m)	15
Maximum structural diameter at seabed (base slab) (m)	49
Maximum caisson diameter (m)	37
Maximum transition Piece diameter (m)	15
Maximum number of piles per structure potentially requiring ground strengthening	15
Maximum pin pile diameter (m)	4
Maximum hammer energy (kJ)	3,000
Maximum number of suction buckets per gravity base structure, in the scenario where ground strengthening is required	6
Maximum suction bucket diameter (m)	15

Parameter	Maximum design parameters
Maximum suction bucket depth (m)	15
Maximum seabed area – per structure per foundation (m^2)	1,886
Maximum seabed area – scour protection per foundation (m^2)	5,665
Maximum seabed area – total foundations and scour protection for all foundations with gravity base foundations (m^2)	612,084
Average total scour protection volume for all foundations with gravity base foundations (m^3)	1,432,275

Table 3.17: Maximum design parameters for gravity base foundations – OSPs.

Parameter	Maximum design parameters
Maximum total number of structures (gravity base)	4
Maximum structural diameter at sea surface (for conical shape) (m)	20
Maximum structural diameter at seabed (base slab) (for conical shape) (m)	80
Maximum structural diameter at sea surface (for rectangular shape) (m)	80
Maximum structural diameter at seabed (base slab) (for rectangular shape) (m)	100
Maximum caisson diameter (m)	70
Maximum Transition Piece diameter (m)	20
Maximum number of piles per structure potentially requiring ground strengthening	15
Maximum pin pile diameter (m)	4
Maximum hammer energy (kJ)	3,000
Maximum number of suction buckets per structure potentially requiring ground strengthening	6
Maximum suction bucket diameter (m)	15
Maximum suction bucket depth (m)	15
Maximum number of suction buckets per structure requiring ground strengthening	6
Maximum seabed area – per structure per foundation (m^2)	5,027
Maximum seabed area – scour protection per foundation (m^2)	13,600
Maximum seabed area – total foundations and scour protection for all foundations with gravity base foundations (m^2)	24,941
Maximum total scour protection volume for all foundations with gravity base foundations (m^3)	58,361

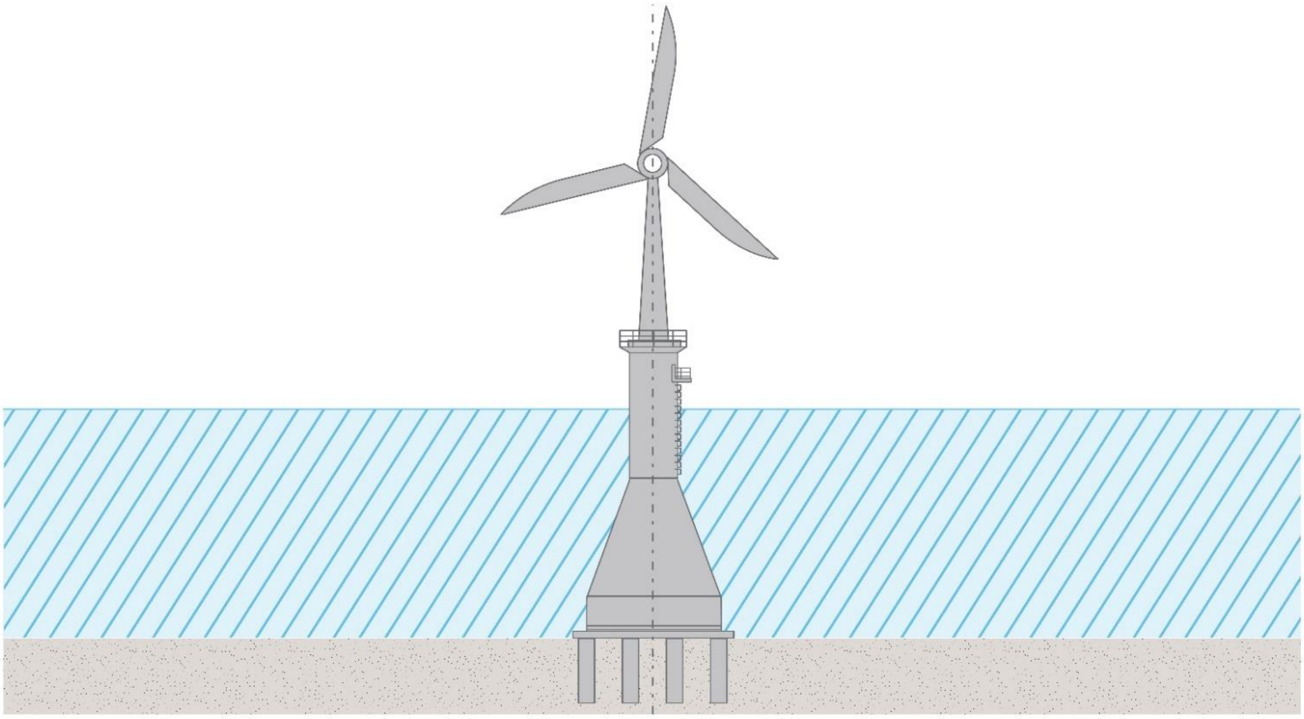

Figure 3.11: Schematic of a gravity base foundation with piled ground strengthening for the 10 locations where ground reinforcement could be required.

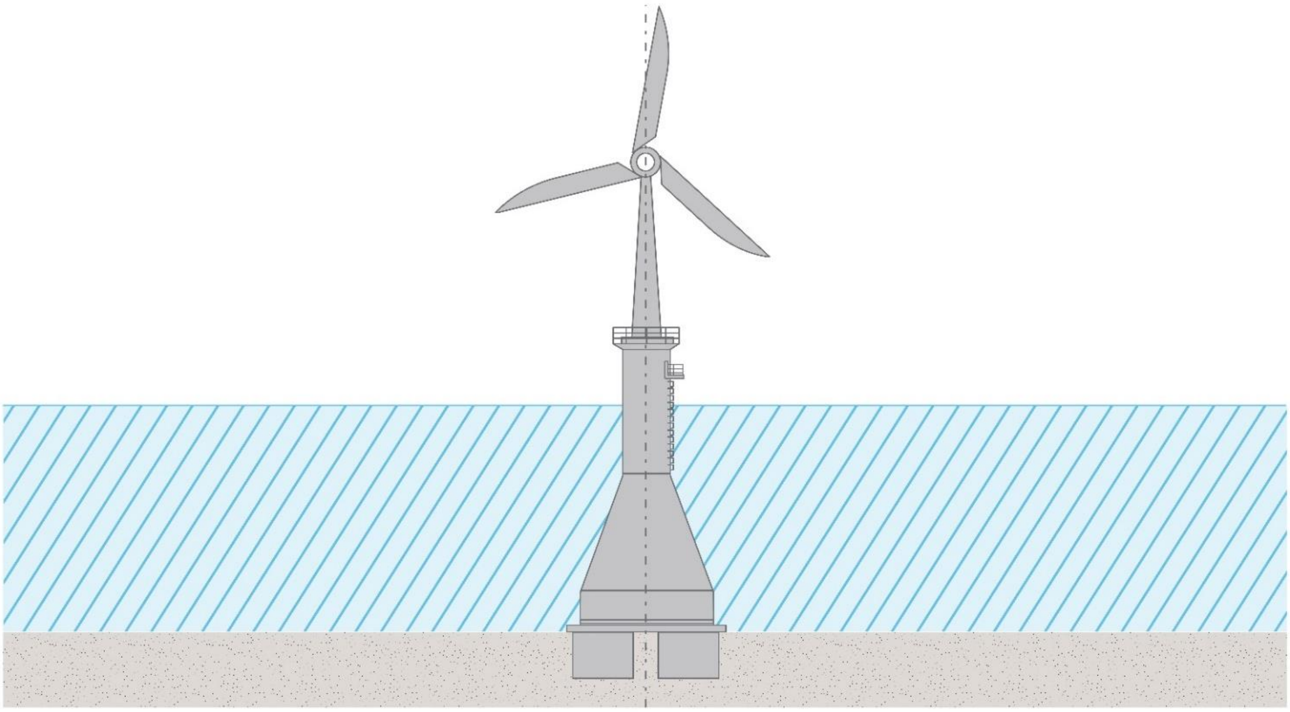

Figure 3.12: Schematic of a gravity base foundation with suction bucket ground strengthening for the 10 locations where ground reinforcement could be required.

Installation of a gravity base foundation

~~3.5.8.18~~3.5.8.17 Gravity base foundations can be either transported by a vessel or barge to site or self-floated and being pulled by tugs. Lowering at location will be supported by self-flooding of the gravity base foundation with seawater, for some designs assisted by a suitable crane from a heavy lift vessel to the seabed. Seabed preparation might be necessary in terms of levelling and/or stabilising the upper soil layer, which is described in section 3.5.3. After the gravity base foundation is installed, it will be ballasted with a suitable material before finally the transition piece will be installed on top. The suitable material may include the following:

- Gravel
- Rock
- Crushed concrete
- Aggregate
- High density rocks such as olivine or iron ore
- Possible dredged sand (or other seabed material) from site preparation at each gravity base foundation location within the Morgan Array Area.

~~3.5.8.19~~3.5.8.18 Further information is provided in Volume 2, Chapter 1: Physical processes of the Environmental Statement.

~~3.5.8.20~~3.5.8.19 The method to be used is dependent on the final gravity base design and the installation method would be confirmed following final design post-consent. The transition piece that is lifted on top of the gravity base may be either installed on site or installed prior to the transportation of the gravity base foundation.

~~3.5.8.21~~3.5.8.20 The seabed preparation is described in section 3.5.3. The vessel movements for the installation are presented in Table 3.13 above.

Scour protection for foundations

~~3.5.8.22~~3.5.8.21 Foundation structures for wind turbines and OSPs are at risk of seabed erosion and ‘scour hole’ formation due to natural hydrodynamic and sedimentary processes. The shape of the foundation structure is an important parameter influencing the potential depth of scour hole formation. Scour protection may be employed to mitigate scour around foundations. Several types of scour protection are under consideration, they are described below and presented in Figure 3.13:

- Rock: either layers of graded stones placed on and/or around structures to inhibit erosion or rock filled mesh fibre bags, which adopt the shape of the seabed/structure as they are lowered on to it
- Concrete mattresses: several metres wide and long, cast of articulated concrete blocks which are linked by a polypropylene rope lattice which are placed on and/or around structures to stabilise the seabed and inhibit erosion
- Artificial fronds mattresses: mats typically several metres wide and long, composed of continuous lines of overlapping buoyant fronds made of either polypropylene or alternative materials that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base. Seabed Scour Control Systems (SSCS) Frond Mats installed in the North Sea in 1984 remain in place today and have required no maintenance since being deployed, as the mats are designed not to degrade with time (SSCS, 2022). The final design of these frond mattresses will be detailed in the offshore construction method statement that will be submitted to and approved by the MMO prior to

commencement of development. This is secured within the Draft DCO (Document Reference C1) submitted with the application for consent.

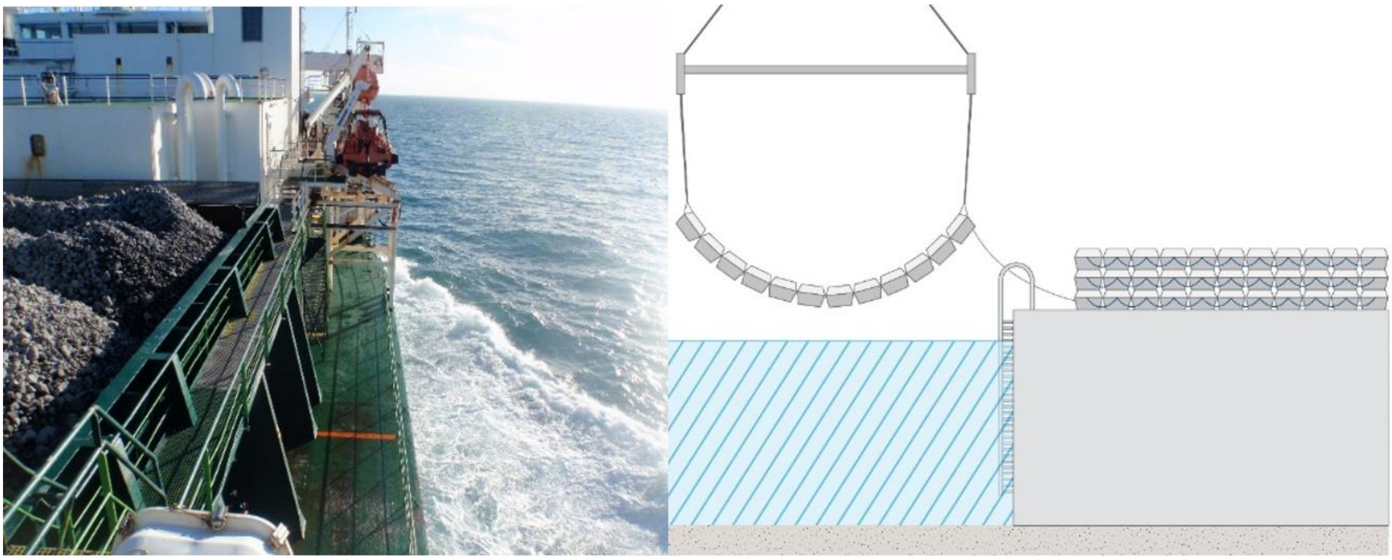

Figure 3.13: Illustrative scour protection types (Left: delivery of rock to EnBW's Hohe See Offshore Wind Farm; Right: concrete mattresses).

~~3.5.8.23~~3.5.8.22 The amount of scour protection required will vary for the different foundation types being considered for the Morgan Generation Assets. Scour protection parameters for the different foundations being considered are presented in Table 3.11, Table 3.14 and Table 3.16.

~~3.5.8.24~~3.5.8.23 The final choice and detailed design of the scour protection will be made after detailed design of the foundation structure, taking into account a range of aspects including geotechnical data, meteorological and oceanographic data, water depth, foundation type and maintenance strategy. The dMLs within the Draft DCO (Document Reference C1) includes a condition requiring an offshore construction method statement to be submitted to and approved by the MMO prior to commencement of construction, which is to include details of scour protection management and cable protection management including details of the need, type, sources, quantity and installation methods for scour protection.

3.5.9 Inter-array cables

3.5.9.1 Inter-array cables carry the electrical current produced by the wind turbines to an OSP. A small number of wind turbines will typically be grouped together on the same cable 'string' connecting those wind turbines to the OSP, and multiple cable 'strings' will connect back to each OSP.

Design

3.5.9.2 The maximum design parameters for inter-array cables are presented in Table 3.18 below.

Table 3.18: Maximum design parameters for inter-array cables.

Parameter	Maximum design parameters
Maximum cable diameter (mm)	300
Maximum total length of cable (km)	390
Maximum voltage (kV)	132

Installation

3.5.9.3 The inter-array cables will be buried below the seabed wherever possible and protected with a hard-protective layer (such as rock or concrete mattresses) where adequate burial is not achievable. ~~Cable protection shall be designed to minimise snagging hazards as far as possible. For example, by minimising height above seabed, smooth and shallower profiles, grade used for rock placement, type of rock (e.g. smoother edges).~~ Possible installation methods include ploughing, trenching and jetting whereby the seabed is opened and the cable laid within the trench. Pre-trenching or post-lay burial methods may be used, or alternatively the approach of simultaneous lay and burial using a tool towed behind the installation vessel. The installation method will be defined post-consent with a detailed Cable Specification and Installation Plan (CSIP) incorporating a Cable Burial Risk Assessment (CBRA) which will take into account environmental and human considerations such as trawling and vessel anchors. Figure 3.14 shows an inter-array cable being installed. Typically the cable will be buried between 0.5 to ~~6~~3 m. A CBRA will inform cable burial depth, dependent on ground conditions as well as external risks. This assessment will be undertaken post-consent. The target burial depth, depending on the outcome of the CBRA, is 2 m. The dMLs within the Draft DCO (Document Reference C1) includes a condition requiring an offshore construction method statement to be submitted to and approved by the MMO prior to commencement of construction, which is to include details for cable specification, installation and monitoring.

3.5.9.4 The Applicant may also need to undertake seabed preparation within the Morgan Array Area prior to installation of inter-array cables in order to level sandwaves and clear boulders on the inter-array cable routes. This is discussed in section 3.5.4.

3.5.9.5 Inter-array cables will need to be protected where the route crosses obstacles such as exposed bedrock, pre-existing live cables or pipelines that mean the cable cannot be buried. Cable protection methods include rock placement (rock protection), concrete mattresses, fronded mattresses and rock bags. Up to 10% of the total inter-array cable length may require protection due to ground conditions (this excludes cable protection due to cable crossings, the parameters for which are set out in in Table 3.19). The maximum design parameters for inter-array cable installation are presented in Table 3.19. The cable protection methods being considered are described below. No more than 5% reduction in water depth (referenced to Chart Datum) will occur at any point on the cable route without prior written approval from the Licensing Authority. Cable protection shall be designed to minimise snagging hazards as far as possible, f~~. F~~or example, by minimising height above seabed, smooth and shallower profiles, grade used for rock placement, type of rock (e.g. smoother edges).

3.5.9.6 Interconnector and inter-array cables may be installed before foundations of the OSPs and wind turbines have been installed. In such cases, cables will be installed to their final position up to a point close to the OSPs/wind turbines locations.

Cables will be cut with loose ends put to the seabed using a standard cable recovery system. The cables will then be covered with cable protection material. At a later moment in time (not anticipated to be greater than one year), the cable ends will be retrieved and connected to the OSPs/wind turbines. This technique would only apply to a small proportion of the overall cable length and would be completed within the overall footprint of seabed disturbance assessed for the interconnector and inter-array cables.

Figure 3.14: Example of inter-array cable installation at the EnBW Hohe See Offshore Wind Farm construction site in the German North Sea.

Table 3.19: Maximum design parameters for inter-array cable installation - cable protection.

[a] Typically the cable will be buried between 0.5 to ~~6~~3 m. A CBRA will inform cable burial depth, dependent on ground conditions as well as external risks. This assessment will be undertaken post-consent.

[b] Subject to further survey work. Assessments were carried out on the basis of up to 10 crossings as a precautionary measure.

Parameter	Maximum design parameters
Installation methodology	Prelay plough, plough, trenching and jetting
Target burial depth (m)	2 dependent on CBRA[a]
Maximum width of seabed affected by installation per cable (m)	20
Maximum duration: total (months)	12 months during a 24 month period
Maximum seabed disturbance – total for installation (m^2)	7,800,000
Maximum height of cable protection (m)	3
Maximum width of cable protection (m)	10
Maximum percentage of route requiring protection (%)	10

Parameter	Maximum design parameters
Maximum cable protection area (m^2) (length of cable requiring protection x cable protection width)	390,000 (39 km x 10 m)
Maximum cable protection volume (m^3)	585,000
Maximum number of crossings	10[b]
Maximum cable/pipe crossings: total impacted area (m^2) (footprint of each crossing x total number of crossing)	28,800 (2,880 m^2 x 10 m)
Cable/pipe crossings: maximum cable protection volume (m^3)	57,600

Types of Cable Protection

Rock placements

3.5.9.7 Initially small stones are placed over the cable as a covering layer. This provides protection from any impact from larger size rocks, which may then be placed on top of this smaller scale level. Rock placement is often achieved using a vessel with equipment such as a 'fall pipe', which allows installation of rock close to the seabed. The length of the rock protection is dependent on the length of cable which is either unburied or has not achieved target depth. For rock protection, the Applicant will explore the use of rock that is as similar as possible to the rock that occurs naturally in the area.

Mattress placements

3.5.9.8 Concrete mattresses are constructed using high strength concrete blocks and U.V. stabilised polypropylene rope. Mattresses provide protection from direct anchor strikes but are not able to protect from anchor drag. The mattresses are lowered to the seabed from an installation vessel and once the correct position is confirmed, a frame release mechanism is triggered and the mattress is deployed on the seabed. This single mattress installation is repeated for the length of cable that requires protection. The mattresses may be gradually layered in a stepped formation on top of each other dependant on expected scour. Mattresses with sloped edges would be deployed to reduce the potential for fishing gear to snag the edges of the mattresses.

Frond mattresses placements

3.5.9.9 Frond mattresses (mats) are typically several metres wide and long, composed of continuous lines of overlapping buoyant polypropylene fronds that create a drag barrier which prevents sediment in their vicinity being transported away. The frond lines are secured to a polyester webbing mesh base that is itself secured to the seabed by a weighted perimeter or anchors pre-attached to the mesh base. Frond mattresses are installed following the same procedure as general mattress placement operations. The fronds floating in the water column, however, can impede the correct placement of additional mattresses. The fronds are designed with the aim to catch and trap sediment to form protective, localised sand berms. SSCS Frond Mats installed in the North Sea in 1984 remain in place today and have required no maintenance since being deployed, as the mats are designed not to degrade with time (SSCS, 2022). The final design of the frond mattresses will be selected post-consent and will be detailed in the offshore construction method statement that will be submitted to and approved by the MMO prior to commencement of development. This is secured in the dMLs within the Draft DCO (Document Reference C1).

Rock bags

3.5.9.10 Prefilled rock bags consist of various sized rocks constrained within a rope or wire netting containment and can be placed above the cables with specialist installation beams. Rock bags are more suited for cable stability or trench/scour-related solutions. The number of rock bags required is dependent on the length of cable which requires protection.

3.5.9.11 Table 3.19 shows the details for the cable protection required for inter-array cables and Table 3.20 shows the envelope for vessel movements associated with inter-array cable installation.

Table 3.20: Maximum design parameters for inter-array cable installation vessel requirements.

Parameter	Maximum number of vessels on site at any one time	Maximum number of return trips per vessel type over the construction period
Cable lay and support vessels	7	56
Survey vessels	2	4
Seabed preparation vessels	5	5
CTVs	2	365
Cable protection installation vessels	2	2

3.5.10 Offshore interconnector cables

~~3.5.10.1~~3.5.10.0 The Morgan Generation Assets will require cables to connect the OSPs to each other in order to provide redundancy in the case of cable failure. The interconnector cables will have a similar design and installation process to the inter-array cables. The parameters for design and installation of the interconnector cables are presented in Table 3.21, Table 3.22 and Table 3.23.

Table 3.21 Maximum design parameters for interconnector cables.

[a] Typically the cable will be buried between 0.5 to 3 m. A CBRA will inform cable burial depth, dependent on ground conditions as well as external risks. This assessment will be undertaken post-consent.

Parameter	Maximum design parameters
Maximum number of cables	3
Maximum total cable length (km)	60
Maximum voltage (kV)	275

Table 3.22 Maximum design parameters for interconnector cable installation and interconnector cable protection.

[a] Typically the cable will be buried between 0.5 to 3 m. A CBRA will inform cable burial depth, dependent on ground conditions as well as external risks. This assessment will be undertaken post-consent.

Parameter	Maximum design parameters
Installation methodology	Prelay plough, plough, trenching and jetting
Target burial depth (m)	1m dependent on CBRA[a]
Maximum width of seabed affected by installation per cable (m)	20
Maximum duration: total (months)	4 months during an 18 month period
Maximum seabed disturbance – total (m^2)	1,200,000
Maximum height of cable protection (m)	3
Maximum width of cable protection (m)	10
Maximum percentage of route requiring protection (%)	20
Maximum cable protection area (m^2)	120,000
Maximum cable protection volume (m^3)	180,000
Maximum number of crossings	10
Cable/pipe crossings: maximum total impacted area (m^2) (length x width x number of crossings)	10,000 (50 m x 20 m x 10)
Cable/pipe crossings: maximum cable protection volume (m^3)	30,000

~~3.5.10.2~~3.5.10.1 The parameters for vessel movements associated with interconnector cable installation are presented in Table 3.23.

Table 3.23 Maximum design parameters for interconnector cables - vessel requirements.

Parameter	Maximum number of vessels on site at any one time	Maximum number of return trips per vessel type over the construction period
Cable lay and support vessels	7	56
Survey vessels	2	4
Seabed preparation vessels	5	5
CTVs	2	365
Cable protection installation vessels	2	2

3.5.11 Adverse weather

3.5.11.1 In the event of adverse weather during cable laying, operations will be temporarily suspended. Cables will be cut, and using a standard cable recovery system their loose ends will be put to the seabed and covered with cable protection material. At a later moment in time (not anticipated to be greater than one year), the cable ends will be retrieved/uncovered and connected to the remaining cables. Further information will be provided in the Construction Method Statement.

3.5.12 Aids to navigation, colour, marking and lighting

3.5.12.1 The Morgan Generation Assets will be designed and constructed in accordance with relevant guidance from:

- Trinity House (2016) (Provision and Maintenance of Local Aids to Navigation Marking Offshore Renewable Energy Installations)
- Civil Aviation Authority (CAA) (2016) Civil Aviation Publication (CAP) 764 Policy and Guidelines on Wind Turbines
- Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) (2021) (Recommendation G1162 on the Marking of Man-Made Offshore Structures)
- MCA (2018) (Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response).

3.5.12.2 The dMLs within the Draft DCO (Document Reference C1) includes a condition requiring an Aids to Navigation Management Plan to be submitted to and approved by the MMO, in consultation with Trinity House, prior to commencement of construction.

3.5.12.3 Appropriate marking, lighting and aids to navigation will be employed during the construction, operational and maintenance and decommissioning phases as appropriate to ensure the safety of all parties. The nacelles, blades and towers will be painted light grey (RAL 7035) and the foundation structures, up to +15 m from Highest Astronomical Tide (HAT), will be traffic light yellow (RAL 1023).

3.5.12.4 Appropriate lighting, in line with MCA (2018) guidance, will ensure the offshore structures are visible for search and rescue and emergency response procedures. In addition, Morgan Generation Assets lighting will conform to the following:

- Red, medium intensity aviation warning lights (of variable brightness between a maximum of 2000 candela (cd)) to a minimum of 10% of the maximum which would be 200 cd) will be located on either side of the nacelle of significant peripheral wind turbines. These lights will flash simultaneously with a Morse W flash pattern and will also include an infra-red component
- All aviation warning lights will flash synchronously throughout the Morgan Array Area and be able to be switched on and off by means of twilight switches (which activate when ambient light falls below a pre-set level)
- Aviation warning lights will allow for reduction in lighting intensity at and below the horizon when visibility from every wind turbine is more than 5 km (to a minimum of 10% of the maximum (i.e. 200 cd)
- SAR lighting of each of the non-periphery turbines will be combi infra-red (IR)/200cd steady red aviation hazard lights, individually switchable from the control centre at the request of the MCA (i.e. when conducting SAR operations in or around the Morgan Array Area)

- All wind turbines will be fitted with a low intensity light for the purpose of helicopter winching (green hoist lamp). All wind turbines will also be fitted with suitable illumination (minimum one 5 cd light) for ID signs
- Marine navigational lights will be fitted at the platform level on Significant Peripheral Structures (SPS). These lights will be synchronized to display simultaneously an IALA 'special mark' characteristic, flashing yellow, with a range of not less than 5 nm.

3.5.12.5 The location of all infrastructure (including wind turbines, OSPs and cables) will be communicated to the UK Hydrographic Office (UKHO) so that they can be incorporated into Admiralty Charts and the Notice to Mariners procedures. These locations will also be provided to the Defence Geographic Centre (DGC).

3.5.12.6 A marking and lighting plan will be submitted to the MCA and Trinity House for review prior to construction.

3.5.13 Safety zones

3.5.13.1 During construction and decommissioning, some restrictions on vessel movements within the Morgan Array Area will be required to protect the health and safety of all users of the sea. The Applicant will apply for a 500 m safety zone around all infrastructure that is actively under construction. Safety zones of 50 m will be applied for vessels not associated with the Morgan Generation Assets around incomplete structures for which construction activity may be temporarily paused (and therefore the 500 m safety zone is no longer applicable) such as installed foundations without wind turbines or where construction works are completed but the Morgan Generation Assets have not yet been commissioned.

3.5.13.2 The Applicant will also apply for rolling advisory exclusion zones of 500 m to be present around vessels installing inter-array cables and interconnector cables, all of which will be outlined in the Safety zone statement (Document Reference J5). Temporary restrictions to fishing activity and/or anchoring, will also be required in areas where full cable burial to target depth has not yet been achieved and/or surface-laid cable exists (prior to cover by external cable protection). In such areas of temporarily shallow buried/surface-laid cable, the restricted areas will be monitored by guard vessels.

3.5.13.3 During the operations and maintenance phase, the Applicant may apply for a 500 m safety zone for infrastructure undergoing major maintenance works (for example a blade replacement). Further information regarding the Safety Zones which the Applicant intends to apply for post-consent is outlined in the Safety zone statement (Document Reference J5) (provided alongside this Environmental Statement).

3.5.13.4 Guard vessels will be used during the construction and the operations and maintenance phases of the Morgan Generation Assets as necessary.

3.5.14 Ancillary works

3.5.14.1 Ancillary works will form part of the final design of the Morgan Generation Assets, however, the precise specifications and numbers of these will be determined at the detailed design phase. Ancillary works may include:

- Temporary landing places, moorings or other means of accommodating vessels in the construction and / or maintenance of the Morgan Generation Assets

- Buoys, beacons, fenders and other navigational warning or ship impact protection works

3.5.14.2 Buoys would be required across the Morgan Array Area and could include:

- Up to 30 light buoys and marker buoys (cardinal buoys), although the final number will be determined by Maritime and Coastguard Agency (MCA)/Trinity House requirements
- Up to three LiDAR buoys
- Other buoys including waverider buoys, buoys for potential noise monitoring, wave measurement buoys, and mooring buoys for transportation vessels.

3.5.14.3 Each buoy would include a lantern suitable for use as a navigational aid.

3.5.14.4 These devices would be attached to the seabed using mooring devices such as common sinkers (small block of heavy material such as concrete and steel) or anchored by means of regular anchors. They could have one single mooring point or several points (usually up to three).

3.6 Construction phase

3.6.1 Construction programme

~~3.6.1.1~~3.6.1.0 A high-level indicative construction programme is presented in Table 3.24. The programme illustrates the likely window in which the construction of the major project elements will occur. It covers installation of the major components but does not include elements such as preliminary site preparation, and commissioning of the wind farm post-construction. Further details of where preliminary site preparation work will fit within the outline programme is discussed in section 3.5.3. Construction is currently planned to commence in 2026.

Table 3.24: Indicative construction programme for the Morgan Generation Assets.

Activity (time in brackets is time taken for completion, blue colouring denotes window)	Year 1 construction				Year 2 construction				Year 3 construction				Year 4 construction			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Seabed preparation activities (9 months)																
Foundation installation (12 months)																
OSP installation and commissioning (9 months)																
Interconnector cables installation (4 months)																
Inter-array cables seabed preparation (3 months)																
Inter-array cables installation (12 months)																
Wind turbine installation (9 months)																
Wind turbine commissioning (9 months)																

3.7 Operations and maintenance phase

3.7.1.1 The overall operations and maintenance strategy will be finalised once the technical specifications of the Morgan Generation Assets are known, including wind turbine type and final layout. A single port or multiple ports in the northwest of England and/or north Wales could be used to support primary elements of operations and maintenance. The operations and maintenance requirements for the Morgan Generation Assets have been set out within an outline Offshore operations and maintenance plan (Document Reference J9) which has been submitted alongside the application for consent.

3.7.1.2 The general operational and maintenance strategy may rely on CTVs, service operation vessels, supply vessels, cable and remedial protection vessels, plus helicopters for the operations and maintenance services that will be performed at the Morgan Generation Assets. The maximum number of operations and maintenance vessels on site at any one time are presented in Table 3.25. The total operations and maintenance vessel and helicopter round trips per year for the Morgan Generation Assets are presented in Table 3.26.

3.7.1.3 Routine inspections of inter-array and interconnector cables will be undertaken to ensure that the cables are buried to an adequate depth and not exposed. The integrity of the cables and cable protection systems will also be checked. It is expected that on average the cables will require up to one visit per year. Maintenance works to rebury/replace and carry out repair works on inter-array and interconnector cables, should this be required, are presented below.

Table 3.25: Maximum design parameters for offshore operations and maintenance activities.

Parameter	Maximum number of vessels on site at any one time
CTVs	5
Jack-up vessels	3
Cable repair vessels	3
SOVs or other vessels	4
Excavators or backhoe dredgers	1
Helicopters	7
Inspection drones	5

Table 3.26: Maximum design parameters for offshore operations and maintenance activities per year.

Parameter	Maximum number of return trips per vessel type per year
CTVs	608
Jack-up vessels	25
Cable repair vessels	6
SOVs or other vessels	78
Excavators or backhoe dredgers	2

Parameter	Maximum number of return trips per vessel type per year
Helicopters	639
Inspection drones	214

3.8 Security

3.8.1.1 The Morgan Generation Assets will be appropriately secured throughout all phases of development to ensure the safety and security of those working on the Morgan Generation Assets. The offshore infrastructure is by nature inaccessible due to being situated offshore.

3.9 Quality, health, safety and environment

3.9.1.1 The Applicant has a strong focus on Health, Safety and Environment (HSE) and the HSE Policy, together with processes and procedures ensure that the Applicant's wind farms are safe by design and that this is verified.

3.9.1.2 The Applicant places Health, Safety and Environment (HSE) as a top priority within a culture of care. The Applicants "safe by design" philosophy alongside robust processes and procedures dovetail with the commitments the Applicant has made in their HSE Policy statement to provide a workplace with an emphasis on employee safety.

3.9.1.3 The Morgan Generation Assets will be risk assessed, verified against regulatory compliance, industry best practice and internal minimum requirements. The risk management process will form the basis of the methods and safety mitigations put in place across the life of the Morgan Generation Assets. These risk assessments will then form the basis of the methods and safety mitigations put in place across the life of the Morgan Generation Assets. The Applicant has a focus on employee safety and its HSE policy ensures that the Applicant's wind farms are safe by design and that the processes and procedures are adhered to. There is a clearly defined safety culture in place in order to avoid incidents and accidents. There will be constant controls to ensure that the safety measures are observed and followed, and the Applicant has built a safe workplace for its employees and contractors.

3.9.1.4 The Applicant strives to establish and maintain a safety culture that is inclusive and puts people first to avoid incidents and accidents.

3.10 Waste management

3.10.1.1 Waste will be generated as a result of the Morgan Generation Assets, with most waste expected to be generated during the construction and decommissioning phases. In accordance with Government policy contained in National Policy Statement (NPS) EN-1 (Department for Energy Security and Net Zero, 2023), consideration will be given to the types and quantities of waste that will be generated.

3.10.1.2 Procedures for handling waste materials will be set out in the Offshore Environmental Management Plan (OEMP) submitted post-consent and secured through the Draft DCO (Document Reference C1). Further information on the OEMP is provided in Table 5.3 of Volume 1, Chapter 5: EIA methodology of the Environmental Statement.

3.11 Decommissioning phase

3.11.1 Overview

3.11.1.1 Section 105 of the Energy Act 2004 allows the Secretary of State to serve a notice on a developer of an offshore wind farm requiring a decommissioning programme be submitted for approval prior to any commencement of works to develop the wind farm. A draft of the decommissioning plan for the Morgan Generation Assets will be submitted prior to construction commencing. The decommissioning plan and programme will be updated during the Morgan Generation Assets lifespan to take account of changing best practice and new technologies. The scope of the decommissioning works would be determined by the relevant legislation and guidance at the time of decommissioning.

3.11.1.2 At the end of the operational lifetime of the Morgan Generation Assets, it is anticipated that all structures above the seabed or ground level will be completely removed where feasible and practical. The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment.

3.11.2 Decommissioning

Wind turbines

~~3.11.2.1~~3.11.2.0 Wind turbines will be removed by reversing the methods used to install them, as described in section 3.5.8.

Foundations

~~3.11.2.2~~3.11.2.1 Foundations would likely be cut below the seabed at a level that means they will not create a hazard for fishing or shipping. At this time, it is not thought to be reasonably practicable to remove entire piles from the seabed, but best practice will be employed to ensure that the sections of pile that remain in the seabed are fully buried.

~~3.11.2.3~~3.11.2.2 The project position is that scour protection will preferably be left *in situ,* but removal has been assessed as the MDS.

Offshore cables

~~3.11.2.4~~3.11.2.3 All inter-array and interconnector cables may be retrieved and, if retrieved, will be disposed of onshore. The project position is that cable protection (cable ducting, rock dumping, etc) will preferably be left *in situ,* but removal has been assessed as the MDS.

~~3.11.2.5~~3.11.2.4 At this time, it is difficult to foresee what techniques will be used to remove cables during decommissioning. However, it is not unlikely that equipment similar to that which is used to install the cables could be used to reverse the burial process and expose them. Therefore, the area of seabed impacted during the removal of the cables is likely to be the same as the area impacted during the installation of the cables.

3.12 References

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