ENGINEERING

NATIONAL GRID VIKING LINK COMPULSORY PURCHASE ORDER 2019

PROOF OF EVIDENCE

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1. QUALIFICATIONS AND EXPERIENCE

1.1 My name is Graham John Symons and I am employed by National Grid as a Senior Development Engineer. I have been assigned to the Viking Link Interconnector project since April 2017. I have been responsible for the selection and development of the High Voltage Alternative Current ("HVAC") and High Voltage Direct Current ("HVDC") cable routes, utilising my experience and understanding of the technical requirements for the installation of cables.

1.2 I have been employed in the High Voltage cable industry since 1976 and have worked on a number of major overseas projects since 1988. Some of the projects I have worked on include the first 132kV XLPE contract in Rihand India, a 132 & 33 kV British Aid project via world bank in Bangladesh, the 275kV Pergau Dam project in Malaysia, and 230kV Electrification of South Thornberry Bangkok.

1.3 Between 2004 and 2013 I was working in the Middle East area specifically the United Arab Emirates and Qatar. This involved development of the power network around Dubai and the underground 400kV electrification of Abu Dhabi.

1.4 I have worked on other long linear projects similar to National Grid Viking Link Limited's ("NGVL") Viking Link Interconnector, such as the Qatar phase 7400kV route double circuit, which was a 42km route.

1.5 Back in the UK, between 2013 and 2017 I was the commissioning manager on the Western Link 600kV HVDC and HVAC link between Flintshire Bridge in North Wales to Hunterston in West Kilbride Scotland, a 422km route with submarine and land cables similar to the Project.

1.6 I was the engineer responsible for the preparation and delivery of engineering evidence on behalf of NGVL at the successful planning appeal inquiry into East Lindsey District Council's refusal to grant planning permission for part of the HVDC route.

2. INTRODUCTION AND SCOPE OF EVIDENCE

2.1 My proof of evidence is set out as follows:-

2.1.1 **Section 1**- Outlines my qualifications and experience.

2.1.2 **Section 2**- Introduces my proof of evidence.

2.1.3 **Section 3**- Provides an overview of the Viking Link Interconnector and the UK Onshore Scheme.

2.1.4 **Section 4**- Describes the works required for the UK Onshore Scheme.

2.1.5 **Section 5**- Comments on objections made to the Order.

2.1.6 **Section 6**- Contains my conclusions.

2.1.7 **Section 7**- Contains my declaration.

3. THE VIKING LINK INTERCONNECTOR AND UK ONSHORE SCHEME

Overview of the Viking Link Interconnector

3.1 The Viking Link Interconnector is a proposed 1400 megawatt ("MW") HVDC electricity interconnector between the British and Danish electricity transmission systems, connecting at the National Grid Electricity Transmission plc ("NGET") Substation at Bicker Fen in Lincolnshire and Revising in south Jutland, Denmark. The Viking Link Interconnector will be approximately 760km long and will allow electricity to be exchanged between Great Britain and Denmark equivalent to approximately 1.3% of Great Britain's current usage.

3.2 The key components of the Viking Link Interconnector, which are shown on BoP 1 at Appendix 1 of my proof of evidence, are as follows:

3.2.1 The installation of approximately 650km of HVDC submarine cables, which will cross through UK, Dutch, German and Danish territorial waters in the North Sea and come ashore at "landfall points" in the UK and Denmark;

3.2.2 The construction of a converter station at each end of the interconnector in the UK and Denmark, which is required because both countries' existing electricity networks operate HVAC electricity transmission systems, so in order to transmit electricity between the two countries via the HVDC submarine cables it is necessary to convert the electricity between HVAC and HVDC, and vice versa;

3.2.3 The installation of underground onshore cables in the UK and Denmark, which will connect the landfall points to the convertor stations, and the convertor stations to existing sub-stations;

3.2.4 New equipment within the existing NGET Substation in the UK, where the Viking Link Interconnector will connect to the British National Electricity Transmission System ("NETS"); and

3.2.5 New equipment within an existing substation in Denmark to connect the Viking Link Interconnector to the Danish electricity transmission system.

Overview of the UK Onshore Scheme

3.3 The Order has been made to acquire the land and new rights required for that part of the Viking Link Interconnector comprising the 'UK Onshore Scheme', the main components of which are as follows:

3.3.1 At the proposed landfall, two (2) submarine HVDC cables and one (1) submarine fibre optic monitoring cable will be installed through the Mean Low Water Springs ("MLWS") point on the beach, an onshore joint will be made which will connect the submarine and onshore cables in a Transition Joint Pit ("TJP");

3.3.2 From the TJP, two (2) onshore HVDC cables and two (2) onshore fibre optic monitoring cables (one to monitor each HVDC cable), will be installed between the landfall at Boygrift in East Lindsey and the converter station at North Ing Drove in South Holland (NB: The single submarine fibre optic monitoring cable that enters the TJP will be split in to two onshore fibre optic monitoring cables so that one cable can run alongside, and monitor, each of the HVDC cables between the TJP and the point where they reach the converter station);

3.3.3 Construction of associated Temporary Construction Compounds ("TCC"), Temporary Works Areas ("TWA") and temporary vehicle access arrangements to facilitate construction work;

3.3.4 Erection of converter station buildings and outdoor electrical equipment together with the construction of internal roads, erection of security fencing and provision of landscaping at North Ing Drove in South Holland;

3.3.5 Construction of a permanent access road from the A52 to the converter station site including a new permanent bridge crossing over Hammond Beck;

3.3.6 Installation of six (6) onshore HVAC cables (in two circuits), with associated protection and fibre optic monitoring cables, between the converter station at North Ing Drove and connection bays at the existing NGET Substation;

3.3.7 Installation of link pillars at joint bays along the HVAC cable route for inspection and maintenance purposes, which will be contained within protected, fenced areas;

3.3.8 Installation of temporary and permanent land drainage works as well as provision of temporary water management areas to assist with construction activities; and

3.3.9 Installation of fibre-optic cable(s) with the HVDC cables for the purpose of monitoring cable performance and with the HVAC cables for the purpose of monitoring cable performance along the HVAC route.

4. WORKS REQUIRED FOR THE UK ONSHORE SCHEME

4.1 The land and new rights proposed to be acquired within the Order Land are needed to enable the installation and operation of the UK Onshore Scheme. A summary of the works that comprise the UK Onshore Scheme is provided at in section 3 above. This section of my proof provides further detail on:

4.1.1 the infrastructure that will be installed;

4.1.2 the construction works that are required; and

4.1.3 the spatial extent of the land and new rights that are needed to facilitate the construction, operation and future maintenance of the UK Onshore Scheme.

4.2 A Glossary of terms is provided at Appendix 2 to my proof of evidence to assist the reader.

4.3 NGVL has developed a base scheme design for the UK Onshore Scheme for the purposes of seeking planning permission and promoting the Order. This was informed by a wide range of surveys and assessments, including ecological surveys, geophysical surveys, ground investigations (e.g. boreholes), soil surveys, and land drainage assessments. Details of the soil surveys and drainage recommendations are provided in section 4 of the proof of evidence of Mr David Royle (NGVL/DR/1).

4.4 The appointed civil, cable and converter station contractors will be responsible for further developing the detailed design, including matters such as route alignment, micro siting and identifying joint bay locations. The procurement process which will lead to the appointment of the civil, cable and converter station contractors is ongoing. It is currently anticipated that contracts will be awarded in Q2/3 2019.

4.5 The detailed design process, whilst meeting a number of technical and physical constraints, must also follow the controls set out in the four planning permissions granted for the UK Onshore Scheme.

4.6 With a long linear project such as the Viking Link Interconnector, it is not practical to start at one end of the route and work systematically towards the far end. For these type of projects the route needs to be split into smaller working areas, to allow similar activities to be carried out across multiple areas so that as soon as the cable delivery reaches the UK it can be installed and the jointing works commenced on multiple fronts. The initial design by NGVL has been based on the route being split into three main sections. The appointed civil contractor may follow or alter this proposed approach to suit its most efficient working pattern after the available quantity and delivery date of the cable batches is confirmed.

HVDC Route

HVDC Route – Landfall (shown on Order Map 1)

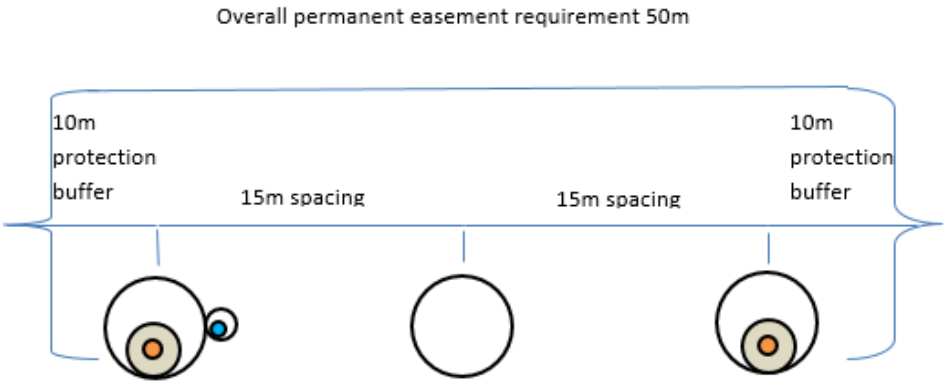
Landfall Works

4.7 The landfall point is of critical importance because it is the point where two HVDC submarine cables and one subsea fibre optic monitoring cable come ashore and connect to the onshore HVDC cables. NB: The submarine cables will be installed beneath the beach out with the Order Land pursuant to a licence and lease from The Crown Estate.

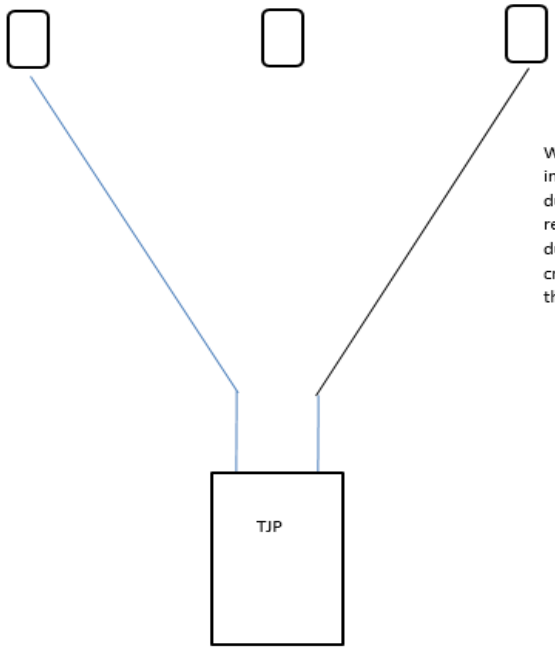
4.8 Whilst there are various methods of bringing a submarine cable onto land, in this location, the presence of sea defences has led to a decision to use a technique called Horizontal Directional Drilling ("HDD"). This technique avoids disruption to the surface of the land, and any structures on it, as all the installation work is below ground. This removes any risk of damaging/breaching the sea defences in this location and the potential for any localised flooding.

4.9 The two HVDC submarine cables and one fibre optic cable will be installed below the existing sea defences in three ducts (one for each cable). Due to the critical importance of the landfall point and complexity of the installation works, a fourth duct, in which a new cable could be installed, will be installed, sealed and left empty to 'future proof' the landfall in case of a cable fault.)

4.10 The ducts will be approximately 15 metres apart, measured from their centre points. The indicative drawings below show the anticipated spacing of the cable ducts and the area needed either side of them for protection. The exact position and spacing of the cables will be finalised during detailed design.



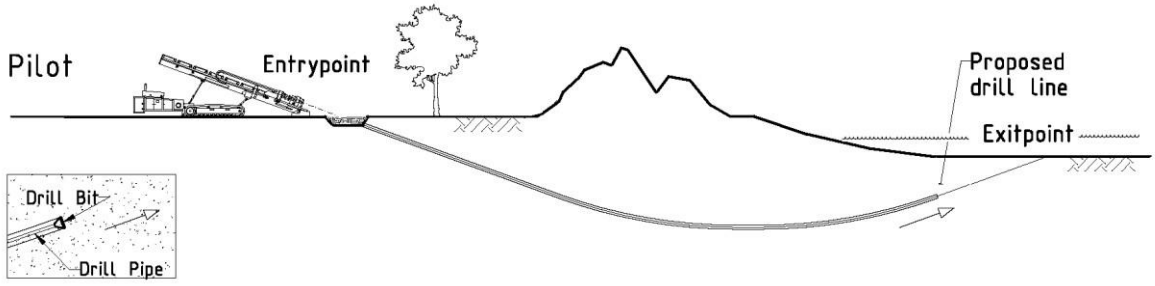
Cross sectional view towards the sea of the four (4) ducts. The submarine power cables will be installed in the outer two ducts with the submarine fibre optic installed adjacent to one core



4.11 The submarine cables will terminate at a buried TJP located inland of the existing sea defences to the west of Roman Bank, where they will connect to the underground onshore cables.

Construction activities

4.12 As noted at paragraph 4.9 above, the HVDC cables will be installed beneath the existing sea defences using a technique called HDD. HDD involves installing the cables in a duct along a prescribed underground path using a surface-launched drilling rig as indicatively shown in the drawing below.



4.13 A wider working area of 50m is needed where HDD is to be utilised than where trenched installation methods are used. This is because:

4.13.1 the specialist equipment needed is much larger, as can be seen from the photograph of an example HDD below; and

4.13.2 the deeper the cables need to be installed, the greater the distance required between the drilled ducts. This is to ensure sufficient thermal separation- each cable runs most efficiently at an optimal temperature so the aim is to install the cables in an environment where they are totally independent from each other and one cable does not mutually heat each other.

4.14 As can be seen from the diagram and table at Appendix 3 of my proof of evidence, the cables will be installed at a depth of up to 20m below the existing sea defences which necessitates as distance of 15m between each of the three HVDC cable ducts. These separation distances, together with the 10m protection 'buffer' required at either side of the installed infrastructure to prevent interference with/damage to the cables and any associated injury to members of the public (as illustrated in the drawing at paragraph 4.10 above,) mean that the land needed to accommodate and protect the installed infrastructure in this location, over which rights will be required in perpetuity, is 50m. The protection buffers be used by NGVL for the carrying out of maintenance and repair works.

4.15 A temporary construction compound of 95mx 75m will need to be established near to the landfall point for the storage of plant and machinery, and for stockpiling materials, as well as the provision of site management offices, parking and welfare facilities for construction personnel (kitchen facilities, store rooms, toilets) in accordance with Health and Safety and Construction (Design and Management) Regulations 2015 ("CDM") (CD Ref: A.6) requirements.

4.16 Access will need to be taken (i) from the public highway via a haul road to be constructed from the A52 to the compound and landfall point, and (ii) from the compound and landfall to the beach, with or without equipment.

Operational activities

4.17 The installed infrastructure will need to inspected periodically, by personnel on foot or via aerial survey. Routine maintenance works may need to be undertaken

such as checking ground levels above the cables to avoid heat pockets. In the unlikely event of a fault or damage to the cables or other associated equipment, repair or replacement works may need to be undertaken.

4.18 Access will need to be taken from the public highway to the beach, with or without equipment, for the purposes of inspection/maintenance/repair etc.

Rights required

4.19 In light of the above, rights are required to:

4.19.1 enable construction of the Landfall Works i.e. the installation of the cables beneath the existing sea defences using HDD; the construction of a TJP where the submarine cables will connect to the onshore underground cables; the carrying out of drainage works, including temporary drainage works required for the HDD;

4.19.2 create and use a temporary construction compound;

4.19.3 create a temporary working area to facilitate the HDD works, which will enable the necessary 24hr working and house materials needed to maintain the drilling rig with spares of high risk items, such as hydraulic hoses and generators, as well as messing and welfare facilities with drying rooms for the working team;

4.19.4 construct a temporary haul road for the purposes of the compound and HDD works, given that pursuant to the terms of the planning permission vehicle access is not permitted off Roman Bank Road;

4.19.5 take access to the beach, to facilitate the construction activities and the operational activities;

4.19.6 enable operational activities, such as maintenance, repair/replacement of the cables in the unlikely event of a fault/damage, and future decommissioning of the HVDC cables;

4.19.7 protect and prevent interference with the installed infrastructure.

4.20 Section 4.14 of Mr Oliver Heselton's proof of evidence (NGVL/OH/1) describes the rights that have been included in the Order to facilitate construction, operation and decommissioning at the landfall and protection of the cables during their operational life.

4.21 The Order Land boundary, over which these rights are required, is wider at the landfall point due to factors which include, but are not limited to:

4.21.1 the criticality and high risk of the HDD operation for the project;

4.21.2 complexity of the Landfall HDD operation, due to the depth and length of the HDD ducts;

4.21.3 unknown ground conditions that cannot be identified until the HDD operations take place;

4.21.4 size of the specialist equipment needed to complete the HDD operation; and

4.21.5 site establishment, storage of installation material, safe access and egress and the working area required to complete the HDD operation.

HVDC Cable – beyond Landfall (shown on Order Maps 1 to 40 and 42)

HVDC Cable Works

4.22 The HVDC route runs underground for approximately 68Km from the Landfall Zone to the converter station at North Ing Drove.

4.23 The HVDC route will comprise of two HVDC cables, together with two fibre optic cables for the purpose of monitoring cable performance, all installed in a single trench. There will be cable joint bays at intervals along the route to connect the cable sections together. There will also be above ground cable marker posts installed to indicate the location of the cables.

Construction activities

4.24 Construction of the HVDC cable will be undertaken using a combination of:

4.24.1 trenched installation techniques across open land, with the cables being installed within buried ducts, surrounded by a thermally suitable material; and

4.24.2 trenchless methods, such as HDD, to cross obstacles where appropriate, including (but not limited to) roads, railway lines, buried utilities and watercourses.

4.25 The HVDC land rights corridor, shown coloured blue on Order Maps 1 to 40 and 42 (CD Ref: D.2), is in general approximately 60m in width. Construction will typically be carried out within a 30m working width, however rights to construct the HVDC route are required over a wider circa 60m land rights corridor for reasons including the following:

4.25.1 the space required at crossing points (see paragraphs 4.34 to 4.40 below);

4.25.2 the space required for access and egress, vehicles, equipment, and site establishment to install a cable joint bay (60m);

4.25.3 the need to allow sufficient flexibility to enable the cable to be routed around any obstacles/constraints which may be encountered during construction, including but not limited to archaeology; and

4.25.4 the need for flexibility in locating the cable joint bays along the route due to further route optimisation to be completed in detailed design.

4.26 Cable joint bays are where two adjacent sections of cable have been installed and are subsequently joined together. BoP3 (Appendix 1) is a cross-sectional representation of a typical joint bay. Within the HVDC corridor, a construction area of 60m is required to allow space for specialist cable delivery vehicles and installation equipment, site set up and welfare access, and emergency access at the point of works.

4.27 At this stage in the design process NGVL does not know where the joint bays will be located along the route. Joint bay locations will be determined during detailed design in coordination between the Cable and Civil contractors post contract award in Q2 and Q3 2019 respectively. The joint bay locations will consider the logistics of cable delivery lengths and cable installation calculations and design, to see if cable lengths can be increased in certain areas, with the intention of minimising the number of joint bays needed. Accordingly, it is necessary for NGVL to seek construction rights across the entire circa 60m corridor in order to ensure that cable joint bays can be appropriately sited.

4.28 The construction of the HVDC route will typically be undertaken using trenched installation.

4.29 BoP4 is a cross-sectional representation of the construction corridor within which the two HVDC cables will be installed in ducts using trenched installation.

4.30 With the exception of cable joint bays, trenched installation will typically take place within a 30m 'working width', and will involve the following:

4.30.1 Cable trench: this is the excavation within which the two HVDC cables will be installed in ducts, within one trench, together with two fibre optic cables required for monitoring purposes.

4.30.2 Working areas: these are areas on either side of the trench which are needed to allow the safe and efficient movement of the personnel, plant and machinery used to perform the construction activities required, including trench excavation, cable installation and reinstatement. These areas will also include defined safety walkways along the cable route for the construction team.

4.30.3 Topsoil bund: this area will be used for the storage of topsoil. Given that the cable will be installed predominantly within high quality agricultural land, it will be important to separate and store the topsoil in a way that maintains its integrity and structure as per the requirements of a Soil Handling and Storage Protocol ("SHSP") (CD

Ref: C.10). The topsoil would be stripped and stockpiled adjacent to the area stripped to ensure the soil is returned to the same area during reinstatement.

4.30.4 Subsoil bund: this area will be used to store the soil that has been excavated to create the trench. The sub soil removed from the trench will be stockpiled adjacent to the area where it was removed from to ensure the soil is returned to the same area during reinstatement and would be stored away from the topsoil to prevent mixing of soil types. It will also need to be stored in a manner that maintains its integrity and structure as per the requirements of a SHSP (CD Ref: C.10) as it will be used to backfill and reinstate the trench after the ducts, cable, and cable joints have been installed. Any subsoil remaining after reinstatement will be disposed of as per the requirements of the Waste Management Plan ("WMP") (CD Ref: C.9).

4.30.5 Temporary haul road and passing places: the working width will include a haul road for construction traffic along the cable route. This will need to be wider in certain places to allow vehicles to safely pass each other. The haul road will typically be 5m wide, increasing to up to 10m where there are passing places. This is particularly important to ensure access in the event of an emergency. The haul road will have a slightly different orientation at joint bays to allow the specialist drum trailer to move into position to enable the cable to be pulled in to position. By including a haul road, NGVL can minimise the amount of construction-related traffic that will need to use public roads. The haul road material will be specified during detailed design.

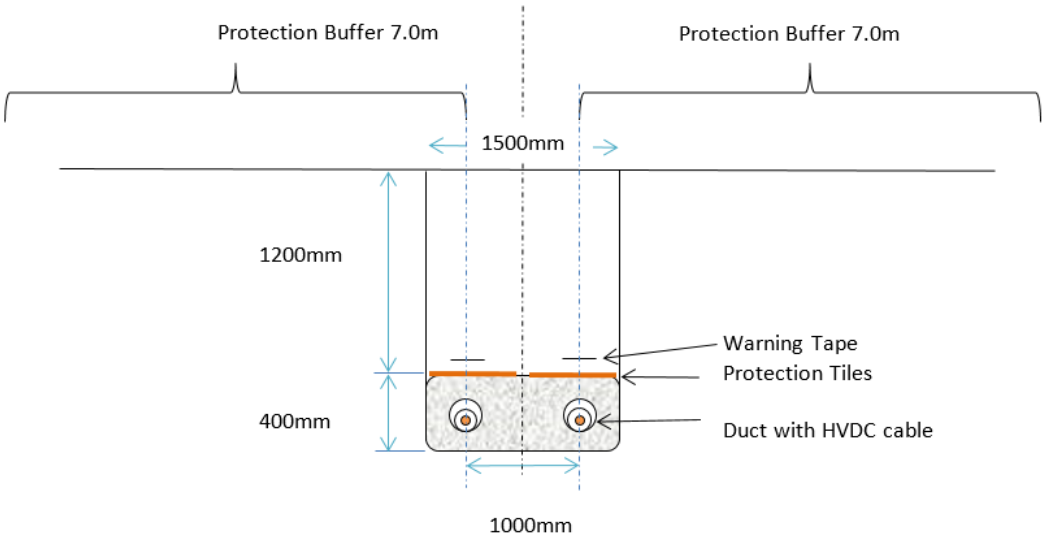
4.30.6 Fence: to ensure compliance with the CDM Regulations (CD Ref: A.6) the working width will be fenced off to define the area in which construction activities will be undertaken.

4.30.7 Drainage: de-watering and land drainage repair/installation works.

4.31 The industry standard depth for installation of HVDC cables is 900mm to the top of the protection titles (which are shown coloured grey on the indicative diagram below). However, following discussions with landowners, and in light of the unique drainage characteristics of the Lincolnshire region, this depth has been increased to 1200mm to the top of the protection tiles. The requisite distance between the cables to ensure sufficient thermal separation is anticipated to be 1000mm given the increased burial depth of 1200mm.

4.32 A 7m 'protection buffer' is required at either side of the installed infrastructure to prevent interference with/damage to the cables and any associated injury to

members of the public. These buffers will be used by NGVL for the carrying out of maintenance and repair works.



4.33 There are also a number of points along the HVDC route where the cables need to 'cross' (i.e. be installed beneath) obstacles such as roads, railway lines, certain utilities and watercourses. The construction area needs to be wider than 30m at these points to allow space for the specialist installation equipment (such as HDD) to be used.

4.34 NGVL has sought to identify so far as practicable the obstacles along the HVDC route which will need to be 'crossed'. These have been grouped wherever possible so that a number of them can be crossed by a single trenchless installation arrangement (e.g. road and cables located in the verge). The need for further trenchless installations maybe identified during construction.

4.35 BoP5 shows a typical cross-sectional representation of a small watercourse crossing where a trenchless installation will be carried out. It shows a temporary bridge which would be installed to allow construction and emergency vehicles access across the watercourse (with materials and equipment sited at both ends of the HDD) during the works.

4.36 BoP 6 (Appendix 1) shows a haul route 'dead end' where a temporary bridge cannot be used to cross the watercourse or obstruction.

4.37 In the construction industry it is standard practice to cross other companies' assets at right angles where ever possible. This is particularly relevant in the electrical industry where it may be possible to pick up circulation currents from close adjacent cables if long parallel routes are followed. For each crossing a study will be done to determine the best depth and spacing needed to cross the asset following any specific requirements of the asset owner. These details will be submitted and checked by all parties and after agreement a permit will be

issued to allow the works to be undertaken. At this stage the contractor may seek to amend the crossing angle if, after a detailed review, it is found that the asset owner is in agreement to do so.

4.38 As a result of the need to cross other companies' assets, potentially at right angles, it has in some instances been necessary to take rights over an area greater than the 'standard' 60m width.

4.39 Appendix 4 of my proof of evidence contains copies of Order Maps 3, 4 and 13. These show examples of HVDC crossings which are wider than the 'standard' 60m:

4.39.1 Map 3 shows the crossing of a Cadent Gas pipe. The asset owner, Cadent Gas, has requested that its asset be crossed at 90 degrees, as is industry practice. The indicative route of the HVDC cable is shown by the dashed red line on Map 3. The corridor of land over which rights will be required at this crossing point is therefore wider than the 'standard' 60m.

4.39.2 Map 4 shows the route crossing the A111 road. The corridor of land over which rights will be has been widened here to allow the approach to the road to be at 90 degrees as is industry practice. Apparatus located within the road owned by Anglian Water (water pipe) and Open reach fibre optic cables) will be 'crossed' at the same time using a single HDD. The indicative route of the HVDC cable is shown by the dashed red line on Map 4.

4.39.3 Map 13 shows the HVDC cable route as it approaches a chalk stream in the Lincolnshire Wolds Area of Outstanding National Beauty. To minimise any disruption to the chalk stream the crossing will be at right angles to it as indicatively shown by a dashed red line on Map 13. The corridor of land over which rights will be required at this crossing point is wider than the 'standard' 60m as a result.

Operational activities

4.40 The installed infrastructure will need to be inspected periodically, by personnel on foot or more likely, given the scale of the HVDC route, via aerial survey. Routine maintenance works may need to be undertaken such as checking ground levels above the cables to avoid heat pockets. In the unlikely event of a fault or damage to the cables or other associated equipment, repair or replacement works may need to be undertaken.

Rights required

4.41 In light of the above, rights are required to:

4.41.1 enable installation of the cables and associated equipment, including cable joint bays, and the carrying out of land drainage works etc. over a 60m corridor;

4.41.2 enable operational activities, such as surveys/inspections, maintenance, repair/replacement of the cables in the unlikely event of a fault/damage, and future decommissioning of the HVDC cables;

4.41.3 protect and prevent interference with the installed infrastructure

Note: Where HDD/trenchless construction techniques are used, a 'rights corridor' of 25m in width will be required to accommodate the installed infrastructure, access for maintenance and a protective 'buffer'. In all other areas, i.e. where trenched installation is used, a 'rights corridor' of 15m in width is required. The wider area for the HDD is due to the increased spacing required to allow the cable ducts to be drilled at the correct spacing to maintain the cables thermal independence from each other. This width will be defined by the cable designer

4.41.4 take access over the Order Land to the 'rights corridor' from the public highway.

Note: NGVL will need rights to take access over the Order Land situated between the 25/15m 'rights corridor' and the nearest public highway to facilitate the carrying out of operational activities, such as maintenance/repairs, and decommissioning.

4.42 Section 4.12 of Mr Oliver Heselton's proof of evidence describes the rights that have been included in the Order to facilitate construction, operation, decommissioning and protection of the HVDC cables during their operational life.

Converter Station Site (shown on Order Map 42)

Converter station works

4.43 The proposed site for the converter station at North Ing Drove occupies a single field of approximately 30ha that is currently used for agricultural purposes.

4.44 At the converter station electricity will be converted from High Voltage Direct Current (HVDC - which is the form in which it will be transmitted through the submarine and onshore underground cables from Denmark) to High Voltage Alternating Current (HVAC - which is the form required for the connection to the existing 400kV Bicker Fen substation) or vice versa for power flow to Denmark from Great Britain.

4.45 The converter station layout is illustrated on BoP7 (Appendix 1), Proposed Converter Station: Base Design Layout.

4.46 The component parts are described in more detail below.

(a) Buildings and outdoor electrical equipment - shown coloured blue

4.47 This area comprises both the indoor and outdoor high voltage electrical equipment as well as other buildings supporting the operation of the conveter station, as follows:

4.47.1 HVAC switchyards (outdoor): this is where the 400kV HVAC cables from the National Grid Bicker Fen substation ("NGET Substation") terminate inside the converter station. The HVAC switchyard also includes other 400kV equipment associated with the control and protection of the converter station, e.g. circuit breakers, current and voltage transformers and harmonic filters.

4.47.2 Converter transformer bays (outdoor): the converter transformer bays house the converter transformers that are located between the HVAC switchyard and the converter hall. The converter transformers adapt the voltage of the HVAC electricity from the National Grid to the voltage required by the HVDC converters. Each transformer is contained in a noise enclosure to reduce its sound emissions and is separated from adjacent transformers and the converter hall by firewalls.

4.47.3 Converter halls (indoor): these buildings contain the HVDC converter equipment which converts the electricity from HVAC to HVDC (and vice versa).

4.47.4 DC halls (indoor): this is where the HVDC cables are terminated inside the converter station to allow connection to the HVDC converters.

4.47.5 Control building (indoor): this building contains the operator control room where the converter station is operated from as well as rooms that contain control, protection and telecommunication systems. Office space, welfare facilities and other auxiliary systems are also located within the control building.

4.47.6 Diesel generator (indoor): The diesel generator can provide power to operate the converter station auxiliary systems in the event that the normal supply from the Distribution Network Operator (DNO) fails.

4.47.7 Spare parts buildings (indoor): these buildings house spare parts and special tools needed for the operation and maintenance of the

converter station. Adjacent hardstanding areas provide storage for large and/or heavy items e.g. spare cable drums.

(b) Landscape Screening- shown coloured light and dark green

4.48 As required by the South Holland District Council planning permission, landscaping is to be provided to screen the converter station from nearby visual receptors.

4.49 Screening will be achieved through a combination of tree and shrub planting, earthworks and boundary treatments such as hedgerows to help integrate the site into the surrounding landscape with the aim of making it less conspicuous. Breaks in the planting exist to accommodate the main access road into the converter station as well as the HVAC and HVDC cable routes (light green areas on BoP7).

4.50 Sufficient space has been allowed between the closest point of the security fencing (shown coloured pink on BoP7) and the outer boundary of the converter station site (indicated by a dashed black line on BoP7) to accommodate a suitable landscaping screen of up to 40 metres wide creating a 'green' perimeter around the converter station site.

(c) Security perimeter zone and perimeter road zone- shown coloured pink and grey respectively

4.51 The Security Zone (shown coloured pink on BoP7) comprises an 8-metre-wide '*buffer*' zone within which security fencing would be erected. The security fence will incorporate security gates for pedestrian and vehicle access and egress to the convertor station and closed circuit TV cameras will be installed at regular intervals along the perimeter fence for security and surveillance purposes.

4.52 Inside the security zone, a permanent perimeter road around the converter station (shown coloured grey on BoP7) will be constructed to facilitate access based on the largest vehicles which will require access to the site.

(d) Hardstanding Zone - shown coloured brown

4.53 The hardstanding will be provided for car parking, laydown areas, equipment storage and temporary offices for future maintenance or refurbishment activities.

(e) Construction laydown area/'Reinstated Zone'- shown hatched black

4.54 During construction of the converter station, HVDC and HVAC cable routes and landscaping works, the area hatched black will be used for but not limited to:

4.54.1 Excavation of soil to allow reprofiling of the converter station site (see 4.55 below).

4.54.2 Site accommodation, laydown areas, car parking and welfare facilities for the converter station and HVAC cable works (see 4.59 below).

4.54.3 HVAC and HVDC cable route installation works, which would include the need for haul roads and the CDM area as described in paragraphs 4.77.5 and 4.77.6.

4.55 During operation of the converter station, the 'Reinstated Zone' would also provide for site accommodation in the event of future asset management related activities. These could include major midlife refurbishment of the converter station, equipment dismantling as part of a failure investigation or a laydown area in the event of an HVAC or HVDC cable fault repair.

4.56 Ultimately, the 'Reinstated Zone' could be used to construct a replacement converter station to extend the asset life of the Viking Link Interconnector. The HVDC underground and submarine cables comprise much of the capital cost of the Viking Link Interconnector and are expected to have a longer asset life than the converter stations in Denmark and the UK. The 'Reinstated Zone' provides the opportunity to construct a replacement converter station with the existing converter station in operation, thus avoiding an extended outage.

(f) Attenuation zone - shown hatched red

4.57 This area is required to establish an attenuation pond which will comprise part of the permanent drainage scheme for the converter site.

Construction works

4.58 As discussed in paragraphs 2.2.2 and 3.2.6 of Chapter 17 of the Environmental Statement which accompanied the applications for planning permission for the UK Onshore Scheme (CD Ref: C.8), the existing ground levels within the converter station site vary from approximately 2 to 3m AOD. To provide a level site for the converter station and also to mitigate future flood risk, the land on which the converter station will be constructed will be reprofiled to approximately 2.9m AOD. Soil from the "reinstated zone" will be used for this purpose, thereby avoiding a large amount of large goods vehicle movements on the surrounding public roads to bring in imported soil.

4.59 Once the ground beneath the converter station is made up to the required level, the reinstated zone will be used to provide temporary construction accommodation for the converter station and HVDC and HVAC cable works. The temporary accommodation would provide for the following facilities:

4.59.1 Contractor and NGVL site offices

4.59.2 Welfare facilities, e.g. first aid, canteen, showers

4.59.3 Lay down and storage areas

4.59.4 Car parking

4.59.5 Site security

4.59.6 Temporary utilities, water, electricity, telecommunications

4.59.7 Waste management

Land required

4.60 As explained in section 4.6 of Mr Heselton's proof of evidence, NGVL only seeks to acquire freehold title to parcels within the Order Land for the purposes of above ground permanent infrastructure. This is justified for the following reasons:

4.60.1 An HVDC converter station constitutes significant above ground permanent infrastructure.

4.60.2 The SHDC planning permission requires landscaping to be provided and maintained, to screen the converter station from nearby visual receptors. NGVL needs to be able to maintain the landscaping in order to fulfil this planning requirement and therefore need exclusive possession and control of the land on which the landscaping sits.

4.60.3 NGVL needs to control activities in the "reinstated zone", e.g. to prevent development that might be detrimental to the operation of the converter station or restrict future maintenance, refurbishment or replacement activities.

4.60.4 NGVL needs unrestricted access to the converter station for both normal operational staff changeover and the short notice movement of abnormal indivisible loads, e.g. following a converter transformer failure.

4.60.5 The converter station is vital to ensure the continuous flow of electricity along the Viking Link Interconnector, and any unauthorised interference with it could adversely affect security of supply for GB and Denmark. It also contains high voltage equipment that could cause significant or potentially fatal injury. For both reasons, NGVL need exclusive possession and control to maintain security of the converter station.

<u>Converter access road (shown on Order Maps 42 to 44)</u>

Access road works

4.61 Access to the proposed converter station site is currently provided by a network of local roads. Due to a combination of their size, condition and in order to

minimise the impact of construction traffic movements on the local community, a new permanent access road will be constructed from the A52 to the converter station site.

4.62 The access road is approximately 2.8km long and 6 metres wide. The width is necessary to accommodate two-way traffic during construction and the movement of large indivisible loads such as the converter transformers. The access road will also provide access into adjacent agricultural to allow landowners access. Security gates will be provided at each end of the access road to prevent unauthorised access from the A52 and North Ing Drove with appropriate arrangements put in place to allow landowner access to be maintained.

Construction activities

4.63 Access to and from the converter station site will only be via the new access road so this needs to be constructed first. A temporary construction compound will be established to provide temporary facilities and storage during the construction of the permanent access road.

Operational activities

4.64 Following the completion of construction activities, the presence of the access road provides free and unobstructed access to the converter station should, for example, a converter transformer or other large item of equipment need to be moved offsite for repair or replacement.

Land required

4.65 As explained at paragraph 4.67 above, the access road (which will provide access to the converter station from the public highway, and vice versa), is approximately 2.8km long and 6 metres wide. The width is necessary to accommodate two-way traffic during construction and the movement of large indivisible loads such as the converter transformers. The route of the access road between the converter station and the A52 has been chosen to avoid operational traffic using the small roads though Bicker and Northorpe. The land on which it will be constructed is currently used as a farm access track so avoids the acquisition of land which is currently being used for growing crops.

4.66 As explained in paragraph 4.62 above, a temporary construction compound of approximately 1 hectare in size will need to be located adjacent to the new junction with the A52 to facilitate construction of the permanent access road. This will be required for the duration of construction to enable the storage of equipment, provision of site offices, welfare, car parking etc.

4.67 The access road, if unsecured, could present an unauthorised alternative route for local traffic and attract anti-social behaviour e.g. fly tipping. NGVL need to be able to manage the safety and security of the access road and thereby maintain continuous, unobstructed access to the converter station during

operation and maintenance. For these reasons, NGVL requires freehold acquisition of the land upon which the access road is constructed.

HVAC cable (shown on Order Maps 41 and 42)

HVAC Works

4.68 The HVAC route starts at the converter station and runs underground approximately 2.2Km to the NGET Substation.

4.69 Unlike the HVDC route, where only two cables are needed, the HVAC route will comprise of six (6) cables, installed in two groups of three in two trenches.

4.70 The HVAC system requires above ground features, called link pillars, to enable maintenance and monitoring of the HVAC cables. One pillar per circuit is required at each joint bay location within a shared protected area.

4.71 At the NGET Substation, the HVAC cables will be terminated at two substation bays provided by NGET, to connect the UK Onshore Scheme to the NETS.

4.72 Due to uncertainty about where other infrastructure projects will connect their cables to the NGET Substation NGVL has had to include sufficient land in this area to enable flexibility to route around them and/or HDD under them.

Construction activities

4.73 Construction of the HVAC cable will be undertaken using a combination of:

4.73.1 trenched installation techniques across open land, with the cables being directly installed or installed within buried ducts, surrounded by a thermally suitable material; and

4.73.2 trenchless methods, such as HDD, to cross obstacles where appropriate, including (but not limited to) roads and buried utilities.

4.74 Like the HVDC route, construction of the HVAC route will be undertaken using a combination of trenched and trenchless installation methods. The construction corridor is in general approximately 75m in width. This is principally governed by:

4.74.1 the space required at crossing points (see paragraphs 4.78 to 4.80 below);

4.74.2 the space required for access and egress, vehicles, equipment, and site establishment to install two cable joint bays adjacent to each other (75m) (BoP8 is a cross-sectional representation of a typical joint bay which illustrates why a construction area of 75m is required to allow space for specialist cable delivery vehicles and installation equipment, site set up and welfare facilities, and emergency access at the point of works);

4.74.3 the need to allow sufficiently flexibility to enable the cables to be routed around any obstacles/ constraints which may be encountered during construction, including but not limited to archaeology; and

4.74.4 the need for flexibility of location of cable joint bays along the route in order to achieve electrical balancing, which will be established during detailed design.

4.75 The construction of the HVAC route will typically be undertaken using trenched installation.

4.76 BoP9 is a cross sectional representation of the construction corridor within which the six HVAC cables will be installed in ducts using trenched installation.

4.77 With the exception of cable joint bays, trenched installation will typically take place within a 50m 'working width', and will involve the following:

4.77.1 Cable trench: this is the excavation within which six cables will be installed in ducts in two trenches, together with two fibre optic cables for the purpose of monitoring and protection.

4.77.2 Working areas: these are areas on the side and between the two trenches which are needed to allow the safe and efficient movement of personnel, plant and machinery used to perform the construction activities required including trench excavation, cable installation and reinstatement. These areas will include defined safety walkways along the cable route for the construction team.

4.77.3 Topsoil Bund: these areas will be used for the storage of the topsoil. Given that the cables will be installed predominantly within high quality agricultural land, it will be important to separate and store the topsoil in a way that maintains its integrity and structure as defined in the SHSP (CD Ref: C.10). The topsoil would be stripped and stockpiled adjacent to the area stripped to ensure the soil is returned to the same area during reinstatement. Given the wider area needed for the two HVAC circuits more topsoil will need to be stored and wider stock piles will be necessary.

4.77.4 Subsoil bunds: These areas will be used to store the soil that has been excavated to create the trench. The subsoil removed from the trench will be stockpiled adjacent to the area where it was removed from to ensure the soil is returned to the same areas during reinstatement. The subsoil will be stored as far as practicable away from the topsoil to prevent mixing of soil types. It will also need to be stored in a manner that maintains its integrity and structure as per the requirements of the SHSP (CD Ref: C.10) as it will be used to backfill and reinstate the

trench after the ducts, cables and cable joints have been installed. Any subsoil remaining after reinstatement will be disposed of as per the requirements of the WMP (CD Ref: C.9).

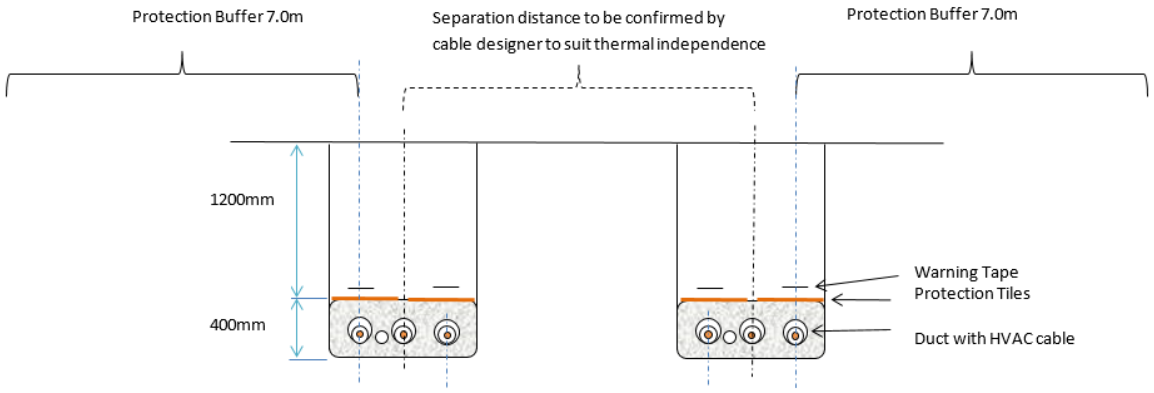
4.77.5 Temporary haul road and passing places: the working width will include a haul road for construction traffic along the cable route. This will need to be wider in certain places to allow vehicles to safely pass each other. The haul road will be typically 5m wide increasing up to 10m where there are passing places. This is particularly important to ensure access in the event of an emergency. The haul road will have a slightly different orientation at joint bays to allow the specialist drum trailer to move into position to enable the cable to be pulled into position. By including a haul road NGVL can minimise the amount of construction-related traffic that will need to use public roads. The haul road material will be specified during detailed design.

4.77.6 Fence: to ensure compliance with the CDM regulations the working area will be fenced off to define the area in which the construction activities will be undertaken.

4.77.7 Drainage: de-watering and land drainage repair/installation works.

4.78 The industry standard depth for installation of HVAC cables is 900mm to the top of the protection titles (which are shown coloured grey on the indicative diagram below). However, following discussions with landowners, and in light of the unique drainage characteristics of the Lincolnshire region, this depth has been increased to 1200mm to the top of the protection tiles. The requisite distance between the cables to ensure sufficient thermal separation is anticipated to be 1000mm given the increased burial depth of 1200mm. The distance between the three cables in each circuit, and between the two circuits, will be determined by the cable designer to maintain thermal independence between the two circuits and the cables within them.

4.79 A 7m 'protection buffer' is required at either side of the installed infrastructure to prevent interference with/damage to the cables and any associated injury to members of the public. These buffers will be used by NGVL for the carrying out of maintenance and repair works.



4.80 There are a number of points along the HVAC route where the cables need to 'cross' (i.e. be installed beneath) obstacles such as roads, certain utilities and drains, including a small field due to the complexity of the existing drainage system. The construction area needs to be wider at these points to allow space for the specialist installation equipment set up (such as HDD) to be used.

4.81 NGVL has sought to identify so far as practicable the obstacles along the HVAC route which will need to be 'crossed'. These have been grouped wherever possible so that a number of them can be crossed by a single trenchless installation. The need for further trenchless installations may be identified during construction.

Operational activities

4.82 The installed infrastructure will need to inspected periodically, by personnel on foot or via aerial survey. Routine maintenance works may need to be undertaken such as checking ground levels above the cables to avoid heat pockets. In the unlikely event of a fault or damage to the cables or other associated equipment, repair or replacement works may need to be undertaken.

Rights required

4.83 In light of the above, rights are required to:

4.83.1 enable installation of the cables and associated equipment, including cable joint bays, and the carrying out of land drainage works etc. over a 75m corridor;

4.83.2 enable operational activities, such as surveys/inspections, maintenance, repair/replacement of the cables in the unlikely event of a fault/damage, and future decommissioning of the HVDC cables;

4.83.3 protect and prevent interference with the installed infrastructure

Note: Where HDD/trenchless construction techniques are used, a 'rights corridor' of 50m in width will be required to accommodate the installed infrastructure, access for maintenance and a protective

'buffer'. In all other areas, i.e. where trenched installation is used, a 'rights corridor' of 25m in width is required. The wider area for the HDD is due to the increased spacing required to allow the cable ducts to be drilled at the correct spacing to maintain the cables thermal independence from each other, this width will be defined by the cable designer.

4.83.4 take access over the Order Land to the 'rights corridor' from the public highway.

Note: NGVL will need rights to take access over the Order Land situated between the 50/25m 'rights corridor' and the nearest public highway to facilitate the carrying out of operational activities, such as maintenance/repairs, and decommissioning.

4.84 Section 4.13 of Mr Oliver Heselton's proof of evidence describes the rights that have been included in the Order to facilitate construction, operation, decommissioning and protection of the HVAC cables during their operational life.

Land Drainage

Drainage works

4.85 NGVL needs to be able to carry out de-watering works in connection with construction of the cables and to carry out works to mitigate potential impacts of the UK Onshore Scheme on existing land drainage systems. This is explained in greater detail in section 5 of the proof of evidence of Mr David Royle.

Construction

4.86 During construction dewatering and associated drainage will be required.

4.87 Ground water will need to be controlled during the physical excavation of the soil and the installation of the cable ducts. In order to achieve this pipes will be drilled into the ground to the depth of the cable trench and connected to a vacuum pump on the surface of the land. The water will be sucked out of the ground allowing the soil to be removed and the ducts installed under controlled conditions. The pipes are removed after the soil is backfilled. This process is known as 'dewatering'.

4.88 Drainage works are also required to collect and divert surface water from the working area. This will involve a 'header drain' being laid across the high side of the existing field drains to collect any surface water. This drain will then be taken across the cable trench to a discharge drain on the lower side of the field. The discharge pipe may be run into existing drains or other suitable areas following local licencing requirements

4.89 Paragraphs 5.122 to 5.177 of the proof of evidence of Mr David Royle explain the nature of the proposed land drainage mitigation works.

Operational activities

4.90 Remedial works may be carried out to new land drainage systems, if required.

Rights

4.91 In light of the above, rights to carry out de-watering and drainage works and to install, alter or reinstate land drainage systems, including the right to access the land with or without vehicles, plant and machinery to undertake those works.

4.92 Section 4.9 of Mr Oliver Heselton's proof of evidence describes the rights that have been included in the Order to facilitate the carrying out of de-watering and drainage works, the alteration and/or reinstatement of land drainage systems.

Construction compounds

Compound works

4.93 Temporary Construction Compounds ("TCCs") and Temporary Working Areas ("TWAs") are required along the HVAC and HVDC route to facilitate construction. There will be a total of 10 TCCs and 18 TWAs along the two routes

4.94 TCCs are required for the storage of plant and machinery and for stockpiling materials, as well as the provision of site management offices, parking and welfare facilities for construction personnel (kitchen facilities, store rooms, toilets) in accordance with Health and Safety and CDM requirements.

4.95 There are two types of TCC proposed; 'primary' and 'secondary'. The typical layout of each type is shown in the figures at Appendix 5. While their overall function/purpose is the same, there are minor variances in their size and potential duration of operation. Primary TCCs will be larger in size (approximately 1.5 ha) and will be in place for the duration of cable construction. Secondary TCCs will be approximately 1.1 ha and will likely be in place for the majority of construction, but not the full duration of the work.

4.96 TWAs are required at various locations along the HVDC route (18 TWAs in total) and at one location along the HVAC route. They are typically located at areas where works require a larger area than the typical working width such as at locations where trenchless construction methods are proposed. TWAs are smaller than the TCCs and will cover an area of approximately 0.43 ha. They will be utilised for laydown of construction plant and equipment and storage whilst works are being undertaken in the vicinity. It is therefore unlikely that the TWAs will be in place for the full construction programme.

4.97 The diagram at Appendix 6 shows the locations of the TCCs and TWAs along the HVDC and HVAC cable route.

Construction

4.98 The construction of the compounds will follow a standard format. The land will be marked out and with all agreements in place the top soil will be stripped and stored in bunds adjacent to the area. A protective covering will be used as a base onto which suitable firm material will be laid to allow vehicles to drive across it. Drainage will be installed to maintain the quality of the soil. Fences will be built with a security access gate to monitor all vehicles and personnel arriving at the site. Offices, welfare, car parking and storage areas will be marked out and installed along with foul water storage and initially electrical generation facilities, until a direct line power source can be installed.

Operation

4.99 TCCs and TWAs are not required during operation. TCCs will be removed following completion of the construction phase. TWAs may be removed sooner as they may not be required for the full construction programme.

Rights

4.100 Rights are required to erect/create, use and remove TCCs and TWAs.

4.101 Section 4.11 of Mr Heselton's proof of evidence (NGVL/OH/1) describes the rights that have been included in the Order to facilitate the creation, use and removal of TCCs and TWAs.

Accesses

Access works

4.102 NGVL needs to be able to take access from the public highway to the construction/rights corridor to facilitate construction, operation, maintenance, decommissioning of the Viking Link Interconnector. Minor works, such as the creation of temporary bell mouths and turning areas to allow construction vehicles to access TCCs, will need to be carried out to facilitate access during construction. The Transportation Statement comprising Appendix 7 to my proof of evidence, sets out NGVL's approach to establishing access requirements.

Construction

4.103 As noted above, minor works, such as the creation of temporary bell mouths and turning areas to allow construction vehicles to access TCCs, will need to be carried out to facilitate access during construction.

Operation

4.104 Access will be needed from the public highway to the installed infrastructure to facilitate its operation, maintenance and decommissioning.

*Right*s

4.105 Rights of access are needed, with or without vehicles, plant and machinery, to facilitate the construction, maintenance, repair and decommissioning of the HVDC and HVAC cables, including rights to carry out minor works to facilitate such access.

4.106 Sections 4.8 and 4.10 of Mr Oliver Heselton's proof of evidence describes the rights that have been included in the Order to facilitate access for the purposes of construction, maintenance, repair and decommissioning of the HVDC and HVAC cables.

5. RESPONSE TO OBJECTIONS

5.1 A total of 13 objections were made to the Order. Those made by Witham Fourth Internal Drainage Board (OBJ7), Black Sluice Internal Drainage Board (OBJ8), Lindsay Marsh Drainage Board (OBJ9), Mr and Ms Stanley (OBJ11), and P&N Benjamin (OBJ12), have since been withdrawn Insofar as the objection letters from Western Power Distribution, Cadent Gas Limited, National Grid Electricity Transmission Plc, National Grid Gas Plc, Triton Knoll Offshore Wind Farm Limited raise points regarding the 'crossing' of their assets, I have explained above how this will be achieved without interfering with them. I note that none of the objections raise technical/engineering concerns.

6. SUMMARY AND CONCLUSIONS

6.1 In this proof of evidence I have provided an overview of the Viking Link Interconnector and the UK Onshore Scheme. I have described the key components of the UK Onshore Scheme i.e. the Landfall, HVDC route, converter station and access road, and the HVAC route and explained what they will physically comprise of. I have described the works that will need to be undertaken to construct these component parts and the different construction techniques that will be utilised by NGVL in different circumstances e.g. trenched installation and trenchless installation (HDD). I have also given details of the activities that NGVL will need to carry out during operation and maintenance of the UK Onshore Scheme/Viking Link Interconnector.

6.2 I have described the extent of land required for the converter station and access road thereto and explained why it is necessary for NGVL to acquire the freehold title to this land.

6.3 I have described the extent of land over which rights are required for the construction of the HVDC and HVAC routes, including land required for TCCs, access and the carrying out of land drainage works, and explained why that extent of land is necessary and justifiable. I have also explained why the extent of land over which rights are required during construction of the UK Onshore Scheme is greater than that required for the purposes of operation, maintenance and protection of the UK Onshore scheme. Sections 4.2 to 4.4 of the proof of evidence of Mr Oliver Heselton explains how the Order has been drafted to enable acquisition of the necessary rights over land for these different purposes.

6.4 For the reasons explained in this proof of evidence, I consider that all of the land included in the Order is necessary for the construction, operation, maintenance and protection of the UK Onshore Scheme.

7. Declaration

I confirm that the opinions expressed in this proof of evidence are my true and professional opinions.

Dated 4 June 2019