Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume II, Chapter 3: Consideration of Alternatives

Version	Date	Status	Author	Checked by	Approved by
1.0	13/05/2024	Final (External)	GoBe Consultants / Sure Partners Limited	GoBe Consultants	Sure Partners Limited

Statement of Authority

Name	Qualifications	Relevant Experience
Marc Walshe	BEng (Hons), MSc.	Marc Walshe is a Consents Manager with SPL/SSE Renewables and a full Member of the Institution of Environmental Sciences. Marc holds a honours degree in Environmental Engineering (BEng), a masters degree in Renewable Energy (MSc) and an Advanced Diploma in Planning and Environmental Law. Marc has over 23 years experience working in both the energy and environmental sectors on a range of projects which include large scale infrastructural developments in both Ireland and the UK. The management of consents has been key to his role whether through the consent application process or ensuring compliance with the subsequent post consent requirements during construction and/or operation.
Kaj Christiansen	BEng (Hons.) in Environmental Engineering from the University of Galway, MSc (Hons.) in Renewable Energy from University of Aberdeen, CEng with Engineers Ireland	Kaj has over 14 years' experience within the renewable energy industry, specifically in the field of offshore wind and solar energy development Kaj has acted in both project engineering and project management roles for a number of offshore wind projects throughout the North Sea. Within these projects Kaj was responsible for delivering

	foundation structures and has experience across the project lifecycle; from procurement and design to construction and commissioning. Kaj also has extensive Irish based development management experience in taking solar and offshore wind energy infrastructure through the development cycle; from early conceptual planning stages through to design, construction and operation.

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Glossary

Term	Meaning
Alternatives	A description of other options that may have been considered during the conception of a project; these include alternative locations, alternative designs and alternative processes.
Arklow Bank Wind Park 1 (ABWP1)	Arklow Bank Wind Park 1 consists of seven wind turbines, offshore export cable and inter-array cables. Arklow Bank Wind Park 1 has a capacity of 25.2 MW. Arklow Bank Wind Park 1 was constructed in 2003/04 and is owned and operated by Arklow Energy Limited. It remains the first and only operational offshore wind farm in Ireland.
Arklow Bank Wind Park 2 (ABWP2) – Offshore Infrastructure	"The Proposed Development", Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements under the existing Maritime Area Consent.
Arklow Bank Wind Park 2 (The Project)	Arklow Bank Wind Park 2 (ABWP2) (The Project) is the onshore and offshore infrastructure. This EIAR is being prepared for the Offshore Infrastructure. Consents for the Onshore Grid Infrastructure (Planning Reference 310090) and Operations Maintenance Facility (Planning Reference 211316) has been granted on 26th May 2022 and 20th July 2022, respectively. • Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements to be consented in accordance with the Maritime Area Consent. This is the subject of this EIAR and will be referred to as 'the Proposed Development' in the EIAR. • Arklow Bank Wind Park 2 Onshore Grid Infrastructure: This relates to the onshore grid infrastructure for which planning permission has been granted. • Arklow Bank Wind Park 2 Operations and Maintenance Facility (OMF): This includes the onshore and nearshore infrastructure at the OMF, for which planning permission has been granted. • Arklow Bank Wind Park 2 EirGrid Upgrade Works: any non-contestable grid upgrade works, consent to be sought and works to be completed by EirGrid.
Array Area	The Array Area is the area within which the Wind Turbine Generators (WTGs), the Offshore Substation Platforms (OSPs), and associated cables (export, inter- array and interconnector cabling) and foundations will be installed.
Cable Corridor and Working Area	The Cable Corridor and Working Area is the area within which export, inter-array and interconnector cabling will be installed This area will also facilitate vessel jacking operations associated with installation of WTG structures and associated foundations within the Array Area.
Do Nothing Scenario	The environment as it would be in the future should the Proposed Development not be developed.
Landfall	The area in which the offshore export cables make landfall and is the transitional area between the offshore cabling and the onshore cabling.
Maritime Area Consent (MAC)	A consent to occupy a specific part of the maritime area on a non-exclusive basis for the purpose of carrying out a Permitted Maritime

Term	Meaning
	Usage strictly in accordance with the conditions attached to the MAC granted on 22nd December 2022 with reference number 2022-MAC-002.
Permitted Maritime Usage	The construction and operation of an offshore windfarm and associated infrastructure (including decommissioning and other works required on foot of any permission for such offshore windfarm).
The Developer	Sure Partners Ltd.
Trenchless techniques	Trenchless techniques include steerable direct pipe thrusting (“Direct Pipe”) and Horizontal Directional Drilling (HDD) which allow cable ducts to be installed underground without the need to excavate trenches.

Acronyms

Term	Meaning
ABP	An Bord Pleanála
ABWP1	Arklow Bank Wind Park 1
ABWP2	Arklow Bank Wind Park 2
CBRA	Cable Burial Risk Assessment
DC	Direct Current
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic field
EPA	Environmental Protection Agency
E-W	East - West
GWA	Global Wind Atlas
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
HWM	High Water Mark
IEC	International Electrotechnical Commission
LAT	Lowest Astronomical Tide
MAC	Maritime Area Consent
MSL	Mean Sea Level
MTBM	Micro-Tunnel Boring Machine
NETN	National Electricity Transmission Network
N-S	North - South
O&M	Operations and Maintenance
OGI	Onshore Grid Connection Infrastructure
OSP	Offshore Substation Platform
OSWF	Offshore Wind Farm
PSR	Primary Surveillance Radar
SAC	Special Areas of Conservation
SLVIA	Seascape Landscape Visual Impact Assessment
SPAs	Special Protection Areas

Term	Meaning
UXO	Unexploded Ordnance
WTG	Wind Turbine Generators

Units

Unit	Description
GW	Gigawatt
km	Kilometres
kV	Kilovolt
m	Metre
MW	Megawatts (power; equal to one million watts)
m^2	Square metre
m^3	Cubic metre

3. Consideration of Alternatives

3.1. Introduction

3.1.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) provides a description of the alternatives considered by the Developer during the development of the Arklow Bank Wind Park 2 (ABWP2) Offshore Infrastructure (hereafter referred to as 'the Proposed Development').

3.1.1.2 Paragraph 2 of Annex IV of Directive 2011/92/EU as amended by 2014/52/EU (the EIA Directive) requires that the EIAR contains:

> *"A description of the reasonable alternatives (for example in terms of project design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects."*

3.1.1.3 This chapter focuses on the alternative Proposed Development locations, designs, technologies, sizes and scales studied, and sets out the main reasons why the final Project Design Options (Volume II, Chapter 4: Description of Development) were selected over the alternatives considered. During the Proposed Development design stage, iterative feedback, between the environmental assessment team (led by GoBe Consultants Ltd.) and the engineering design team, influenced the selection of the Proposed Development (including the Project Design Options) presented in Volume II, Chapter 4: Description of Development. The environmental assessment process has helped to either avoid, reduce or minimise the impacts of the Proposed Development on the environment.

3.1.1.4 This chapter describes the following reasonable alternatives considered and the main reasons for selecting the final Proposed Development (including the Project Design Options):

- Alternative offshore wind farm locations
- Alternative Offshore Substation Platform (OSP) Layouts
- Alternative Landfalls and Cable Corridor and Working Areas;
- Alternative Landfall construction techniques; and
- Alternative designs.

3.1.1.5 The consideration of each of these alternatives addresses the key issues associated with each option and also outlines how environmental considerations were taken into account in deciding on the selected option.

3.1.1.6 Chapters 6 to 21 of the EIAR provide a description of the environment in the event that the Proposed Development does not proceed (i.e. the 'Do nothing' scenario').

3.2. Alternative offshore wind farm locations

3.2.1.1 The government's Offshore Renewable Energy Development Plan (OREDP) and its accompanying Strategic Environmental Assessment (SEA) and Natura Impact Statement (NIS) (Department of Communications, Energy and Natural Resources, 2014) established a framework comprising the key principles, policy actions and enablers for the sustainable development of Ireland's offshore renewable energy resource. OREDP included a high-level goal that offshore renewable energy developments do not adversely impact Ireland's rich marine environment and its living and non-living resources.

3.2.1.2 The OREDP was subject to SEA and Appropriate Assessment (AA) and for the purposes of the Plan, the marine area was assessed by way of six Assessment Areas. Within the SEA, the development potential for fixed wind development in Assessment Area 2 for the East Coast South Area (where the Proposed Development is located) that could be accommodated without likely significant adverse effects on the environment was found to range between 3000 and 3300 MW (Department of Communications, Energy and Natural Resources, 2014, SEA, Table 2.7). This range took into account the offshore wind developments in Irish waters that had then been approved by means of the foreshore consenting process including Arklow Bank Windfarm (520 MW) as well as other projects such as Codling Bank (approximately 1,100 MW) and the proposed Dublin Array offshore wind farm (approximately 214 MW). The Proposed Development is located on the same site as the previously consented Arklow Bank Windfarm although the current iteration of the Proposed Development proposes significantly less numbers of WTGs and a greater output capacity on the site. The advances in technology which have enabled this reduction in numbers of WTGs and an increase in output capacity would suggest that the East Coast South Area could potentially accommodate more fixed wind development without likely adverse effects on the environment than the SEA previously concluded.

3.3. Constraints Analysis of the Proposed Development

3.3.1.1 As part of the alternative assessment process for the Proposed Development, the constraints to offshore wind development in Ireland and the identification of preferred regions were re-examined (Volume III, Appendix 3.4 Arklow Bank Wind Park 2 Constraints Analysis). This re-examination reassessed the most suitable regions for offshore wind development in Ireland and Arklow Bank's suitability to offshore wind. This assessment was based on the most up-to date data including but not limited to the Ecological Sensitivity Analysis (ESA) of the western Irish Sea that was undertaken by the Marine Protected Area Advisory Group, as well as enhanced mapping tools. On the basis of this information, the suitability of the Proposed Development's location was re-evaluated.

3.3.1.2 A macro level review of constraints to offshore wind in Ireland's Exclusive Economic Zone (EEZ) was undertaken to identify suitable areas for offshore wind energy development. This review considered a wide range of factors comprising Resource (Wind Speed, Direction and Seasonality and Extreme Wind Events), Engineering (Seabed Conditions and Metocean Conditions), Ports (in the East, South and West Coast), Environmental Constraints (Physical, Biological and Human), Land Usage (Offshore Leases and Easements/Crossings) and Interconnection (i.e. grid). This assessment highlighted very limited technical potential for fixed development on the west coast with a key driver being wave heights and the availability of electrical grid and pointed to restricted potential on the south coast with key limiting factors being wave heights and seabed geology. Furthermore, these regions had an increased presence of environmentally sensitive areas and a lack of ports suited to support offshore wind construction activities. The east coast was identified as the least constrained region within the EEZ with shipping lanes running north south, one of the limited hard constraints in the region. The macro-assessment identified some key regional constraints to the development of offshore wind in the East, South-east, South-west, West and North regions and a summary comparison of these is presented in Table 3.1.

3.3.1.3 In the context of this high-level regional constraints study, the east coast of Ireland was confirmed as a suitable region to develop an offshore wind energy development project.

Table 3.1: Regional Constraints Overview

Constraint	East	South-east	South-west	West	North
Shipping					
Interconnection					
Biological					
Visual Sensitivity					
Seabed Conditions					
Metocean Conditions					
Fishing					
Overall Rank	1 out of 5	2 out of 5	4 out of 5	5 out of 5	3 out of 5

3.3.1.4 The assessment concluded that the Array Area for the Proposed Development represents a favourable site in the context of Irish offshore wind. An excellent wind resource combined with calmer metocean conditions than in most other areas of the Irish EEZ, and depths well suited to fixed-bottom foundations, make the site attractive from an engineering perspective. The consideration of the ESA confirmed that the Array Area for the Proposed Development does not overlap with areas that were identified as suitable for Marine Protected Areas. From an environmental perspective, the potential for likely significant effects on fishing, shipwrecks, marine mammals, ornithology, benthic habitats and seascape and landscape were identified. More detailed environmental impact assessments based on additional surveys and desktop assessments have been carried out by technical specialists and are presented in the relevant chapters of this EIAR.

3.4. Need for the Proposed Development

3.4.1.1 As set in Section 11.6 of Volume II, Chapter 1: Introduction, the latest Climate Action Plan 2024 for Ireland includes mandatory targets of 80% renewables and at least 5GW of offshore wind by 2030. Six Maritime Area Consents (MACs) were granted by the Minister for the Environment, Climate and Communications in 2022, representing a potential opportunity for approximately 4.2GW of offshore wind generation capacity. These Phase 1 developments, which include the Proposed Development are aiming to export power to the Irish grid in the late 2020s, subject to securing a planning consent, and therefore represent the most likely opportunity sites to deliver on these mandatory targets. However, it is clear that the capacity of Ireland's offshore wind development pipeline, based on the current pipeline of identified proposed developments, is not yet sufficient to meet the Climate Action Plan targets of at least 5GW of offshore wind by 2030. Therefore, it is considered that the Proposed Development and all the other alternative offshore wind development in the current pipeline which come forwards for consent within the required timelines will be needed.

3.5. Alternative Landfall Locations

3.5.1.1 In May 2022, An Bord Pleanála (ABP) granted planning approval (Case Reference: 310090) to develop the Onshore Grid connection Infrastructure (OGI) for Arklow Bank Wind Park 2 (ABWP2). The OGI includes a 220 kV substation at Shelton Abbey, with an associated connection from the new substation to the existing National Electricity Transmission Network (NETN). The consented development also includes an underground cable route and associated infrastructure connecting the substation to the Landfall point at Johnstown North (approximately 4.5 km North of Arklow harbour), where it will meet the proposed offshore export cables connecting to the Proposed Development.

3.5.1.2 The Landfall is the point at which the offshore export cables come onshore i.e. the Landfall above the High Water Mark (HWM) and is a key component of the OGI. Potential Landfall locations were primarily assessed on the basis of hard constraints. Four options were considered for the Landfall location.

3.5.1.3 As part of the application submitted for consent for the OGI, the Developer considered suitable cable Landfall methods and locations. The assessment of alternative Landfall methods and locations was submitted to ABP as part of the application for the OGI and was reviewed by ABP as part of the determination.

3.5.1.4 The Landfall was subsequently consented by ABP as part of the OGI application in May 2022. The Landfall is therefore considered as a hard constraint for the assessment of alternative Cable Corridor and Working Areas and OSP solutions as part of this Application.

3.6. Alternative Cable Corridor and Working Areas

3.6.1.1 Based on the consented Landfall location (section 3.5), two Cable Corridor and Working Area routes (named N-S and E-W) were considered to connect to the Landfall. The location and number of Cable Corridors and Working Areas is inextricably linked to the number of OSPs required for the Proposed Development. The Developer initially considered two Cable Corridor and Working Areas (as per the OSPs options considered).

3.6.1.2 Key environmental effects of the two offshore cable corridors up to the HWM at the Landfall are set out in Table 3.2.

Table 3.2: Key environmental effects of Cable Corridor and Working Area routes up to the HWM at the Landfall

Environmental Aspect	E-W Cable Corridor and Working Area	N-S Cable Corridor and Working Area
Airborne Noise	During construction, there is potential for disturbance from Airborne Noise on noise sensitive receptors located in close proximity to the Landfall associated with vessels during cable laying activities.	During construction, there is potential for disturbance from Airborne Noise on noise sensitive receptors located in close proximity to the Landfall associated with vessels during cable laying activities.
Air Quality and Climate	During construction phase only, potential effects on Air Quality and Climate are minimal due to the nature of the cable laying activities and their distance from shore.	During construction phase only, potential effects on Air Quality and Climate are minimal due to the nature of the cable laying activities and their distance from shore.

Environmental Aspect	E-W Cable Corridor and Working Area	N-S Cable Corridor and Working Area
Benthic subtidal and intertidal ecology	There is potential for temporary and long term habitat loss/disturbance, increased suspended sediment concentrations and associated sediment deposition and accidental release of pollutants due to the installation of offshore export cables. The benthic subtidal ecology characterisation showed that the offshore export cable route E- W was primarily comprised of sand with fine mud and was characterised by infralittoral mobile clean sand with sparse fauna. The intertidal habitats along the E-W Cable Corridor and Working Area were characterised by a narrow intertidal zone, containing mobile sediments with little or no fauna. The intertidal survey at the Landfall did not indicate the presence of rare species or species of conservation importance.	There is potential for temporary and long term habitat loss/disturbance, increased suspended sediment concentrations and associated sediment deposition and accidental release of pollutants due to the installation of offshore export cables. The benthic subtidal ecology characterisation showed that the offshore export cable route N-S was primarily comprised of sand with fine mud and was characterised by infralittoral mobile clean sand with sparse fauna. The intertidal habitats along the N-S Cable Corridor and Working Area were characterised by a narrow intertidal zone along an existing rock armour revetment. The intertidal survey at the Landfall did not indicate the presence of rare species or species of conservation importance.
Fish and Shellfish and Sea Turtle Ecology	There is potential for temporary and long term habitat loss, increased suspended sediment concentrations and associated sediment deposition, and accidental release of pollutants due to the installation of offshore export cables, which can directly and indirectly effect Important Ecological Features. There is also potential for changes in electromagnetic fields (EMF) from subsea electrical cabling which could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electrosensitive species (including elasmobranchs) and migratory fish species.	There is potential for temporary and long term habitat loss, increased suspended sediment concentrations and associated sediment deposition, and accidental release of pollutants due to the installation of offshore export cables, which can directly and indirectly effect Important Ecological Features. There is also potential for changes in EMF from subsea electrical cabling which could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electrosensitive species (including elasmobranchs) and migratory fish species.
Marine Mammals	During construction there is potential for injury and/or disturbance to marine mammals from vessel activities associated with cable laying activities and potential pollution from vessels. During operation, changes in EMF from	During construction there is potential for injury and/or disturbance to marine mammals from vessel activities associated with cable laying activities and potential pollution from vessels. During operation, changes in EMF from

Environmental Aspect	E-W Cable Corridor and Working Area	N-S Cable Corridor and Working Area
	subsea electrical cabling also has potential to impact on marine mammal species.	subsea electrical cabling also has potential to impact on marine mammal species.
Shipping and Navigation	There is potential that vessels and works associated with the installation or maintenance of the offshore export cables may lead to displacement of vessel traffic and temporarily affect port access. Also there is potential for snagging/interaction by vessel anchors.	There is potential that vessels and works associated with the installation or maintenance of the offshore export cables may lead to displacement of vessel traffic and temporarily affect port access. Also there is potential for snagging/interaction by vessel anchors.
SLVIA	There is potential for seascape, landscape and visual impacts arising from movement of boats associated with cable laying to the Landfall	There is potential for seascape, landscape and visual impacts arising from movement of boats associated with cable laying to the Landfall
Marine Archaeology	Seabed activities to facilitate the construction, maintenance and decommissioning of the E-W Cable Corridor and Working Area has the potential to impact the cultural heritage on Arklow Bank and the seabed between the bank and shore.	Seabed activities to facilitate the construction, maintenance and decommissioning of the N-S Cable Corridor and Working Area has the potential to impact the cultural heritage on Arklow Bank and the seabed between the bank and shore.
Infrastructure and other Users	There is potential for interactions with existing infrastructure (including Arklow Bank Wind Park Phase 1 (ABWP1)) and recreational activities.	There is potential for interactions with existing infrastructure (including ABWP1) and recreational activities.
Population and Human Health	During construction, there is potential for effects on population and human health arising from noise disturbance, effects on water quality and impacts on visual amenity.	During construction, there is potential for effects on population and human health arising from noise disturbance, effects on water quality and impacts on visual amenity.

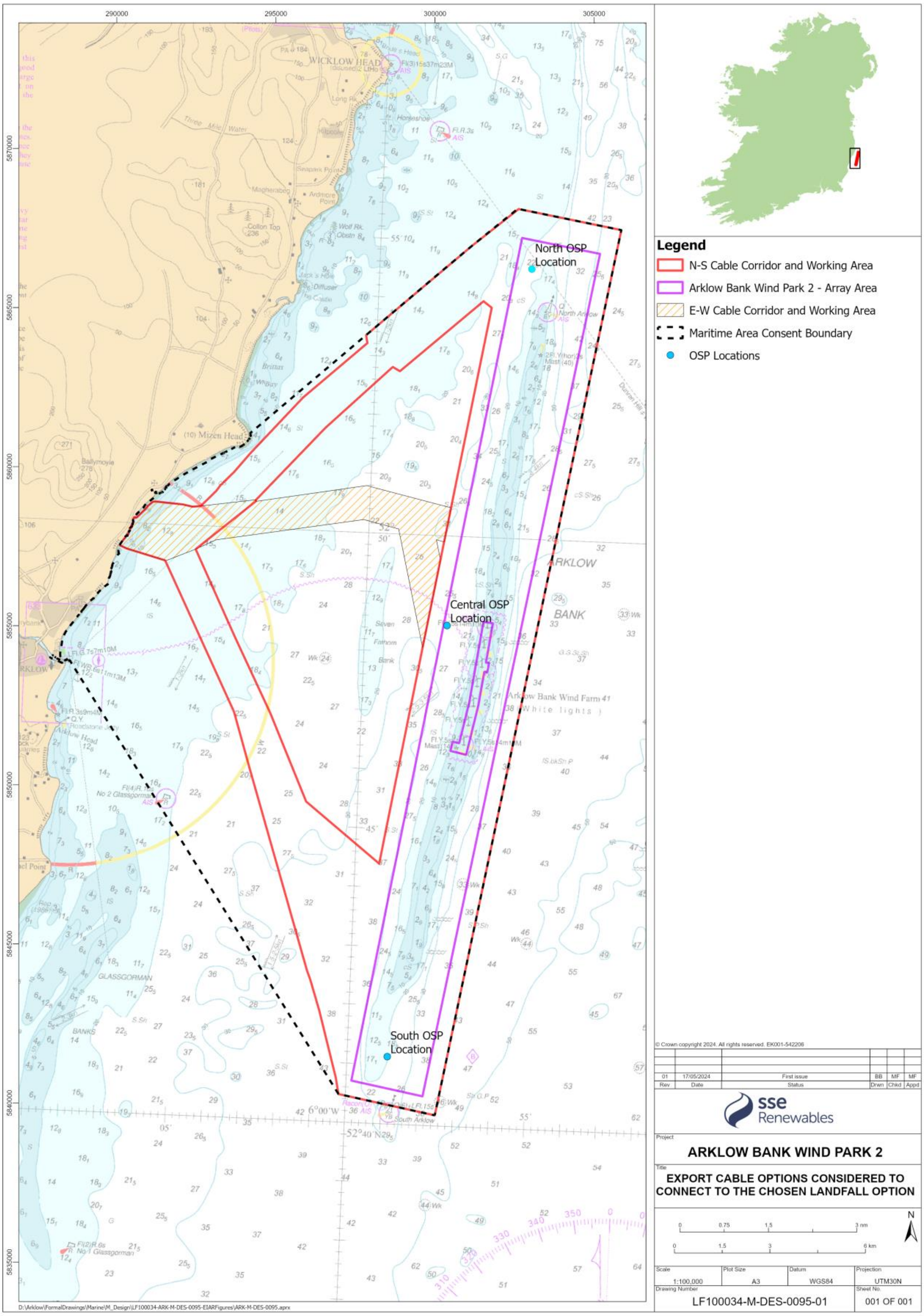

Figure 3.1: Export cable options considered to connect to the chosen Landfall option

3.6.1.3 As outlined in Table 3.2, the potential environmental effects associated with the offshore export cables N-S and E-W are similar for each environmental aspect. The N-S Cable Corridor and Working Area was chosen as the selected option for the Proposed Development along with the preferred OSP and Landfall option displayed in Figure 3.2. This was on the basis that the environmental impacts of the N-S and E-W Cable Corridor and Working Area were comparable but that the E-W Cable Corridor and Working Area is not required as the three OSP solution was not taken forward for the Proposed Development. The comparison of effects indicates that the chosen two OSP option is preferable to the three OSP option as overall, it results in the least potential for environmental impacts in particular on seascape, landscape and visual receptors as well as benthic and seabed disturbance (Section 3.7).

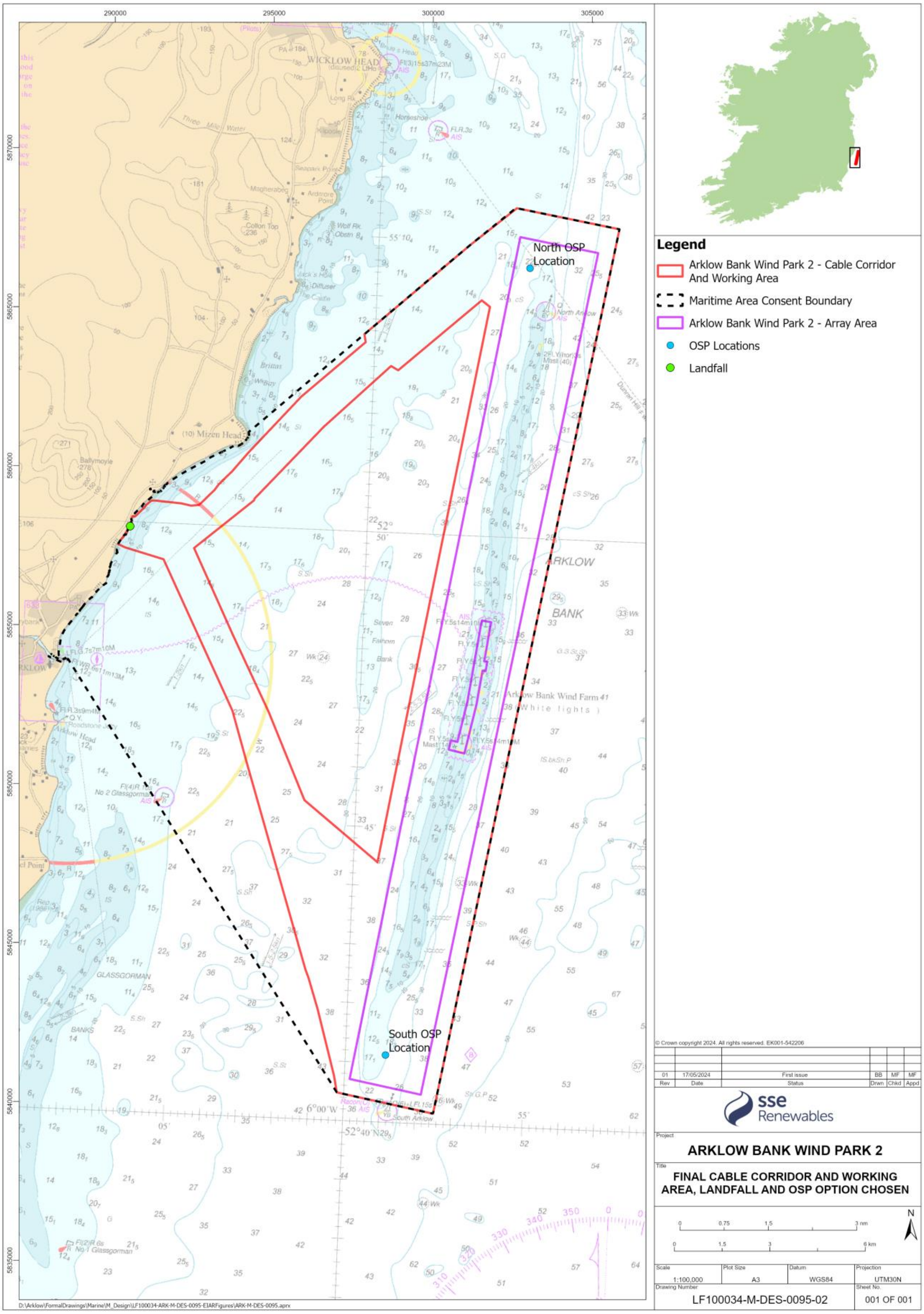

Figure 3.2: Final Cable Corridor and Working Area, Landfall and OSP option chosen

3.7. Alternative Offshore Substation Platforms (OSP) layouts

3.7.1.1 The purpose of the OSPs is to transform the electricity generated by the wind turbines (at 66 kV) to a higher voltage (220 kV), allowing the power to be efficiently transmitted to shore. The OSP foundations will comprise steel monopile foundations.

3.7.1.2 During the iterative design process, five options for the number of OSPs were considered for the Proposed Development early in the design process:

1. The option to exclude the requirement for OSPs was considered but was discounted as it would require significantly more cables both onshore and offshore. This option would result in increased potential for increased suspended sediment concentrations and associated sediment deposition.
2. The option to include one OSP was considered but was discounted as it would require laying cables to turbines which are diametrically opposite the location of the substation.
3. The option to include four or more OSPs was deemed unlikely to provide the best option from an economical and environmental perspective due to the potential impacts on benthic ecology and visual impacts.
4. The option to include two OSPs allows for the two platforms to be diametrically opposite each other, reducing the longest 66 kV route length.
5. The option to include three OSPs was considered disadvantageous due to the visual impacts of an additional OSP, but was taken forward for further assessment (see Table 3.3 and Table 3.4).

3.7.1.3 A layout study was conducted, focusing on the two platform and three platform layouts. Table 3.3 and Figure 3.3 display the options taken forward for this study.

Table 3.3: Overview of OSP Options.

Name	Number of platforms	Platform areas proposed	Comments
North – South (N-S)	Two	Northern end of bank and Southern end of bank	No sandbank crossing required
East – West (E-W)	Two	Centre of West flank and centre of East flank	Sandbank crossed by two 220 kV cables, carrying about half of wind farm output.
Three OSP (3OSP)	Three	Centre of West flank, Northern tip, mid-South Eastern flank	Sandbank crossed by one 220 kV cable, carrying less than half of wind farm output

3.7.1.4 Table 3.4 provides a comparison of the key environmental effects of the two options considered.

Table 3.4 Number of OSPs and comparison of key environmental effects.

Environmental aspect	Two OSPs (the selected option for the Proposed Development)	Three OSPs
Benthic subtidal and intertidal ecology	Temporary and permanent habitat loss.	Larger areas of temporary and permanent habitat loss associated with the footprint of the greater number of OSPs and due to the requirement to cross Arklow Bank. However, there may be a reduction in inter-array cable length as a result of having more OSPs,

Environmental aspect	Two OSPs (the selected option for the Proposed Development)	Three OSPs
		which may result in a lower area of habitat loss associated with the cable length.
Seascape Landscape Visual Impact Assessment (SLVIA)	Potential for effects on seascape, landscape and visual impacts.	Higher potential for more significant effects on seascape, landscape and visual impacts associated with more OSPs.
Marine Archaeology and Cultural Heritage	Potential to disturb unknown archaeology.	Greater potential to disturb unknown archaeology as a result of increased seabed activities with more OSPs.
Shipping and Navigation	Potential for allision risk.	Additional OSPs may increase the risk of allision if positioned on the periphery of the wind farm.

3.7.1.5 During the final stages of the design process, two options for the number of OSPs were brought forward for final consideration: three OSPs, or two OSPs optionality was subsequently reduced to one option with two OSPs.

3.7.1.6 The comparison of effects indicates that the chosen two OSP option is preferable to the three OSP option as overall, it results in the least potential for environmental impacts in particular on seascape, landscape and visual receptors as well as benthic and seabed disturbance.

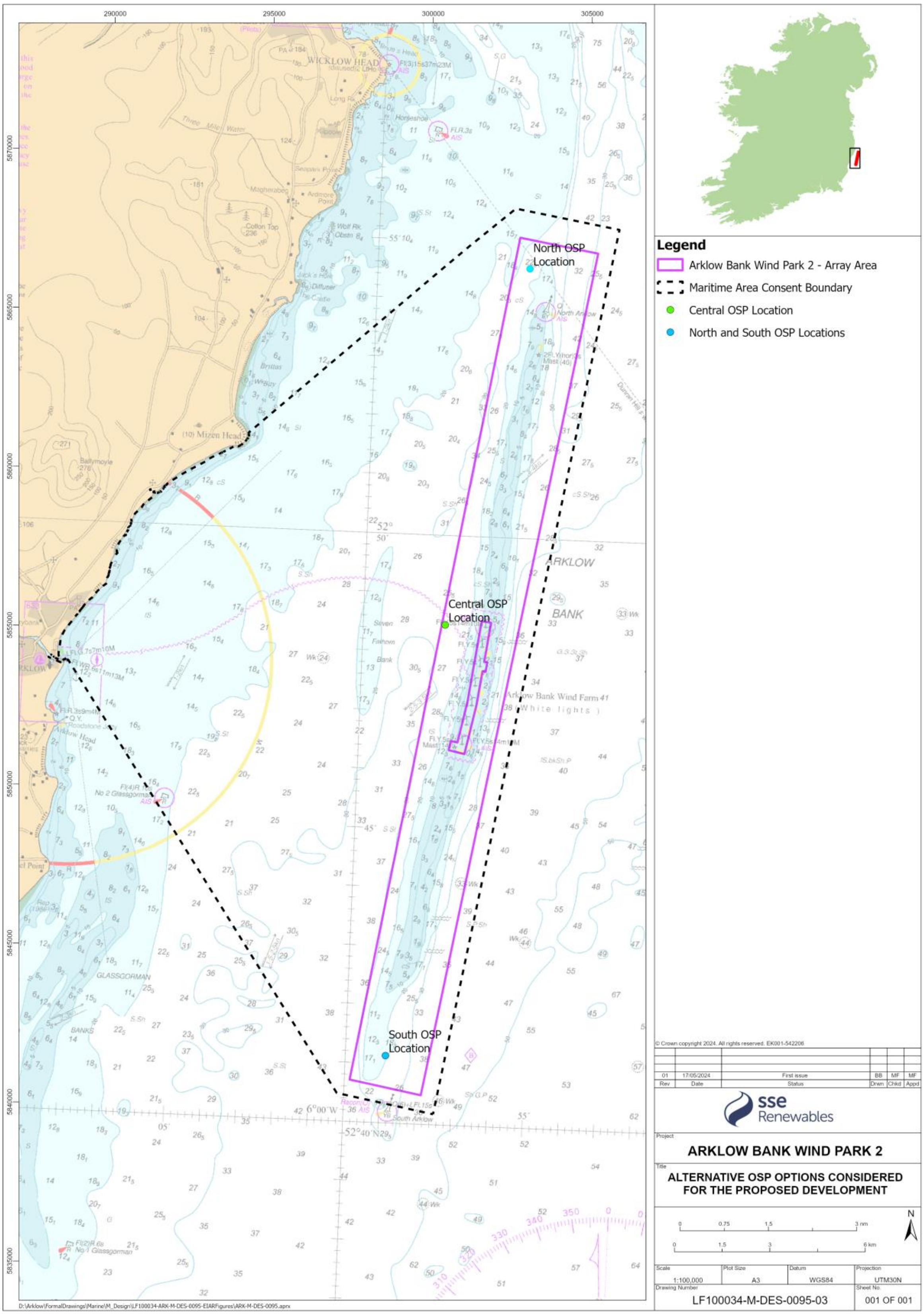

Figure 3.3: Alternative OSP options considered for the Proposed Development

3.8. Alternative Landfall construction techniques

3.8.1.1 A feasibility exercise to establish the most appropriate cable landing technique at the Landfall was undertaken by the Developer.

3.8.1.2 The study considered the following construction techniques to install the offshore export cables at the Landfall:

- Open cut trenching;
- Trenchless techniques:
  - Steerable Direct Pipe Thrusting (Direct Pipe);
  - Micro-tunnelling/pipe jacking; and
  - Horizontal Directional Drilling (HDD).

3.8.1.3 Open Cut-Trenching involves the following:

- Removing the surface material and excavating from the surface down to the required trench depth through the overburden and rock;
- Supporting the trench sides, if necessary, depending on ground conditions;
- Installing the cables and cable surround materials; and
- Backfilling with appropriate materials, including installing marker tapes, as required, and reinstating the surface material.

3.8.1.4 Direct Pipe is a proprietary method developed by Herrenknecht whereby a Micro-Tunnel Boring Machine (MTBM), which has cutting wheels and high-pressure jetting nozzles, is launched from an excavated launch pit onshore. A steel casing is attached to the MTBM, and the whole assembly is then jacked seawards by hydraulic rams located within the launch pit. The arisings generated by the MTBM are then passed back along the casing annulus, suspended in drilling mud, and processed through shakers and screeners, located onshore, for disposal, and drilling muds recycled. The casing forms the permanent ducting through which the cabling will be installed at a later date.

3.8.1.5 Micro Tunnelling (pipe jacking) involves a similar method as described above for the Direct Pipe proprietary method. However, this non-proprietary method may require intermediate thrust jacking stations along the bored tunnel route.

3.8.1.6 HDD is a technique whereby a hole is drilled from land under any coastal features such as cliffs, dune systems or sensitive features, to a point a suitable distance offshore, ensuring environmental constraints are avoided. HDD involves pushing a steerable rotating boring head, supported by a drilling fluid, through the ground. When the pilot bore is completed, it is enlarged to the required diameter by pulling a reamer back towards the drilling machine and pulling the duct into place. Cables can then be installed within the duct.

3.8.1.7 Table 3.5 provides a summary of the advantages and disadvantages of using each of these methods at the Landfall.

Table 3.5: Advantages and disadvantages of open cut and trenchless techniques at the Landfall.

Options	Advantages	Disadvantages
Open-cut Trench	Allows accuracy of installation operations; Relatively low cost when compared to trenchless techniques; and Can be installed rapidly.	Steep cliffs (approximately 9 m high) in conjunction with an exposed location susceptible to stormy sea conditions will preclude the use of open cut trenching; and Increased potential for environmental impact due more invasive form of construction.

Options	Advantages	Disadvantages
Micro-tunnelling / pipe jacking	Suitable for geological conditions at the Landfall Allows accuracy of installation operations; Speed of installation operations; Minimum impact to environment due to trenchless nature of installation; Pre-cast concrete sections installed with the advancing tunnel drive providing immediate shoring support; and Suitable for installation below groundwater level.	Typically, cannot be curved when drill length <1 km; Typical maximum single drive of 300 m to 500 m (intermediate thrust jacking stations may be required); Relatively expensive; and Temporary sheet piles required for launch and reception pits.
HDD	Suitable ground conditions at the Landfall Minimum impact to environment due to trenchless nature of installation; Allows accuracy of installation operations; Speed of installation operations; and Continuous monitoring and control during the operations.	Additional space required for stringing out / laydown if required; Minor earthworks required to create level area at proposed entry compound; and Potential breakout of drilling muds.
Direct Pipe	Suitable ground conditions; Minimum impact to environment due to trenchless nature of installation; Allows accuracy of installation operations; and Speed of installation operations.	Challenging bending radii to account for topography / need to pass below cliff line; Disposal of potentially contaminated arisings.

3.8.1.8 Table 3.6 provides a comparison of environmental effects on sensitive receptors.

Table 3.6: Key environmental effects on receptors from open cut and trenchless techniques below the HWM.

Environmental Aspect	Open Cut	Trenchless Techniques – chosen option for Proposed Development
Benthic Subtidal and Intertidal Ecology	There is potential for temporary habitat loss/disturbance, increased suspended sediment concentrations and associated sediment deposition and accidental release of pollutants arising from the open cut method. There is also the greater potential for significant effects on the nearby Natura site (Buckroney-Brittas Dunes and Fen SAC) from an open cut trenching methodology.	There will be no direct impact on intertidal habitats and minimal direct effects on subtidal environments. There is a risk to benthic subtidal and intertidal Important Ecological Features from water-based drilling mud which is used as a lubricant during the trenchless process. However, any potential break outs or accidental spills of bentonite will be managed and as such any loss of bentonite to the environment is minimal.
Fish, Shellfish and Sea Turtle Ecology	There is potential for increased suspended sediment concentrations and accidental release of pollutants	There is minimal potential for release of drilling fluids as outlined above. There is potential for elevations in subsea noise

Environmental Aspect	Open Cut	Trenchless Techniques – chosen option for Proposed Development
	arising from the open cut method that has potential to impact on fish shellfish and sea turtle ecology	and vibration during trenchless operations in the nearshore, but this is considered to result in very localised, short-term effects on fish and shellfish.
Marine Mammals	There is potential for increased suspended sediment concentrations and accidental release of pollutants arising from the open cut method that has potential to impact on marine mammal species.	It is unlikely that low frequency cetaceans would be within the vicinity of the trenchelss works in the nearshore. Also, the works will occur over a very short period (weeks and therefore any effects are predicted to be very localised and of short-term duration.
SLVIA	There is potential for temporary seascape, landscape and visual impacts arising from construction plant and vessels associated with open cut. Any interference with the cliff face has potential for permanent impacts.	There is potential for very short term seascape, landscape and visual impacts arising from construction plant and vessels associated with trenchless techniques.
Ornithology	There is potential for temporary disturbance to intertidal birds during construction phase.	There is minimal potential for disturbance to intertidal birds during construction phase.
Marine Archaeology	Open cut has the potential to impact on unknown archaeology in the intertidal and shallow subtidal areas.	As trenchless techniques have minimal impact on the subtidal area, it is unlikely that there will be impacts on unrecorded archaeological material.

3.8.1.9 The latter two methods (HDD and Direct Pipe) were considered to result in minimal impact on the environment. This is because these methods are trenchless techniques that involve installing the cable without the need to excavate an open trench through the intertidal zone. Micro-tunnelling was discounted due to the requirement for significant intrusive works at the entry and exit pits.

3.8.1.10 Table 3.6 outlines that there is higher potential for environmental effects associated with installing the cable using open cut at the Landfall compared to using trenchless techniques.

3.8.1.11 Through a process of options appraisal, HDD and direct pipe were selected as the preferred method for the following reasons:

- Suitability of the ground conditions;
- Minimum impact to environment;
- Accuracy of installation operations; and
- Speed of installation operations.

3.9. Alternative Layouts and designs

3.9.1 Foundation types

3.9.1.1 Three different types of foundations were initially considered for the Proposed Development to support the WTGs and OSPs. These included:

- Monopiles;
- Piled jackets; and
- Gravity bases.

3.9.1.2 Monopile foundations typically consist of a single hollow steel tube installed at depth into the seabed. Transition pieces are fitted over the monopile and secured via bolts or grout. The transition piece may include boat landing features, ladders, a crane, and other ancillary components as well as a flange for connection to the turbine tower. Monopiles are installed into the seabed by either piling or drilling techniques, or a combination of both (drive-drill-drive), depending on seabed conditions. Typically, monopiles will be piled into the seabed using a vibro/hydraulic hammer until any hard ground is encountered, with drilling techniques deployed to install the remaining length of pile, if required. If necessary, the monopile is then grouted in place where the annulus between the rock and pile is filled with inert grout. Grout is pumped into the monopile from a vessel, with the process carefully controlled and monitored to ensure minimal spillage to the marine environment.

3.9.1.3 Jacket foundations comprise a steel lattice structure, with tubular steel members and welded joints, secured to the seabed by hollow steel pin piles. Jacket piles can be installed into the seabed using either piling or drilling techniques, or a combination of both (drive-drill-drive), depending on seabed conditions. As for monopiles, piles will be driven into the seabed using a vibro/hydraulic hammer until any hard ground is encountered, at which point drilling techniques will be deployed to install the remaining length of pile, if required. If required, the jacket piles would then be grouted in place where the annulus between the rock and pile is filled with inert grout. It is possible for the pin piles to be installed in advance of installation of the jacket structure. If this is the case, a piling template will be placed onto the seabed to guide the installation, and the jacket structure is then welded to the piles. Alternatively, the pin piles can be installed after the jacket structure has been lowered to the seabed, through the jacket legs or pile sleeves attached to the jacket leg.

3.9.1.4 Gravity base foundations are heavy concrete, or steel and concrete structures, sometimes including additional ballast, that sit on the seabed to support the turbine tower. Gravity bases vary in shape, but are significantly wider at the base (at seabed level) to provide support and stability to the structure. They then generally taper to a smaller width at or below seabed level. A gravity base does not require piling or drilling to remain in place.

3.9.1.5 Table 3.7 provides a comparison of the key environmental effects associated with each foundation.

Table 3.7: Comparison of key environmental effects from foundation types.

Environmental Aspect	Monopiles – selected option for the Proposed Development	Jackets	Gravity Bases
Coastal Processes	This foundation has potential for changes to tidal currents, wave climate and sediment transport.	This foundation has the lowest potential for changes to tidal currents, wave climate and sediment transport	This foundation has the highest potential for changes to tidal currents, wave climate and sediment transport.
Benthic Subtidal and Intertidal Ecology	This foundation results in habitat loss from the foundation and scour protection.	This foundation results in the least habitat loss when compared to the other foundations.	This foundation results in the largest habitat loss when compared to the other foundations.

Environmental Aspect	Monopiles – selected option for the Proposed Development	Jackets	Gravity Bases
Marine Mammals Fish, Shellfish and Sea Turtle Ecology	This foundation results in habitat loss from the foundation and scour protection for Fish, Shellfish and Sea Turtle Ecology. Potential to temporarily displace species from the vicinity or harm species from underwater noise during installation (similar noise impact in terms of monopiles and jackets).	This foundation results in the least habitat loss when compared to the other foundations for Fish, Shellfish and Sea Turtle Ecology. Potential to temporarily displace species from the vicinity or harm species from underwater noise during installation (similar noise impact in terms of monopiles and jackets).	This foundation results in the largest habitat loss when compared to the other foundations for Fish, Shellfish and Sea Turtle Ecology. Lowest potential to temporarily displace species from the vicinity or harm species from underwater noise during installation.

3.9.1.6 During the development of the Project Design Options, gravity base and jacket foundations were excluded from further consideration for the following reasons:

- Gravity base foundations are not widely used in the offshore wind industry and are therefore the least proven technology;
- There is a less-established supply chain for gravity base foundations, which could potentially increase development costs and execution risk. Installation methods can constrain the supply chain in terms of transportation and installation vessels, fabrication yards and marshalling ports;
- Gravity base and jacket foundations have a higher cost to fabricate and install; and
- Jacket foundations require bespoke fabrication which takes a considerable amount of time and manpower to fabricate.

3.9.1.7 From an environmental perspective, gravity base and jacket foundations are less preferred compared to monopile foundations because:

- Gravity base foundations can have significantly greater physical dimensions, leading to a greater obstruction to flow in the water column and associated potential impacts on physical processes such as waves, currents and sediment transport;
- Gravity base foundations rely on shallow waters, which means they are more susceptible to seabed mobility than other foundation types. Consequently, considerable levels of scour and seabed mobility protection are required to prevent against structural damage of the foundation, leading to a greater seabed footprint; and
- Gravity base and jacket foundations require large areas of seabed preparation, which would result in larger quantities of scour protection and higher potential for environmental impacts such as habitat loss and habitat disturbance;
- The methodologies to install gravity base foundations require a large footprint; and
- Jacket foundations take up a considerable amount of deck space so a limited quantity can be shipped by barge or installation vessel at one time thereby prolonging installation timeframes and therefore potential impacts during construction.

3.9.1.8 Due to the reasoning above monopile foundations were chosen to support the WTGs and the OSPs.

3.9.2 Scale of wind farm (number of WTGs)

3.9.2.1 The Proposed Development has evolved through several iterations with the initial scope of the project, which was approved by means of a foreshore lease granted by the Minister for Marine and Natural Resources in 2002, following a consent application that was supported by an Environmental Impact Statement. The project at this time comprised a windfarm of 200 WTGs with a maximum export capacity of 520 MW. Only seven WTGs from the windfarm with a capacity of 25.2 MW were constructed in 2003-2004 as Arklow Bank Wind Park 1 (ABWP1)) on Arklow Bank. A second phase of this wind farm was to be developed consisting of 193 turbines but this phase and planned connection to Eirgrid transmission system was cancelled in 2007.

3.9.2.2 In March 2021, Sure Partners Ltd submitted an application inclusive of an Environmental Impact Assessment Report and Natura Impact Statement to the Minister for Housing, Planning and Local Government (DHPLG) to facilitate the extension of longstop dates within the foreshore lease area. The development as proposed then comprised a windfarm with up to 76 WTGs to achieve the same installed capacity of 520 MW as the previously consented development.

3.9.2.3 However, with the introduction of the Maritime Area Planning Act in 2021, Sure Partners again revised the technical envelope and substantially increased the power generation output from the site based on an iterative design process. The final design of the Proposed Development presented and assessed in this EIAR now comprises a windfarm of either 47 or 56 WTGs with a capacity of approximately 800 MW. The final design presented and assessed in this EIAR is for two layouts comprising either 56 or 47 WTGs. The final layout will be chosen based on the WTG model procured.

3.9.2.4 The main reason that a reduction in the number of wind turbines from 200 WTGs to either 47 or 56 WTGs, in conjunction with an increase in power generation output has been possible, is due to the increase in output of WTG models that are available now in comparison with those that were available on the market in 2002 and in 2021. The reduction in the numbers of WTGs for the Proposed Development, in comparison with the alternative options previously considered, has resulted in a significant reduction in the potential for adverse environmental effects arising from the reduced seabed footprint, reduced operation noise, reduced potential for disturbance and injury to fish, shellfish, sea turtles and marine mammals, reduced seabird collision risk, reduced impacts on commercial fisheries and reduced visual impact (See Table 3.8).

Table 3.8: Scale of wind farm options (number of WTGs) and comparison of key environmental effects.

Environmental Aspect	56 or 47 WTGs (selected options for the Proposed Development)	200 WTGs
Coastal Processes	Potential for changes to tidal currents, wave climate and sediment transport as outlined in Chapter 6: Coastal Processes.	Potential for larger changes to tidal currents, wave climate and sediment transport due to greater number of turbines.
Airborne Noise	Operational noise effects as outlined in Chapter 8: Airborne Noise.	Potential for higher operational noise effects associated with greater number of turbines.
Air Quality and Climate	Output depending, the overall positive effects on climate would be similar (Chapter 20: Air Quality and Climate).	Output depending, the overall positive effects on climate would be similar.

Environmental Aspect	56 or 47 WTGs (selected options for the Proposed Development)	200 WTGs
Benthic Subtidal and Intertidal Ecology	Temporary and permanent habitat loss (as outlined in Chapter 9: Benthic Subtidal and Intertidal Ecology).	Potential for larger areas of temporary and permanent habitat loss associated with greater number of turbines.
Fish and Shellfish and Sea Turtle Ecology	Potential for disturbance and injury to important ecological features (as outlined in Chapter 10: Fish and Shellfish and Sea Turtle Ecology).	Higher potential for disturbance and injury to important ecological features with greater number of turbines.
Marine Mammals	Potential for disturbance and injury to marine mammals (as outlined in Chapter 11: Marine Mammals).	Higher potential for disturbance and injury to marine mammals with greater number of turbines.
Ornithology	Potential for collision mortality (as outlined in Chapter 12: Offshore Ornithology).	Higher potential for significant collision mortality associated with greater number of turbines.
Commercial Fisheries	Potential for interference with and displacement of fishing activities (as outlined in Chapter 14: Commercial Fisheries and Aquaculture).	Higher potential for interference with and displacement of fishing activities with greater number of turbines (and inter-array cables).
Shipping and Navigation	Potential for vessel displacement, port access, collision risk, allision risk, cable interaction, diminishment of emergency response (as outlined in Chapter 15: Shipping and Navigation).	Higher potential for collision risk, allision risk, cable interaction, diminishment of emergency response associated with greater number of turbines and (inter-array cables).
Civil and Military Aviation	Potential for effects on air traffic and interference with civil and military Primary Surveillance Radar (PSR) systems (as outlined in Chapter 16: Civil and Military Aviation).	Higher potential for effects on air traffic and interference with civil and military PSR systems associated with greater number of turbines.
SLVIA	Potential for effects on seascape, landscape and visual impacts (as outlined in Chapter 17: Seascape, Landscape, Visual Impact Assessment).	Higher potential for more significant effects on seascape, landscape and visual impacts associated with greater number of turbines.
Marine Archaeology	Potential to disturb unknown archaeology (as outlined in Chapter 18: Marine Archaeology).	Higher potential to disturb unknown archaeology as a result of increased seabed activities and greater number of turbines.
Infrastructure and other Users	Potential to interfere with existing infrastructure in the Array Area (as outlined in Chapter 19: Infrastructure and Other Users).	Higher potential to interfere with existing infrastructure in the Array Area as a result of seabed activities and greater number of turbines.
Population and Human Health	Employment benefits during operation would be similar (as outlined in	Employment benefits during operation would be similar.

Environmental Aspect	56 or 47 WTGs (selected options for the Proposed Development)	200 WTGs
	Chapter 21: Population and Human Health).	

3.9.3 Layout

3.9.3.1 The project layout went through a design iteration by virtue of the pre-planning application process with ABP. When the Applicant entered the pre-planning process the proposal was to identify the realistic worst-case scenario, referred to as the Maximum Design Scenario (MDS), for the main impact assessments for each EIA topic. The MDS was to be selected from four discrete wind turbine generator options. The approach proposed was to assess the scenario with the greatest impact (i.e. largest footprint, longest exposure, tallest dimensions) depending on the topic with robust justification to support the conclusion of further assessment.

3.9.3.2 However, in consultation with the Board it became clear that this approach had a number of difficulties and based on the pre-application engagement with ABP, the Applicant revised the project design reducing it from four design options to two.

3.9.3.3 The decision to change the proposal was based on the following considerations:

- Irish legislative requirements on project flexibility;
- The An Bord Pleanála circular (issued to the applicant on 31st July);
- GoBe's experience in EIAR methodology and the associated guidance and legislation;
- GoBe's experience of all phases of offshore wind farm project development and the level of flexibility that is required for projects of these scales;
- The work that has been carried out by SSE to refine the ABWP2 project parameters;
- The need for a robust and rationale assessment of design scenarios and the need for consent application submission in Q3 2024;
- Discussions with ABP during pre-application meetings; and
- The need for alignment/translation between assessment approach and the details that form the 'Plans and Particulars' within the consent application.

3.9.3.4 Two turbine layouts have been provided for the purposes of the Application for the Proposed Development. The layouts of the Proposed Development have been designed around a number of physical and environmental constraints:

- Wind speed and direction;
- Water depth;
- Ground conditions;
- Existing infrastructure: the Proposed Development infrastructure will be designed with reference to the location of the existing ABWP1 wind turbines and cables;
- Underwater archaeology (i.e. wrecks): the WTG and inter-array cable layouts have been designed to avoid known wreck sites; and
- Sensitive habitats: the layout of the offshore export cable routes will be refined around any areas of Annex I reef habitat and seed mussel beds.

3.9.3.5 In addition, the two layouts have been informed by layout principles including ensuring a minimum spacing of 500 m is maintained between blade tip to blade tip of all surface infrastructure and 500 m spacing between WTGs and OSPs.

3.9.4 Offshore export and interconnector cables

3.9.4.1 During the iterative design process, the following transmission system technologies were considered as part of the design of the export system technology for the Proposed Development: High Voltage Direct Current (HVDC) and 275 kV, 220 kV, 132 kV, 110 kV and 66 kV High Voltage Alternating Current (HVAC).

3.9.4.2 Table 3.9 provides a technical and environmental appraisal of the options considered.

Table 3.9: Technical and environmental appraisal of the export transmission system technology options.

Export Transmission System	Technical Appraisal	Environmental Appraisal
HVDC	This option was discounted as it is not cost effective unless located in excess of 600 km for HVDC	Requires additional infrastructure such as power-converters, direct current (DC) inductors, filters, and other components offshore and onshore, which increases potential for environmental impacts in particular seascape, landscape and visual impact.
275 kV HVAC technology	It was considered that this technology was not advanced enough or properly tested to consider further in the design process.	Fewer cables would result in potential for reduced environmental impacts including temporary subtidal habitat loss during construction and reduced suspended sediment concentrations and associated sediment deposition.
132 kV, 110 kV and 66 kV HVAC technologies	These options all require additional cables to achieve the capacity to transmit the power to shore.	Additional cables would result in higher potential for increased environmental impacts including temporary subtidal habitat loss during construction and increased suspended sediment concentrations and associated sediment deposition.
220 kV HVAC technology (the selected option for the Proposed Development)	This option requires the least number of cables to achieve the capacity to transmit the power to shore.	Temporary subtidal habitat loss and increased suspended sediment concentrations and associated sediment deposition during construction, but no significant effects are predicted.

3.9.4.3 The appraisal of options indicates that the 220 kV HVAC technology option is preferable from a technical perspective and also because it results in the least potential for environmental impacts.

3.9.4.4 Two 220 kV offshore export cables will be required to transmit the power to shore for the Proposed Development.

3.9.5 Inter-array cables

3.9.5.1 During the iterative design process, two options for inter-array system technologies were considered: 33 kV and 66 kV HVAC for the Proposed Development.

3.9.5.2 Table 3.10 provides a technical and environmental appraisal of the options considered.

Table 3.10: Technical and environmental appraisal of the inter-array cable options.

Export Transmission System	Technical Appraisal	Environmental Appraisal
33 kV HVAC technology	This option was discounted as it would require approximately 30% more inter-array cables to connect the same number of wind turbines than the 66 kV due to the reduced rating capacity at 33 kV.	Additional cables would result in higher potential for increased environmental impacts including temporary subtidal habitat loss during construction and increased suspended sediment concentrations and associated sediment deposition.
66 kV HVAC technology (selected option for Proposed Development)	This option was selected because it required fewer inter-array cables than the 33 kV HVAC system.	Temporary subtidal habitat loss and increased suspended sediment concentrations and associated sediment deposition during construction, but no significant effects are predicted.

3.9.5.3 The 66 kV HVAC technology was selected for the Proposed Development as it requires the fewest number of inter-array cables and is unlikely to cause significant effects on coastal process and benthic receptors.

3.10.Air Gap

3.10.1.1 The iterative project design process has culminated in raising the WTG's lower blade tip height to 37 m above Lowest Astronomical Tide (LAT) for both Project Design Options for which development permission is being sought.

3.10.1.2 WTG options with air gaps ranging from 22 m to 45 m above LAT were considered (Table 3.11). The alternative air gap scenarios considered comprised air gaps of 22 m, 25 m, 35 m, 37 m and 45 m above LAT.

3.10.1.3 Selecting a higher minimum blade tip height has delivered significant mitigation of bird collision risk impact. Moving the rotor swept area to altitudes where seabird densities are lower due to the skewed nature of bird flight height distribution has significantly reduced the impact, by minimising the risk of collision for the key seabird species in flight so far as feasible within the current bounds of technical feasibility of the Proposed Development. It is worth noting too that the measures that have been implemented through the design development process to reduce impacts on birds may also potentially benefit bats (refer to Volume III, Chapter 13 Offshore Bats).

3.10.1.4 Considering site specific constraints such as water depth and ground conditions which influence the size of the installation jack-up vessel required for WTG installation, an air gap of 37 m above LAT is considered to be the maximum air gap technically feasible for the Proposed Development. Increasing the air gap beyond 37 m above LAT is considered not technically feasible from a WTG installation perspective as installation vessels do not currently have the capability to perform installations at the heights required to install full towers, nacelles and blade assemblies in the conditions set within the Proposed Development. This is due to a combination of water depth (jack-up legs), site specific ground conditions (jack-up leg penetration requirements), turbine component heights, rigging height and boom clearance gap requirements and the derived crane hook height and installation load capabilities at that hook height. There is also the effect on structural design to consider whereby raising the air gap directly influences the forces and frequencies required to be resisted by the foundation substructures. The current air gap already necessitates consideration of extra-large MPs and consideration of novel connection technologies between monopile (MP) and transition piece (TP) substructures. Increasing the air gap beyond 37 m above LAT would challenge the very upper limits of current foundation manufacturing capability and throughput capacity.

3.10.1.5 Therefore, any further increase in air gap is not currently technically feasible and would substantially increase the Proposed Development's costs and supply chain risk, which would jeopardise early delivery of low-cost generation for the benefit of Ireland's electricity consumers.

Table 3.11: Technical and environmental appraisal of the airgap options.

Airgap Options	Technical Appraisal	Environmental Appraisal
22 m LAT	This option was discounted as although technically feasible had the most potential for collision risk for seabirds.	This option would result in increased potential for collision risk for seabirds.
25 m LAT	This option was discounted as although technically feasible had potential for collision risk for seabirds.	This option would result in increased potential for collision risk for seabirds.
35 m LAT	This option was discounted as although technically feasible had potential for collision risk for seabirds.	This option would result in increased potential for collision risk for seabirds.
37 m LAT	This option was selected as it was technically feasible and minimised the potential for collision risk for seabirds.	This option would achieve the greatest balance in reducing the potential for collision risk for seabirds.
45 m LAT	This option was discounted as it was deemed to be technically unfeasible due to constraints associated with water depth, turbine height and crane capabilities.	This option would result in the least potential for collision risk for seabirds.

3.11. Rehabilitation Schedule Options

3.11.1.1 In accordance with the requirements of the MAC for the Proposed Development, the Application includes a Rehabilitation Schedule, within the meaning of section 95 of the Maritime Area Planning Act 2021, as amended. The Rehabilitation Schedule, which sets out the proposed rehabilitation activities for the Proposed Development, is provided (Volume III, Appendix 4.1) and has been assessed in this EIAR and the NIS for the Proposed Development.

3.11.1.2 In accordance with section 96 of the Maritime Area Planning Act 2021, as amended, the obligation on the holder of a MAC to rehabilitate a part of the maritime area may include one, or more than one, of the following:

- the decommissioning of infrastructure;
- the removal of infrastructure;
- the partial removal of infrastructure;
- the re-use of infrastructure for the same or another purpose;
- the burying or encasing of infrastructure; and
- the removal of any deposited or waste material.

3.11.1.3 In accordance with section 95 of the Maritime Area Planning Act 2021, as amended, rehabilitate in relation to a part of the maritime area means -

(a) a treatment for the part in such a way as to either —

(i) restore the part to a satisfactory state, with particular regard to the seabed, water quality, wildlife, natural habitats, landscape and seascape, or

(ii) restore the part to a satisfactory state to enable it to be reused for the purpose for which it was previously used (and whether or not pursuant to a MAC) or for another purpose and, consistent with such purpose, with particular regard to the seabed, water quality, wildlife, natural habitats, landscape and seascape, and

(b) after the restoration referred to in paragraph (a)(i) or (ii) has been completed and, if appropriate, to maintain, for a period specified in the rehabilitation schedule concerned, the part so that it continues to be in the satisfactory state referred to in that paragraph;

3.11.1.4 The Developer will rehabilitate the maritime area through the removal of the offshore wind farm and cable infrastructure as set out in Section 3.11, with the offshore components being removed from site, transported to shore for re-use, recycling or energy recovery leaving a clear seabed for re-use and which does not pose a risk or restriction to other users of the sea. However, in the context of the provisions of Section 95 of the Maritime Area Planning Act 2021, alternative solutions involving complete and partial removal or leaving some infrastructure *in-situ* were considered in the iterative design development for the Proposed Development.

3.11.1.5 The main assumptions for rehabilitation of the Proposed Development are:

- The scope of decommissioning and removal (including partial removal) covers all infrastructure associated with the Proposed Development;
- There will be either 47 or 56 WTG units, depending on which Project Design Option is chosen, which will be removed from site
- There will be 2 x OSP's, which will be removed from site;
- Foundations (MPs) will be cut to 2 m below the mudline;
- Export, Inter-array and interconnector cables are to be cut at, or below sea-bed level and to remain *in-situ;* and
- Scour protection materials will be left *in-situ.*

3.11.1.6 Six criteria form the assessment of the rehabilitation options:

- Technical Feasibility
- Harm to people – Safest option involving standard procedures (reverse installation)
- Restore the part to a satisfactory state, with particular regard to the seabed, water quality, wildlife, natural habitats, landscape or seascape
- Restore the part to a satisfactory state to enable it to be reused for the purpose for which it was previously used or for another purpose
- Potential for re-use of materials
- Commercial Viability - Extensive cost of removal. Costs associated with removal may be partially offset by recycling of scrap metal.

3.11.2 Monopiles

3.11.2.1 During the iterative design process, two options for the decommissioning of the monopile foundations were considered: complete or the partial removal of monopile foundations by cutting the monopile 2 m below the seabed. For the complete removal option, a length of 20 – 37 m of the monopile which is embedded below the lowest seabed level, will require removal. For partial removal, the option considered is for the cutting of the pile 2 m below the surface.

3.11.2.2 Table 3.12 provides a technical and environmental appraisal of the monopile removal options considered.

Table 3.12 Technical and environmental appraisal of the monopile removal options.

Appraisal Criteria	Full Removal	Partial Removal
Technical Feasibility	Currently complete excavation and removal of the monopiles is not technically feasible. Significant risk associated with deep seabed excavations. Considerable excavation needed with associated storage or disposal of larger volumes of excavated waste. Removal of the monopiles is unlikely to be possible in harder substrates.	Partial removal is technically feasible. Utilises tried and tested procedures and equipment including the use of a cutting tool with an internal high pressure waterjet cutter, and reduced risk due to minimising offshore construction activity.
Harm to people (safest option involving standard procedures)	Significant excavation of the seabed down to penetration depth (below lowest seabed level 20 - 37 m) required to remove seabed material prior to monopile removal. Excavation of any surface sediment would be required to expose the monopile at the rock layer requiring significant offshore activity and duration.	Significantly less activity required over a shorter period though still extensive campaign. Cutting operations will take around 60 hours to be completed (per monopile). Depending on the cutting method adopted it may be possible to avoid the use of divers, minimising risk to personnel. Provided the monopile is cut 2 m below the seabed surface, there will be no enduring health and safety risk to other sea users. Post- decommissioning site monitoring will identify any unlikely exposure with the result that safety risk is insignificant.

Restoration to a satisfactory state environmentally (seabed, water quality, wildlife, natural habitats, landscape or seascape)	Excavation pits over a wide area causing potentially significant impact to the seabed, to water qualify, wildlife and natural habitats. Associated dumping of excessive volume of excavated waste material may be required. Disturbance would also take place over a longer duration. Neither option will impact landscape and seascape.	Considerably reduced works footprint relative to complete removal. Works would take place over reduced time period and involve less equipment. Seabed recovery time shorter than complete pile removal scenario. Considerably less excavation and seabed and construction disturbance over a shorter time period, would result in reduced impacts to water quality, wildlife, and natural habitats. Neither option will impact landscape and seascape.
Restoration to enable reuse (either the purpose for which it was previously used or for another purpose)	Seabed restored for reuse	Seabed restored for reuse.
Potential for re-use of materials	Maximum length of monopiles potentially available for re-use.	Less foundation material available for re-use relative to complete removal.
Commercial Viability	Costs are considered extreme - excavation and lifting involves major equipment requirements over longer periods of time. Campaign costs significantly higher due to level of risk. As noted above there is currently not a suitable technical and cost-effective method of removing monopiles.	Less expensive alternative to complete removal, involving minimal or no excavation and minimising environmental impacts.

3.11.2.3 The option to partially remove the monopiles by cutting below the seabed was selected in consideration of the fact that it was technically feasible and was a proven technology. Due to the reduced scale and complexity of the construction works, it also represented the safest options, had less potential for environmental impacts and was the most commercially viable option. Both options enable restoration of the seabed for reuse.

3.11.3 Cables and Ducting

3.11.3.1 During the iterative design process, two options for the decommissioning of the cables (export, inter array and interconnector cables), ducting and cable protection were considered: complete removal by excavation or the partial removal of cables by means of cutting them at seabed level and retention *in-situ*. Any sections of cable (including cut ends) that are left *in-situ* will be adequately buried or otherwise protected with berms of loose rock.

3.11.3.2 Table 3.13 provides a technical and environmental appraisal of the cables and ducting options.

Table 3.13: Technical and environmental appraisal of the cable and ducting removal options

Appraisal Criteria	Full Removal of ducting and cabling	Retention *in situ* of ducting and cabling
Technical Feasibility	Technically feasible. Would involve reversing the installation process using a similar vessel and equipment spread to that of the installation campaign.	Technically feasible. Any sections of cable (including cut ends) that are left in-situ will be adequately buried, or otherwise protected with berms of loose rock.
Harm to people (safest option involving standard procedures)	Full removal of ducts at cable crossings and at the landfall area will require significant excavation of the sea defences and intertidal areas and the construction of a cofferdam. The removal of the cables requires the excavation of a wider trench (15 – 20 m) for removal than installation in order to ensure that the trench remains open for the period between de-burial and cable retrieval campaigns. It requires a more extensive programme of works. Therefore, it presents a greater safety risk than the option to retain *in-situ*.	Retention *in-situ* by means of cutting does not require cofferdam or extensive trench excavations and therefore the programme of works is less extensive. Therefore, this option represents a safer option than full removal.
Restoration to a satisfactory state environmentally (seabed, water quality, wildlife, natural habitats, landscape or seascape)	Full removal requires the excavation of a wider trench (15 – 20 m). As a result of this, the area of impact on the seabed from decommissioning and removal is even larger than construction and significantly larger than an option to leave the ducting and cabling *in-situ*. Therefore, it is anticipated that the impacts on the seabed, water quality, wildlife (including benthic habitats and species) and natural habitats will also be more significant. Neither option will impact landscape and seascape.	Retention in situ does not require the excavation of such a large wide trench and therefore the potential for environmental impact on the seabed, water quality, wildlife (including benthic habitats and species) and natural habitats from decommissioning and partial removal is less significant. Neither option will impact landscape and seascape.
Restoration to enable reuse (either the purpose for which it was previously used or for another purpose)	This option enables restoration of the seabed for reuse.	This option enables restoration of the seabed for reuse.
Potential for re-use of materials	This option enables the re-use of retrieved cabling.	This option does not enable re-use of retrieved cabling.

Commercial Viability	Due to the extent of excavations and the construction programme, this option is considerably more expensive that the option to retain the cables *in-situ*. However, the costs would be partially offset by the potential for re-use of the reclaimed cabling.	This option is more commercially viable as it involves considerably less construction works.

3.11.3.3 The option to retain the ducting and cables *in-situ* was selected in consideration of the fact that it had significantly less potential for environmental impacts and due to the reduced scale of the construction works it also represented the safest option and the most commercially viable option. Both options enable restoration of the seabed for reuse.

3.11.4 Scour and Cable Protection

3.11.4.1 The Proposed Development will require scour protection for installed infrastructure comprising loose rock, rock bags or mattressing. Options for the removal of the scour protection or its retention *in-situ* were considered as part of the rehabilitation plan of the maritime area. The option to retain the scour protection will require re-profiling following any cable or foundation removal works which will ensure that any seabed depressions are levelled.

Table 3.14: Appraisal of decommissioning scour protection

Appraisal Criteria	Full Removal of scour protection	Retention *in situ* of scour protection
Technical Feasibility	Technically feasible.	Technically feasible.
Harm to people (safest option involving standard procedures)	Full removal requires significant programme of excavation works on the seabed in both the Array Area and the Cable Corridor and Working Area and therefore presents a greater risk than the option to retain the scour protection *in-situ*.	Retention *in-situ* does not require extensive excavations and therefore the programme of works is less extensive. Therefore, this option represents a safer option than full removal.
Restoration to a satisfactory state environmentally (seabed, water quality, wildlife, natural habitats, landscape or seascape)	Full removal requires a significant programme of excavation and disturbance works on the seabed in both the Array Area and the Cable Corridor and Working Area. Therefore, it is anticipated that the impacts on the seabed, water quality, wildlife (particularly benthic habitats and species) and natural habitats will also be more significant. Neither option will impact landscape and seascape.	Retention *in-situ* requires significantly less excavation and disturbance and therefore the potential for environmental impact on the seabed, water quality, wildlife (particularly benthic habitats and species) and natural habitats from decommissioning and partial removal is less significant. Neither option will impact landscape and seascape.
Restoration to enable reuse (either the purpose for which it was previously used	This option enables restoration of the seabed for reuse.	This option, which provides for reprofiling of the seabed after infrastructure removal, also

Appraisal Criteria	Full Removal of scour protection	Retention *in situ* of scour protection
or for another purpose)		enables restoration of the seabed for reuse.
Potential for re-use of materials	This option enables the re-use of retrieved rock, rock bags or mattressing.	This option does not enable re-use of retrieved rock, rock bags or mattressing.
Commercial Viability	Due to the extent of excavations and the construction programme, this option is considerably more expensive that the option to retain the cables *in-situ*. However, the costs would be partially offset by the potential for re-use of the reclaimed rock, rock bags or mattressing.	This option is more commercially viable as it involves considerably less construction works.

3.11.4.2 Where loose rock, rock bags or mattressing is used, the option to leave this *in-situ* has been selected as this option reduces the potential for significant environmental impacts particularly impacts on the benthic environment in conjunction with reductions in health and safety risks, and costs. Both options enable restoration of the seabed for reuse.