Chapter 2: Project Description

Co-financed by the European Union
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NorthConnect KS
Serviceboks 603, Lundsiden
N-4606 Kristiansand
Norway

Phone +47 38 60 70 00
Mail: post@northconnect.no
Web: www.northconnect.no

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2 Project Description

2.1 Introduction

This chapter describes the NorthConnect project proposals, concentrating on the elements which are relevant to the UK consenting process. The chapter covers the needs case for the project, the project components, anticipated activities during construction and operation, and presents a consideration of alternatives to the proposals. As mentioned in Chapter 1, the anticipated life of this project is at least 40 years. At the end of the operational phase the HVDC cables will be appropriately decommissioned.

In addition to this Environmental Impact Assessment Report (EIAR), there are a number of other documents which have been produced to support the planning and marine license applications:

- HVDC Cable Infrastructure – UK Construction Method Statement (NorthConnect, 2018a);
- HVDC Cable Infrastructure – UK Fisheries Liaison Mitigation Action Plan (NorthConnect, 2018b);
- HVDC Cable Infrastructure – UK Marine Communications Strategy (NorthConnect, 2018c);
- HVDC Cable Infrastructure – UK Post Installation Survey Plan (NorthConnect, 2018d); and
- HVDC Cable Infrastructure – Transport Statement (Allen and Gordon, 2018).

The project description provided in this chapter aims to provide sufficient information to support the assessment, not to duplicate the other documents.

2.2 Background

2.2.1 UK Electricity Generation and Transmission System

Within the UK, the National Electricity Transmission System is operated by National Grid Electricity Transmission plc (NGET), who have responsibility for operating a transmission system which provides people with a safe and reliable energy supply. Generated electricity is fed into the transmission system and distributed around the UK as required. Currently, electricity cannot be stored efficiently in large quantities and so it is substantially only generated when required.

Although NGET are system operators (SO) for the whole of the UK, the Scottish transmission system is owned by Scottish Power Energy Networks (SPEN) and Scottish and Southern Energy Networks (SSEN). These are referred to as transmission owners (TO’s) and SSEN are the TO responsible for the network at the location where NorthConnect links to the grid near Peterhead. Any generators/suppliers requiring grid connections in Scotland do so under a regulated agreement with NGET, who work in collaboration with SPEN or SSEN.

The UK power system consists of a mix of different electricity sources. At present, thermal production capacity (burning fossil fuels primarily gas with some coal) and nuclear generation dominates. Wind power, solar power, hydro and bioenergy production are currently the main alternative sources of energy. Their proportion of the electricity mix has grown rapidly over the last 10 years and continues to increase (Ofgem, 2018). Currently, onshore wind accounts for the majority of installed renewables capacity. The overall capacity for hydro and pumped storage hydro is limited in the UK, as most of the suitable sites for large scale hydro have already been developed. The marine energy sector for wave and tidal energies is still largely in the developmental stage. As such, on and offshore wind energy will be the major renewable source for the foreseeable future.

2.2.1.1 Scotland's Renewable Energy Development

In Scotland, there has been a dramatic increase over the last decade in the amount of renewable energy development and connection requirements to the electricity transmission system (Scottish Government, 2017a). This has resulted in planned and on-going large-scale improvements to the grid infrastructure, to expand upon the system's electricity transmission capacity. These improvements have included the strengthening of the existing transmission infrastructure (e.g. Dounreay to Beauly) and installation of new sections of overhead line and underground cabling (e.g. Beauly to Denny). In addition, subsea cables are required to strengthen the system including the Western Subsea HVDC project (linking Scotland to England), Caithness-Moray HVDC, Kintyre-Hunterston HVAC and links from the Western Isles, Orkney and Shetland to the UK mainland grid.

With changes in generation to more renewable sources, and the consequential change in the location of generation capacity to areas with good renewable resources, major network changes are required.

2.2.2 Norwegian Electricity Generation and Transmission System

The Norwegian power market is dominated by hydro power (approximately 96%) (NVE, 2016). A large proportion of the hydro capacity is associated with reservoirs, providing flexibility by being able to store energy until it is required. This is known as in-line or flexible storage (Norway has hardly any pumped storage capacity). This large degree of flexible production enables suppliers to quickly and cheaply follow the demand, both in the short (minute-hourly) and medium (seasonal) terms. However, reservoir capacity is finite, meaning that reservoir levels, hydro generation and its flexibility, are strongly influenced by rainfall. Currently, Norway is typically a net exporter of electricity. In the future, the surplus of electrical energy in Norway is predicted to become even higher. In cases of an extremely dry year, or in long winters, Norway may need to import electricity.

The Norwegian power system is well connected with the other Scandinavian/Nordic power systems, both physically and as a single trading market. From this connectivity, the Norwegian grid can access northern European grids and markets. The neighbouring countries have a considerably lower share of hydropower and, therefore, are less flexible. Extensive renewables projects, which will provide a power surplus, are planned for the future in Scandinavian countries.

Norway has an open electricity market, integrated with the other Nordic countries. Export and import is routine over the direct power links to Sweden, Denmark and the Netherlands. The market is handled by NASDAQ OMX Commodities Europe and Nord Pool Spot.

2.3 Needs Case

As long ago as 2002, the European Council set European Union Member States a target of having electricity interconnections equivalent to at least 10% of their (installed production) capacity by 2005. Currently, Great Britain is only half way to meeting this target. In May 2014, as part of its work on European energy security, the European Commission proposed an interconnection target of 15% for 2030. This was adopted by the European Council in its 23 October 2014 conclusions on the European Union's 2030 Climate and Energy Policy Framework (European Commission, 2014).

The European Union (EU) has set the target that 20% of Europe's energy requirements will be met by renewable sources by 2020 in the European Parliament Directive 2009/28/EC (European Parliament, 2009). The Scottish Government aims to exceed this target and is looking to achieve 100% of the demand within Scotland (gross consumption) for electricity being met from renewable sources by

2020 (Scottish Government, 2016). The Scottish Government set an interim target of 50% by 2015, which was achieved. 54% of gross energy consumption was sourced from renewables in 2016 (Scottish Government, 2017b). Hence Scotland is on track to meet the 2020 target. Further to this, Scotland continues to be a net exporter of electricity, exporting 29% of generation to other parts of the UK in 2016 (Scottish Government, 2017a). The Scottish Government updated its energy strategy at the end of 2017 (Scottish Government, 2017c). The Scottish Energy Strategy set two new targets for the Scottish energy system to achieve by 2030:

- The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources; and
- An increase by 30% in the productivity of energy use across the Scottish economy.

In 2015 the equivalent of 17.8% of Scotland's heat, transport and electricity consumption was supplied by renewables. An increase of 32.2% in 15 years demonstrates the scale of the Scottish Government's ambition (Scottish Government, 2017c).

The 2017 Scottish Energy Strategy also lays out a vision for 2050, which includes six priorities, one of which is renewable and low carbon solutions in which the Scottish Government stated their intention to continue to champion Scotland's huge renewable energy resource (Scottish Government, 2017c). Another priority is System Security and Flexibility, which highlights the requirement for Scotland's energy capacity to be flexible and resilient to maintain secure and reliable supplies of energy. Scotland's energy security can be enhanced while maintaining its ability to export and import energy through the interconnection between power markets and networks using interconnectors. The importance of interconnectors in improving Scotland's energy security is highlighted in the strategy, by referring to the likely energy security and consumer benefits posed by the NorthConnect project, which provides access to alternative sources of renewables (Scottish Government, 2017c).

The 2012 Electricity Networks Strategy Group (ENSG) Report (ENSG, 2012) sets out a view of how the UK electricity transmission system needs to be reinforced to help meet these renewables targets for 2020. The electricity generation portfolio will move from the traditionally more predictable energy generation provided by coal / gas fired power stations and hydro, towards an increasing proportion from renewable sources. Consequently, the predictability in generation capacity will reduce. Investment in greater renewable capacity will therefore lead to a rise in demand for reserve generation capacity to supply the grid during periods when windfarms cannot meet demand.

Adjusting power production according to consumption by using a standby thermal plant or similar is costly and fluctuating consumption/supply leads to fluctuating prices. In periods with low consumption and high wind power production, there will be low prices. In periods with high consumption and low wind there will be a need to activate thermal units with high marginal costs, therefore, wholesale prices will be considerably higher. Providing alternative methods of balancing this system, and so stabilising prices, will be a key factor in the success of the UK's move to a low carbon power system.

The Scottish Government published the Electricity Generation Policy Statement (EGPS) 2013 (Scottish Government, 2013). This examines the way in which Scotland generates electricity, considers the changes which will be necessary to meet the targets which the Scottish Government has established, and reflects both views from industry and other stakeholders regarding developments in UK and EU electricity policy. It looks at the sources from which that electricity is produced, the amount of electricity which is utilised in Scotland and the technological and infrastructural advances and requirements which Scotland will require over the coming decade and beyond. The EGPS states:

> *"Scotland's renewables potential is such that, should the relevant technologies be developed successfully, it could deliver up to £46bn of investment and be much more than enough to meet domestic demand for electricity. The remainder could be exported to the rest of the UK and continental Europe to assist other countries in meeting their binding renewable electricity targets".* (Scottish Government, 2013).

Significant new investment will be needed both in electricity generation capacity and in the associated transmission infrastructure to facilitate the renewable goals. The transmission infrastructure will need to be improved to both deliver electricity across Scotland and to access the other markets which offer electricity generated from renewable sources.

Moving to an increased dependency on renewable electricity sources presents Scotland with a number of challenges. Windfarm productivity is dependent on when the wind blows and the wind speed, while demand for electricity varies with time of day and the time of year. In order to secure supply, especially during peak demand, the electricity transmission grid needs to be able to access power sources quickly. Thermal power generation sources (fossil fuels), mostly gas and diesel, have traditionally been used because of their ability to respond to these changes in demand quickly. The renewable option to meet future security of supply requirements may be to increase access to hydro generation because it has the same fast response time as thermal power to meet peaks in electricity demand.

The NorthConnect project proposes to provide a link between the electricity grids of Scotland and Norway. By linking wind and hydro generation resources between the two countries, NorthConnect will strengthen the security of power supply for consumers in both Scotland and Norway and will support the achievement of Scottish, Scandinavian and European renewable energy targets.

There are three key drivers associated with the NorthConnect project:

- **Security of Supply*:*** Linking the Scottish and Norwegian networks will support energy security in both regions, compensating for fluctuations when future Scottish energy demand is met by a higher proportion of wind energy. The link will also compensate for low Norwegian precipitation and low hydro storage levels, enhancing the electricity transmission infrastructure for both countries;
- **Green Battery*:*** Wind power is subject to fluctuations in production. These fluctuations make a 'Green Battery' energy storage approach attractive to ensure renewable power is available for consumers when the wind is not blowing. About half of Europe's reservoir capacity lies in Norway which also has good potential for energy storage, to provide on demand renewable electricity and the long-term realisation of a low carbon electricity supply for Europe; and
- **Reduced Price Fluctuations*:*** The project will stabilise electricity prices in the UK and Norwegian markets by leading to increased power exchange and competition in European energy markets.

In achieving this, NorthConnect will address three key cycles of power supply and demand between the two countries:

- Daily fluctuations for storage of night-time renewable generation and supplementing day-time peak demand;
- Seasonal variations with wetter winters, drier summers and possible icing up of Norwegian hydro in some years; and
- Non-seasonal weather cycles: the wind – hydro relationship that can help to balance generation and demand dependent upon weather conditions.

In parallel with this, there is emerging international cooperation in the European energy sector and the clear political goal of linking the European power systems closer together. NorthConnect will be a means to connect the two complementary and hitherto disconnected power systems of Scotland and Norway. It will provide reserve capacity to help balance the grid and will allow wider trading across Europe. The energy needs, financial and environmental drivers for interconnection are valid irrespective of the UK's changing status in the European Union.

There are additional benefits to the transmission system also. According to National Grid's assessment of Benefits of Interconnectors to Great Britain's Transmission System 2014 (National Grid, 2014), additional ancillary services that interconnectors will provide to the UK grid and consumers are:

- **Frequency response and reserve***:* The ability to address real-time frequency imbalances which demand, and generation impose on the grid system;
- **Black Start capability***:* The capability to be started quickly in a grid blackout situation in a coordinated and controllable way which enables the national grid to be brought back on line;
- **Reactive Power Reserve***:* Allows voltage control across the localised grid network due to the type of technology used for the HVDC link; and
- **Boundary Capability & Constraint Management***:* In certain market conditions, the ability to relieve constraints on the Scottish grid by exporting power to the Nordic region.

The Department of Energy and Climate Change (DECC) UK have undertaken studies which show that up to 4 gigawatt (GW) of interconnection (NorthConnect's capacity is 1.4GW) with the hydro-focussed areas of Europe would be beneficial for consumer and provide an economic boost of up to £2.5bn (DECC, 2013). NorthConnect also provides a significant socioeconomic benefit, in terms of electricity cost savings, and details of this are provided in Chapter 21: Local Community and Economy.

2.4 Consideration of Alternatives

NorthConnect have considered alternatives at every stage of the design process. Initially to identify the UK best landing point (NorthConnect, 2011), then to provide a specific location for the UK converter station, landfall point and onshore cable routing (NorthConnect, 2014). Alternative landfall locations and converter station sites in Norway were also considered. Potential cable route options across the North Sea between the two landfall points have been considered, with greater resolution provided with each step of the process (Xodus, 2012, 2015).

This section details the consideration of alternatives completed to achieve the current design.

2.4.1 UK Landfall Selection and Subsea DC Cable Routing

A preliminary study was undertaken for this project looking at the key aspects that will affect the design and viability of the scheme. A key objective of the study was to identify potential landfall options within the UK and assess these to identify a preferred option. Options were assessed against the following:

- Sub-sea and overland route requirements;
- Environmental assessment including permitting aspects;
- Technical implications of both grid connections and system configuration;
- Cost and economic appraisal;
- Option risk and particularly UK north / south revenue, tariff and underwriting risks; and
- Outline programming durations for development and construction.

This assessment first identified the preferred landfall zones adjacent to a suitable grid connection point and then undertook a review of the local options with regard to a specific landing point within the selected zones.

From an initial list of 25 potential options a screening study was undertaken that identified five potential options that were targets of more detailed appraisal. These five options were:

- Peterhead in Aberdeenshire;
- Cockenzie on the Forth Estuary;
- Hawthorn Pit in County Durham;
- Creyke Beck on Humberside; and
- A variation on Creyke Beck for routeing via the planned Round 3 Dogger Bank offshore wind farms.

The proposed locations are shown in Figure 2.1.

Figure 2.1 Straight Line Routes for Landing Point UK Options.

To undertake the assessment to select the preferred option, a weighting and scoring system was applied to each of the assessment factors. A workshop approach was taken to deploy this methodology and went through a process of assessing each option. Details of the assessment process and scoring are present in the NorthConnect Strategic Options Appraisal report (NorthConnect, 2011) and are summarised in Table 2.1.

Table 2.1 Summary of the results from the Regional Review.

Results	Peterhead	Cockenzie	Hawthorn Pit	Creyke Beck	Creyke Beck (Via Dogger)
Total Normalised, Weighted Score	54.4	48.4	48	46	45.6
Total Normalised, Weighted Score Available	66	66	66	66	66
Grand Total (%)	82%	73%	73%	70%	69%
Overall Rank	1	2	3	4	5

Category Results						
Routeing	Weighted Score	8	10	6	4	4
	Rank	2	1	3	4	4
Environmental	Weighted Score	12	8.4	8.4	7.2	6
	Rank	1	2	2	4	5
Technical	Weighted Score	9.6	9.6	9.6	12	12
	Rank	3	3	3	1	1
Cost	Weighted Score	12	9.6	9.6	7.2	9.6
	Rank	1	2	2	5	2
Risk	Weighted Score	4.8	6	9.6	10.8	10.8
	Rank	5	4	3	1	1
Programme	Weighted Score	8	4.8	4.8	4.8	3.2
	Rank	1	2	2	2	5

The output from this assessment showed the Peterhead region as clearly the preferred option. Peterhead was ranked first from a cost, economic, environmental and programme perspective. It was therefore taken forward as the preferred option for more detailed landfall and route corridor assessment within this zone.

Following the outcome of this assessment, a Grid Connection Application was made by NorthConnect for a connection point to the National Grid at Peterhead and, after receipt of a connection offer, further assessment was undertaken to identify landfall points in the general area of the substation, which is located to the south west of the port at Peterhead, approximately 1km from the outskirts of the town.

Further information on the surveys and decision-making processes specifically linked to the Interconnector converter station and HVAC cabling can be found in the ES for the NorthConnect Interconnector Converter Station and High Voltage Alternating Current Cable Route (NorthConnect, 2015). The result was that the HVDC cabling needs to connect to the approved convertor station site known as Fourfields, at NK119 412 (Drawing 3022).

2.4.2 Onshore Cabling

The cabling required for the interconnector will comprise of two HVDC cables and one ducted fibre optic cable. The onshore cable routing from the Fourfields convertor station to the subsea cabling connection at the shoreline considers the following principles:

- Where practicable, it should avoid archaeological features;
- Road crossings should be minimised;
- Infrastructure crossings should be minimised;
- The number of landowners affected should be minimised;
- Where practicable, valuable ecological assets should be avoided;

- The route should avoid disturbance to residential properties where possible; and
- The route should not be excessively long.

The decision-making process for this was twofold. Firstly, to decide broadly whether the cables should go from the convertor station to the sea via a northward route to the beach, or a southward route to the cliffs. Secondly, to decide the finer-scale route and exact entry point on land, which then has an exit point at sea.

The broad-scale, initial options for the HDVC onshore cabling route, identified three differing routes for the onshore cabling in a site selection optioneering study (Figure 2.1). The two northward options would take the cables from the converter station to a beach north of Sandford South. One route would cross the A90 further south, and the second would cross the A90 further north (NorthConnect, 2014). A third option was a southward option that would take the cables from the convertor station to an entry point to the sea via a HDD hole by the cliffs south of Boddam (NorthConnect, 2014). The options were assessed against the following:

- Health and Safety;
- Environmental Impact;
- Technical;
- Socio-economic; and
- Commercial.

Figure 2.1 Initial HVDC Routing Options

The results from the initial HVDC onshore cable routing options are presented in Table 2.2.

Table 2.2 Advantages and disadvantages of initial HVDC onshore cable routing options.

Route option	Advantages	Disadvantages	Total weighted score
Sandford Bay south of substation	• Route covers fields with no designated sites, so ecological impacts are of less concern.	• Health and Safety risks associated with working in the intertidal area. • Potential water quality impacts associated with potential pollution incidents during construction in the intertidal area. • Visual impacts of construction as route passes through Sandford Bay and along the A90. • Archaeological disturbance as route could require cutting through a disused railway embankment • 3 gas-line pipes and 2 electric circuit crossings would be required. • Construction access issues.	161/275
Sandford Bay north of substation	• Route covers fields with no designated sites so ecological impacts are of less concern. • No need to cut through the railway embankment so reduced archaeological impact. • No need to cross the two electrical feeds from the power station.	• As above except for the Archaeological disturbance and the electrical feed disturbance, which would not occur.	173/275
Longhaven cliff	• No service crossings identified on the route, minimising interface complexity. • Health and Safety risks lower for the construction period. • Use of HDD would lesson visual impacts during construction period. • Options available to avoid disturbing the disused railway line. • More flexible routing options available. • Shorter cabling route, hence potentially the cheapest of the three options	• Route passes through designated sites.	200/275

It was apparent that neither of the Sandford South routes would be a favourable exit to the sea. As the cliff exit at Longhaven cliffs, with the use of HDD, ranked the highest of the three options, it was taken forward.

A NorthConnect Landfall Option Study was commissioned to identify which location along the Longhaven cliffs would be most suitable. Three possible landfall options along the cliffs were considered: 1. By Longhaven cliffs between Boddam and Longhaven; 2: Between the old Cadet Barracks and the shore outside Boddam; or 3: In Boddam village (Technip, 2013). The report conclusively found that Location 1 was considered the most feasible in terms of environment, consenting, economic viability and execution schedule. At location 2, the onshore drilling location would not be as suitable as location 1 due to the topography and rocks. Location 3 was deemed unsuitable as the onshore cable installation would involve going through the local village and this disturbance to the local population could be avoided by choosing an alternative location.

Once Fourfields became the chosen location for the convertor station, an investigation of routes from the convertor station to the potential HDD onshore entry site at Longhaven cliffs was carried out. A search corridor was identified from Fourfields to the HDD onshore entry point, as seen in Drawing 3149.

The cable route survey area was then narrowed using ground investigation surveys carried out from 6th November 2017 to 7th March 2018. A total of 13 test pits and 2 bore holes were drilled within the entire HVDC onshore cable routing search corridor. The results from these surveys led to the final consenting cable corridor for the onshore cabling. An indicative cable route has been identified (Drawings NCGEN-NCT-Z-XE-0002-01 and NCGEN-NCT-Z-XD-0001-01 to 04), taking account of the following factors:

- Location of ecological receptors, to minimise disturbance;
- Location of archaeological features to prevent physical impacts;
- Ground conditions;
- Technical requirements such as cable bend radii and substrate type;
- Effects on local walking routes; and
- Accessibility for construction plant.

The exact cable route will be defined by the cable contractor, taking into account pre-construction surveys, but the route will remain within the boundaries of the consenting cable corridor as seen in Drawing NCFFS-NCT-X-XG-0001-01 and take into account the factors discussed above.

2.4.3 Horizonal Directional Drilling (HDD)

The decisions behind determining the HDD onshore entry and marine exit points are inherently linked and, as such, are considered concurrently in this section.

An HDD search area for the onshore entry was mapped and is provided in Drawing 3149.

The HDD marine exit point at sea required nearshore and subsea investigations to assess the suitable substrate for the exit. The nearshore survey took place in winter 2016 to avoid the most sensitive time for breeding seabirds along the nearby cliffs. An area for the HDD marine exit was identified as being suitable, as it was an area of gravelly sands, which is a desirable substrate for excavation. This area was in water depths of approximately 26m and allows for suitable protection of the HDD pipe and cables whilst ensuring the surrounding seabed height does not increase by more than 5% of the water depth.

A clifftop ornithology walkover in 2014 assessed which areas of the cliff had the fewest seabirds present, and this helped to inform the HDD onshore entry point (discussed further in Chapter 17 Ornithology). The Marine Survey was then integral to help inform the onshore HDD entry point, by narrowing the location along the Longhaven cliffs within which it would be possible to have the onshore and offshore HDD from a technical perspective. The initial HDD Feasibility Report, presented two possible alignment options: a Northern HDD Alignment and a Southern HDD Alignment (Riggall, 2017). The Northern Alignment would drill towards a bearing of 070º (OS Grid), whereas the Southern Alignment would drill towards 120º (OS Grid). In both these alignments, a shallow drill design and a deeper drill design were considered. At the feasibility stage, the Southern Alignment was advised as the preferable route due to having better topography for an HDD from a technical perspective.

Following this Southern Alignment option, further analysis into different design options within this alignment was then carried out. Three possible designs were considered, and a summary of these is shown in Table 2.3 and in Figure 2.3, where design 3 is in fuchsia, design 4 is in red and design 5 is in blue.

Table 2.3 Parameters of the HDD design options.

	Southern Design 3	Southern Design 4	Southern Design 5
Alignment Bearing (OS Grid)	098°	088°	108°
Entry Elevation	+38.17m ODN	+37.12m ODN	+38.38m ODN
Entry Angle	-17°	-17°	-17°
Entry Tangent Length	190.53m	183.38m	220.07m
Vertical Curve Radius	400m	400m	400m
Vertical Curve Length	153.59m	153.59m	153.59m
Exit Tangent Length	101.97m	69.35m	63.71m
Exit Angle	+5°	+5°	+5°
Exit Elevation	-24.63m ODN	-26.41m ODN	-28.10m ODN
Total Horizontal Length	435.52m	396.26m	398.70m
Total Drilling Length	446.01m	406.31m	409.10m

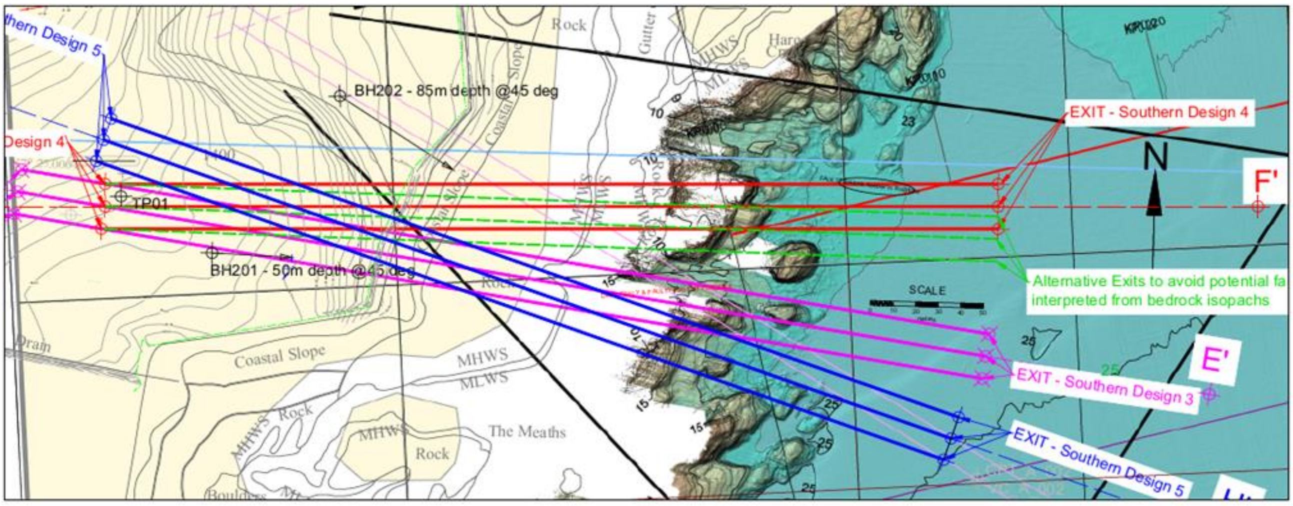

Figure 2.2 HDD Southern Alignment Options

Southern design 5 became the favoured alignment for the following reasons:

- Minimised disturbance to ecological receptors (both flora and fauna);
- Minimised disturbance to archaeological features;
- Best from a technical perspective with favourable ground substrate conditions and favourable conditions at the exit point;
- Being the best alignment for onward cabling towards the converter station; and
- Minimised disturbance to maritime users.

The onshore Landfall HDD entrance was originally chosen as being a gently sloping area towards the lower section of the Landfall field, adjacent to the clifftop path. However, to minimise potential disturbance of cliff-nesting seabirds, the onshore entry point location was moved further back from the cliffs to a location approximately 6m higher than the originally scoped location. This location was still suitable from a technical standpoint.

The favoured onshore HDD entry point and HDD marine exit point, as well as the alignment route and the section view are provided in the updated HDD Feasibility Report provided as Appendix B.1.

2.4.4 Offshore Cabling

2.4.4.1 Initial Selection of Cable Corridor from Scotland to Norway

Xodus were commissioned in 2012 to conduct a desktop options analysis for the NorthConnect offshore cable to identify the preferred route based on existing data, and the full report has been provided as Appendix B.2. The following aspects were considered in the analysis:

- Physical characteristics of the cable;
- Existing infrastructure including pipelines, cables, and offshore installations;
- Bathymetry;
- Seabed geology and sediment characteristics;
- Commercial fisheries, shipping and navigation;
- Cultural heritage and marine archaeology;
- Benthic ecology and habitat types; and
- Designated sites and protected habitats.

The objective of the study was to identify the most efficient cable route between the UK and Norwegian landfalls, considering the physical limitations and whilst minimising socioeconomic, cultural and environmental impacts.

An initial Route Option Analysis Report identified 4 potential offshore corridors between the preferred Peterhead to Samnanger or Sima landing point options (Figure 2.3).

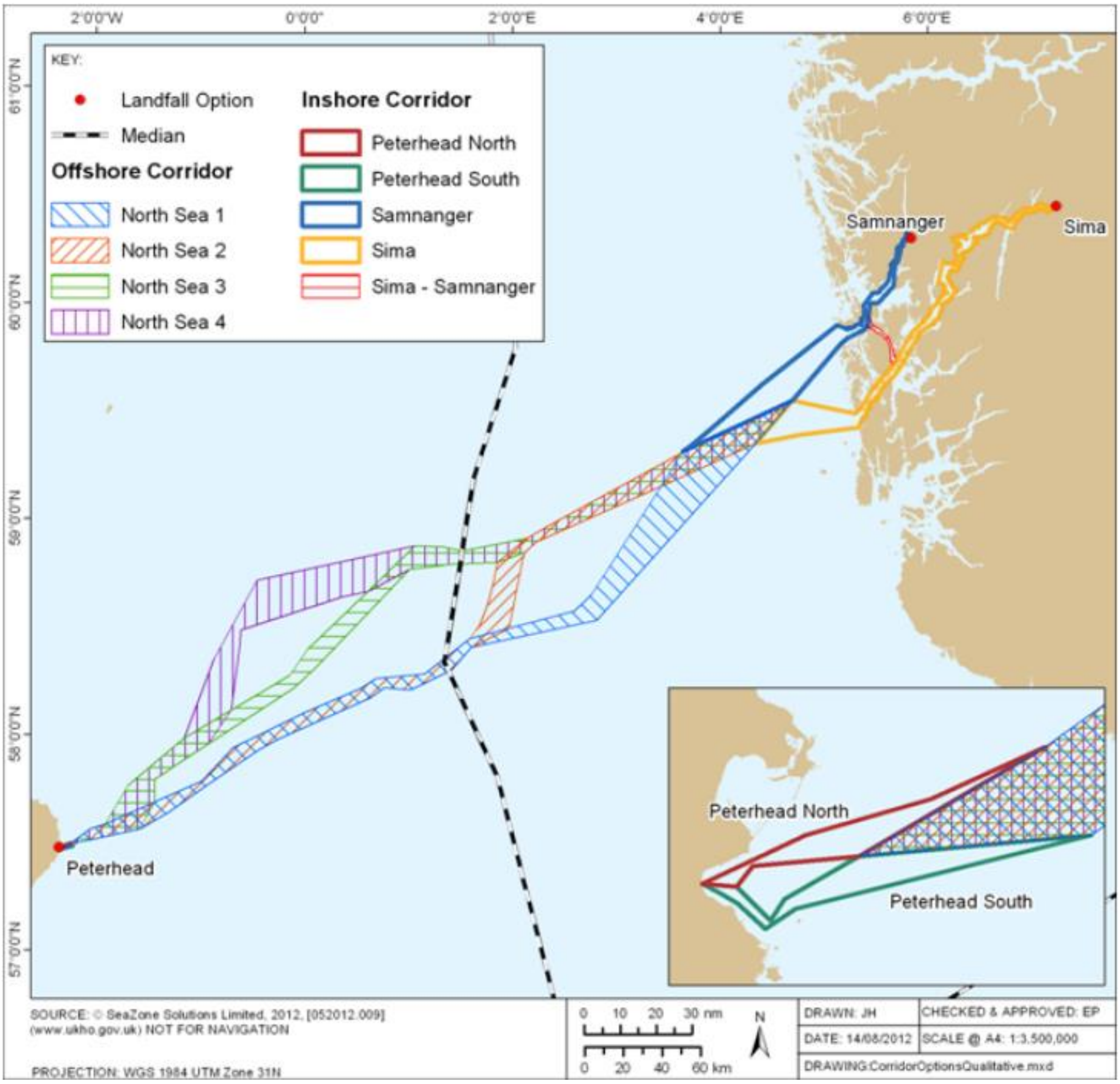

Figure 2.3 Four Proposed Offshore Cable Corridors from Scotland to Norway.

North Sea 3 and North Sea 4 options were discounted based on economic viability and technical suitability. The North Sea 2 option was discounted due to cumulative effects and likely interference with planned development projects within the Utsira High area. North Sea 1 offshore option was selected as the preferred option, with Sima later becoming the preferred Norwegian landfall option.

2.4.4.2 Selection of Broad-Scale Cable Corridor from Long Haven to Simadalen

Following this initial route option analysis study, it was confirmed that Longhaven cliffs would be the entry point for the Scottish landfall location (see section 2.4.2 above). This landfall location was then termed Long Haven, the name of an adjacent cove, in order to distinguish it from Longhaven which is a village a little distance away to the south of the landfall. A further report was commissioned to integrate the landfall location at Long Haven with the previously chosen route across the North Sea to Sima. The chosen Norwegian landfall at Sima is also now termed Simadalen to avoid confusion with a nearby power plant called Sima kraftverk. Simadalen is at the end of the Hardangerfjord, the second longest fjords in Norway.

This study took into a consideration: environmental constraints; technical requirements; safety constraints; and economic viability. Three potential routes were visualised and mapped in GIS. The three nearshore cable corridor options identified are shown in Figure 2.4.

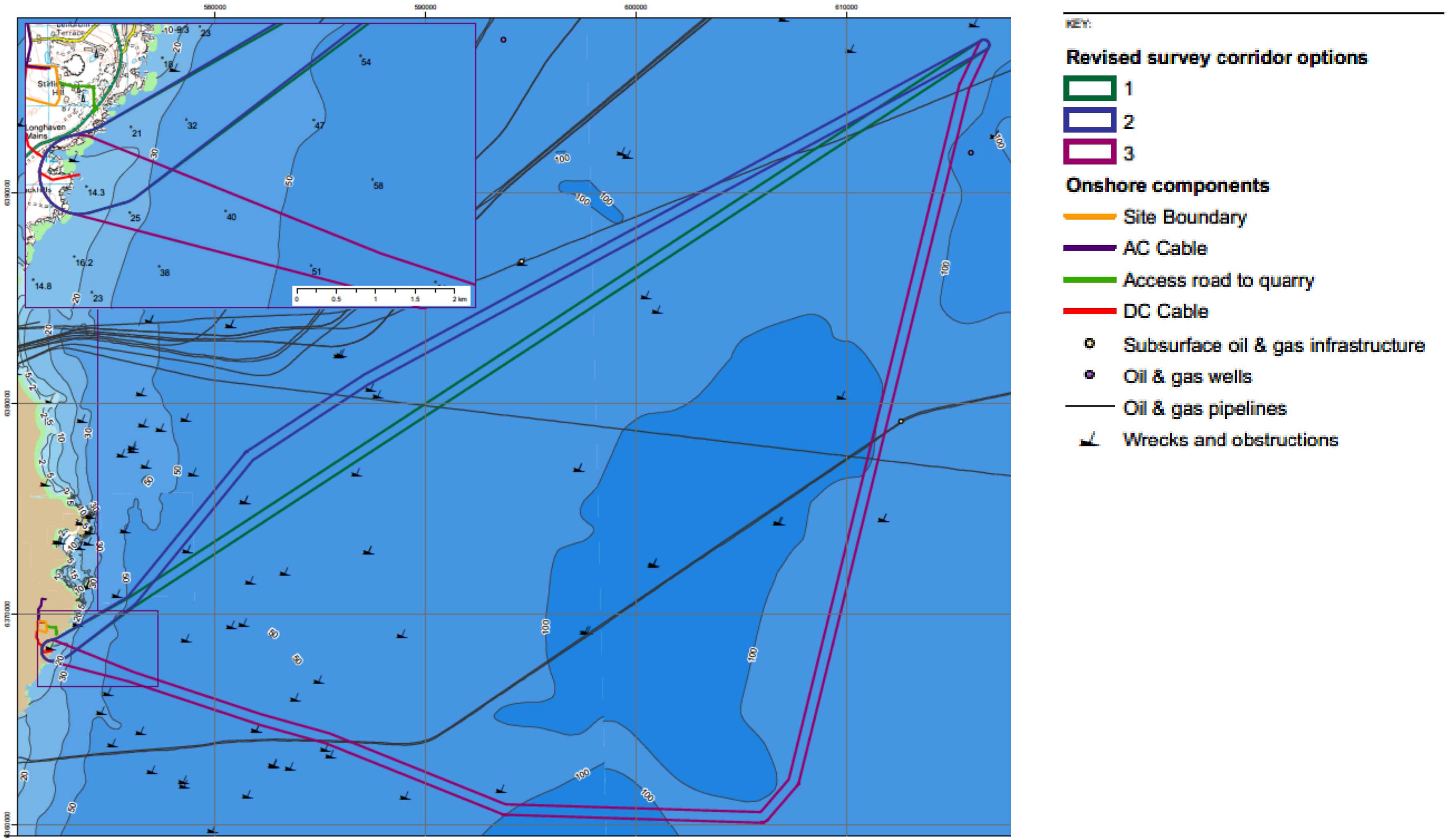

Figure 2.4 Proposed Cable Corridor Options 1, 2, 3

1. Option 1 – A direct corridor route from original cable corridor route to landing point near Long Haven;
2. Option 2 – A route option skirting to the north of potential Annex 1 environmental sensitivity;
3. Option 3 – A southern corridor route option, avoiding the proposed Hywind offshore wind development site and various potential environmental sensitivities.

The advantages and disadvantages of each route option are summarised below in Table 2.4.

Overall Route Option 3, whilst avoiding areas of environmental sensitivity, was considered least favourable due to its length and because it would pass through areas of seabed which could pose technical installation difficulties. Route Option 2 was identified as the preferred option, closely followed by Route Option 1. Whilst some potential environmental constraints were present along these two routes, these can be avoided or mitigated through survey and detailed design. Full details of this report can be found in Appendix B.3.

Table 2.4 Advantages and disadvantages of initial HVDC offshore cable routes.

Route option	Advantages	Disadvantages
Option 1	• No cable crossings along the seabed and only two pipeline crossings at the time of reporting. • Shortest route, and hence most favourable from an economic perspective.	• Crosses designated site: Southern Trench MPA; and a potential Annex 1 habitat for sandeel grounds. • Closer to Peterhead harbour with shipping activity.
Option 2	• No cable crossings along the seabed and only two pipeline crossings at the time of reporting. • Avoids Annex 1 habitat.	• Crosses designated site: the Southern Trench MPA. • Closer to Peterhead harbour with shipping activity.
Option 3	• Avoids more areas of environmental sensitivity compared to routes 1 and 2. • Route does not cross any navigational features.	• Longer cable length and hence more expensive and would cause a greater area of seabed disturbance. • Technically difficult route from a seabed perspective – route more susceptible to sand wave fields. • Would have to make more pipeline crossings along the seabed: 3 cable crossings and 4 pipeline crossings. • Slightly more fishing activity reported in the area.

2.4.4.3 Selection of Survey Corridor from Long Haven to Simadalen

Prior to conducting the marine survey operations, it was necessary to define a more precise survey corridor, since the outputs of the Xodus reports were too broad scale and surveying the whole of even just the preferred corridor would not have been financially viable. In addition, some of the data used to inform the Xodus route options had been superseded, particularly with regard to future offshore developments.

The process of defining the survey corridor was conducted by NorthConnect, in conjunction with the Marine Survey Contractor, MMT Sweden AB, through a series of workshops. The following process was used in order to define the survey corridor:

- The nominal centreline of route Option 2 from the landfall, plus the remainder of North Sea 1 out to the limit of the UK EEZ, was used as the base-case Survey Centreline (SCL);
- It was agreed that a 500m wide survey corridor would provide an appropriate compromise between reducing survey effort, whilst still providing adequate flexibility for detailed cable route engineering within the corridor. Hence a 250m buffer was then added to the SCL, in order to provide a 500m wide base-case survey corridor;
- MMT's Geographic Information System (GIS) was then utilised to conduct a detailed review of the most up-to-date information about seabed conditions, and possible challenges to cable installation, within the base-case survey corridor;
- The SCL was then modified through an iterative process in order to optimise the survey corridor with regard to the following factors, listed in order of priority:
    - Existing and proposed seabed infrastructure:
        - Existing and planned offshore installations (oil and gas, and renewables) were excluded from the survey corridor by at least 500m; and
        - Consideration was given to the preference for the NorthConnect cables to cross existing cables and pipelines at approximately 90^{o}, as opposed to obliquely;
    - Sensitive habitats and designated sites:
        - Where possible sensitive biological sites were excluded from the survey corridor, for example, the SCL was modified to exclude the Scanner Pockmark SAC;
    - Surficial and shallow geography:
        - Areas of hard sediments types were excluded from the survey corridor where possible;
    - Wrecks:
        - The SCL was modified to exclude known wrecks from the survey corridor where possible; and
    - Cable engineering properties:
        - The minimum bending radius of the indicative cable system was considered, to ensure the twists and turns of the SCL could be followed by the cables.

The output of this process was the route position list of the SCL and associated survey corridor, which provided the basis for all NorthConnect marine survey operations to date.

It should be noted that, where unexpected potential challenges to cable installation were identified during the survey operations, the survey corridor was extended at NorthConnect's discretion, in order to identify possible options for avoiding the feature. As such, within this EIAR, the term 'survey corridor' refers to the full coverage of the survey operations conducted to date.

2.4.4.4 Selection of Final Consenting Cable Corridor from Long Haven to Simadalen

Comprehensive geophysical, geotechnical, benthic and archaeological subsea surveys were carried out to further inform the cable routing during late 2016 to late 2017. After the survey, the results were utilised to refine the corridor to form the consenting corridor. A 50m buffer was applied to all wrecks and potential Annex 1 habitats identified within the survey corridor, and these have then been excluded from the UK consenting corridor. The one exception to this is the potential Annex 1 bedrock reef near the UK landfall, as the cable will be routed under it via the HDD ducts.

2.4.4.5 Final Cable Route

The consenting corridor and associated survey results will be provided to the cable supply and installation contractor. The contractor will identify their proposed cable routing, within the consented corridor. They will then carry out their own surveys of their proposed route, as described in the Construction Method Statement (NorthConnect, 2018a), to inform the final cable route.

2.5 Project Components

The interconnector uses HVDC technology because Direct Current (DC) is subject to less transmission loss than Alternating Current (AC), and there is no technology available for cabled transmission of high voltage AC power over more than approximately 110-120 km.

A description of the main components associated with the planning and marine licence application is provided in this section. This is divided into: cables; onshore cable; Landfall horizontal directional drilling (HDD); offshore cable; and temporary construction requirements. It should be noted that the development will be subject to a design and build contract and, as such, a detailed design has not yet been completed. For example, aspects of the cable installation, in both the onshore and offshore components, are dependent on the selection of the cable installer for the contract, as the main companies in the HVDC cabling field have their own proprietary technology and the differences in the components and methodologies can give rise to variations in the cable laying process. Hence, the outline design of the main elements of the HVDC interconnector have been developed by the NorthConnect team to facilitate the consenting process. Certain assumptions have had to be made and a Rochdale envelope approach taken to the assessment process, with worst case assumptions being made where appropriate.

2.5.1 Cables

2.5.1.1 HVDC Cables

There will be two HVDC cables connecting the two converter stations. The exact cable details will depend on which specialist cable manufacturer is involved, but the cables used will be Mass Impregnated (MI) in design. The conductor, which carries the current, is likely to be copper, possibly aluminium as an option, but this is intended for optimisation of the deep installation in the Norwegian fjord. The cable's nominal voltage will correspond to the connection point nominal voltage. The other layers which make up the cable have different roles to prevent the concentration of electric fields between certain layers, to ensure close connection between the layers and to provide protection from water and mechanical stresses.

Typical HVDC cable parameters are provided in Table 2.5. A cross section example of an MI HVDC cables is shown in Figure 2.6. For the onshore cabling, it will be similar in components to Figure 2.6, but without the same level of armouring. The protective armouring for the offshore cables may include galvanised steel and polypropylene layers and will be the first level of protection from hazards for the cable. The cables are also likely to be sheathed with polypropylene or polyethylene material.

Table 2.5 Indicative HVDC Cable Parameters

Cable Parameter	Quantity
HVDC export system	2 x 700 MW HVDC cables
Nominal voltage (kV)	±525
HVDC onshore cable route length (km)	2
Cable linear weight (kg/m)	52 (approximately)
Cable outer diameter (mm)	130 (approximately)
Cable minimum bending radius (m)	5
Cable duct outer diameter (mm)	560-600
Cable maximum pulling tension (kN)	315
Fibre optic linear weight (kg/m)	1.6
Fibre optic cable outer diameter (mm)	24-30
Fibre optic minimum bending radius (m)	<1
Fibre optic duct outer diameter (mm)	90
Cable trench depth onshore (m)	1.6

Figure 2.5 Indicative MI HVDC Cross-Sectional Diagram

2.5.1.2 Fibre Optic cable

The fibre optic cable will be installed so there can be instant communication between the two converter stations in Scotland and Norway. The cable is likely to be armoured with layers of steel wire and sheathed with either a polypropylene or polyethylene material for outer protection. The offshore section of the cable will be bundled with one of the HVDC cables. The fibre optic communications will be used for the control and electrical protection of the transmission system. The fibre optic cable will not have any repeaters within the marine environment and is landed at the Norwegian coastline where it will connect into the wider Norwegian fibre optic network.

The fibre optic cable will be routed to the converter station in Fourfields. The HVDC Cable Route Scoping Report (NorthConnect, 2016) suggested that a building may be required near the UK Landfall for the fibre optic cable. This is no longer thought to be the case and, as such, has not been included within this EIAR.

2.5.2 HVDC Onshore Cables

The onshore cable consenting corridor is wider than the actual onshore cable construction corridor required to allow for micro routing during detailed design. The actual construction corridor will include space for access along the route for excavation of cable and drainage trenches, storage of topsoil and soil from the trenches, delivery of materials and transport of personnel, and excavation and cable installation plant and equipment. An overview of the onshore consenting corridor and indicative cable routes is provided in Drawing NCGEN-NCT-Z-XE-0002-01, with additional indicative detail provided in Drawings NCGEN-NCT-Z-XD-0001-01 to -04.

From Joint Pit 1 to the converter station, it is assumed that the onshore HVDC cables will be laid within one trench. The width of the cable construction corridor for this section is likely to be around 20m (10m access road, 10m trench plus soil storage).

From the Landfall HDD entrance to Joint Pit 1, it is assumed the HVDC cables will be laid in two separate trenches. For this section, the construction corridor would be 30m (10m access road and 2 x 10m trenches plus soil storage).

The onshore cables trench will be approximately 1.3m deep and 4.5m wide, with an approximate distance of 1m between the two HVDC cables if both cables are within a single trench (Drawing NCGEN-NCT-Z-XE-0003-01). For a two-trench design there will be a separation of approximately 3m between the two trenches and 7m between the two cables (Figure 2.7). The depth of the cables are such that arable farming techniques can be employed in the reinstated fields without risk of interaction with the cables. All trenches will be reinstated to former levels.

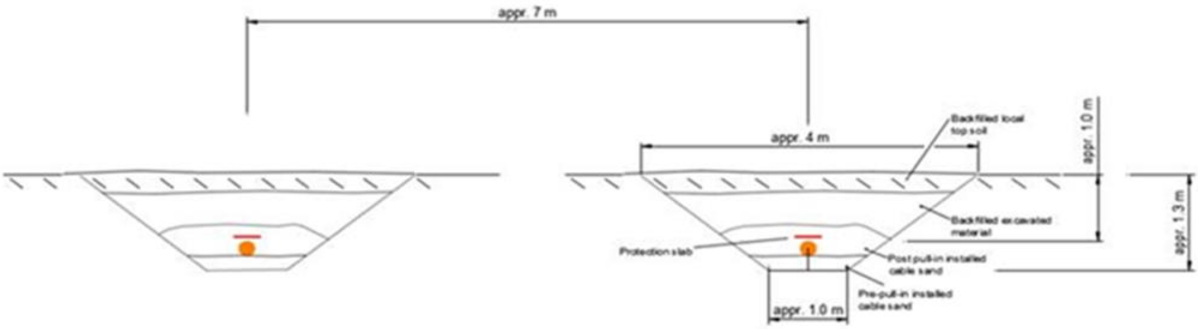

Figure 2.7: Onshore Cable Trench Cross-section a Two-Trench Design

Onshore HVDC Cables have a different armour protection composition to offshore cables, so there will be a joint pit (Jointing Pit 1) approximately 450m from the landing point to the south of the disused railway, where the transition between the two cable types will be located. Limitations on the maximum length of onshore HVDC cable that can be delivered means the maximum deliverable cable lengths are likely to be in the range of 850m – 1000m. As the proposed route is approximately 2km, a second onshore HVDC cable joint pit will be required to join the sections of onshore HVDC cables. Jointing Pit 2 will be located just to the south of Fourfields (Drawings NCGEN-NCT-Z-XD-0001-02 and NCGEN-NCT-Z-XD-0001-03).

Both joint pits are expected to be approximately 25m long by 6m wide. Each cable will be under a precast concrete slab located at least 1 m below surface level (Drawing NCGEN-NCT-Z-XE-0003-01). The joint pit will include earthing wires. The ground over the joint pits will be re-instated to former levels following the completion of the joints, such that farming activities can be resumed. In event of access to the joint be being required, the ground would be dug out to allow the concrete slab to be removed and access to the cable gained.

Link Boxes will be required at each joint pit, to connect or earth the cables outer screens at the joint bay (4 in total). The exact design will be determined by the cable contractor. They maybe above ground similar to those associated with the HVAC cable as shown in Figure 2.8.

Figure 2.8: Above Ground Link Box

It is however more likely that they will be inserted within the ground. Below ground link boxes will be no more than 1m by 1m and 0.6m deep. The box would be buried in the ground at a depth appropriate to allow access to the top/lid, while not impeding the continued farming use of the area. To avoid disruption to users of the A90 trunk road and to avoid disturbing the disused railway line, HDD will be utilised here also. The entry point will be on the southeast of the A90 next to Joint Pit 1 as shown in Drawing NCGEN-NCT-Z-XD-0001-02. The drilling distance under the A90 and the disused railway will be between 150m and 250m.

The HVDC cables pass under the landscape bunds around the converter station into the converter station site. The actual location will be determined by the final converter station design; however, it is likely that the cables will need to come into the site below the converter station platform. Depending on where the cables enter this may be 8 to 17m below the existing ground level, and 20m or greater below the final ground level when landscape bunds are installed. An indicative layout is provided in Drawing NCGEN-NCT-Z-XE-0004-01.

2.5.3 Landfall Horizontal Directional Drill (HDD)

The marine cables will be pulled ashore through ducts which will be installed into holes drilled from a point 100-120m inland from the cliffs, and under the cliffs, with a marine exit point approximately 190m offshore. The HDD onshore entrance and marine exit points are provided in Figure 2.9. The marine exit point will be in approximately 26m of water depth. There will be 3 boreholes drilled: one for each of the HVDC cables; and one for the fibre optic cable. However, all three holes will be drilled to a diameter suitable for an HVDC cable. This is to provide redundancy such that, if there is an issue with one of the HVDC ducts preventing the cable pull, there is a backup route available. In this instance the fibre optic would be bundled with an HVDC cable for pulling through the same duct.

The positioning of the likely area for the boreholes have been informed by ground investigations carried out in late 2017 to early 2018. However, the micrositing of the boreholes will be determined by the cable contractor before the commencement of the HDD operations.

Further details with regard the Landfall HDD are provided in Appendix B.1.

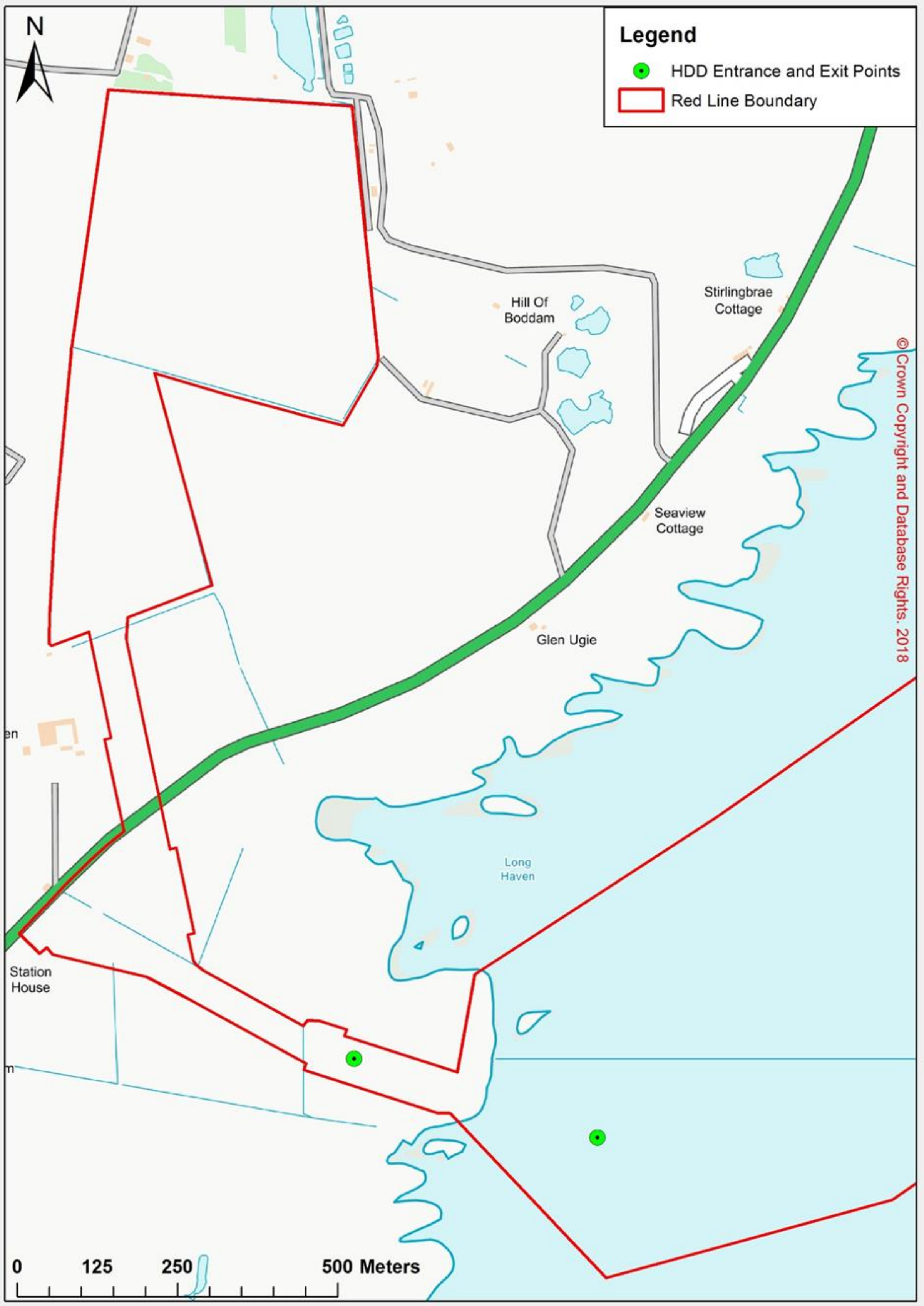

Figure 2.9: Indicative Locations of HDD Entry and Exit Points.

2.5.4 HVDC Offshore Cables

The HVDC offshore cabling will be around 665km from the UK to Norway. The offshore cabling from the HDD marine exit point to the UK median line is approximately 230 km. The cable installation will begin at both Scottish and Norwegian landfall sites and will meet in the North Sea.

It is likely that cable joints will be required at intervals of between approximately 150km to 170km for the two cables. The number of joints will be dependent mainly on the loading capacity of the installation. If cables were to be bundled, then the joint intervals would be half that of unbundled cables. Joints in the offshore cables are normally made inline, on the ship as the cable is being laid, and do not require any additional marine infrastructure.

The HDD marine exit point is located in water depths of approximately 26m. The fibre optic cable will be routed towards one of the marine HVDC cables and bundled with it for the remainder of the route. It is assumed that the two HVDC cables will be installed separately. There is, however, a small potential that they could be bundled together and laid in the same trench.

The cables will be laid in water depths varying between 26m at the UK landfall to 860m in the deepest part of the Hardangerfjord. The distances between the two HVDC cables will vary based on seabed conditions, water depth and EMF requirements. Typical separation in the North Sea will be between 20m-100m depending on the seabed conditions. In waters up to 12NM, the proposed cable corridor width will be 60m, with a cable separation of 20m as a minimum and 40m as a maximum. In waters outwith the 12NM limit, there will be a variable corridor width, with a minimum of 20m.

2.5.4.1 Cable Protection

Cable routing is the principle method of avoiding hazards and seabed assets. However, further protection beyond standard burial within a trench will be required. Where additional cable protection is required, beyond the natural backfill of sediment within a dug seabed trench, the most likely technique for cable protection is expected to be rock placement. At the HDD exit point, it is expected that concrete mattressing will be used temporarily to protect the duct until the cable is installed. Protective piping may be required for certain pipeline or cable crossings in conjunction with pre and post rock-placement.

To protect the cable from damage, the cable will be buried or protected by rock placement for the entire cable route. To identify the level of protection required, taking into account the various threats to the cable, a Cable Burial Risk Assessment (CBRA) has been completed and is included as Appendix 1 of the Construction Method Statement (NorthConnect, 2018a).

The CBRA took into account the understanding of the seabed conditions gained by the completion of the subsea survey. Primary hazards included shipping, anchorages, fishing, on-bottom stability, dredging/spoil dumping and, with particular regard to the Norwegian waters and fjords, fish farming, rockfall, submarine slopes and slide escarpments. The secondary hazard of mobile sediments was also considered. The assessment considers sections of the corridor, split by sediment type based on the survey results from the centre line of the survey corridor.

The CBRA was utilised to inform the protection level required by the NorthConnect project to reduce the risk of cable damage to a sufficient level.

Cables can be protected in four main ways:

1. They can be laid on the seabed then post-lay trenched into place. The depth the cable achieves lower than the original seabed level (OSL) is called the Depth of Lowering (DOL). The seabed material will naturally infill, the extent of which will be determined by the seabed composition;

2. The cable can be laid directly onto the seabed and rock placed onto the cable to provide protection;
3. Rock can also be utilised in conjunction with trenching, where trenching has not provided a sufficient DOL; or
4. Pre-lay trenching can be utilised where post-lay trenching is unlikely to provide sufficient DOL to minimise the need for above OSL rock placement. However, in seabed types where this is likely to be the case, natural backfill may be slow and, as such, forced backfill may be required. To prevent damage to the cable from backfill ploughing, then backfill rock placement is the preferred means to bury the cable up to OSL. The use of backfill augers or inverted plough to provide forced backfill may be considered by NorthConnect, only if the installation contractor can demonstrate relevant experience records and/or sea trials show that the cable is not jeopardised by the technique.

For the purpose of marine licencing it has been assumed that where pre-lay trenching is utilised, backfill rock placement will be required to protect the cable, but that this will not normally be above OSL. Material removed from the trench by pre-lay trenching may form berms either side of the trench, but these will naturally disperse with time.

All cables within Scottish Territorial Waters (STW) and the UK Exclusive Economic Zone (UK EEZ) were identified as requiring the top 2 protection levels (full information about protection levels is provided within the Construction Method Statement (NorthConnect, 2018a)). As such, the lowest DOL below the seabed in STW and UK EEZ (excluding crossings) is 0.4m and this should occur for no more an 10% of the cables length. For the majority of the route ≥90% the cables will be lowered and/or buried by at least 0.8m. In some seabed substrates the cable may be lowered by 1.5m.

The only area of bedrock within the STW/UK EEZ consenting corridor is very close to shore and the cable will be pulled under this through the HDD ducts. It is not anticipated that any sections of the cables within the UK consenting corridor, barring those close to crossings (see below), will be laid directly on the seabed and protected solely by rock placement.

2.5.4.2 Crossings

In the UK EEZ there are a total of 18 infrastructure crossings required: 4 of these are cables; and 14 are pipelines. There are two sections of out of service telecommunications cables which will be removed and, hence, will not be crossed. Drawing NCOFF-NCT-X-XG-0008-01 shows the locations of the asset crossing that will require above OSL rock protection.

NorthConnect is following the International Cable Protection Committee (ICPC) recommendation (No. 3, Issue: 10A) for cable and pipeline crossings (International Cable Protection Committee, 2017). The crossings shall be treated individually during detailed design considering aspects such as regional constraints, requirements from the crossed infrastructure owner, practicalities regarding trenching near the crossing, volume of rock ramps, stability and top cover. The angle between the NorthConnect HVDC cables and the crossed utility shall be as close to 90 degrees as practicable and not be less than 45 degrees for a distance of minimum 200 m from the crossed asset.

NorthConnect has defined 4 standard types of crossings which form the basis for the planning of work, unless other designs are required by the crossed infrastructure owner, and these are all provided within the Construction Method Statement (NorthConnect, 2018a). One example is provided in Figure 2.10.

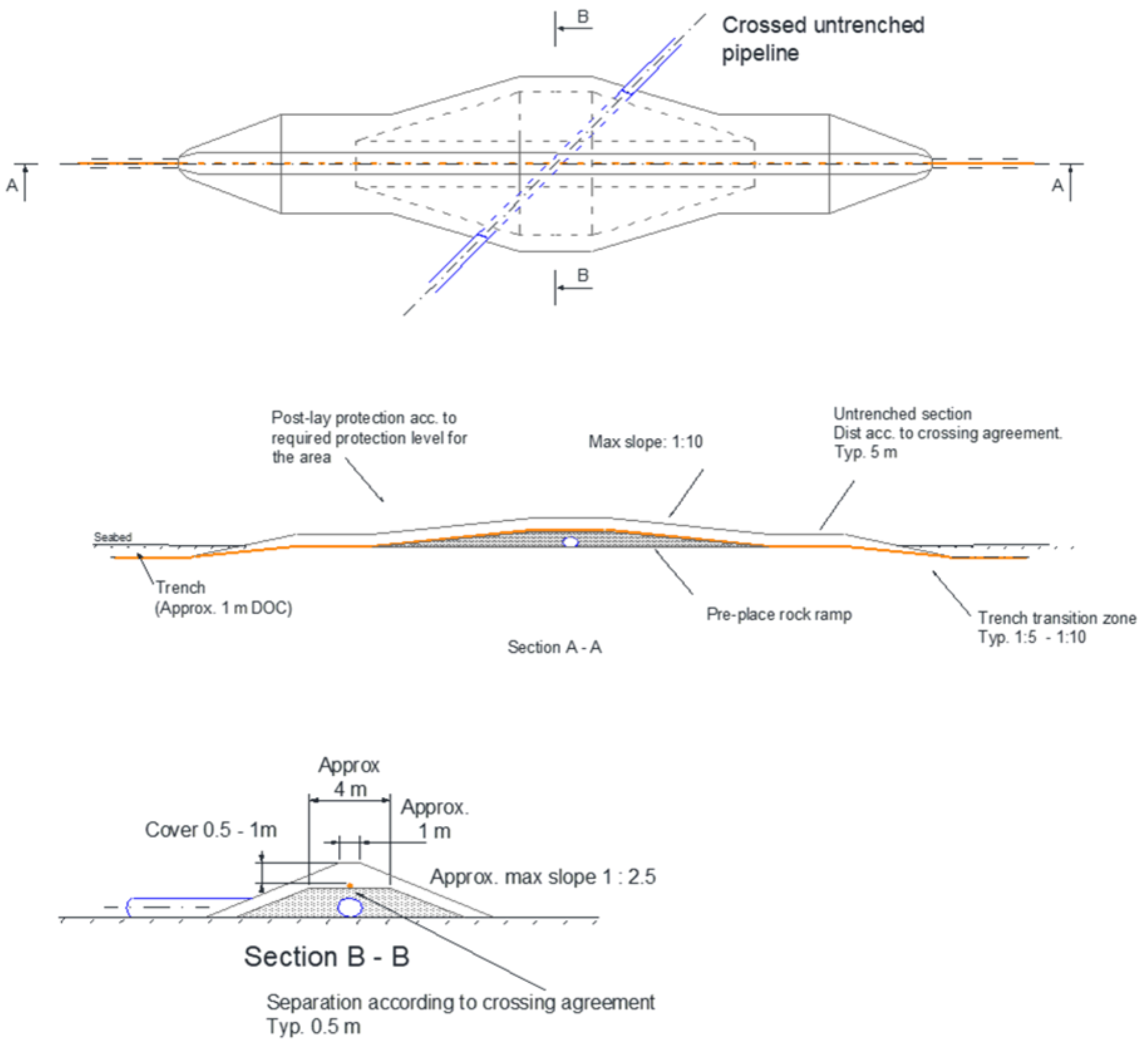

Figure 2.10: Crossings Design A - Crossing Un-trenched Pipeline

To ensure that the asset being crossed is not damaged during the HVDC Cable installation, trenching will not be carried out within the vicinity of the crossing. The distance from the asset to be crossed to the point the trenching will cease is based on the risk posed by the technique employed and the owner of the crossed infrastructure's requirements. Indicative distances are provided in the Construction Method Statement (NorthConnect, 2018a).

2.5.4.3 Cable Installation

A Cable Protection Analysis Report (CPAR) has been completed and is included as Appendix 2 of the Construction Method Statement (NorthConnect, 2018a). It considers the techniques that could be employed to provide the desired protection levels along the cable route. The five tools considered for cable installation are:

- Jet trencher;
- Chain Cutter;
- Combined Jet/Chain Cutting tool;
- Pre-lay Plough; and
- Cable Burial Plough.

The different techniques which may be used for cable laying are summarised in Table 2.6. The environmental impacts of the differing techniques are discussed in the relevant chapters within this

EIAR (Chapters 7, 14-16, 18-20, 23). For the purposes of the environmental assessment, we will consider the worst-case scenario which, in this case, would be the one that would take the longest period of time to achieve: i.e. where the cables are laid and buried separately, rather than simultaneously.

Table 2.5 Possible cable laying techniques

Cable laying technique	Technique type	Technique summary	Image example of device
Jet trenching: **Using either:** **>Tracked cable burial vehicles;** **>Free swimming ROVs**	Separate lay and burial (post-lay)	A tracked, wheeled, or free-swimming tool is applied on the cable and cuts into the seafloor using high-pressure water through jet-swords on both sides of the cable. The seabed material is put into suspension, the cable gently sinks into the trench whilst the jet trencher moves forward. The trench walls then collapse on top of the cable and suspended material settled back into the trench by natural infill.	 
Ploughing: **Using either:** **>Narrow share cable ploughs** **>Advanced cable ploughs** **>Rock ripping ploughs** **>Vibrating share ploughs**	Simulataneous lay and burial or separate lay and burial (pre-lay)	Ploughing is a versatile technique and can be used in areas with stiff clay, where jet trenching may not work. A plough cuts a trench in the seafloor using a vessel which pulls the tool along the seabed floor with great force. Pre-cut ploughs (creating a trench in advance of cable installation) and simultaneous ploughing (where the cable is installed with the ploughing) may take place. Ploughs may be equipped with jet propulsion or be vibrating ploughs. Ploughs designed for route clearance exist.	 

Cable laying technique	Technique type	Technique summary	Image example of device
Mechanical trenching (cutting): **Using either:** **>Mechanical rock wheel cutter** **>Mechanical chain excavator**	Separate lay and burial (post-lay)	A cutting chain or wheel cutter is used to create a trench. Is used for seabed conditions of stiff clay or materials with stone or bedrock. The cable is guided into the trench by a mechanical trencher. They are generally manoeuvrable devices which makes them useful for complex route sections.	 

It is anticipated that, for the majority of the cable route (~97%), jet trenching will be suitable and enable the target protection levels to be achieved. However, in areas of dense boulders (and potentially dense subsurface boulders), tills and coarse surficial sediments, pre-lay ploughing may offer a lower risk solution with greater potential for achieving the necessary target trench depths. In STW/UK EEZ the main area where jet trenching may not be suitable is between 213564E, 6378161N and 228191E and 6389279N. This is the majority of the route within STW.

NorthConnect wish to keep the range of permitted cable installation tools as wide as possible to facilitate competition from potential cable contractors, however, the contractors will be required to meet the protection levels outlined in Section 4.3.1. Cable contractors will be required to carry out sea trials, to demonstrate that they can achieve the required levels of protection in the more challenging substrates, prior to their methodology being accepted by the project.

2.5.4.4 Rock Placement

Rock placement is required for crossings as discussed in Section 2.5.4.2. It will also be required to protect cables by increasing the DOB. The amount of rock required will be determined by the cable installation method utilized. The two options utilised to calculate the rock volumes required were:

- **Option 1: Jet Trenching** for the full route, which will potentially require remedial rock placement; and
- **Option 2: Jet Trenching in combination with Pre-lay Ploughing** for the initial section in STW until the seabed conditions makes jet trenching more acceptable. It has been assumed that pre-lay ploughing will require backfill rock placement and a small amount of remedial rock placement.

Drawings NCT-X-XG-0006-01 and NCT-X-XG-0007-01 show the location of potential rock placement for each of the options considered within STW. The two options are the same outwith STW, as it is unlikely the Pre-lay Ploughing would be utilised here, and the rock placement locations are shown in Drawing NCT-X-XG-0008-01. The main difference between the two options is that the majority of rock utilised for Option 2 is backfill and, as such, will be below OSL, with an estimate of 5 to 10% of the cable lengths within STW requiring remedial rock placement. Whereas the majority of the rock required for Option 1 will be above OSL, with almost 100% of the route within STW requiring remedial rock placement above OSL. In the UK EEZ it is estimated that less than 1% of the route will require remedial rock placement (<2km).

The full rock estimate calculations can be found in the CPAR (Appendix 2 of the Construction Method Statement (NorthConnect, 2018a)), and these are summarised in Table 2.7. Option 2 requires only 4% more rock volume (3800m^3) than Option 1.

On the basis that the total rock volumes involved are similar for the two options, and that there is a preference not to change the seabed profile to minimise effects on fishing, either Option 2, or techniques that can achieve a DOL such that remedial rock is not required for the majority of the route, are preferred. Hence, it is assumed for the purpose of assessment that remedial rock placement above OSL is between 5 and 10% of the route in STW and 1% of the route from 12nm to the limit of the UK EEZ.

The anticipated rock grading to be used is 1”-5” (CP45/125mm) and D10 45mm, D50 80mm, D90 125mm, with an installed bulk density of 1.5 – 1.7 tons/ m3. Hence, the total rock requirement assuming Option 2 in STW/UK EEZ is 163,880 tonnes. 170,000 tonnes of rock placement have been allowed for within the Marine Licence.

Table 2.7: Rock Volume Estimates

Assessed Length	Remedial rock placement estimate (m^3)	Backfill estimate (m^3)	Subtotal (m^3)	Crossings estimate (m^3)	Theoretical Total (m^3)	Total including 40% contingency factor (m^3)
Full Route: Option 1 - Jetting	67600	0	67600	54200	121800	170600
Full Route: Option 2 - Jetting with Pre-lay ploughing KP0.823 - 17.891	21800	48600	70400	54200	124600	174400
KP0 to 12NM limit: Option 1 - Jetting	50400	0	50400	1800	52000	72800
KP0 to 12NM limit: Option 2 - Jetting with pre-lay ploughing KP 0.823 - 17.891	4400	48600	53000	1800	54800	76600
KP0 to UK EEZ limit: Option 1 - Jetting	52400	0	52400	13800	66200	92600
KP0 to UK EEZ limit: Option 2 - Jetting with pre-lay ploughing KP0.823 - 17.891	6600	48600	55200	13800	68800	96400

2.5.5 Temporary Construction Requirements

2.5.5.1 Construction Access

During the construction process, the majority of the site offices, staff welfare facilities, parking, storage and laydown areas, will be provided at the Fourfields Converter Station Construction site and have already been incorporated into the planning consent for that element of the project. Access to the cable corridor northwest of the A90 will primarily be from the Fourfields site which, in turn, is accessed from the A90 by an existing quarry road (Allen and Gordon, 2018).

Access to the southeast of the A90 will require a new access track to be constructed, the design for which is shown in Drawing NCGEN-NCT-Z-YX-0002-01. The justification for the design of the junction and the access track is provided in the Transport Statement (Allen and Gordon, 2018).

Staff parking will be kept to a minimum at the HDD site, personnel will arrive at Fourfields and travel together to the south of the A90 to minimise the disturbance caused by vehicle movements.

During construction, the HVDC cable corridor will include a haul road to facilitate access to the cable trench route and joint pits as per Drawing NCGEN-NCT-Z-XE-0003-01.

2.5.5.2 Works Southeast of the A90

To support the HDD and works southeast of the A90 there will be a need for:

- Laydown and HDD work area including:
    - A heavy lift drilling rig pad at the cliff HDD entry point;
    - A drilling rig pad for the A90 HDD entry point; and
    - Laydown area for the storage of pipes, drill sections and tools;
- Welfare facilities; and
- A water supply.

A potential layout for the landfall HDD temporary works area is provided in Figure 2.11.

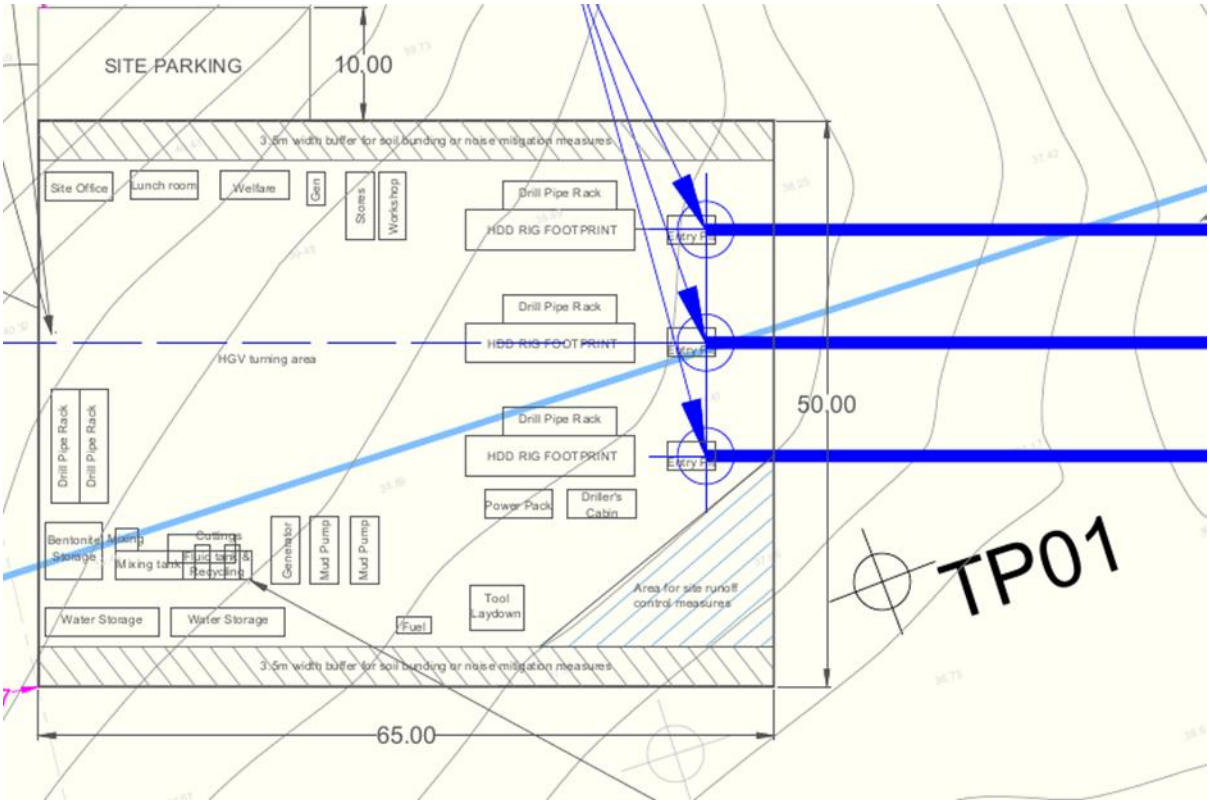

Figure 2.11 Indicative Site set-up for the Landfall HDD Works Area

The HDD Temporary Works Area will be reinstated to the previous levels once the cable has been installed, to allow it to return to its previous agricultural use.

A water supply will be required for the HDD works, so a connection will be made from the water main which runs parallel to the A90 on the seaward (south east) side.   The temporary water supply will be laid adjacent to the access road.

During construction, the HVDC cable corridor will comprise a haul road, safety area, area for spoil storage, temporary surface water drainage and boundary fencing. The total construction corridor width required will be a maximum of 50m wide, although this can be narrowed over short lengths where constraints may be encountered. The cable corridor will be reinstated once construction is complete to allow activities such as farming to continue as before.

2.5.5.3 Works Northwest of the A90

The majority of the support facilities for works to the Northwest of the A90 will be from the Fourfields site. There is a potential for some laydown and welfare facilities to be required to minimise the need to cross the core path to the south of Fourfields with equipment.   If required, this will most likely be within the field immediately south of Fourfields.

2.5.5.4 Rock Mattresses

Once the HDD holes are drilled and the ducts inserted, the marine exit points will need to be protected until the cables are ready to be pulled through them. Hence, concrete mattresses will be utilised to protect the holes as a temporary measure and these will be removed to allow the cables to be installed (NorthConnect, 2018a).

2.5.5.5 Guard Vessels

The Cable Lay Vessel and Trenching/Protection Vessel cannot interrupt their work and abandon the site, other than in an emergency. To prevent collisions with merchant, recreation and fishing vessels, Guard Vessels will be used to alert and redirect vessels which come too close to the working spreads. In addition, Guard Vessels will be utilised to maintain protection zones around exposed cable sections, in particular, crossings with existing cables and pipelines, between laying and trenching or between laying and rock placement activities.

NorthConnect are committed to minimising the time that protection areas are in place, preferring the prompt installation of cable protection. The cable contractor is required to protect the cable for a maximum of 3 months, however, it is assumed that the majority of the cable will be protected and hence protection zones removed in much shorter timescales.

The cables will be installed in sections; therefore, the end of each cable section be guarded until the jointing and post-lay burial operation of each joint is completed.

Full details with regard to guard vessels and communications with marine users are provided in the Fisheries Liaison and Mitigation Action Plan (NorthConnect, 2018b) and the Communications Strategy (NorthConnect, 2018c).

2.6 Project Phases

2.6.1 Construction

The following main construction activities are required to facilitate the installation of the cables:

- Onshore Enabling Works;
- Onshore Cable Installation;
- Landfall HDD;
- Offshore Preparations;
- Marine Cable Pull;
- Onshore Demobilisation and Reinstatement;
- Offshore Cable Installation; and
- Reporting.

Full details of each of these stages are provided in the Construction Method Statement (NorthConnect, 2018a). Detailed information with regard to the HDD is provided in the HDD Feasibility Report (Riggall, 2017) as Appendix B.1. To avoid duplicating the aforementioned documents, then only points which are pertinent to the EIA are discussed in this section.

2.6.1.1 Onshore Enabling Works

To prevent livestock and members of the public accessing construction areas, security/livestock fencing will be installed around work areas. The intent is not to fence the full onshore consenting corridor for the duration of the works, but rather to fence areas prior to specific access being required. Once works have been completed in an area they will be reinstated to allow fencing to be removed and access to be restored at the earliest convenience.

The road will be installed as part of enabling works, most likely through the summer months, such that the ground conditions are favourable for the works and that it is in place to allow HDD activities to be completed through the winter.

The Landfall HDD work compound will also need to be prepared and a hardstanding construction required. The topsoil and subsoil removed from the area will be utilised to form bunds to the north and south of the compound to provide some screening of the worksite in terms of noise and shelter from the winds. The east and westerly sides will need to be kept open to accommodate the cables laid inland to the west and the HDD works seawards to the east.

The onshore HVDC cables have to cross a core path which runs along the south side of the Fourfields site. Hence, it is proposed that before the other parallel path (which bisects the Fourfields site) is closed off from public access, cable ducts will be installed under the core path. This will allow the core path users to be rerouted during the duct installation via the bisecting path, and then the core path will be reinstated before the bisecting path is closed. The onshore HVDC cables can then be pulled after the construction of the Convertor building with minimal disturbance to the core path users. The duct installation will be a simple excavation of material to allow the ducts to be installed and reinstatement utilising the materials removed, as far as practicable, with appropriate re-surfacing installed.

A water supply is to be provided to the Fourfields site from the south. This pipeline will be installed in advance of the Convertor station construction and cable installation and, as far as practicable, at the same time as the cable ducts under the core path to minimise disruption.

2.6.1.2 Onshore Cable Installation

The onshore cable installation requires trenches to be dug and prepared for the cables. While the trenches and joint pits are open, there will be a need for water management and this is discussed in Chapter 10: Water Quality (Onshore). The watercourse crossings are also considered within Chapter 10. Means of escape from the open trenches in the form of ramps will be provided for mammals to avoid entrapment.

The trenches will be reinstated to their previous ground levels with any excess material being removed offsite for appropriate disposal.

The Road Crossing HDD works will be carried out in a similar way to the Landfall HDD, see Section 2.6.1.3 and Appendix B.1, however, it will be on a smaller scale and there should be no release of drilling fluids to the environment.

2.6.1.3 Landfall HDD

In addition to the Landfall HDD location and site set up being designed to minimise disturbance to ecological and recreational receptors as discussed in Section 2.4.3, the timing of works has also taken account of disturbance. The majority of the landfall HDD drilling works will be carried out through the winter months, avoiding the bird breeding season to minimise effects associated with disturbance, and further details are provided in Chapter 17: Ornithology.

The primary objective of the drilling fluid is to create a thick gel to suspend soil and rock cuttings and carry them out of the hole. In addition, the fluid hydraulically excavates soil in soft ground, powers the downhole motor in hard ground, cools the drilling equipment, clears debris from the drilling bit, seals the perimeter of the borehole in porous ground and lubricates the borehole to reduce friction on the drilling equipment. The drilling fluid, once used, is pumped into a mud recycling unit so it can be treated and reused. Waste drilling fluid will be tankered offsite for appropriately treatment and disposal.

The drilling fluid for the HDD process is likely to be a bentonite drilling fluid. Alternatives are available; however, bentonite is the most commonly used. This is a mix of water and a naturally occurring, non-toxic clay, bentonite. On occasions, additives such as natural xanthum gum and gypsum need to be added to improve the effectiveness of the fluid. Alternatives available include Ecodrill, a silicate-based drilling fluid.

The drilling fluid losses for HDD design options have been estimated and are discussed further in Chapter 11 Water Quality (offshore) and Chapter 14 Benthic Ecology. There are three stages of fluid and solid losses:

1. At the pilot hole exit;
2. During reaming; and
3. On pullback.

Fluid losses are minimised by pumping out excess fluid from the hole prior to breakout of the pilot hole into the marine environment. For each hole, the estimated total fluid losses to the sea is approximately 1000m^3 and estimated total solid losses to the sea is 6 m^3 for each hole. So, in aggregate, a total of 3000 m^3 fluid losses and 18 m^3 solid losses for the three holes.

The ducts will be installed using a pushed installation technique, which will require less days of offshore works. The ducts are pushed from land to the sea and the cables can then be pulled in through the ducts.

2.6.1.4 Offshore Preparations

As discussed in Section 2.4.4.5 there will be pre-lay surveys completed to confirm the final cable routing, and this will include both UXO, surveying and video surveys for benthic habitat confirmation purposes. The route may be revised within the consenting corridor based on the pre-survey findings to avoid obstacles or previously unmapped sensitive habitats.

Where possible, potential UXO contacts are identified during the survey, and they will be avoided by an appropriate safety buffer during the final route engineering process. If avoidance is not possible, the items of UXO will be disposed of by an appropriately licenced, explosives ordnance disposal contractor, or by the Royal Navy.

Sea trials will be carried out where there is not sufficient existing evidence to demonstrate that the proposed techniques will work. The purpose of sea trials is to prove that vessels, equipment, procedures and personnel are suitable for an efficient installation of the Submarine HVDC and fibre optic Communication Cables, maintaining the cable integrity and in accordance with principles for Health Safety Environment and Quality during all phases of the Work.

The sea trials shall be carried out in the consenting corridor close to the locations where the actual Work will take place. Upon completion of the sea trials, the seabed will be cleared of all temporary equipment deployed for the purposes of the trial.

The methods deployed are equivalent to those utilised in the actual works described below, but on a smaller scale. The trials will be over a length of 200-500m.

Once the cable route has been confirmed the seabed will be prepared to remove any debris, boulders or obstacles, such as abandoned nets and wires from its surface. This may involve a grapnel (hooked) device being dragged along the exact cable route. Alternatively, ROVs or grabs may be used to remove obstacles.

If pre-trenching is planned this will be carried out and rocks will be placed to protect existing infrastructure at crossing points, prior to cables being laid over them.

2.6.1.5 Marine Cable Pull

To allow the cables to be pulled from the offshore environment, the protective mattressing installed to protect the HDD marine exit hole will be removed. An area around the duct (pull in pipe) will be excavated and a clamp with mounting flanges installed. Preparations will be completed immediately prior to each cable being pulled.

The marine HVDC cables will be delivered in approximately 150 km long sections, hence, assuming that the HVDC cables are laid separately, the two marine HVDC cable pulls will be carried out at different times. The fibre optic cable will be pulled during one of the HVDC cable pull campaigns, as it will be bundled with it for the remainder of the route. When the cable lay vessel arrives at site, the bell mouth will be installed to guide the cable into the duct. The cable will be pulled from land. Once the cable is in place, a cap will be installed to isolate the duct from the sea. Bentonite will then be pumped into the duct to fix the cable in the duct. The marine cable on the seabed will then be protected by placing rock over the HDD marine exit point along the cable route until the cable is suitably protected by other means.

2.6.1.6 Onshore Demobilisation and Reinstatement

Once all the marine cables have been pulled onto land and jointed with the onshore cables, the onshore areas can be fully demobilised. Equipment will be removed from site, the temporary water supply removed, hardstanding materials lifted, and the field reinstated for agricultural use to its existing ground levels. The access track will be mainly removed with only a small area of tarmac (approx. 1m wide) remaining adjacent to the A90. This is to minimise the need to control traffic on the A90 during demobilisation works. The access road route will be reinstated to original levels suitable for agricultural use.

2.6.1.7 Offshore Cable Installation

Four sections of 150km long HVDC cable will be required for the STW/UK EEZ. The first cable will be pulled ashore and installed. The second cable section will either be pulled ashore and laid or attached to the end of the first section. This will depend on the timing of the delivery in relation to the bird breeding season. The third section will be attached to the first section, or pulled ashore, depending on the placement of the second section. The fourth section will be attached to the end of the second cable installed from the UK landfall.

If the HVDC cables were to be bundled, all Landfall, cable pulls would be completed in one campaign. The cables would be approximately half the length (75km) and, hence, joints will be every 75km, with each section being jointed to the end of the previous section.

In parallel, cable installation will commence at Simadalen in Norway, working eastward to join with the cables laid from the UK to the middle of the North Sea. The exact location will be determined by cable section lengths, but it is likely to be outwith the UK EEZ.

The cable will be laid, and a survey completed to identify the position of the cable touch down points. The cable will then be trenched into position and resurveyed. Rock will be placed in the following circumstances:

- To provide cable protection at crossings;
- To backfill trenches which have not naturally infilled sufficiently or where natural infilling is not expected to achieve the required DOB; or
- Remedial rock placement to provide the appropriate protection levels where DOL has not been achieved.

A rock placement survey will be completed and, where necessary, remedial works completed. A final post installation/as built survey will then be completed.

2.6.1.8 Reporting

The as-built survey results will provide the exact routes the cables have taken. This information will be shared with the appropriate bodies as detailed in the Communications Strategy (NorthConnect, 2018b).

2.6.2 Operation

Once installed and energised the HVDC and Fibre Optic cables should require minimal maintenance. Whilst the cables should not generally require significant operational maintenance once successfully installed and commissioned, they will be monitored remotely for condition and function.

Regular marine cable surveys will be carried out, as detailed in the Post Installation Survey Plan (NorthConnect, 2018d), to assess the status of the cable, cable protection and to identify any potential risks to the cable system or other users of the sea. If required, maintenance will be completed to rectify the issue identified.

If the cables were damaged in any way they would need to be accessed and repaired. Onshore, this will involve digging up the cable to gain access. On the offshore sections, the cables will be cut to allow them to be brought to the surface for repair and a new section of cable would then be jointed into the cable. The relaying of the cable will require an Ω omega loop for the cable to be laid, to manage the excess cable length. Cables will be laid and protected to their original levels.

2.6.3 Decommissioning

The lifespan of the project is 40 years. The decommissioning plan will be fully developed prior to decommissioning. The likely approach, at a strategic level, will be to remove cables where economically viable, environmentally acceptable and practicable to do so. Due to the value of the metals in the cables it is highly likely that it will be economically viable to remove the cables to allow them to be recycled. Ecological surveys may be required to ensure it is environmentally acceptable, as there is a potential that over 40 years the habitats will have changed and protected habitats or species may have colonised the area.

For the onshore components, a working corridor would be established, a trench dug above the cable, the cable removed, and the trench backfilled and restored to its former use. The impacts will be similar to those associated with construction but will be determined by the area's ecological status and use at the time of decommissioning.

The section of cable installed in the Road Crossing HDD may be technically difficult to remove and, hence, capped and left in-situ, unless there is an overriding reason to remove it.

As with the Road Crossing HDD, the Landfall HDD cables are likely to be cut off and capped at both ends and left in situ. If they were to be removed, then the holes would need to be filled in order to prevent a hydrological link between the field and the seabed.

Offshore cables will be mainly removed. The cable would be pulled out of the trench through any sediment or rock cover, cleaned when recovered and then delivered to a certified recipient for recycling. The main exception to this will be at crossings where the crossed infrastructure is still in service. Sections that are not removed will be isolated and made safe, taking account of the operational survey results, which will have identified any associated seabed issues.

The potential effects of decommissioning the project will require a separate environmental assessment at the time and, therefore, is not considered in detail within the scope of this EIAR.

Decommissioning will be briefly covered within Chapters 14, 15, 16, 19, 20 (Benthic Ecology, Fish and Shellfish Ecology, Marine mammals, Navigation and Shipping and Commercial Fisheries, respectively).

2.7 Project Location

2.7.1 Onshore HVDC Cable

The Fourfields site where the converter station is located is approximately 2.6km south of the outskirts of Peterhead, 4.5km south of Peterhead town centre and 1km southwest of the village of Boddam (Drawing 3022). The Fourfields site is located to the south of Lendrum Terrace and Highfield, east of the Den of Boddam, Sandfordhill and Denhead and west of the Hill of Boddam and Stirling Hill Quarry.

The HVDC cable will be connected to the convertor station at Fourfields and will run from the convertor station to the onshore entrance point of the HDD at Long Haven, following a southerly direction from Fourfields and then south-east towards Longhaven cliffs. Drawings NCGEN-NCT-Z-XE-0002-01 and NCGEN-NCT-Z-XD-0001-01 to 04 show the indicative onshore cable route.

Drawing NCFFS-NCT-X-XG-0001-01 provides the onshore redline boundary and the bounding coordinates.

2.7.2 HDD Entry and Exit Holes

The proposed Landfall HDD entrance point is 100-120m inland from the seacliffs between Heathery Haven and Watery Haven as shown in Drawing NCGEN-NCT-Z-XD-0001-01. The marine exit points will be approximately 190m offshore from the cliffs as indicated in Figure 2.9.

The Road Crossing HDD entry and exit points either side of the A90 and disused railway for the Roadside HDD are shown in Drawing NCGEN-NCT-Z-XD-0001-02.

2.7.3 Offshore HVDC Cable Corridor

The cable's subsea consenting cable corridor from Long Haven to Simadalen is shown in Drawing 3013. Drawings NCOFF-NCT-X-XG-0001-01 to 04 shows a more detailed view of the UK section of the route. The detailed binding coordinates for the corridor have been provided as Appendix 01 to the marine licence application. Table 2.8 provides the main boundary points of the corridor.

Table 2.8: Main Offshore Corridor Boundary Points

ID	Latitude	Longitude
Landfall North	57° 26.962'N	001° 47.860'W
Inflection Point 1 North	57° 32.065'N	001° 38.381'W
STW North	57° 35.661'N	001° 25.652'W
Inflection Point 2 North	57° 40.565'N	001° 04.660'W
Inflection Point 3 North	58° 18.316'N	000° 57.265'E
UK EEZ North (eastern extent of corridor)	58° 25.713'N	001° 28.950'E
UK EEZ South (eastern extent of corridor)	58° 25.445'N	001° 29.201'E
Inflection Point 3 South	58° 18.046'N	000° 57.496'E
Inflection Point 2 South	57° 40.298'N	001° 04.417'W
STW South	57° 35.363'N	001° 25.571'W
Inflection Point 1 South	57° 32.635'N	001° 35.649'W
Landfall South	57° 26.824'N	001° 47.617'W

2.8 Project Programme

Figure 2.12 shows the outline programme for the whole NorthConnect project. The onshore (HVAC Cable and Converter Station) consent for the UK was given in September 2015. If the offshore HVDC Cable is approved, consents for the project should come in early 2019, with the financial investment decision being made by the end of 2019.

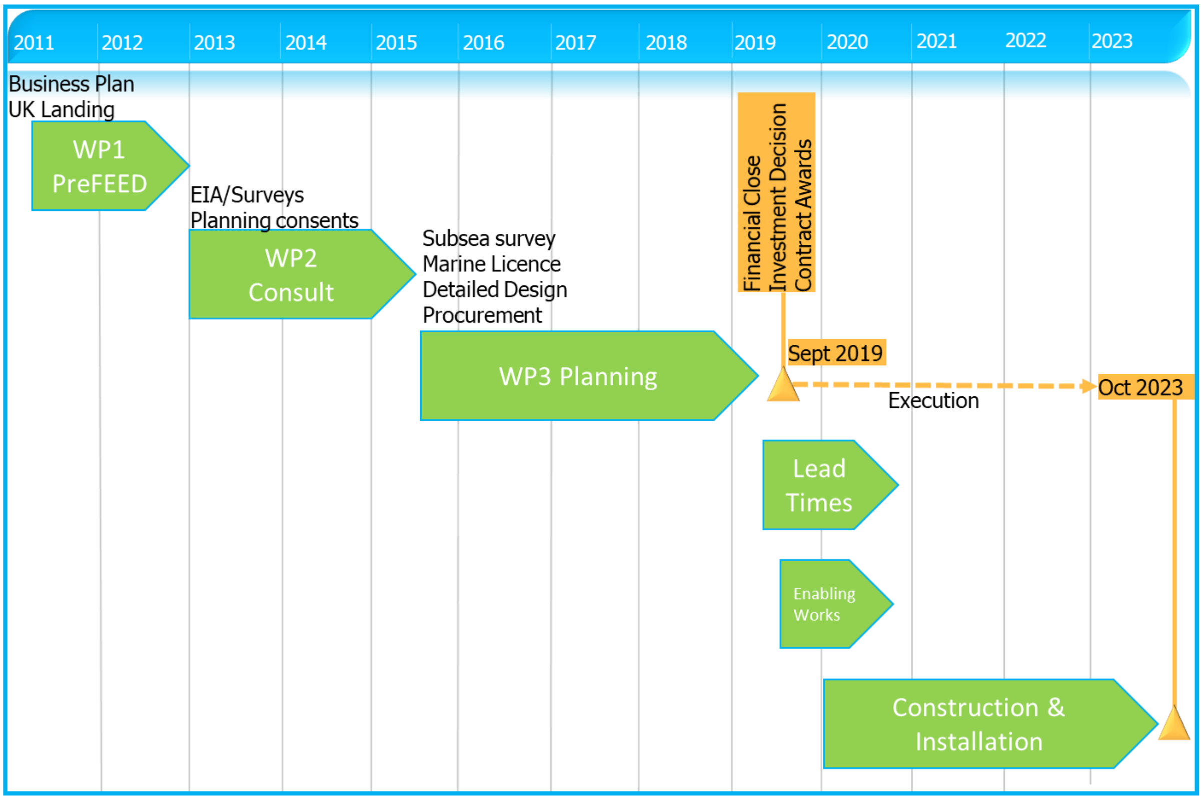

Figure 2.12 Project Programme

2.8.1 Construction Programme

The detailed programme will be developed by the main delivery contractor(s) for the project when appointed. However, approximate timings for each stage are given below in Table 2.9. As further design and then procurement of the design and build contracts is still to be undertaken, the programme has been estimated here for consenting purposes. Overall, a 54 month period of construction work is expected. Some activities are limited as to when in the year they can occur. For example, the Landfall HDD will be drilled in the winter months to avoid disturbance to breeding birds (see Chapter 17: Ornithology).

Table 2.96 Main Project Components with Approximate Timescales

Project Component	Activity	Approximate Timescales (for UK only)	Further Details
Onshore Enabling Works	Construct new junction at the A90.	6 weeks	
Onshore Enabling Works	Construct HDD Access road with water pipe from A90 water supply.	6 weeks	Preparation of access road to the HDD site, and bringing water supply for use at the HDD site.
Onshore Enabling Works	Water pipe from supply north of A90 brought to Fourfields Converter Station.	2 weeks	
Onshore Enabling Works	Ducts installed under the public footpath for the HVDC cables and the water pipe.	1 week	Path bisecting Fourfields will remain open during this time.
Onshore HVDC Cable Installation	Installation of HVDC cables onshore.	2 months	In two trenches from the cliffside HDD site to Joining Pit 1, and in one trench from the A90 HDD site to the converter station.
Onshore HVDC Cable Installation	Joint Pit construction	1 month	Two joint pits required.
Road Crossing HDD	Road Crossing HDD onshore drilling and cable pull under A90 and disused railway.	2 months	
Onshore HVDC Cable Installation	Land reinstatement	1 month	The access road may be left if the landowner prefers this to reinstatement.The fields should be reinstated to usable fields for farm animals, as before.
Landfall HDD	Site set-up	2 months	Getting the site ready for the HDD drilling. Includes setting up the plant and carpark.
Landfall HDD	Onshore drilling and HDD exit preparation.	4-6 months	This timescale is for all three holes to be drilled. May take place over two winters.
Marine Cable Pull	Cable pull site set up	4 days	Short period of time to set up for cable pull activitity.
Marine Cable Pull	Cable pull	1 week per pull	There will be two cable pulls; one for the first HVDC cable, and one for the second HVDC cable and fibre optic cable. There will be a gap inbetween each cable pull of between 4-12 months.

Project Component	Activity	Approximate Timescales (for UK only)	Further Details
Offshore Preparations	Marine Route Surveys	3 months	Carried out by the Contractor to determine fine-scale routing.
Offshore Preparations	Route Clearance, pre-trenching and pre-rockplacement at crossings	1 month	2 out of service cables in the UK EEZ will need removed. Ths activity will be timed to be in place a maximum of 4 weeks prior to the first cable installation. It is the intention to exectue the pre-rock placemnt for all crossings in one operation.
Offshore Cable Installation	Cable laying and post Cable Lay Trenching	1 month* per 170km cable.	Gap of at least 4 months inbetween each cable lay, due to cable production timings. Trenching occurs approximately 7 days after the cable laying has started. Laying and trenching will therefore be carried out concurrently on different sections of the route. This will be repeated for each HVDC cable.
Offshore Cable Installation	Trenching Survey	2 months*	A survey will take place directly after the cable has been trenched.
Offshore Cable Installation	Rock Placement Further cable protection, e.g. rock placement operations.	2 months* per 170km cable.	This will occur where the laying and trenching has not reached the minimum accepted depth of lowering, and at crossings. There will be a survey operation of the rockplacement also taking place.
Offshore Cable Installation	Post Installation Survey/As-built survey	1 month	

* The aim is to have no more than 3 months between cables being laid and them being fully protected to allow all activities (including trawl fishing) to recommence.

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