Offshore Wind Power Limited

West of Orkney Windfarm Onshore EIA Report

Volume 1, Chapter 4 – Site Selection and Alternatives

WO1-WOW-CON-EV-RP-0084: Approved by S.Kerr
Document Control 20/10/2023

ASSIGNMENT **OWPL Document**
DOCUMENT **OWPL Document**

XODUS

West of Orkney Windfarm

REVISIONS & APPROVALS

REV	DATE	DESCRIPTION	ISSUED	CHECKED	APPROVED	CLIENT
A01	10/10/2023	OWPL authored chapter	AB	LF	LS	OWPL
R02	22/05/2023	OWPL authored chapter	AB	LF	LS	OWPL
R01	25/11/2022	OWPL authored chapter	AB	LF	LF	OWPL

CONTENTS

PAGE LEFT INTENTIONALLY BLANK

4 SITE SELECTION AND ALTERNATIVES

4.1 Introduction

This chapter outlines the site selection process that has been undertaken by Offshore Wind Power Limited (OWPL) when defining the West of Orkney Windfarm (the Project). It also outlines the alternatives to the Project that have been considered, both in terms of the different design options throughout the development process as well as the consideration of not developing the Project at all (the 'do nothing' option).

As defined in chapter 3: Planning policy and legislative context, Schedule 4 (2) of The Town and Country Planning (Environmental Impact Assessment (EIA)) (Scotland) Regulations 2017 stipulates '*A description of the reasonable alternatives (for example in terms of development 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*.'

4.2 The 'do nothing' option

The English courts[1] have cast doubt on whether the 'do nothing' option is a true alternative, however for completeness, and given reference to it in pre-existing guidance, the 'do nothing' option is considered here. The 'do nothing' option is a consideration of what would happen if the Project did not go ahead.

As presented in the Onshore Environmental Impact Assessment (EIA) Report, chapter 2: Need for the Project, the Project will aim to achieve the following:

- Supply electricity generated from wind energy to meet energy demand;
- Support the transition to a net zero economy;
- Contribute to Government commitments to climate change;
- Provide a secure source of energy; and
- Deliver sustainable low-carbon economic growth.

A 'do nothing' scenario would not meet any of the above Project aims.

The 'do nothing' option would result in no offshore windfarm development within the N1 Plan Option (PO) and loss of over two gigawatts (GW) of offshore wind capacity.

The Project location has been strategically identified through the Scottish Government Sectoral Marine Plan (SMP) process and has been subject to Strategic Environmental Assessment (SEA), Habitats Regulations Appraisal (HRA), Socio-Economic Impact Assessment (SEIA) and an Island Communities Impact Assessment. If the Project does not proceed, a significant area of seabed identified by the Scottish Government's SMP as suitable and made available for large-scale offshore wind development would not be developed in the near-term, if at all. This could result in ramifications for all future ScotWind applications.

[1] *Humber Sea Terminal Ltd v Secretary of State for Transport and another [2005] EWHC 1289 (Admin), comments at paragraph 84.*

In support of climate change legislation, the Draft Scottish Energy Strategy and Just Transition Plan was published in January 2023 and provides a roadmap of how net zero emissions by 2045 can be accomplished. A key ambition for Scotland as outlined in the draft plan is the production of more than 20 GW of additional renewable electricity by 2030. The Offshore Wind Policy Statement (OWPS) sets ambitions for offshore wind development, initially as much as 11 GW of offshore wind capacity in Scottish waters by 2030. The Project is the most advanced ScotWind Project, with a grid connection date before 2030 (first power planned 2029). In the 'do nothing' scenario there would be a gap between Scottish AR3 Offshore Windfarms (OWFs) (coming online in the next few years) and future ScotWind developments (likely to mostly come online from 2033). Scotland cannot be expected to meet its target for offshore wind capacity if the Project does not go ahead. It is not compatible with a climate emergency to 'do nothing'.

The Scottish Government is committed to ensuring secure, reliable and affordable energy supplies (i.e., social and economic benefits), within the context of long-term decarbonisation of energy generation (i.e., environmental benefits). The continued growth of the renewable energy sector in Scotland is an essential feature of the future clean energy system and a key driver of economic growth (Scottish Government, 2020a). Development of the Project will be an important step in the continued growth of renewable energy in Scotland and for meeting the current energy demand. Thus, doing nothing (no West of Orkney Windfarm) would substantially hinder decarbonisation and security of supply efforts during the critical 2020s and would ignore the clear need for rapid OWF deployment at scale. The importance of the decarbonisation, energy security and related affordability challenges mean that no viable OWF projects should be passed over in the development process.

As part of the ScotWind application, the Project produced a Supply Chain Development Statement (SCDS), which included commitments to the Scottish and United Kingdom (UK) supply chains. If the Project was not to go ahead, these local and national supply chain opportunities would be missed.

For all the above reasons, the 'do nothing' option was discounted.

4.3 Site selection process

The site selection process for the West of Orkney Windfarm has been guided and informed by key events in the Project's development timeline:

- Development of the Scottish Government's SMP for Offshore Wind Energy;
- The selection and award of the West of Orkney Option Agreement Area (OAA) through the ScotWind leasing processes;
- The securing of the grid connection agreement with National Grid; and
- Consultation and environmental and technical investigations which have enabled refinements to be made to the Project design and areas within which Project infrastructure will be located.

An overview of the key events in the Project's development timeline are shown below in Figure 4-1.

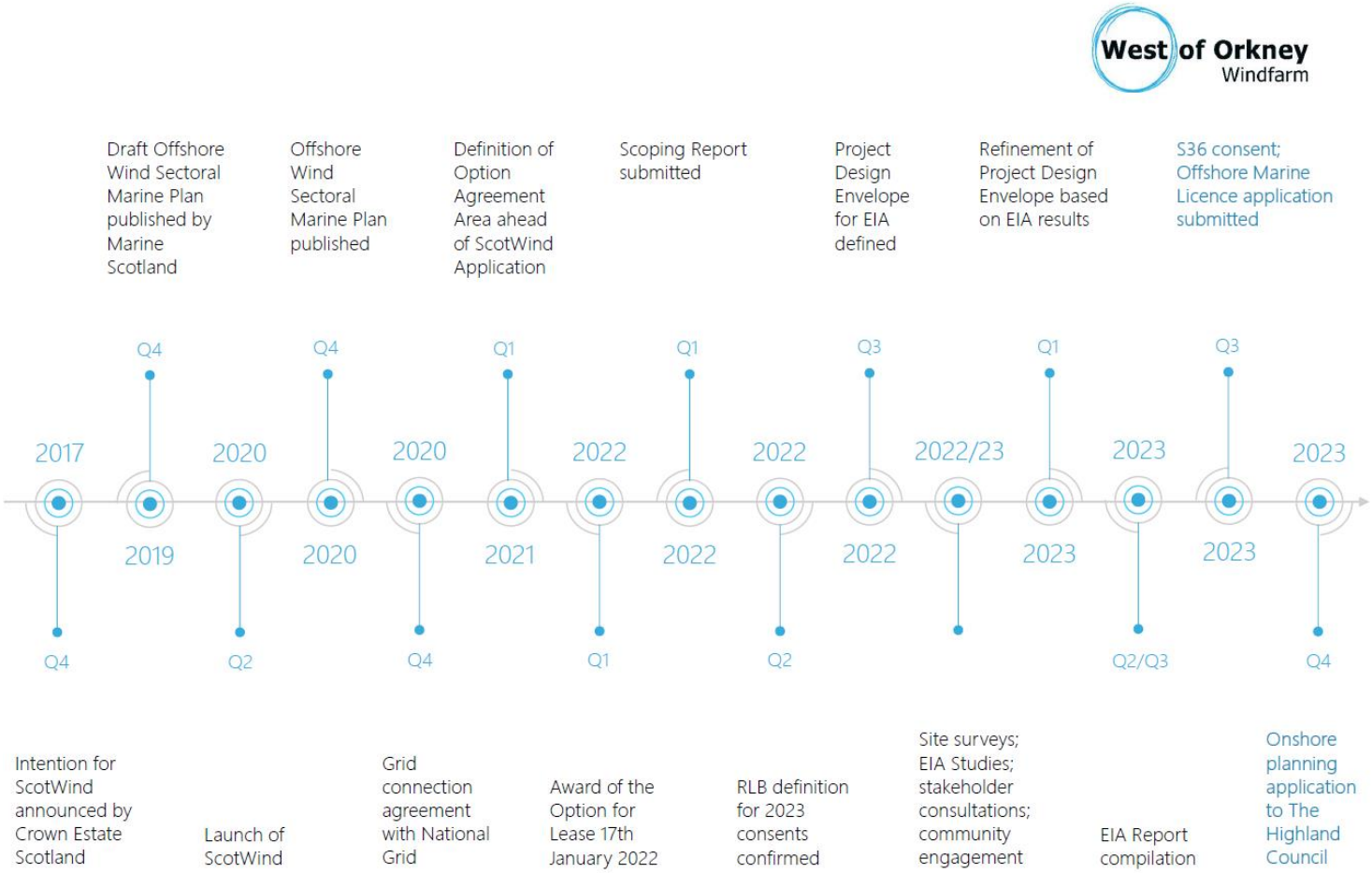


Figure 4-1 The Project site selection process and refinement of Project design

4.4 Sectoral Marine Plan and ScotWind

In November 2017, Crown Estate Scotland (CES) announced their intention to run a leasing round for commercial scale offshore wind energy projects in Scottish Waters. This round became known as ScotWind and was the first offshore wind leasing round in Scotland for over a decade. This initiative was consistent with the Scottish Energy Strategy which envisaged further offshore wind developments playing a key role in Scotland's future energy mix. To inform the spatial development of this leasing round, Marine Scotland[2], as Planning Authority for Scotland's Seas was required to undertake a planning exercise, in accordance with relevant European Union (EU), UK and Scottish legislation (CES, 2020).

As identified by the Scottish Government, offshore wind has the potential to play a pivotal role in Scotland's energy system over the coming decades. This resulted in the SMP being developed to identify areas suitable for the future development of commercial-scale offshore wind energy in Scotland (Scottish Government, 2020b). The Draft SMP was published in December 2019 and identified 17 Draft Plan Option (DPO) areas. The final plan was published in October 2020 and identified 15 PO areas split across four regions around Scotland, (two of the DPO areas were not progressed).

The SMP process was iterative, informed through stakeholder engagement and evidence from the related social, economic and environmental assessments. Information and consultation feedback was gathered throughout the process and used to support the Scottish Ministers in identifying the POs and policies included in the SMP.

Having identified the N1 PO as their preferred development site, OWPL commenced work to identify the preferred development area, i.e. proposed OAA, within the N1 PO. Selection of the OAA and proposed offshore Export Cable Corridor (ECC) route options were an important step in the preparation of the ScotWind bid application and considerable work was done ahead of the bid application to define these areas. Further details of the constraints analysis process which was used to determine the OAA and ECC are available in the Offshore EIA Report, chapter 4: site selection and alternatives.

4.5 Onshore site selection

The process of selecting the onshore site was an iterative process, influenced by the grid connection location. In August 2019, OWPL received a grid connection offer from the National Grid, with a potential connection in Caithness on mainland Scotland. This was the main driver for the selection of landfall options and onshore cable route options. In November 2020, this offer was refined and it was indicated the grid connection would be "at or near Spittal".

Ahead of the ScotWind bid application, considerable work was undertaken to define potential onshore cable routes and substation location. The Project Geographic Information System (GIS) database which contains over 1,000 layers of technical and environmental data, consultation with local stakeholders, desk-based studies and Project specific surveys informed selection and refinement of the onshore Project areas.

The following sections detail the processes by which the cable landfalls, cable route corridor and substation areas of search have been identified and refined.

[2] *Now the Marine Directorate.*

4.5.1 Landfall

The landfall represents the location where the offshore export cables will be brought ashore, the interface between the offshore and onshore Project infrastructure. An initial cable routing study was commissioned (OWC, 2021), which identified six cable landfall options along the north coast of Caithness and a number of associated offshore routes between the OAA and the potential landfall options. These offshore cable route and landfall options (some landfalls with multiple options), together with key technical and environmental constraints associated with each route are summarised in Figure 4-2 and detailed in the following tables. The criteria used to inform the assessment are summarised below:

The environmental constraints analysis criteria:

Low - Lowest / most preferred option;
Low to moderate - No significant consenting risk – with the use of best practice approaches;
Moderate - Potential for consenting risk, but mitigation measures anticipated to reduce risk appropriately;
High – High chance of consenting risk, potential to require design changes and mitigation; risk of stakeholder objection; and
Very high – Very high chance the Project will not be consented.

The technical criteria used a scored risk assessment matrix. Consequences to personnel, programme, assets and reputation were assigned a score from 1 – 5 based on the severity of the potential impact from the technical criteria (ranging from slight (1), minor (2), moderate (3), major (4) and severe (5)). In a similar manner, the probability of the consequence occurring ranged from remote (1), very unlikely (2), unlikely (3), likely (4) and very likely (5). When considering each technical aspect, the potential consequence score and the probability score were multiplied to give the overall ranking. Colours have been assigned to the respective technical criteria rankings based on:

Low risk – a score of 1 -5
Medium risk - a score of 5 – 15; and
High risk – a score of 15 – 25.

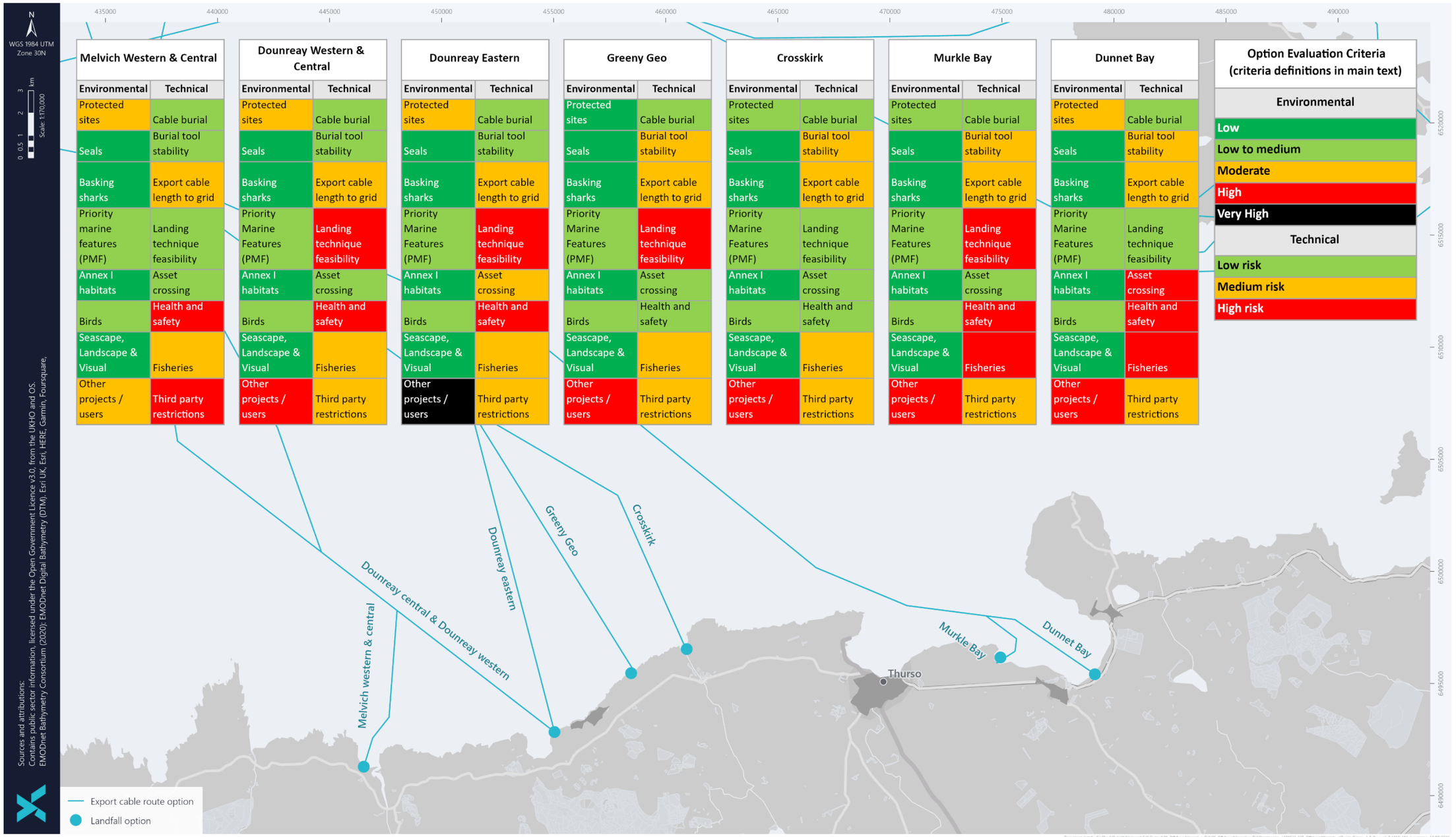
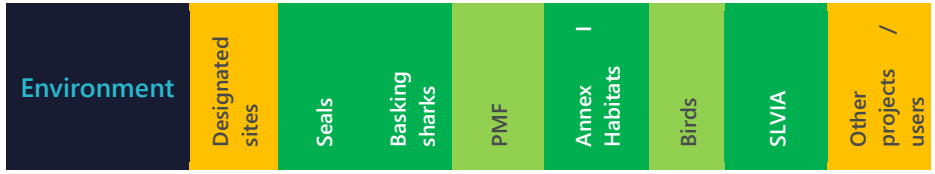


Figure 4-2 Technical and environmental constraints associated with the offshore cable routes and landfall options - details behind ranking for each constraint and route in following tables

MELVICH: WESTERN AND CENTRAL ROUTES

Key Technical Risks

- Potential presence of ammunitions from the Caithness Firing Range;
- Mostly feasible for cable burial and burial tool suitability, possible risk of reduced performance of burial tool due to dense sand and gravelly sediments;
- Shortest offshore export cable to landfall (32.3 Kilometre (km)); the longest onshore cable to grid connection (30 km);
- Moderate to high density of fishing activity along the cable route; and
- No third-party cable crossings.



Key Environmental Constraints

- This landfall is in close proximity to the North Caithness Cliffs Special Protection Area (SPA) and Strathy Point Site of Special Scientific Interest (SSSI). Designated features of these sites include bird and sensitive habitats which could be disturbed or damaged as a result of cable installation activities;
- The landfall overlaps a Special Landscape Area (SLA), however the visual impacts of the cable installation will be temporary and not considered to be a significant risk;
- Close proximity to the Pentland Floating Offshore Windfarm (PFOWF). Due to this proximity, there is potential for cumulative impacts to arise from this landfall location; and
- Based on the information available at the time of the routing desk study, there were no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, Priority Marine Features (PMFs), Annex I habitats, and birds.

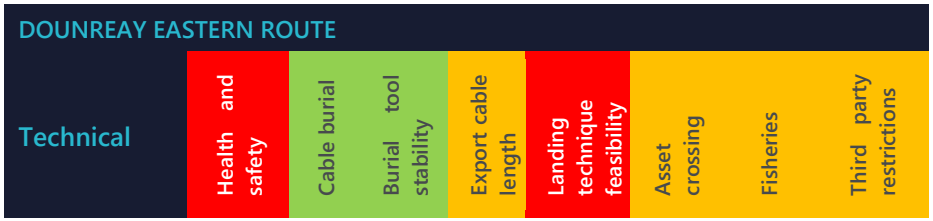
DOUNREAY: WESTERN AND CENTRAL ROUTES

Key Technical Risks

- Installation in a contaminated area approaching Dounreay landfall;
- Mostly feasible for cable burial and burial tool suitability, possible risk of reduced performance of burial tool due to gravelly sand, sand and dense sand;
- Slightly longer offshore export cable to landfall (32.5 km central; 33.9 km western route); and slightly longer onshore export cable to grid connection (25 km);
- No third-party cable crossings required. However, cable route coincides with PFOWF export corridor; and
- Moderate to high density of fishing activity along the cable route.

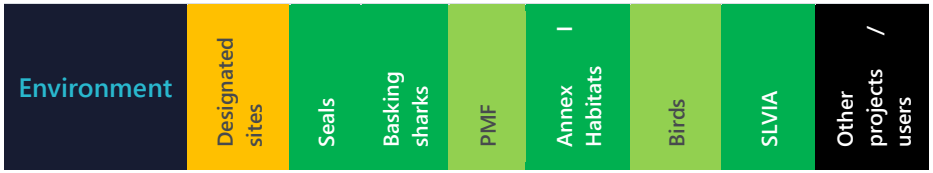
Key Environmental Constraints

- Landfall in close proximity to the North Caithness Cliffs SPA and Strathy Point SSSI. Designated features of these sites include bird and sensitive habitats which could be disturbed or damaged as a result of cable installation activities;
- Projects in the vicinity of this landfall include: PFOWF (overlaps) and the proposed Scottish Hydro Electric Transmission plc (SHET-L) Caithness to Orkney High Voltage Alternating Current (HVAC) Link (overlap). Due to this proximity, there is potential for cumulative impacts;
- High number of other projects in this area also presents lack of space for development immediately adjacent to this landfall; and
- Based on the information available at the time of the routing desk study, there were no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I habitats, birds and Seascape, Landscape, and Visual Impact Assessment (SLVIA).



Key Technical Risks

- Installation in a contaminated area approaching Dounreay landfall;
- Mostly feasible for cable burial and burial tool suitability;
- Slightly longer offshore export cable to landfall (33.5 km); slightly longer onshore export cable to achieve grid connection (25 km);
- Moderate to high density of fishing activity along the cable route; and
- One potential future third-party cable crossing will be required. Route coincides with PFOWF export corridor.

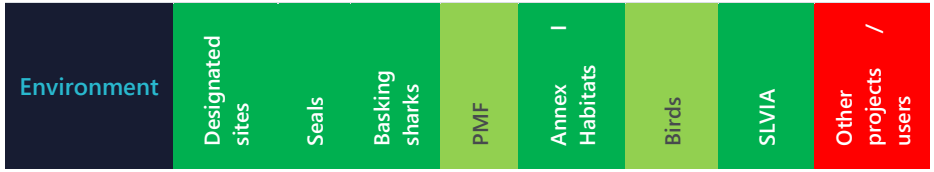


Key Environmental Constraints

- Landfall in close proximity to the North Caithness Cliffs SPA and Strathy Point SSSI. Designated features of these sites include bird and sensitive habitats which could be disturbed or damaged as a result of cable installation activities;
- Projects in the vicinity of this landfall include: PFOWF (large portion of this Project overlaps) and the proposed SHET-L Caithness to Orkney HVAC Link (significant overlap). Due to this proximity, there is potential for cumulative impacts;
- Number of other projects presents lack of space for development at this landfall; and
- Based on the information available at the time of the routing desk study, no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I habitats, birds and SLVIA.

Key Technical Risks

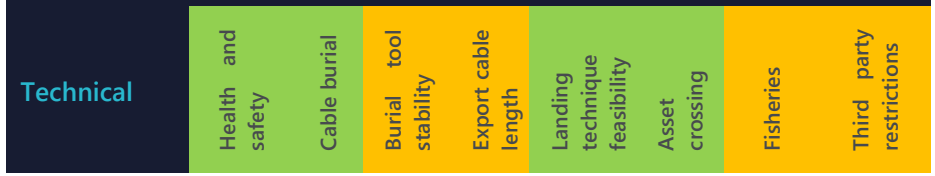
- No health and safety risks identified in the installation corridor;
- Mostly feasible route, possible complexities in rock area approaching landfall;
- Likely feasible for most of route, potential difficulties penetrating gravelly sediments;
- Slightly longer offshore export cable to landfall (32.3 km) and reasonable onshore export cable length to grid connection (22 km);
- Horizontal Directional Drilling (HDD) only feasible option;
- One potential future third-party cable crossing will be required;
- Moderate to high density of fishing activity along the cable route; and
- Cable route will cross the SHET-L Caithness to Orkney HVAV Link.



Key Environmental Constraints

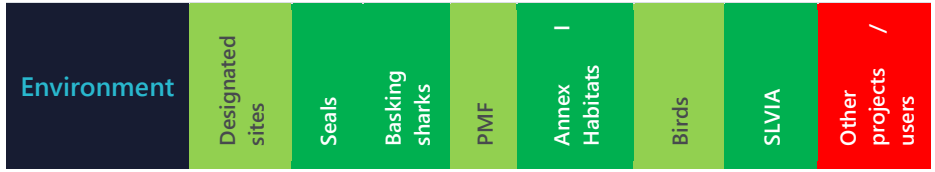
- Landfall located approximately 3.6 km from North Caithness Cliffs SPA and 2.6 km from Ushat Head SSSI. Due to these separation distances, impacts from cable laying activities will be absent / minimal compared to other landfall options;
- Projects in the vicinity of this landfall include: PFOWF and the proposed SHET-L Caithness to Orkney HVAC Link (overlaps). Due to this proximity, there is potential for cumulative impacts;
- Developments at this landfall will require a crossing agreement; and
- Based on the information available at the time of the routing desk study, no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I Habitats, Birds and SLVIA.

CROSSKIRK ROUTE



Key Technical Risks

- No health and safety risks identified in the installation corridor;
- Mostly feasible for burial, possible complexities in rock area approaching the landfall;
- Likely feasible for most of route, potential difficulties penetrating gravelly sediments;
- Slightly longer offshore export cable to landfall (34.2 km) and reasonable onshore export cable length to achieve grid connection (20 km);
- Potential to employ more than one cable landing technique;
- One potential future third-party cable crossing will be required;
- Moderate to high density of fishing activity along the cable route; and
- Cable route will cross the SHET-L Caithness – Orkney HVAC Link.



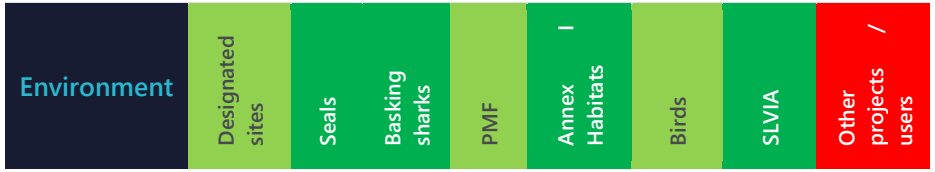
Key Environmental Constraints

- This landfall is directly adjacent to Ushat Head SSSI. Protected features of this site may be disturbed as a result of installation activities;
- Projects in the vicinity of this landfall include: PFOWF and the proposed SHET-L Caithness to Orkney HVAC Link (overlaps). Due to this proximity, there is potential for cumulative impacts;
- Developments at this landfall will require a crossing agreement; and
- Based on the information available at the time of the routing desk study, no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I Habitats, Birds and SLVIA.

MURKLE BAY ROUTE

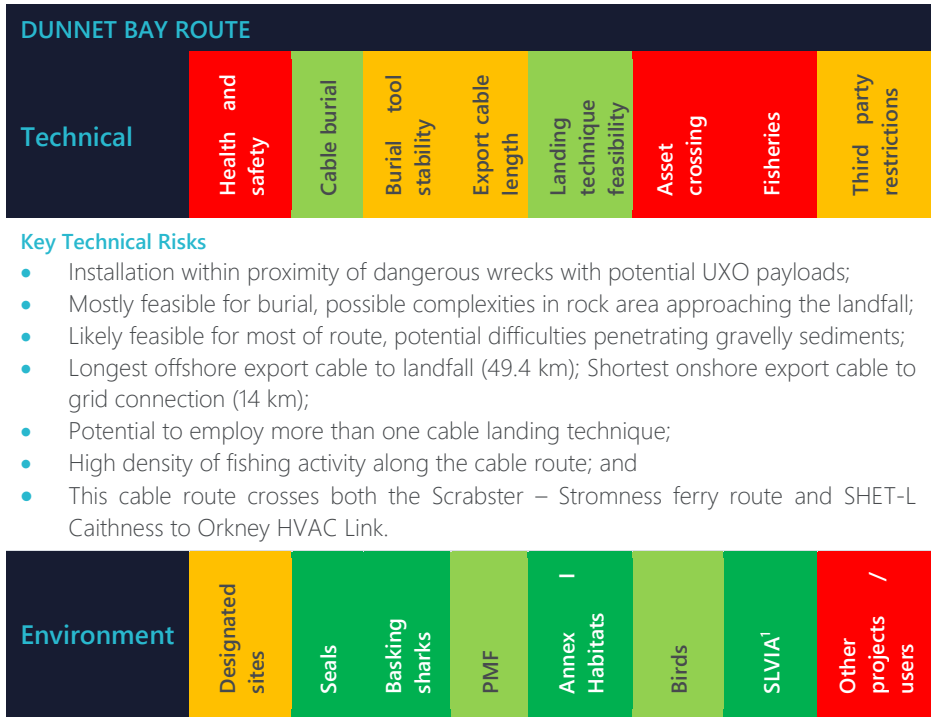
Key Technical Risks

- Installation within proximity of dangerous wrecks with potential Unexploded Ordinance (UXO) payloads;
- Mostly feasible for burial, possible complexities in rock area approaching landfall;
- Likely feasible for most of route, potential difficulties penetrating gravelly sediments;
- Second longest offshore export cable to landfall (46.8 km); Shortest onshore export cable to achieve grid connection (14 km);
- Only one landing technique feasible at Murkle Bay;
- High density of fishing activity along the cable route; and
- This cable route crosses both the Scrabster – Stromness ferry route and Orkney – Caithness Interconnector crossing.



Key Environmental Constraints

- Landfalls route approach passes through the North Caithness Cliffs SPA. While there might be some disturbance to protected species, it is expected to be of a lesser scale;
- Projects in the vicinity of this landfall include: three in-service and one out of service cables served by these routes and the proposed SHET-L Caithness to Orkney HVAC Link. Due to this proximity, there is potential for cumulative impacts dependant on Project timing;
- Developments at this landfall will require a crossing agreement; and
- Based on the information available at the time of the routing desk study, no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I habitats, birds and SLVIA.



Key Technical Risks

- Installation within proximity of dangerous wrecks with potential UXO payloads;
- Mostly feasible for burial, possible complexities in rock area approaching the landfall;
- Likely feasible for most of route, potential difficulties penetrating gravelly sediments;
- Longest offshore export cable to landfall (49.4 km); Shortest onshore export cable to grid connection (14 km);
- Potential to employ more than one cable landing technique;
- High density of fishing activity along the cable route; and
- This cable route crosses both the Scrabster – Stromness ferry route and SHET-L Caithness to Orkney HVAC Link.

Key Environmental Constraints

- Landfall within close proximity of the North Caithness Cliffs SPA and Strathy Point SSSI. Designated features include birds and sensitive habitats which could be disturbed or damaged as a result of cable laying activities;
- Dunnet Bay overlaps with a Special Landscape Area, however the visual impacts of the cable installation will be temporary and not considered a significant risk;
- Projects in the vicinity of this landfall: three in service and one out of service cable and the proposed SHET-L Caithness to Orkney HVAC Link. Due to proximity, potential for cumulative impacts dependant on Project timing;
- Developments at this landfall will require a crossing agreement; and
- Based on the information available at the time of the routing desk study, no significant distinguishing characteristics with respect to the following constraints: seals, basking sharks, PMFs, Annex I habitats, and birds.

Ahead of the ScotWind bid application, following the desk-based study as presented above, the Dunnet Bay and Murkle Bay landfalls and associated offshore routes were discounted. These routes posed a high technical risk, as both landfall locations:

- Required additional cable length;
- Required a number of cable crossing agreements with third parties;
- Had natural geohazards present, and
- Required mitigation due to the proximity to ferry routes.

The routes were also found to pose a moderate to high offshore consenting risk due to:

- Commercial fisheries – higher density of fishing recorded along the offshore route, compared to the other route options;
- Shipping and navigation – shipping in the vicinity of the route due to a high number of shipping and navigation features; high levels of vessel tracks and the Orkney-Scrabster passenger ferry; and
- Other projects and cables – due to other nearby projects and cables, there was a potential for cumulative impacts as a result of installation activities and cable crossing agreements would have needed to be agreed.

At the point of ScotWind award the following landfall options remained, and were the subject of the Scoping Report:

- Melvich;
- Dounreay;
- Greeny Geo; and
- Crosskirk.

Following scoping, there was further consideration of the technical and environmental constraints associated with the onshore cable route options, including the engagement of a land agent. This work led to the Melvich and Dounreay landfall options being discounted for the following reasons:

- Melvich – This was the longest proposed onshore route between cable landfall and connection to the grid at or near Spittal. There are also some very constrained areas along the route e.g., around the Reay village and golf course, which were considered too high risk for the Project; and
- Dounreay – This landfall was very constrained due to a number of future consented and potential projects in and around Dounreay including:
  - The Pentland Offshore Floating Windfarm (PFOWF), its offshore export cables and associated onshore infrastructure;
  - The consented SHET-L Caithness to Orkney High Voltage Alternating Current (HVAC) Link and associated onshore infrastructure; and
  - Other future developments.

Following the elimination of the above landfall options, Crosskirk and Greeny Geo were retained as the final two potential landfall options for the Project. At this time, there will be no further refinement of the landfall locations as engineering surveys and studies and land access negotiations are ongoing. It is currently anticipated that the five offshore export cables may landfall into a single location at either Crosskirk or Greeny Geo. However, if constrained, the offshore export cables will be split across these two landfall options.

4.5.2 Onshore cable corridor

The onshore export cable corridor is the area where the underground export cables will be installed. The main drivers for the selection of the corridor were the landfall options and the location at which the Project will connect to the grid. Alongside the identification of the potential offshore ECCs and associated landfalls (as described above), an onshore cable routing study was progressed. This assessment informed the offshore routing and landfall study and considered potential cable routes associated with the original six landfall options, as shown in Figure 4-3.

Technical constraints considered as part of this study included:

- Roads;
- Utilities;
- Ground conditions;
- Watercourses; and
- Planning consents including windfarms.

Environmental constraints included:

- Forestry and woodland – habitat map of Scotland: areas of woodland and ancient woodland;
- Protected sites – Special Area of Conservation (SAC), SPAs, Ramsar, SSSIs and Geological Conservation Review (GCR) sites;
- Landscape designations – Special Landscape Area (SLAs), National Scenic Areas (NSAs) and Wild Land Areas (WLAs);
- Cultural heritage – scheduled monuments and listed buildings; and
- Tourism and recreation – core paths, cycle ways and tourist attractions.

Due to the constraints presented above (section 4.5.1), the assessment resulted in the removal of the Dunnet Bay and Murkle Bay offshore cable route options and subsequent onshore export cable route options ahead of ScotWind application. The remaining four landfalls remained as the subject of the Scoping Report. Following submission of the Scoping Report, there was further consideration of the technical and environmental constraints (as discussed in Section 4.5.1) which led to the discounting of the Melvich and Dounreay landfall options.

The remaining landfall options of Crosskirk and Greeny Geo were subject to further refinement ahead of definition of the Red Line Boundary (RLB) for the onshore Planning Permission in Principle (PPP) Application. With the potential corridors sketched on an Ordnance Survey map, a walkover visual survey was conducted alongside further desktop study. This work considered:

- The shortest and most economical route;
- Topography;
- Land use;
- Ground conditions;
- Hydrogeological aspects and impacts;
- Environmental constraints and potential impacts;
- Existing infrastructure and building; and
- Securing access arrangements.

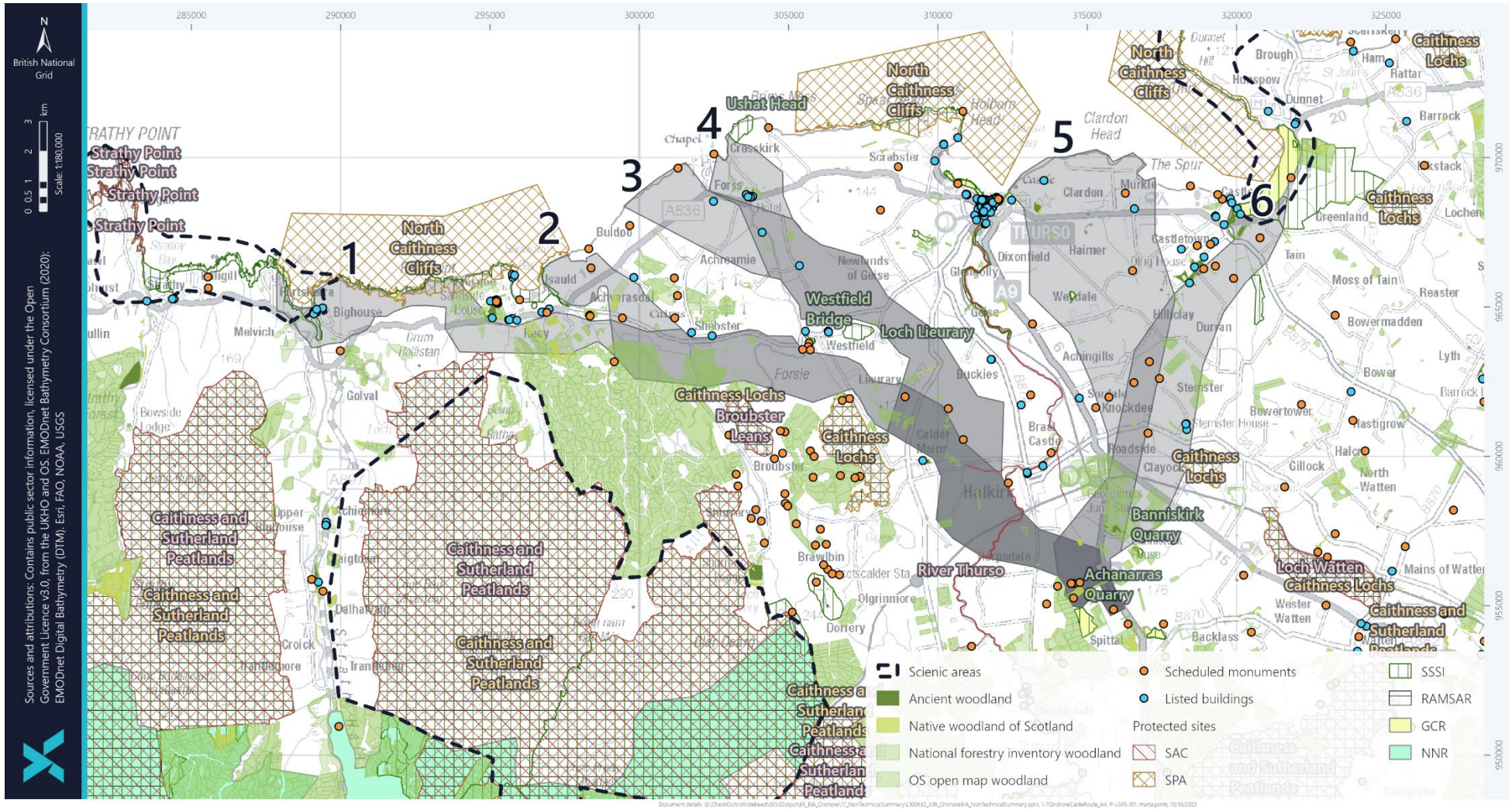


Figure 4-3 Onshore environmental constraints for the initial potential landfalls

The proposed onshore cable route options, known as the onshore Project area, are shown in Figure 4-3. The area includes a 500 m buffer to potential route centrelines to allow for future route refinement, with a wider 1 km buffer used in areas with a higher degree of uncertainty, such as river and railway line crossings where HDD will be required.

The topography of the area of search formed a key part of the corridor route selection, with the preferences for the route to avoid slopes where possible. In the initial absence of site investigation data, the visual walkover of the route confirmed the presence of rock at shallow depths across significant lengths of the route and the presence of quarries. The cable corridor route attempts to minimise, although it is not possible to completely avoid, obvious areas of shallow rock.

An initial reconnaissance onshore ground site investigation was undertaken in 2022, with the aim of obtaining site-specific geotechnical data to inform cable engineering activities including HDD at landfall and river crossings, Transition Joint Bay (TJB) and cable burial activities (Fugro, 2023).

Inputs required prior to cable route finalisation are further ground investigation surveys and agreement on access to land.

4.5.3 Onshore substation

In order to accommodate power from the Project, a new onshore substation to be constructed and operated by SHET-L, is required. SHET-L are in the pre-planning process of determining the new onshore substation (to be known as Spittal 2), location and have identified a number of potential sites, including a preferred location, as detailed in Figure 4-4. OWPL will also be required to construct and operate a separate onshore substation in order to ensure power from the offshore windfarm is grid compliant.

Location considerations for the new SHET-L Spittal 2 substation will be guided by The Horlock Rules (as presented by National Grid (2003)):

- Consideration must be given to environmental issues from the earliest stage to balance the technical benefits and capital cost requirements for new developments against the consequential environmental effects in order to keep adverse effects to a reasonably practicable minimum;
- The siting of new substations, sealing end compounds and line entries should, as far as reasonably practicable, seek to avoid altogether internationally and nationally designated areas of the highest amenity, cultural or scientific value by the overall planning of the system connections;
- Areas of local amenity value, important existing habitats and landscape features including ancient woodland, historic hedgerows, surface and ground water sources and nature conservation areas should be protected as far as reasonably practicable;
- The siting of substations, extensions and associated proposals should take advantage of the screening provided by land form and existing features and the potential use of site layout and levels to keep intrusion into surrounding areas to a reasonably practicable minimum;
- Any proposals should keep the visual, noise and other environmental effects to a reasonably practicable minimum;
- The land use effects of the proposal should be considered when planning the siting of substations or extensions;
- In the design of new substations or line entries, early consideration should be given to the options available for terminal towers, equipment, buildings and ancillary development appropriate to individual locations, seeking to keep effects to a reasonably practicable minimum;

- Space should be used effectively to limit the area required for development consistent with appropriate mitigation measures and to minimise the adverse effects on existing land use and rights of way, whilst also having regard to future extension of the substation; and
- The design of access roads, perimeter fencing, earth shaping, planting and ancillary development should form an integral part of the site layout and design to fit in with the surroundings.

With the Horlock Rules in mind, OWPL undertook a screening exercise to identify a suitable location for their onshore substation. As part of this screening exercise, the following criteria were considered:

Avoidance of the following land-types and land use areas:

- Heather moor;
- Blanket bog;
- Peatland;
- Woodlands;
- Wetlands;
- Quarries;
- Urban areas, factories; and
- Existing and planned windfarms.

In addition to the avoidance of the aforementioned features, the slope of the terrain was also taken into account. Lower areas of slope were considered more opportunistic and areas of steeper slope were considered to be unfavourable. Additionally, buffers were added to the following features:

- Buildings (50 m buffer);
- Large roads (5 m buffer);
- Railways (10 m buffer);
- Surface water areas and high flood risk areas (50 m buffer);
- Environmentally protected sites (250 m buffer); and
- Scheduled monuments and listed buildings (100 m buffer).

An overlay of all the above criteria is shown in Figure 4-4, along with the preferred and non-preferred onshore substation locations as identified by SHET-L (SSEN, 2023). The results of the constraints mapping identified a suitable area of search for the onshore grid substation, as shown in Figure 4-4.

Having identified the area of search for the onshore substation, for the purposes of the EIA, an indicative substation layout was developed. This is described further in the Offshore EIA Report, chapter 5: Project description and chapter 17: Landscape and visual. The construction and presence of the OWPL substation has been assessed in the Onshore EIA Report topic specific chapters appropriate.

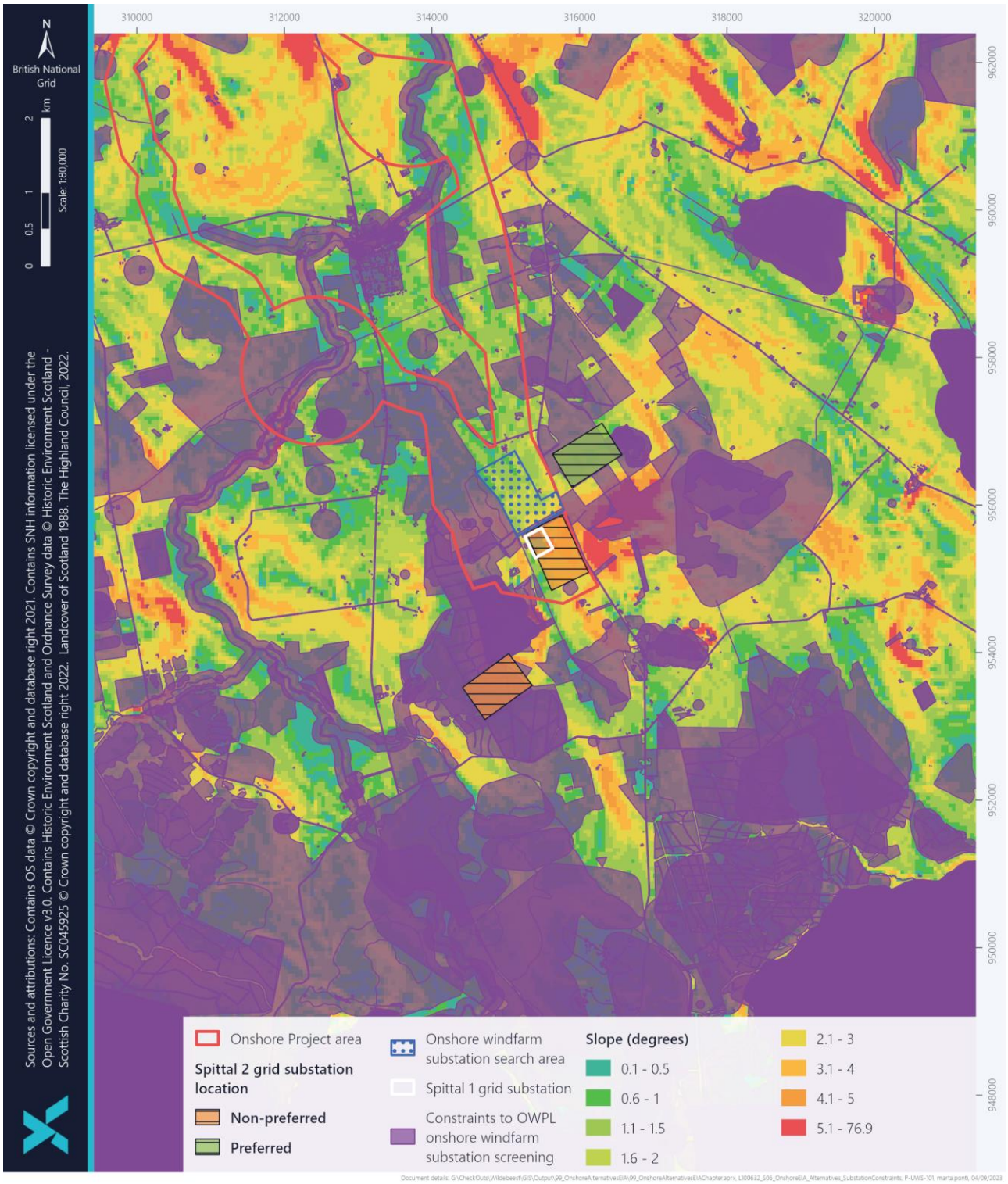


Figure 4-4 Constraints mapping of the OWPL onshore windfarm substation search area

4.6 Red Line Boundary for onshore Application

At the point of RLB definition for the PPP and accompanying EIA, engineering studies and land access negotiations were ongoing, therefore two onshore export cable route options have been retained for the EIA, these are illustrated by the onshore Project area in Figure 4-3.

4.7 Project design alternatives

At the time of production of the Scoping Report (March 2022), the Project had retained a number of options associated with different aspects of the onshore Project design including cable landfall installation techniques and electrical architecture. Since the submission of the Scoping Report, key design decisions have been taken which removed certain design concepts from the Project design envelope, these being:

- Rock pinning and Open Cut Trenching (OCT) landfall installation techniques; and
- Use of High Voltage Direct Current (HVDC) export cables.

The rationale behind these design decisions is provided in the sections below.

4.7.1 Landfall installation techniques

Following identification of the preferred landfall locations, the suitability of rock pinning, OCT and HDD cable installation techniques were considered:

- Rock pinning is the process by which cables are stabilised in areas where the seabed can maintain lateral loads. Rock bolts are used to stabilise subsea cables in rocky areas where trenching is not an option. They are typically installed using divers to ensure that the bolts are drilled into the ground and grouted;
- The OCT method requires the excavation of a trench prior to installation of the cable, and, once installation is complete, the trench is back-filled. The offshore cable can be installed from a cable lay vessel or barge by pulling from a land-based winch assisted by buoyancy aids if necessary; and
- HDD involves drilling a bore hole between two points at a specified depth through which the cable will be installed. These points are called the HDD entry and exit points respectively with the drill rig positioned at the entry point, typically located above the high-water mark at a distance back from the coastline.

A landfall methodology conceptual assessment (OWPL, 2022) indicated rock pinning was an unsuitable technique at both Crosskirk and Greeny Geo, due to the technical difficulties presented by the size of the proposed cables and presence of steep rocky shelves and cliffs in the area. Similarly, OCT was not considered a feasible option for landing locations to the east and west of Crosskirk, or at Greeny Geo, due to low to medium scale cliffs and slumping dunes with an inter-tidal zone of rocky wave-cut platforms which would require significant rock removal. The central part of the Crosskirk landfall would potentially be suitable for OCT. However, large amounts of clearance would be required in terms of parallel cable separation and would result in a significant footprint which was unlikely to be achievable.

HDD installation is technically feasible at both the eastern and western areas of Crosskirk and could also be possible in the central part of Crosskirk, although less preferrable due to potential impacts to St. Mary's chapel and other possible archaeological sites. Similarly, HDD is the preferred method of installation at Greeny Geo with sufficient space available for equipment and access routes.

Due to the geographical features and associated technical risk and spatial requirement, OCT and rock pinning were removed from the Project design envelope and HDD installation only, for both landfalls retained in the Project Design Envelope.

4.7.2 High Voltage Direct Current power export

The use of HVDC can offer a means of transmitting a large amount of power over long distances and offers an alternate solution for connecting power to the grid. HVDC is becoming more important in the energy landscape and is supported by the need for decarbonisation. The use of HVDC can result in a smaller infrastructure footprint for a given amount of power transmitted compared to HVAC. However, HVDC is a much more capitally intensive system when compared to HVAC over shorter distances. In other words, relative losses from HVDC are smaller and HVAC costs (including losses) rise significantly over long distances.

The distance of the offshore Project from shore is at the 'breakeven point' from the tipping point (where HVDC would be advantageous), with regards to operational expenditure losses, and therefore, HVAC is considered the more efficient system overall for the Project. HVAC also offers greater flexibility to incorporate an additional circuit for a future potential connection to Flotta.

The current experience with HVAC solutions is extensive in the UK and the lead time for supply of HVAC solutions is considerably shorter than for HVDC. Based on this, and together with the distance of the Project location offshore, HVAC has been selected as the preferred option.

4.7.3 Project Design Process

The Project's technical team has a structured process for technical decisions, the aims of which are:

- To provide clear justification and documentation of decisions;
- To provide clarity on the timing of decisions;
- To make clear the different options and pros and cons relating to all decisions;
- To ensure all relevant parties are consulted and informed on decisions;
- To ensure decisions consider the full range of aspects (environmental, health and safety etc.) and are not made purely on a technical or cost basis;
- To ensure decisions are made holistically across engineering packages and the wider Project considerations; and
- To ensure the decision-making process is transparent, objective and fair, without room for biases (hence the use of multi-criteria assessment and Levelised Cost of Energy (LCoE) metric).

Two tools are used to inform decision making: (i) a techno-economic model focusing on the LCoE metric which provides a method to assess overall benefits across a Project life and across all design aspects in tandem, and (ii) a Strengths, Weaknesses, Opportunities, Threats (SWOT) multi-criteria assessment that captures considerations from a qualitative perspective and includes technical, commercial, environmental, health and safety and other key criteria which are weighted and scored to provide an indication of the relative merits of different options. The SWOT assessment results and the LCoE analysis are combined to guide decision making towards a balanced solution.

Past and future technical decisions for the Project are documented and approved using a structured Design Decision Log (DDL) which incorporates Construction, Design and Management (CDM) requirements. The following are considered for each engineering design decision:

- Implications for other engineering packages;
- Cost;
- Schedule;
- Supply chain / procurement;
- Environmental;
- Health and safety; and
- Lifecycle (including decommissioning

The DDL details the personnel involved or required to be involved in the decision (to ensure cross-package interactions are factored), any missing information and any residual risks. Each decision has a tangible document for review and approval through the Project's document control system that summarises the key considerations relating to the decision and sets out the evidence and justification for the decision made, along with any additional supporting documents or drawings. For decisions made around the time of the development of the Project Design Envelope for the EIA, a higher-level optioneering style process was employed based on the higher uncertainty and lower availability of data and information. This enabled early screening such as the removal of floating foundation types and HVDC transmission. These decisions did not require a fully holistic optioneering process to be employed due to the strong logic already available to justify the screening process. However, the screening process made use of multi-criteria assessments along with cost considerations. The process undertaken for the Project Design Envelope was an initial screening to rule out non feasible options for the Project in order to provide feasible potential options for consideration within the EIA. All of these decisions are documented in the DDL.

4.8 Summary

Overall, during the site selection and consideration of alternatives for the West of Orkney Windfarm, the Project has endeavoured, where possible to reduce environmental effects through the Project's design and the Project alternatives that have been considered. To date, the Project has:

- Assessed other offshore site alternatives as presented in the SMP produced by Marine Scotland[3] using plan level SEA, HRA, socio-economic impact and island impact assessments, and consultation, to guide PO areas;
- Reduced the offshore site boundary (44% reduction between N1 PO and OAA) in order to reduce impacts to shipping, seascape, landscape and visual, aviation and commercial fisheries receptors;
- Reduced the Project Design Envelope, and associated environmental effects, by the removal of floating foundations, removal of gravity-based structures, the use of HVAC and the selection of HDD as a landfall installation technique. In addition, several Project parameters have since been refined, including, increased lower blade tip clearance and reduction in length of inter-array cables (see chapter 5: Project description);
- Reduced the onshore Project area as far as feasible at the current time avoiding key environmental receptors;
- Developed a strategic method to capture all decisions (past and future) to ensure all possible options are considered and the decision process clearly recorded; and
- The overall aim to provide a secure, low-carbon source of energy to meet the energy demand and support the transition to net zero while meeting the Scottish Government's climate change and renewable energy targets.

[3] *Now Marine Directorate.*

4.9 References

CES (2020). ScotWind Leasing – Launch Summary. 10th June 2020. Available online at: https://www.crownestatescotland.com/resources/documents/scotwind-leasing-launch-summary [Accessed 21/11/2022].

Fugro (2023). West of Orkney Windfarm Onshore Reconnaissance Geotechnical Survey. 10th March 2023. Document reference: F211025-1 02

National Grid (2003). NGC Substations and the Environment: Guidelines on Sitting and Design. Available online at: https://www.nationalgrid.com/sites/default/files/documents/13796-The%20Horlock%20Rules.pdf [Accessed 19/5/2023].

OWC (Offshore Wind Consultants) (2021). Caithness Export Cable Route Feasibility Study Report. 15th February 2021. Document number: OWC-LO-C1633.

OWPL (Offshore Wind Power Limited) (2022). Technical Note: Caithness Export Cable Landing Methodology – Preliminary Conceptual Assessment. Document number: 100-WOW-OFC-A-DN-0002-02

SSEN (Scottish and Southern Electricity Network) (2023). Spittal Consultation - Substation Options figure. Available online at: https://www.ssen-transmission.co.uk/globalassets/projects/projects/new-spittal-area-400kv-substation-downloads/spittal-consultation-substation-options-map-feb-march-23.pdf. [Accessed 22/05/2023].

Scottish Government (2020a). EU Exit: Marine Environmental Legislation in Scotland. Available online at: https://www.gov.scot/publications/eu-exit-marine-environmental-legislation-scotland-2/pages/6/ [Accessed 21/11/2022].

Scottish Government (2020b). Sectoral Marine Plan for Offshore Wind Energy. October 2020. ISBN: 978-1-80004-242-1 (web only). Available online at: https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2020/10/sectoral-marine-plan-offshore-wind-energy/documents/sectoral-marine-plan-offshore-wind-energy/sectoral-marine-plan-offshore-wind-energy/govscot%3Adocument/sectoral-marine-plan-offshore-wind-energy.pdf [Accessed 21/11/2022].

4.10 Abbreviations

ACRONYM	DEFINITION
CDM	Construction, Design and Management
CES	Crown Estate Scotland
DDL	Design Decision Log
DPO	Draft Plan Option
ECC	Export Cable Corridor
EIA	Environmental Impact Assessment
EU	European Union
GCR	Geological Conservation Review
GIS	Geographic Information System
GW	Gigawatts
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
Km	Kilometre
LCoE	Levelised Cost of Energy
m2	Square meters
NSA	National Scenic Areas
OAA	Option Agreement Area
OCT	Open Cut Trenching
OWF	Offshore Windfarm
OWPL	Offshore Wind Power Limited
OWPS	Offshore Wind Policy Statement
PFOWF	Pentland Floating Offshore Windfarm
PMF	Priority Marine Feature

ACRONYM	DEFINITION
PO	Plan Option
PPP	Planning Permission in Principle
RLB	Red Line Boundary
SAC	Special Area of Conservation
SCDS	Supply Chain Development Statement
SEA	Strategic Environmental Assessment
SEIA	Socio-Economic Impact Assessment
SHET-L	Scottish Hydro Electric Transmission Plc
SLA	Special Landscape Area
SLVIA	Seascape, Landscape, and Visual Impact Assessment
SMP	Sectoral Marine Plan
SPA	Special Protection Area
SSEN	Scottish and Southern Electricity Network
SSSI	Site of Special Scientific Interest
SWOT	Strengths, Weaknesses, Opportunities, Threats
TJB	Transition Joint Bay
UK	United Kingdom
UXO	Unexploded Ordinance
WLA	Wild Land Areas

4.11 Glossary

TERM	DEFINITION
Area of search	The area within a range / buffer, that is examined / researched for potential development.
Draft Plan Option	The initial proposed sustainable options for the future development of commercial-scale offshore wind energy in Scotland, as identified by the Scottish Government in the Sectoral Marine Plan for Offshore Wind Energy. The Draft Plan Options were subsequently refined down to the final Plan Options.
Geological Conservation Review sites	Sites that contain geological and geomorphological features of national and international importance and are selected through a process known as the Geological Conservation Review.
National Scenic Area	An area of outstanding scenic value in a national context.
Plan Option	Sustainable options for the future development of commercial-scale offshore wind energy in Scotland, as identified by the Scottish Government in the Sectoral Marine Plan for Offshore Wind Energy.
Ramsar	A wetland site designated to be of international importance under the Ramsar Convention also known as The Convention on Wetlands.
Red Line Boundary	This is the area in which all onshore development works will take place.
ScotWind	The most recent offshore wind leasing round, run by Crown Estate Scotland.
Sectoral Marine Plan	A plan developed by the Scottish Government to identify areas suitable for the future development of commercial-scale offshore wind energy in Scotland.
Special Area of Conservation	High-quality conservation sites in the UK that make a significant contribution to conserving the habitats and species identified in Annexes I and II, respectively, of European Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, known as the Habitats Directive.
Special Landscape Area	Regionally valuable landscapes identified to protect and enhance landscape qualities and promote their enjoyment.
Special Protection Area	Protected areas for birds in the UK selected to protect one or more rare, threatened or vulnerable bird species listed in Annex I of the Birds Directive, or certain regularly occurring migratory species.
Site of Special Scientific Interest	Conservation designation denoting a protected area in the UK. These sites are the basic building block of site-based nature conservation legislation and most other legal nature / geological conservation designations in the UK are based upon them.
Wild Land Area	The most extensive areas of high wildness and are identified as nationally important in Scottish Planning Policy but are not a statutory designation.