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SCOTTISH HYDRO ELECTRC POWER DISTRUBUTION PLC

Project Description

Coll - Tiree Distribution Cable Replacement

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Project Description

Coll - Tiree Distribution Cable Replacement

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GLOSSARY

AP
Articulated Pipe

AtoN
Aid to navigation

ATV
All-Terrain Vehicle

BS
Basking Shark

CBRA
Cable Burial Risk Assessment

CEMP
Construction Environmental Management Plan

CLV
Cable Lay Vessel

CPSP
Cable Protection and Stabilisation Plan

CR
Client representation

DAW
Double Armoured Wire

DP
Dynamic Positioning

DSE
Designated Special Environmental

DSV
Dive Support Vessel

DTS
Desk -top Study

EPS
European Protected Species

FLMAP
Fisheries Liaison Mitigation Action Plan

FO
Fibre Optic

HV
High Voltage

HVAC
High Voltage Alternating Current

Kg
Kilograms

Km
Kilometres

kV
Kilovolt

LAT
Lowest Astronomical Tide

LP
Landing point

m
Meters

MBES
Multi-beam echosounder

MEA
Marine Environmental Appraisal

MHWS
Mean High Water Springs

MLWS
Mean Low Water Springs

MM
Milometers

NAVTEX
Navigational telex

NTM
Notice to Mariners

OBS
On-Bottom Stability

OCT
Open Cut Trench

OOS
Out-of-service

PLGR
Pre-Lay Grapnel Run

PPY
Polypropylene yarn

ROV
Remotely Operated Vehicle

RPL
Route Position List

RSPB
Royal Society for the Protection of Birds

SHEPD
Scottish Hydro Electric Power Distribution plc

SIMOPS
Simultaneous Operations

SLD
Straight Line Diagrams

sp
Species

SPA
Special Protected Area

SSEN
Scottish & Southern Electricity Networks

TDM
Touch Down Monitoring

TJP
Transition joint pit

USBL
Ultra-Short Baseline

WD
Water Depth

XLPE
Cross-linked polyethylene plastic

1. INTRODUCTION

1.1 Overview

Scottish and Southern Electricity Networks (SSEN) operating under licence as Scottish Hydro Electric Power Distribution plc (SHEPD) is responsible for monitoring and maintaining the efficiency and integrity of the subsea electricity cable networks which provide power supplies to 60 Scottish islands.

A single 33 kilovolt (kV) subsea electricity cable across the Gunna Sound connects the islands of Coll and Tiree to the electricity distribution network. The existing Coll – Tiree subsea cable was installed in 2013 and is reaching the end of its operational life and was recently identified for replacement as part of SSEN's routine inspection programme.

The existing landfalls on both Coll and Tiree will be reused for the new cable. The proposed cable will be approximately 4.3 Kilometres (km) in length in total.

This will be the fourth cable which has been laid in this location, previous installations were in 1974, 1996 and 2014. The original cable developed a fault in 1978 due to abrasion over rocks and was repaired, this cable was then replaced in 1996. The 1996 cable experienced three faults; one in 2005, one in 2011 and one in 2014. The first two faults were repaired and after the third the cable was replaced. All faults were recorded as being due to abrasive wear. The 2014 cable, to date, has not experienced any faults but has been recorded as being in a critical condition following visual inspections in April 2021 (SSEN, 2021).

This project description sets out the methodology proposed to undertake the cable replacement works, as well as details on cable protection and deposits. The works are scheduled to take place in summer and early autumn 2025. The estimated time period for each activity is presented below in Table 1-1.

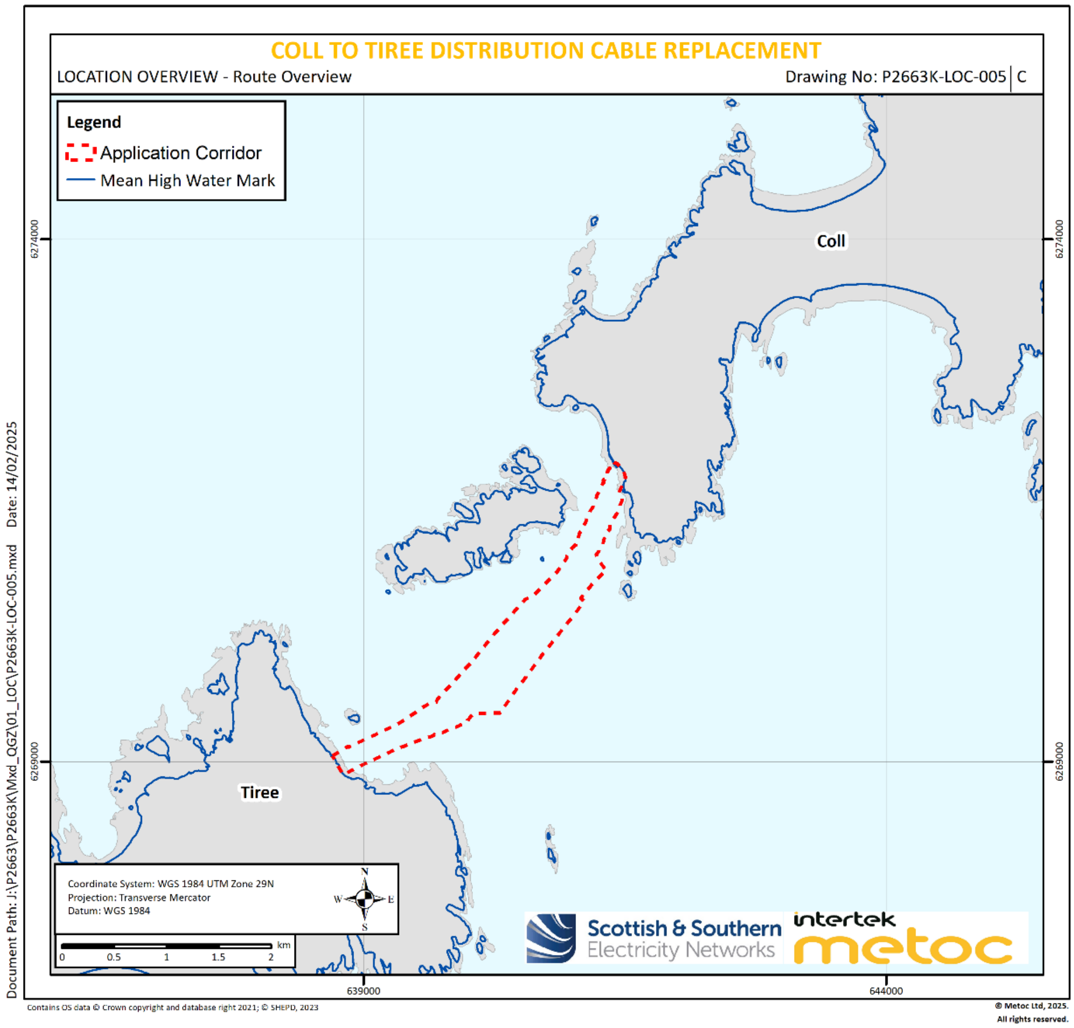
Table 1-1 Estimated Installation Schedule

Activity	Estimated Time Period (Days)
Route Clearance and Pre-lay grapnel run	6 days
Shore-end pull in and intertidal cable burial	13 days
Offshore installation including cable crossing, offshore install, and stabilisation	14 days
Cable protection (split-pipe) for offshore and intertidal areas	40 days
Post-lay inspection	2 days

1.2 Replacement Cable Corridor

The Application Corridor for the replacement cable is shown in red in Figure 1-1 (Drawing Reference: P2663K-LOC-005). The Application Corridor within which the cable will be installed is 177 meters (m) wide at its narrowest point and 530m at its widest point. The Marine Licence Application is for installation of the replacement cable within the boundary of this Application Corridor. It is estimated the proposed new cable will be 4.3km in length and the deepest sections of the crossing will see it sit at 20 metres (m) in Gunna Sound.

Figure 1-1 Coll to Tiree Cable Installation Application Corridor (P2663K-LOC-005)



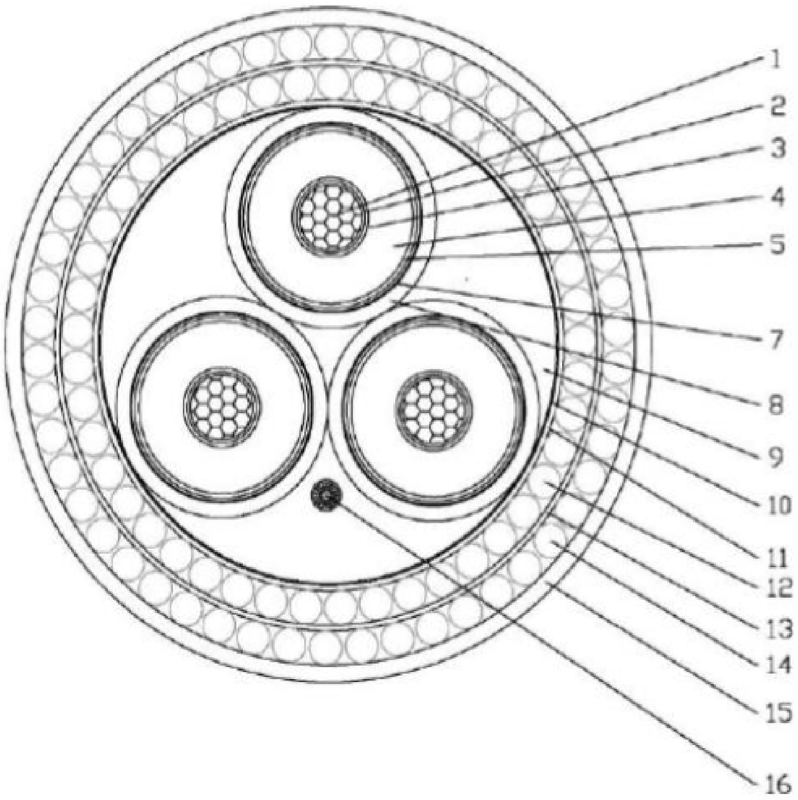
1.2.2 Cable Route Design

SHEPD commissioned a Cable Route Desktop Study (DTS) (Report Reference: 4064-GMSL-G-RD-0001_02). This study considered the potential risks to the replacement cable along the entire route and alternative routes. The report provides a summary evaluation based on the available data of each cable route with respect to engineering and installation of the cable Route Position List's (RPLs) and Straight-Line Diagrams (SLD's) have been developed that comprise the compound knowledge gained from data collected by SHEPD and DTS research. The proposed route has been designed to ensure cable security and prevent loss of service.

2. PROPOSED CABLE CONSTRUCTION

Electricity will be transmitted by the replacement cable using High Voltage Alternating Current (HVAC) submarine cable technology. The typical cable structure is shown below in Figure 2-1.

Figure 2-1 Typical Cross-linked Polyethylene Plastic (XLPE) HVAC Submarine Cable Structure - Cross Sectional Drawing



1 - Copper round stranded compacted class 2 according to BS EN 60228 of nominal cross-section equal to 95 sq.mm, longitudinally water sealed. Waterblocking compound (Solarite KM-4565) is applied between the strands.

2 - Semiconductive waterblocking tape applied helically with overlap.

3 - Conductor non-metallic extruded screen: Extruded semiconducting compound bonded to inner surface of insulation.

4 - Insulation: XLPE water-tree retardant type GP8 according to BS 6622 of 3.4 mm nominal thickness.

5 - Core non-metallic extruded screen: Extruded semiconducting compound firmly bonded to the insulation.

6 - Semiconductive waterblocking tape applied with overlap.

7 - Metallic screen and radial watertightness : CU/PE laminated tape of 0.2 mm nominal thickness bonded to oversheath, longitudinally applied with overlap.

8 - Sheath: HDPE of 2.5 mm approximate thickness. Sheath colour: Black.

9 - Non-hygroscopic fillers at the interstices between cores in order to give the cable a circular cross-section.

10 - Binding tape helically applied with overlap.

11 - One layer of polypropylene yarns of approximate thickness of 1 mm.

12 - Inner layer of armour consisting of one layer of helically applied bitumen compound coated galvanized round steel wires of grade 34. class A. 6.0 mm nominal diameter according to EN 10257-2

13 – Separator layer consisting of a single layer of polypropylene yarns of 1 mm approximate thickness.

14 - Outer layer of armour consisting of one layer of helically applied bitumen compound coated galvanized round steel wires of grade 34. class A. 6.0 mm nominal diameter according to EN 10257-2

15 - Two layers of polypropylene yarns with total approximate thickness of 3 mm. Over the inner (first) layer bitumen is applied. Also, the outer (second) layer shall consist of black and yellow polypropylene yarns as to form one helical yellow stripe.

16 – Armoured Optical unit of 14 mm approximate diameter each one consists of a stainless steel tube (containing 48 optical single mode fibres), scPE inner sheath, galvanized steel wire armour and scPE oversheath.

Source: SSEN, 2023

The subsea cable proposed for installation is a three-core 33kV HVAC power cable. This is a 185mm^2 three-core cable with copper round compacted conductors, XLPE insulation, copper polyethylene laminated tape, polyethylene sheath, polypropylene yarn (PPY), double galvanised steel wire armour and PPY with one interstitial armoured optical fibre cable. The proposed cable features high strength double armour wired (DAW) (6.0mm diameter wire) and is well suited to the project.

Fibre Optic (FO) cables are installed integral to the submarine cable for the purpose of cable condition monitoring, control, and power system protection.

The subsea cable conductor cores specification and power rating has been selected through the assessment of historic demand on the existing network and with consideration given to future demand growth on the network.

A summary of the key mechanical properties of the replacement cable is provided in Table 2-1.

Table 2-1 Proposed Cable – Key Mechanical Properties

Cable Weight (in Air) kg/m	Cable Weight (in Water) kg/m	Cable Diameter (mm)
~40kg/m (in air)	~ 27kg/m (in water)	132.4

Prior to installation, analysis of the proposed installation methodology will be conducted considering the mechanical parameters of the submarine cable shown in Table 2-1. The outputs of this analysis will inform a set of operational parameters that the installation will adhere to.

An On-Bottom Stability (OBS) assessment has been conducted to ascertain whether the cable will be stable on the seabed for its design life, and inform, any additional stability measures that may be required. The OBS assessment showed unstable seabed conditions, therefore Rock bags are recommended at certain points along the route.

3. SURVEY WORKS

3.1 Routing Survey

Initial offshore routing survey works were undertaken during summer 2023 (with nearshore infill and intertidal surveys completed in October and November 2024, respectively), which included the following:

- Offshore geophysical survey
- Offshore environmental survey
- Nearshore geophysical survey
- Landfall topographic survey
- Intertidal ecological survey

The key outputs of the surveys were as follows:

- Seabed bathymetry and land topography
- Drop-down Camera inspection to support classification of existing marine habitats
- Identification of archaeological features along the proposed cable route
- Identification of hazards (debris, existing cables etc.) along the route
- The composition of the top two meters of the seabed

The survey works have informed selection of the Application Corridor. The data was used to engineer the route for this replacement cable. The survey works have also informed the environmental assessment provided in this Marine Environmental Appraisal (MEA) report (Report Reference: P2663_R6275).

4. CABLE PROTECTION AND STABILISATION

4.1 Overview

SHEPD have compiled a deposits plan based on survey data acquired, this is detailed in Table 4-1 below. This conservatively outlines the type and number of seabed deposits required for stabilisation and protection, and is the basis of the assessment made in the MEA. The deposits will be placed where it is considered most appropriate along the cable route. The majority of the cable will be surface laid, but shallow burial may be considered in areas where rock bags or split-pipe are not suitable as cable stabilisation measures, and in areas of sand ripples. All previous cables in this area have also been surface laid.

Engineering studies are ongoing which may alter the final quantity of the deposits required. The information provided in the Cable Protection and Stabilisation Plan (CPSP) is therefore based on worst-case estimates. More information on the types of protection and stabilisation that could be utilised is provided in Section 5.6.

4.2 Cable Protection and Stabilisation

Table 4-1 conservatively outlines the type and number of seabed deposits needed for cable protection and stabilisation.

Table 4-1 Cable Protection and Stabilisation

Type of deposit/ removal	**Deposits**		**Removal**	
	Description	**Quantity & Dimensions (metric)**	**Description**	**Quantity & Dimensions (metric)**
Earthing wire	Copper wire for earthing	Quantity No. 6	N/A	N/A
		Dimensions: Diameter: 95mm^2 Total length: 293m		
		Weight: ~0.6kg/m		
Cast Iron split pipe	Articulated cast iron shell design that interlocks around the cable and is fixed with bolted end clamps. This will be placed on either shore end of the cable where burial is not possible.	Quantity No. 4993	N/A	N/A
		Dimensions: Diameter: 260mm Total Length: 1637m		
		Weight: 51.3kg/m		
Concrete mattresses	Concrete mattresses may be required instead of rock bags to stabilise the cable so as not to reduce navigable water depth by more than 5% and/or manage cable crossings.	Quantity: No. 9	N/A	N/A
		Dimensions: Width: ~3m Length: ~6m Height: ~0.3m		
		Weight 8.75 Th		

Type of deposit/ removal	Deposits		Removal	
	Description	Quantity & Dimensions (metric)	Description	Quantity & Dimensions (metric)
Rock bags (14m Lowest Astronautical Tide (LAT) or deeper	Rock bags may be required to stabilise the cable in water at or deeper than 14m LAT	Quantity: No. 28	N/A	N/A
		Dimensions: Diameter: ~3.0m Height: ~0.7m		
		Weight: ~8T each		
Rock bags (12m LAT or deeper)	Rock bags may be required to stabilise the cable . in water at or deeper than 12m LAT	Quantity: No. 68	N/A	N/A
		Dimensions: Diameter: ~ 2.4m Height: ~0.6m		
		Weight: ~4T each		
Earthing clump weight	Concrete clump weight for earthing wires	Quantity: No 20	N/A	N/A
		Dimensions: Diameter: 1 m Height: 0.5m		
		Weight: Up to 60Kg each		
Clump weight	Concrete, steel, or iron clump weights for securing free cable ends - may be required where existing cable(s) are cut to secure the cable ends.	Quantity: No. 10	N/A	N/A
		Dimensions: Diameter: 1m Height: 0.5m		
		Weight: ~300kg each		
Rock anchors	Stainless steel threaded rod, plus bolt fixing and marine grade resin	Quantity: No. 20	N/A	N/A
		Dimensions: Diameter: ~0.02 m Length: 0.3m		
		Weight: 2 kg each		
Temporary Equipment Deposits below Mean High Water Springs (MHWS)				
Anchors	Delta Flipper anchors may be used for diving support vessel mooring spread.	Quantity: 4	N/A	N/A
		Dimensions: Diameter: 2.4m Length: 2.6m		
		Weight: 2 T		
Mooring Chains		Quantity: 4	N/A	N/A

Type of deposit/ removal	Deposits		Removal	
	Description	**Quantity & Dimensions (metric)**	**Description**	**Quantity & Dimensions (metric)**
	Attached to anchors for diving support vessel mooring spread.	Dimensions: Diameter: 0.3m Length: 54m		
		Weight: N/A		

5. PROJECT DESCRIPTION

5.1 Proposed Route

The proposed replacement cable route has been assessed from an engineering perspective in a number of desktop study reports. These include the Cable Route DTS (Report Reference: 4064-GMSL-G-RD-0001_02), Coll - Crossapol Bay Beach, Dunes and Machair Initial Site Ecology Visit (Ecology Report), Coll To Tiree Submarine Power Cable - Desktop Environmental Report (Report Reference: 70109951), HDD landfall and crossings for 11kV cable, Crossapol Beach, Coll, Scotland (Report Reference: 20231203RA-C-FR01) various marine survey reports, ED2 Coll Landing Point Review 003 PowerPoint presentation and fisheries considerations outlined as part of the Fisheries Liaison Mitigation Action Plan (FLMAP) Argyll.

The location of the replacement cable in relation to existing infrastructure is shown in Figure 1-1 (Drawing Reference: P2663K-LOC-001). The cable routing decisions taken as part of the development of the route are outlined in Section 5.1.1.

5.1.1 Route Decision Making Process

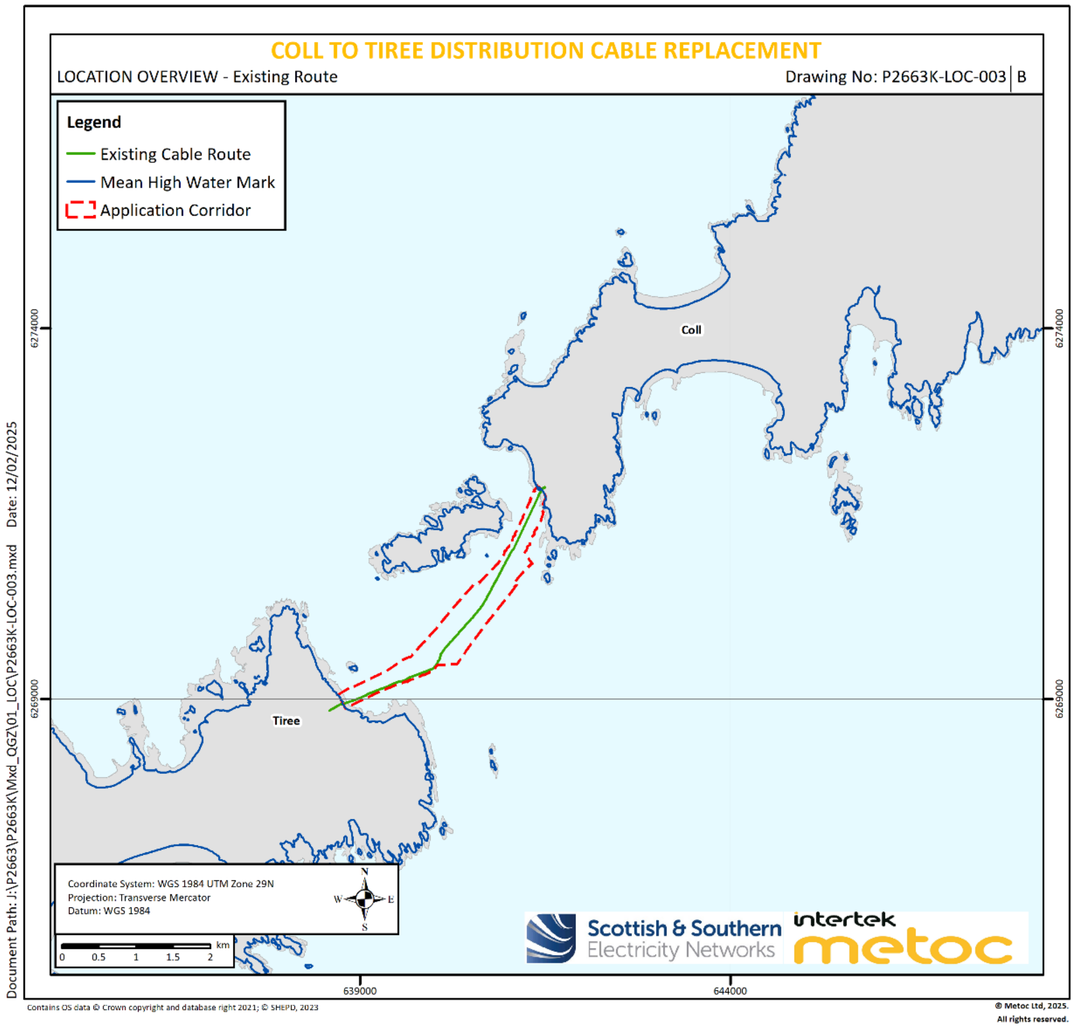
Table 5-1 Key Route Engineering

Stage	Date	Description
Desktop Study Route (prior to survey work)	May 2023	Preliminary RPL based on existing cable
In-field selected route	October 2024	Updated infield selected route from preliminary vessel deliverables
Post survey and route engineering works	TBC	RPL for cable installation generated from geophysical and geotechnical survey data and cable burial risk assessment
HDD Feasibility Study	March 2024	HDD landfall and crossings for 11kV cable, Crossapol Beach, Coll, Scotland

5.1.2 Route Description

The proposed Application Corridor lies between Coll and Tiree as shown in Figure 5-1 (Drawing Reference: P2663K-LOC-003), with the existing operational cable also shown.

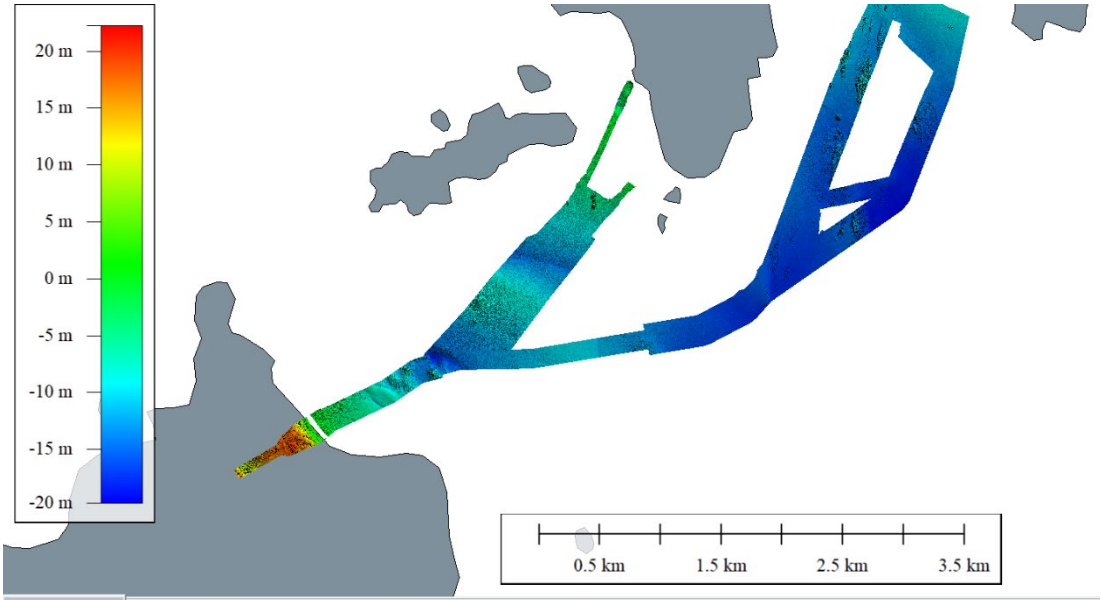
Figure 5-1 Application Corridor and Current Operating Cable



The survey corridor for the replacement cable covered an area approximately 1.33km^2, consisting of a corridor 4.3km long. The survey corridor was selected to avoid key seabed features and to maximise the amount of survey data available to inform route engineering decisions.

A bathymetric overview of survey corridor is presented in Figure 5-2. Where possible the cable route has been optimised to allow for efficient installation, the least disruption possible to the operational cable, and to avoid bedforms in the channel where possible. Geophysical surveys were undertaken in Summer 2023 and November 2024. A Norbit Winghead B51S (400kHz) multi-beam echosounder (MBES) was used to survey the Application Corridor in Summer 2023 and a R2Sonic 2024 Multibeam System 400 kHz was used for the November 2024 survey.

Figure 5-2 Bathymetric Overview



The replacement cable route will be located within the boundaries of the designated Application Corridor.

The route will originate from a new Transition Joint Pit (TJP) at Tràigh Gharb on Coll (Easting 111577, Northing 751870) and traverse the sandy beach and intertidal zone before entering the foreshore area. The cable will be carefully micro-routed within the intertidal zone to avoid rock outcrops. Offshore, the cable will cross the Gunna Sound, where routing will account for boulders, out-of-service (OOS) cables, and the in-service cable. As the route approaches Tiree, it will pass through a boulder field before making landfall on the beach at Port Ruadh, Tiree (Easting 108558, Northing 749223).

5.1.3 Route Corridor Profile

A bathymetric overview of the Application Corridor is presented in Figure 5-3. The survey corridor for the replacement cable encompasses approximately 1.33km², extending 4,200 meters in length and ranging from 177m at its narrowest to 520m at its widest. This corridor has been strategically selected to minimise interactions with key seabed features while maximising the quality and coverage of survey data, ensuring optimal route engineering decisions and cable placement. This overview combines data that was collected across two geophysical campaigns. The replacement cable between Coll and Tiree traverses Gunna Sound, where extensive geophysical surveys have been conducted to optimise the route. This includes multi-phased investigations that utilised bathymetry, side-scan sonar, sub-bottom profiling, and magnetometry to assess seabed conditions and identify potential hazards. A large sandbank and dynamic bedforms present navigational challenges that have influenced route adjustments, ensuring minimal environmental disruption and the preservation of operational cable integrity. The final route aims to accommodate efficient installation practices while maintaining operational resilience.

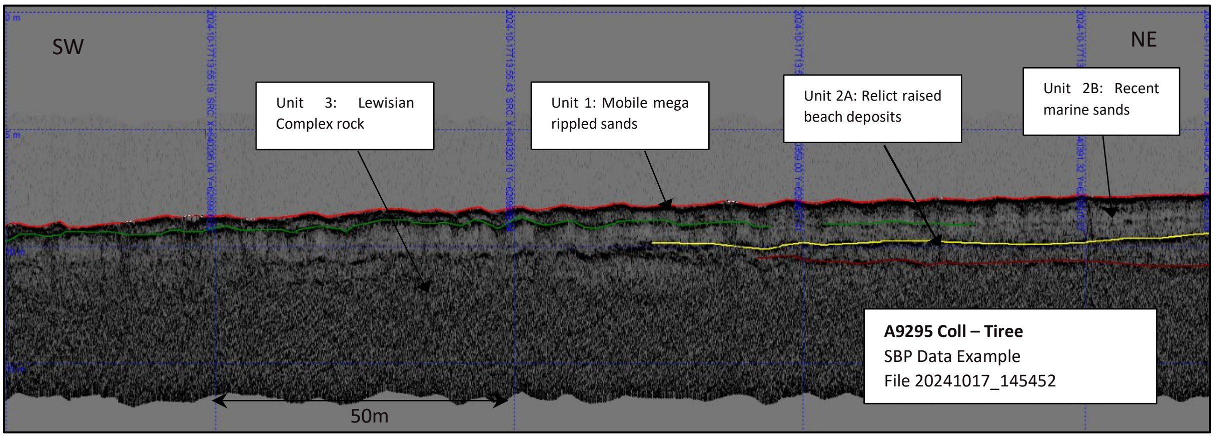
5.1.3.1 Geophysical Survey and Data Integration

The surveys were conducted in two stages, starting with an initial route evaluation into Crossapol Bay on Coll Island. Due to challenges identified during route engineering - including environmental constraints and seabed features - the Coll landing point was adjusted from a potential West Crossapol Bay landing point to utilising the current landing point on Tràigh Gharb, Coll. Bathymetric data collected during both survey campaigns has been combined as outlined in Figure 5-3, revealing variable seabed characteristics such as outcropping bedrock, gravelly sediments, and mobile sand ripples. This integration allowed for precise profiling and route optimisation to mitigate risks like cable abrasion and seabed instability.

5.1.3.2 Subsurface and Seabed Composition

Sub-bottom profiling identified three major subsurface units across the route, these units are outlined in Figure 5-3. The deepest layer consists of the Lewisian complex rock, with limited penetration of overlaying sediments. Above this lies a sequence of relict raised beach deposits and recent marine sands, characterised by granular material with occasional cobbles and boulders. These materials pose potential challenges to burial operations but provide crucial data for engineering solutions. Surface sediments are predominantly sandy with features like mega ripples, indicative of high current activity.

Figure 5-3 Sub Bottom Profiler Data Showing Strata



Source: Aspect, 2024

5.1.3.3 Seabed Features and Recommendations

Notable seabed features include pockmarks, boulder fields, and anthropogenic debris. Several pre-existing cables intersect the route, requiring careful planning during installation. The identified mobile bedforms, particularly near Tiree, suggest a potential for scour, necessitating protective measures. Magnetic anomalies were also mapped, correlating with seabed debris and requiring clearance to avoid installation delays. The findings emphasise the importance of detailed engineering surveys before laying the cable, ensuring both operational safety and longevity of the infrastructure.

5.1.4 Proposed Coll Landing Site

It is proposed that the existing landing site on the beach of Tràigh Gharb, Coll (Figure 5-4) is utilised for the replacement power distribution cable. SHEPD conducted a site visit and landing point review of Tràigh Gharb in May 2023 and October 2024 and outlined the following points in their landfall review:

- Existing Infrastructure for Grid Connectivity: Leveraging the current infrastructure means that the project can connect to the grid with greater ease, reducing both the logistical and regulatory challenges typically associated with establishing a new landfall site. This minimises the need for additional cabling or new access routes, which can expedite project timelines and reduce the overall environmental footprint. It also ensures that the project aligns with existing utility frameworks, thereby simplifying integration with the island's electrical grid.
- Sandy Beach at Landing Point (Figure 5-5) (LP): A sandy beach at the landing point offers several practical advantages, such as facilitating the cable burial process, as sand requires less intensive excavation than rocky or heavily vegetated landings. It allows for cable trenching with minimal disturbance, reducing the environmental impact and protecting the surrounding landscape. The

sandy terrain also typically provides a stable medium for cable installation, enhancing durability and ease of maintenance.

- Short Cable Distance (~4.3km): A shorter cable route of approximately 4.5km reduces the material requirements and labour needed for installation. This condensed distance also minimises potential cable exposure to environmental wear, such as seabed currents and marine activity, which can affect longer cables. With a shorter distance, maintenance and repairs become easier and less costly, leading to longer cable life and increased efficiency in power transmission.

There are a number of environmental sensitivities at and in the vicinity of the Coll landing site, including Gunna Sound (Figure 5-6) Designated Seal Haul Out site which is an important grey seal breeding site. Adult seals with their pups were present on the beaches on the island of Gunna during a site visit on 9th October. The Coll landing is also within the Coll Machair SAC which is designated to protect dune systems and machair. Specific mitigation will be in place to minimise any impact from construction activities on these environmental features. Mitigation will be captured with the construction environmental management plans.

Figure 5-4 Coll Landing Point Location

Source: SSEN, 2024

Figure 5-5 Sandy Beach at Coll Landing Point

Source: SSEN, 2024

Figure 5-6 Coll Landing Point Location Looking Towards Gunna Island

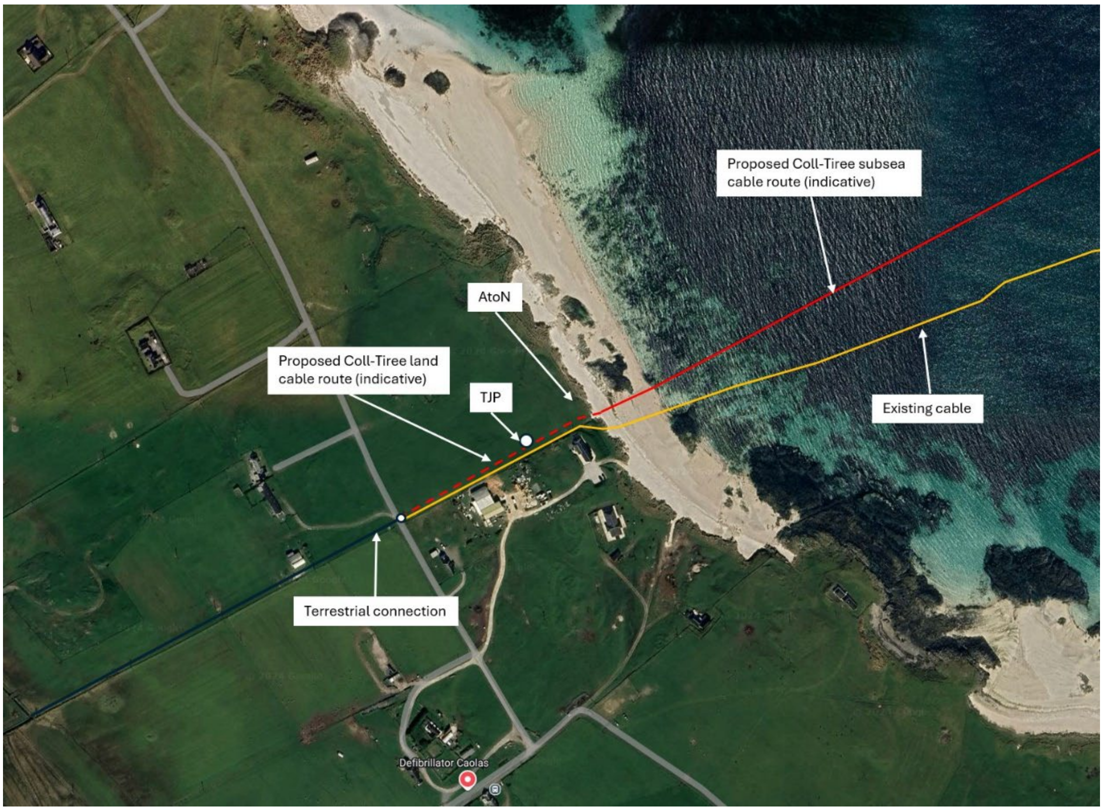
Source: SSEN, 2024

5.1.5 Proposed Tiree Landing Site

The Tiree landfall site utilises the current landfall site of the existing SSEN cable 130 for the replacement power distribution cable on the beach North of Port Ruadh (Figure 5-7). SHEPD conducted a site visit to this landfall site in May 2023 and outlined the following points in their site visit report:

- This landfall site is located on a sandy beach and is approximately 0.25km from the main road at Caolas. There is suitable existing infrastructure to connect to the grid which is located on this site and is capable of connecting 33kV electricity cables, and no upgrades will be required to this over-head line infrastructure.
- The Port Rudah landfall site is a sandy beach with rock outcrops present offshore, meaning there is a potential for abrasion if burial of the cable is not achievable.
- Offshore the seabed slopes away with the 10m depth contour reached approximately 1km from shore. Direct Shore End landing is achievable; however this is only achievable at certain points due to the rock outcrops on the beach. This landfall location is accessible to a Cable Lay Vessels (CLV), however there is an unmarked mooring buoy for small private vessel, there has been no fishing activity observed in the area.

Figure 5-7 Tiree Landfall Site



Source: SSEN, 2024

Figure 5-7 shows the proposed Tiree landfall site, North of Port Ruadh, from the image it can be seen that this beach is the location of the existing SSEN cable 130. This image also identifies the existing overhead pole infrastructure (33kV) and AToN cable warning diamond for the existing Coll-Tiree electricity cable. On the beachside of the dune front an incline of the dune fronts as they descend to the beach can be seen.

Figure 5-8 Agricultural Field and Beach Area of Tiree


Source: SSEN,2023

Figure 5-8 shows a RAMSAR/Special Protected Area (SPA) designation in the intertidal area ”Tiree Wetland and Coast”, which protects a number of bird species including Dunlin (*Calidris alpina*, Ringed Plover *(Charadrius hiaticula),* Redshank (*Tringa tetanus)* and Oystercatcher *(Haematopus).* The proposed landfall is a popular beach area visited by dog walkers and as such advice provided by the local Tiree Royal Society for the Protection of Birds (RSPB) officer at the time of visit, determined that this stretch of water would not pose any disturbance as generally bird species were not normally found at this location.

5.2 Proposed Installation Method

The indicative methodology is intended to give an overview of the options available to the cable installation contractor and has been used to inform the environmental assessment provided in MEA, so that the worst-case impact scenarios of the installation have been considered. The final methodology will be subject to detailed route engineering and any requirements of the installation analysis.

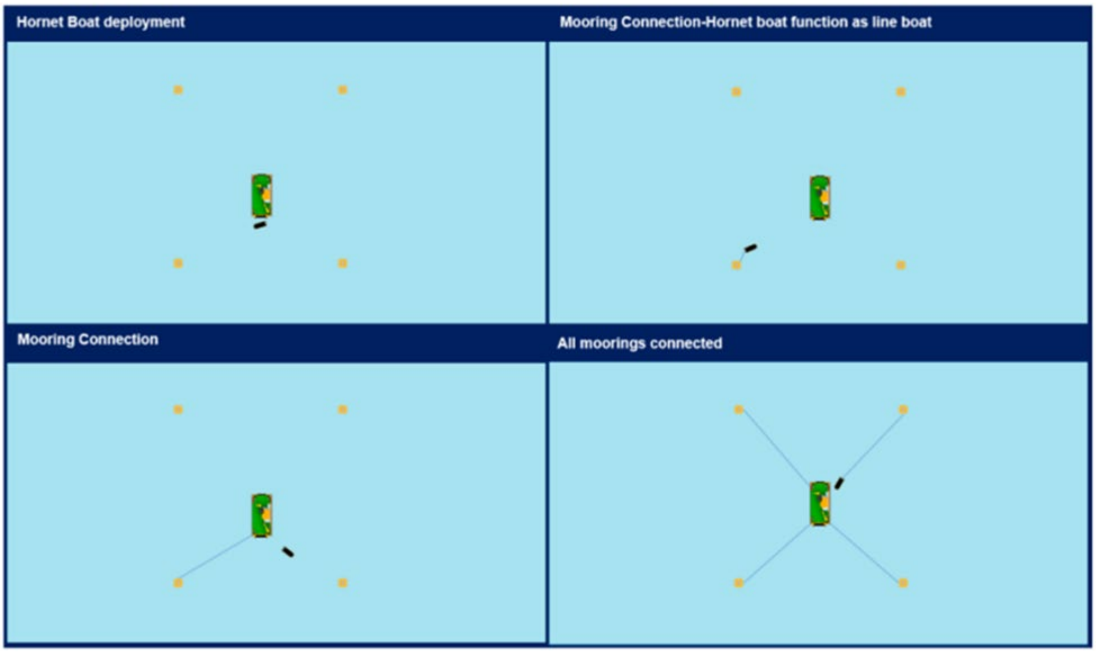
Vessels and equipment proposed to be utilised during the installation are summarised in the subsequent sections. All equipment used will be within the requirements set out within the European Protected Species (EPS) and Basking Shark (BS) Licences provided for the works.

5.2.1 Vessels

Table 5-2 below provides an overview of the types of vessels that will be deployed during the installation of the cable, these vary from Cable Lay Vessels (CLV), Dive Support Vessels (DSV) (the DSV and other support vessels. These specific vessels or vessels with similar specifications will be used in the installation of the replacement cable.

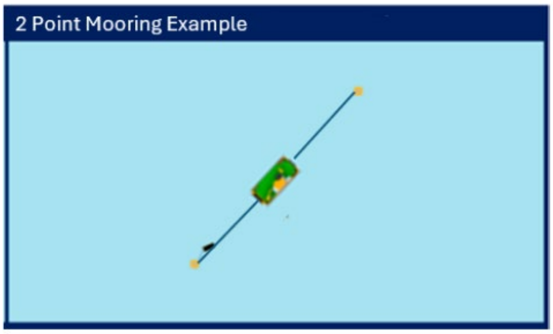
Both the DSV and the shore end pull in support (if used, please see Table 5-2 for further information) will be positioned using up to two spud legs up to 13m LAT, with the potential for a two or four-point mooring spread to be used as an alternative if required. There is the potential for the mooring spread to be left in place between working days, marked with surface buoys and lights. A diagram of the 4-point mooring spread is included in Figure 5-9, and the 2-point spread is shown in Figure 5-10.

Figure 5-9 Lay of Temporary Moorings for 4-point Spread



Source: Briggs Marine, 2024

Figure 5-10 Lay of Temporary Moorings for a 2-point Spread



Source: Briggs Marine, 2024

Due to the shallow nature of the seabed along the cable route and the resulting longshore end pull in; a shallow draft multi-purpose jack-up vessel may be used to assist when positioning the cable. The jack-up vessel would be towed into position by a multicat (such as the Forth Warrior) where it will be pinned into place. A small floating pontoon may also be used, secured in place by up to four spud legs or anchors (2 or 4-point anchor spread).

Table 5-2 Installation Vessels

Name of Vessel	Type of Vessel	Vessel Specification	Positioning System/ Spud diameter	Minimum Working Draft
MV Forth Constructor	Cable Lay Vessel (CLV)	GT – 625 DL – 39.9m DB – 12.4m	DP 2	6m
Forth Atlas	Cable Lay Vessel	GT – 1057m DL -53.34m DB - 20.73m	914 mm with spiked tip 4-point mooring spread	5m
Forth Warrior	Dive Support Vessel (DSV)	GT – 296 DL – 27m DB – 12m	610 mm with spiked tip 4-point mooring spread	5m
Spanish John	Other Support Vessel (DSV)	GT – 498 DL – 19.9m DB – 6.5m	N/A	1m
Celtic Guardian	Other Support Vessel	GT – 9.5 DL – 13.9m DB – 4.3m	N/A	3m
Shore End Pull Support	Other Support Vessel	GT – 78.8 DL- 18.30m DB – 18.3m	N/A	
Celtic Trader	Shore End Support	GT - 4.5t DL - 10.3m DB: 3.3m	N/A	0.5m

GT- Gross tonnage – DL – Dimension Length – DB – Dimension Beam – DP – Dynamic Positioning

5.2.2 Installation Monitoring

Touch down monitoring of the cable will be conducted to confirm the position of the cable, this will be done as the cable is laid, using a Remotely Operated Vehicle (ROV) (Sea Eye Falcon) or a cable fish. The ROV will be deployed from the cable lay vessel (CLV) or a separate support vessel that will be present during the installation. An example of the ROV and survey equipment that will be used during the installation is presented in Figure 5-11. All equipment used will be within the requirements set out within the European Protected Species (EPS) and Basking Shark (BS) Licences provided for the survey works.

5.2.3 Seabed Preparation

5.2.3.1 Pre-Lay Survey and Boulder-Picking

Prior to lay operations commencing, a pre-lay survey may be conducted, this will be undertaken using a work class ROV (Figure 5-11). The objective of the survey is to:

- Identify and investigate possible debris; and

- Identify any obstructions on the proposed route including the presence of boulders which may impede the safe installation of the cable.

A summary of the survey equipment that may be used during the pre-lay survey is outlined in Table 5-3.

Table 5-3 Examples of Proposed SURVEY equipment

System / Survey Equipment	Description
Geophysical	
Ultra-Short Baseline (USBL)	USBL systems are used to determine the position of subsea survey items, including ROVs, towed devices, grab samplers, etc. This involves the emission of sound from a vessel-mounted transducer to a subsea transponder, thereby introducing sound into the marine environment. A USBL system consists of a transducer, which is mounted on the vessel and a transponder attached to the ROV. The transducer transmits acoustics through the water and the transponder sends a response which is detected by the transducer. The USBL calculates the bearing and time taken for the transmissions to be completed and thus the position of the subsea equipment is determined. These systems can either be used continuously or intermittently through the operation they are supporting.
Multi-beam echosounder (MBES)	Multi-beam echo-sounders are used to obtain detailed 3-dimensional (3D) maps of the seafloor which show water depths. They measure water depth by recording the two-way travel time of a high frequency pulse emitted by a transducer. The beams produce a fanned arc composed of individual beams (also known as a swathe). Multi-beam echo-sounders can, typically, carry out 200 or more simultaneous measurements.
Seabed Imagery	
Hi-Resolution Camera	An ROV mounted camera will be utilised to acquire imagery of the cable and adjacent seabed.

Source: SSEN, 2024

Figure 5-11 Example of the Type of ROV

Source: SSEN, 2023

5.2.3.2 Boulder clearance

If required, boulders will be moved from the cable route using a “grab” tool deployed from a support vessel with suitable crane, as shown below in Figure 5-12. This will be dependent on the results of the boulder removal assessment which will be done during the pre-lay survey. Coordinates will be recorded of each boulder pre and post move.

If debris or an obstruction cannot be removed from the planned route, the offshore surveyors will micro-route around the debris/obstruction in consultation with the onboard Client Representative (CR). Any micro-routing will always remain within the licenced installation corridor.

Although the cable route will be engineered to avoid as many boulders as practical, a hydraulic operated grab may be required to remove any boulders that may impede the safe installation of the cable. This system will be operated from the surface and deployed using a boulder removal vessel such as the Forth Constructor (Figure 5-13) support vessel work crane. An ROV (Figure 5-11) will assist in the positioning of this tool.

Figure 5-12 Example of Boulder Grab

Source: SSEN, 2023

Figure 5-13 Forth Constructor - Boulder Removal, Crossing and Stabilisation Operations and Cable Lay Vessel

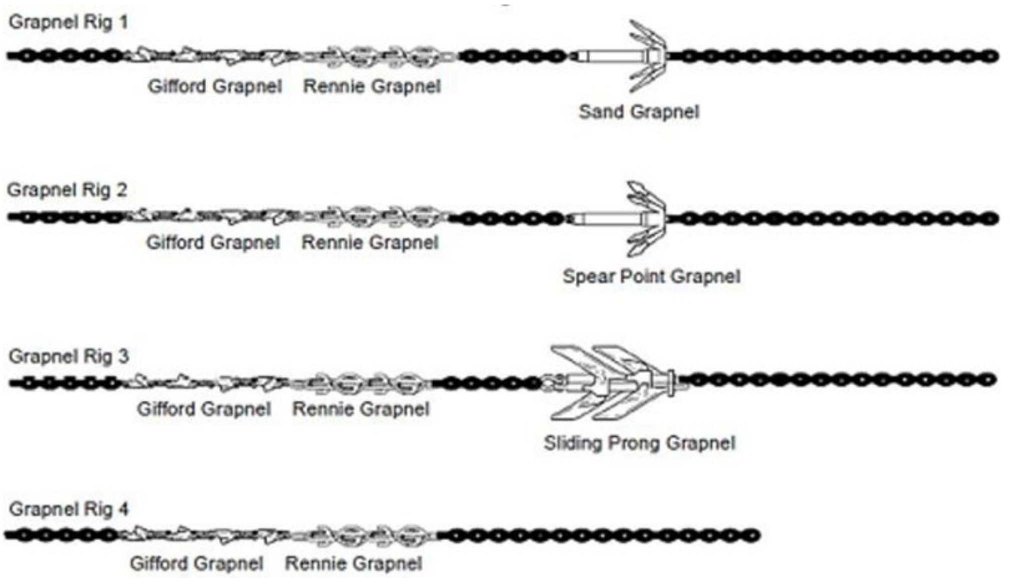
Source: BMC, 2024

5.2.3.3 Pre-Lay Grapnel Run (PLGR)

Any obstructions or debris which cannot be avoided will be removed, if possible. Pre-Lay Grapnel Run (PLGR) may be required to remove debris such as cables, chains, wires, ropes, and fishing gear. It is expected that this activity will be completed prior to the cable installation activities to ensure that the installation corridor remains free of debris during installation. A typical grapnel train is shown below in Figure 5-14 and Figure 5-15 shows an example of a grapnel and chain over the stern of a vessel. Multiple PLGR's both ends to end or perpendicular to the route may be required within the licenced installation corridor to remove debris. In the event that OOS cables require to be cleared, the cut ends will be secured with clump weights to prevent cable movement.

Debris identified and removed along the route will be disposed of as outlined in the offshore Construction Environmental Management Plan (CEMP).

Figure 5-14 Grapnel Train (Typical Example)



Source: SSEN, 2022

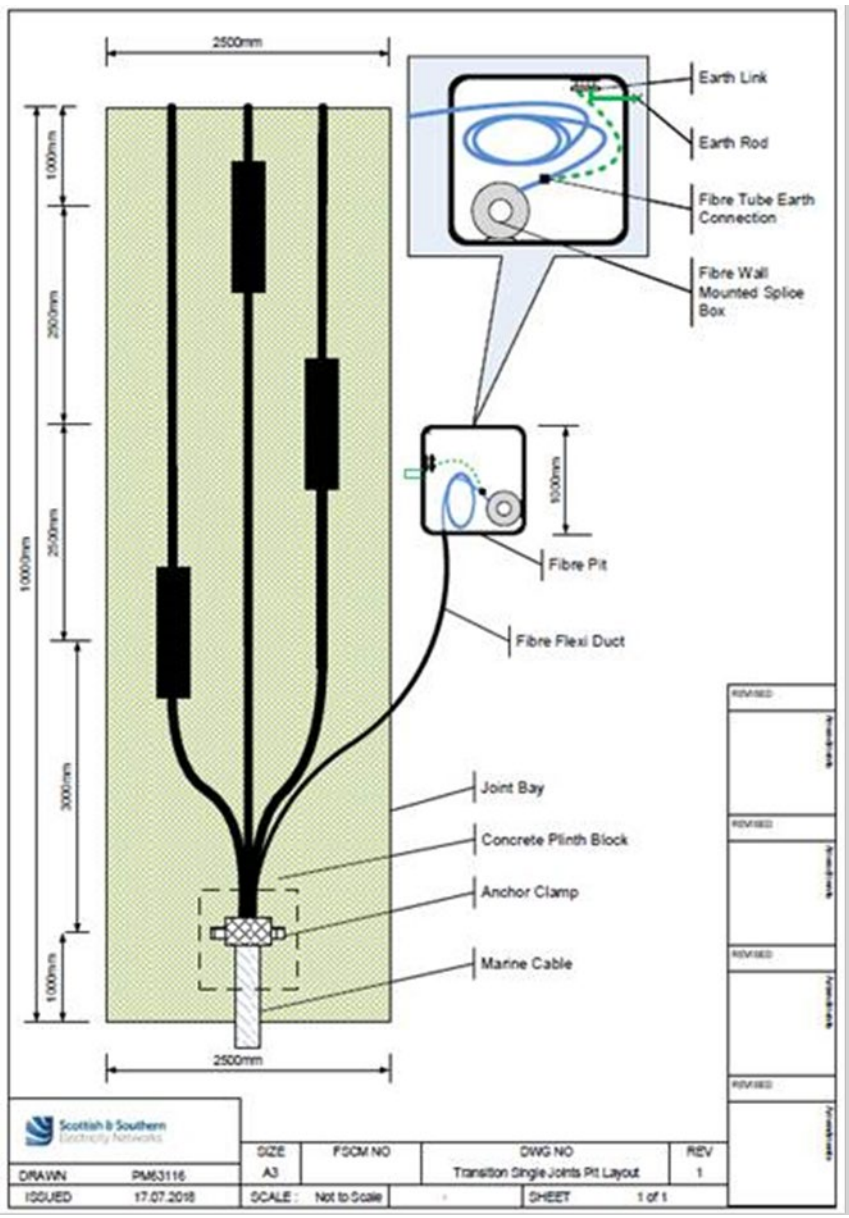
Figure 5-15 Example of Grapnel and Chain at Stern Roller of Vessel

Source: SSEN, 2022

5.2.3.4 Transition joint pit (TJP)

The transition joint pit (TJP) (Figure 5-16) will be the location where the subsea cable is split out into its individual cores and terminated to a land cable. The TJP at each landfall is located above MHWS and will utilise a sea earth. As the Marine Licence Application Corridor only covers up to MHWS, details on the TJP are only included in this report to provide further information on the Project.

Figure 5-16 SSEN Provided TJP Plan (Typical)



5.2.4 Intertidal cable installation

5.2.4.1 Open cut trench

At both landfalls, the cable will be buried (subject to ground conditions) within intertidal area's using an Open Cut Trench (OCT) (Figure 5-17) method, from the MHWS to Mean Low Water Springs (MLWS). Each landfall will have two trenches excavated, one trench will be for the replacement cable and armour earth, while the other trench is for a fibre optic cable earth. This will be undertaken using 1 x 20tn and 1 x 8tn excavators (complete with rock pecker attachment, for areas of bedrock).

The trenches will be 1m in width, and the target depth of the trench will be to the top of the cable at approximately 0.8m below ground level. However, this is subject to ground conditions at the ground conditions such as the soil stability and the nature of subsurface sediments. This will be better understood on completion of the intertidal surveys. Excavators complete with rock pecker attachment, will be utilised to reach the depths required to bury the cable in the intertidal zones of each landfall. It is also possible that a split pipe may be used on sections of the trench route where burial depth cannot be viably done.

Each landfall's OCT will require a 20m corridor width to conduct the works, 20m will be sufficient space to operate the excavator and temporarily store the excavated material. The total length of the trench excavation from the TJP to MLWS and potentially beyond will be a maximum of 250m and 300m at Coll and Tiree, respectively, intertidal burial from MLWS to MHWS will be 29.7m at Coll and 43.2m at Tiree. Once the trenching activities are completed, the excavated material will be backfilled into the trench, returning the intertidal area to pre-works conditions.

Figure 5-17 Example of OCT

Source: SSEN, 2022

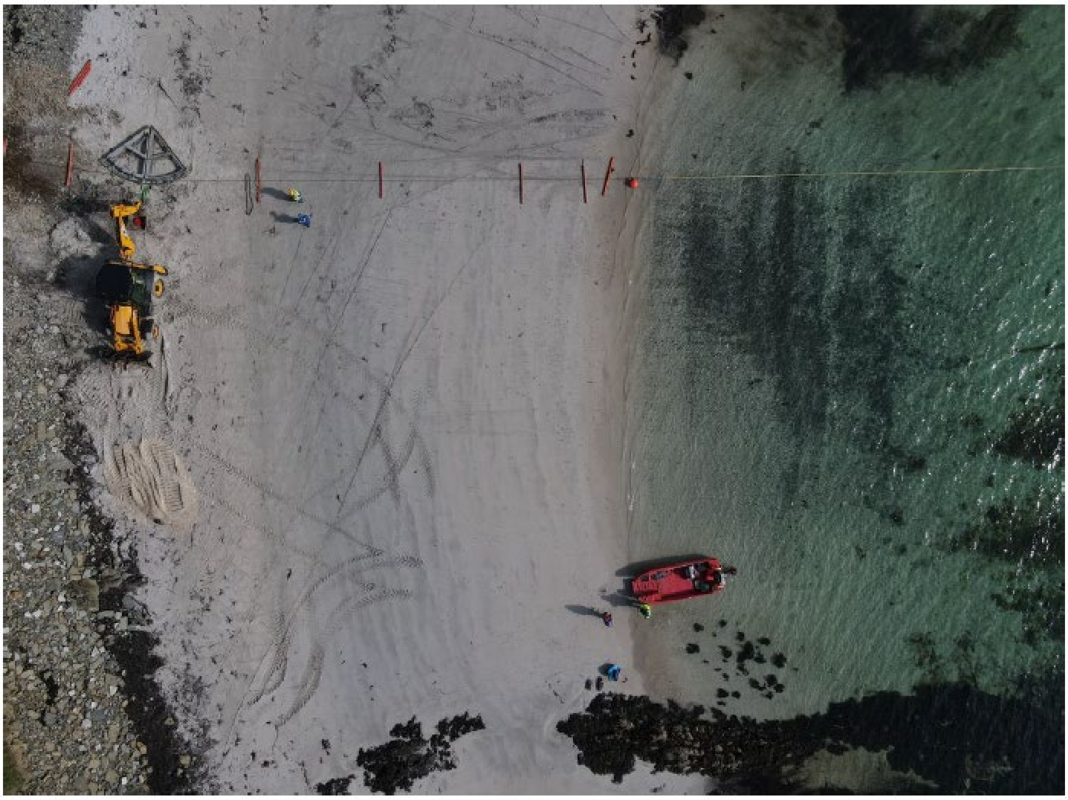
5.2.5 Intertidal cable pull in

Cables will be pulled onto land using two winches, this will be on a rising tide along with a combination of rollers (Figure 5-18), quadrants (Figure 5-19). This equipment will allow the cable to be safely pulled ashore without any damage, rollers will be used to support the flow of the cable as it's pulled in using the winches and the quadrants are used to ensure that the cable is pulled into the intertidal area, in the correct alignment. Anchor plates will hold the rollers and quadrants in place while the process of the pull in takes place, these anchor plates will be buried at first and then removed once the cable has been fully pulled ashore.

Figure 5-18 Example Images of Rollers

Source: SSEN, 2022

Figure 5-19 Example of Rollers and Quadrants



Source: SSEN, 2022

5.2.6 Marine cable installation

The following installation method is based on that utilised during cable burial and cable lay installations that SHEPD have undertaken on other cable routes and advice from the cable installation contractor. This has been used as the basis for the present MEA.

5.2.7 Shore End Pull Support

Due to the long shore end pull required due to the shallow nature of the cable route, a shallow draft multi-purpose jack up vessel may be required to help position the cable when floating. The jack up barge would be towed into position by the Forth Warrior (or similar multicat) where it will then pin, and jack up as required to hold position through all states of the tide. The vessel proposed for this operation is the Haven Sea Jack 1 or similar. A small floating pontoon may also be used which is secured in position either using spud legs or anchors.

Figure 5-20 Example Shore End Support vessel, Celtic Trader

Figure 5-21 Example of Jack Up Barge

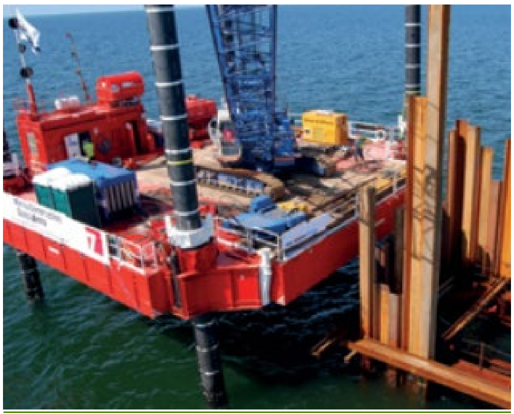


Table 5-4 Jack Up Barge Specifications

Jack Up Barge Specifications	
Type	General Type S50 Flexifloat Modular Self Elevating Platform Classification MCA Workboat Certificate_
Dimensions	Length: 18.30 m Breadth: 18.30 m Depth: 1.52 m
Deck area	298 m^2

Jack Up Barge Specifications	
Max leg length	27.00 m
Leg diameter	0.76 m
Gross Tonnage (GT)	78.8 GT
Lightship Weight	215 tonnes
Jacking System	Jacking Speed 15m/hour Jacking Stroke 1.50m
Operation Conditions	Max Deck Load / Point load 100t / 15t/m2 Max Free Leg Length 22.00m Max Crane Self Weight 80 tonne

5.2.8 First end pull in

The CLV will position at the first end pull-in site (Coll), generally stationed at the 13m water depth (WD) contour (this is dependent on the vessel's draft). Deck handling equipment will be used to direct the cable to the over-boarding chute. An example CLV which will potentially be used during the installation is displayed in Figure 5-13 above.

The first end cable pull in will be conducted on a rising tide due to the long length of the intertidal. A messenger line will be taken from the CLV via small support craft to the shore (Figure 23). This will be connected to the shore winch line at MLWS. The small support craft will then pull back the mooring line and pull-in winch wire from the shore to the CLV where it will be connected to the cable end. The shore end winch will commence pulling in the cable with buoyancy units attached onto the cable as it leaves the vessel to 'float' the cable ashore – these units are removed as the cable reaches MLWS. The floating cable may be held in position by a small jack-up vessel or floating pontoon to ensure it is installed within the confines of the agreed application corridor. The cable will be secured at the TJP and surface swimmers will gradually remove any remaining buoyancy units, completing the first end pull-in operations.

5.2.9 Cable lay operations

Following successful completion of the first end pull in the CLV will commence laying the cable on the seabed from the First end to the Second end; a smaller support vessel may be used in the shallower shore locations. DSV (Figure 5-22), nearshore, and guard vessels may also be required during cable lay operations.

The cable will be majority surfaced laid from MLWS to MLWS, however there is potential for shallow burial of the cable in areas where Articulated Pipe (AP) or rock bags are not suitable and where sandwaves are present. A diver-operated dredge pump may be used, as illustrated in Figure 5-24 or a Controlled Flow Excavator (CFE) (Figure 5-25). The CFE would be operated directly from the vessel crane. This technique provides a precise, minimally invasive approach to sediment removal by allowing the diver to direct the pump to remove sediment specifically beneath the installed cable. As sediment is carefully extracted, the cable gradually settles into the narrow trench created, ensuring it is securely buried without excessive disruption to the surrounding marine environment.

This method is effective for localised sediment removal and is often preferred in sensitive or shallow areas, as it minimises unnecessary seabed disturbance while providing stable cable protection in tidal zones.

Figure 5-22 An Example DSV, Forth Warrior

Figure 5-23 An Example Shore End Pull in Support Vessel, Celtic Trader

Figure 5-24 Example of Diver Dredge

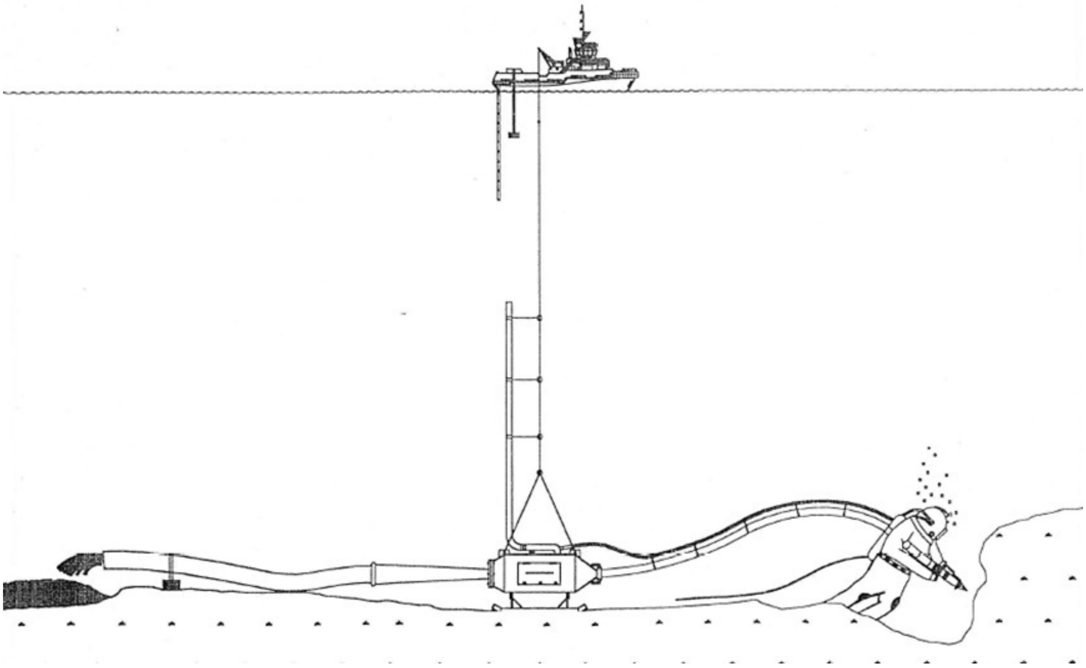
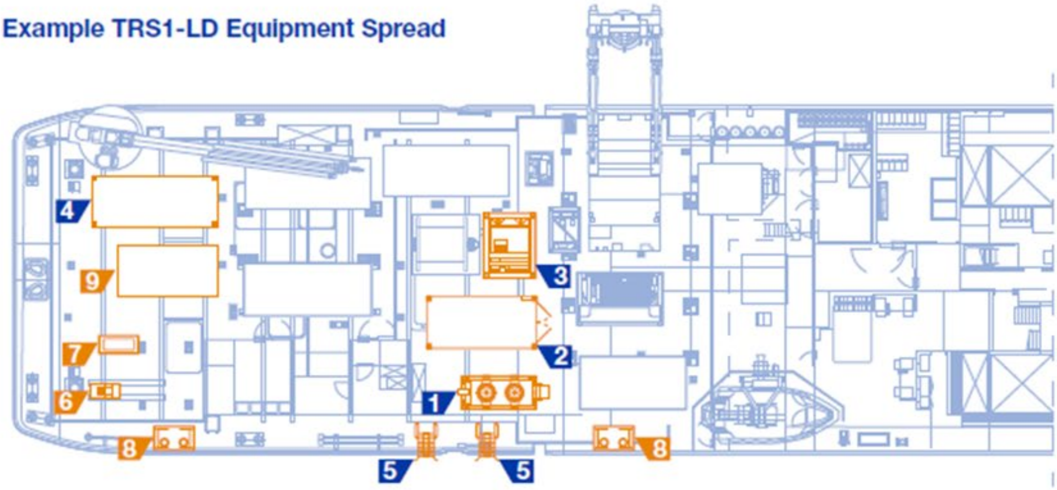


Figure 5-25 Example of a CFE and Equipment Spread

Example TRS1-LD Equipment Spread



Key

No.	Item	Dimensions (m)	Weight (kg)
1	TRS1-LD Tool	4.18 x 2.20 x 1.59	6,000*
2	Twin Tool HPU	6.10 x 2.44 x 2.59	17,000
3	Hydraulic Umbilical Winch	3.05 x 2.44 x 2.59	11,000
4	Spares Container (Rotech)	6.10 x 2.45 x 2.90	12,000
5	Umbilical Chute	2.90 x 0.84 x 1.17	1,000
6	Hydraulic Deck Tugger (optional)	1.00 x 1.16 x 0.68	576
7	Tugger HPU (optional)	1.50 x 0.80 x 1.62	1,000
8	Universal Roller Fairlead (optional)	1.55 x 0.56 x 1.14	500
9	Control Cabin (optional)	3.97 x 2.44 x 2.90	5,000

Source: Rotech Subsea, 2024

During cable lay operations, the vessel crew will monitor the lay to ensure the cable is laid within the consented installation corridor and that the mechanical parameters of the cable are adhered to. A cable fish or ROV may be used for Touch Down Monitoring (TDM) during installation, which contains a camera and USBL system to ensure accurate images of the installation are sent to the crew on the CLV for assessment.

During these operations, the vessel structure may be outside the licenced corridor however all deposits will be installed within the allocated boundary. Vessel movements will be notified by notice to mariners issued to inform other sea users for safety as outlined in the FLMAP.

5.2.10 Second End Pull In

Once the cable is laid across the seabed, the vessel will either manoeuvre off the RPL and float the cable off the vessel or remain in position on the RPL and pay out cable into a floated omega bight. This is to allow the cable to be cut at the required length prior to pulling the cable into the second end landing point at Tiree.

The bight may be outside of the cable installation corridor whilst in the water column at certain points during deployment, however final installed position will be within the boundary of the licenced area. The supporting FLMAP and MEA references the notifications issued to sea users to inform which activities are taking place. Navigational broadcasts will be issued via Navigational telex (NAVTEX) and Notices to Mariners (NTMs) distributed by the Kingfisher fortnightly bulletin and on social media.

As per the First end, buoyancy units will be attached to the cable as it is being paid out to float the cable ashore.

Once the cable is floated out into a bight, a messenger wire will be sent ashore from the CLV on a support craft. The messenger wire will be connected to the to the shore winch which will then be pulled back to the CLV and connected to the cable end. The cable will then be pulled into the Second end landing point. Surface swimmers will then gradually remove the buoyancy units allowing the cable to come to rest on the sea floor. The shore winch will pull in any slack to complete installation operations.

5.3 Cable Protection Methods

This section outlines the envelope of all potential marine cable stabilisation and protection methods for which consent is being sought.

Upon completion of OBS Assessment for the Coll to Tiree route it will be possible to better identify the quantities of cable protection and stabilisation to be employed along the route.

Split pipe, rock bags and Sea Earths will be utilised to provide protection for the replacement cable. Worst case scenario quantities, dimensions and weight for each protection method is provided in Table 4-1 in Section 4 and is the basis of the assessment made in the MEA.

5.3.1 Split Pipe (Articulated Pipe)

The cable protection strategy includes the installation of cast-iron split pipe (articulated pipe). Generally, this is installed following the cable pull-in operations by divers or from the CLV during lay, or by a combination of both methods. This protects and helps stabilise the cable in the nearshore and intertidal section of the cable route.

See the cable protection and stabilisation plan detailed in Table 4-1 for the length of anticipated articulated pipe installation.

5.3.2 Rock Bags

The cable protection strategy may include the installation of rock bags onto the cable to provide stability, where their placement may reduce navigable water depth by more than 5% then consultation will be undertaken with the MCA. The rock bags will be stored on the vessel and lifted into position using the vessel's crane. The vessel's ROV monitors the installation and detaches the crane wire from the rock bag once in position.

Where practical, the rock bags will be filled with stone local to the installation site. The rock bags may be installed as soon as the cable is laid by a separate vessel to the cable lay vessel. Simultaneous Operations (SIMOPS) between the two vessels will be managed in the planning phase as well as the offshore phase via implementation of a SIMOPS plan. Each vessel will be named in the NTM as required in the supporting FLMAP.

5.3.3 Sea Earths

Sea Earths will also be installed to provide protection from surges and lightning strikes to the electrical circuit. It is expected that two earthing cables will be required at each shore end using stainless steel. One cable will earth the armour of the HVAC cable system, while the other provides an earth for the fibre optic armour (integral to the HVAC cable system).

Below MHWS, the earth wire will be installed within the same trench as the subsea cable . The working corridor will be 20m (10m either side of the cable) within the Marine Licence corridor. Concrete clump weights may be used to anchor the sea earths at intervals/at their termination subsea. If used intertidally, they would be completely buried along with the sea earth.

5.3.4 Concrete Mattresses

If shallow water mattress installation is required, a Multicat type vessel will carry out the installation, holding position using spud legs to position the mattresses along the route of the existing cable.

5.4 As-Built Survey and Site Reinstatement

Following completion of operations, an as-built survey will be undertaken of the replacement cable and protection. This will record the as installed position of the cable, and the actual deposits utilised to stabilise and/or protect the cable. The landfall sites will also be re-instated as agreed with landowners and as required in any proposed environmental mitigation. The replacement cable will subsequently be electrically jointed to the land High Voltage (HV) infrastructure. The routing and installation of the land HV infrastructure is not covered as part of this Project Description which supports the marine licence application. The as-built survey will document the installed position of the cable from TJP to TJP with events listed and positions given (i.e. rock bags, mattresses, articulated pipe etc.).

Details of the as-built locations of the cable and associated protection measures will be provided to the UK Hydrographic Office and the Kingfisher Information Service for inclusion on Admiralty Charts, and Offshore Renewable and Cable Awareness Charts respectively.