HAVFRUE

Navigation Risk Assessment
Scotland TS & EEZ

Date: 12 November 2018
Issue: 1.0

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Section	Change
1. INTRODUCTION	Initial Issue
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List of Abbreviations

A

AAE-1 ..... Asia-Africa-Europe-1 Cable System
AC ..... Alter Course
AFT ..... Stern
AOO ..... Area of Operation
ASL ..... Assembly Ship Load
ASM ..... Automatic Speed Mode

B

BAS ..... Burial Assessment Survey
BEC ..... Brass end Cap
BFS ..... Burial Feasibility Study
BMH ..... Beach Manhole
BRH ..... Bight Release Hook
BU ..... Branching Unit

C

CC ..... Cable Counter
CCSI ..... Cable Change Ship Instruction
CDEP ..... Cable Drum Engine Port (also called PCDE)
CDES ..... Cable Drum Engine Starboard (also called SCDE)
CLS ..... Cable Landing Station
COTDR .... Coherent Optical Time Domain Reflectometer
CR ..... Conductor Resistance
CS ..... Cable Ship
CS ..... Cable Station
CTE ..... Cable Termination Equipment
CTU ..... Cable Termination Unit
CX ..... Cable Crossing
CZ ..... Contiguous Zone

D

DA ..... Double Armor
dB ..... Decibel
DC ..... Direct Current
DFF ..... Dispersion Flattened Fiber
DGPS ..... Differential Global Positioning System
DLS ..... Digital Line Section
DOB ..... Depth Of Burial
DOHB ..... Draw Off Hold Back Gear
DP ..... Differential Positioning
DPR ..... Daily Progress Report
DSV ..... Dive Support Vessel
DTG ..... Detrencher Grapnel

E

EEZ ..... Exclusive Economic Zone
EHS ..... Enviromental Health & Safety
EIC ..... Engineer in Charge
EOB ..... End of Burial
EOC ..... End Of Cable
ESD ..... Electrostatic Discharge
ET ..... Electronic Technician

F

FA-NAR .... Factory Alarm – No Apparent Reason
FDC ..... Fiber Distribution Cabinet
FF ..... Flat Fish
FI ..... Final Inspection
FM ..... Factory Splice – Millenia Jointing Technology
FP ..... Fiber Pairs
FS ..... Final Splice
FWD ..... Bow
FWE ..... Finish With Engines

G

GB ..... Optical Termination Box
GEJ ..... Gain Equalizer Joint
GMT ..... Greenwich Mean Time
GPS ..... Global Positioning System
GS ..... Gain Equalizer Joint Shape
GT ..... Gain Equalizer Joint Tilt

H

HD ..... Holding Drive
HDD ..... Horizontal Directional Drill
HDF ..... High Dispersion Fiber
HDPE ..... High Density Polyethylene
HH ..... Hand Hole
HPR ..... Hydroacoustic Position Reference
HV ..... High Voltage

I

ICPC ..... International Cable Protection Committee
IFA ..... Installed Fiber Assignment
IMO ..... International Maritime Organization
INS ..... In Service
IP ..... Inspection Pass / Initial Pass (ROV)
IR ..... Incident Report
IR ..... Insulation Resistance
IS ..... Initial Splice

J

JB ..... Joint Box
JP ..... Jetting Pass

K

KP ..... Kilometer Post

kV ..... Kilovolts

L

Lat. ..... Navigational Latitude position in Degrees and Minutes
LBO ..... Line Build Out
LCE ..... Linear Cable Engine
LFES ..... Loop Fiber End Seal
LJ ..... Land Joint
LME..... Line Monitoring Equipment
LMF ..... Large Mode field Fiber
LMS..... Line Monitoring System
Long. ..... Navigational Longitude position in Degrees and Minutes
LP..... Landing Point
LPFF ..... Long Prong Flat Fish
LT ..... Local Time
LW..... Lightweight cable
LWA ..... Light Wire Armor cable

M

m ..... meter
mA..... mili Ampere
MARPOL .. International Convention on MARitime POLlution
MARSEC.. Maritime Security
MH ..... Manhole
MJ ..... Millennia Joint
MOD..... Ministry of Defense
MOP..... Method of Procedure
MSM..... Manual Speed Mode
MTM..... Manual Tension Mode

N

N ..... North
NDSF ..... Non Dispersion Shifted Fiber
NMS ..... Network Management System
NZDSF ..... Non Zero Dispersion Shifted Fiber

O

OADM ..... Optical Add/Drop Multiplexing
OGB ..... Ocean Ground Bed
OOR..... Out of Range (PLIB)
OOS ..... Out of Service
OPL..... Off Port Limits
OSA..... Optical Spectrum Analyzer
OSP..... Outside Plant
OTDR..... Optical Time Domain Reflectometer

P

P..... Port
PA ..... Public Announcement
PBD..... Physical Build Diagram
PCDE ..... Port Cable Drum Engine (also called CDEP)
PD ..... Port Drum
PFE ..... Power Feed Equipment
PGU ..... Protective Grounding Unit
PLB ..... Post Lay Burial
PLDN..... Plow Down
PLGR ..... Pre Lay Grapnel Run
PLI..... Post Lay Inspection
PLIB ..... Post Lay Inspection & Burial
PLSE..... Pre Lay Shore End
PLUP..... Plow Up
PO..... Pay Out
POL..... Point On Line
POW..... Plan of Work
PSBU ..... Power Switched Branching Unit
PSM ..... Power Safety Message
PSO..... Power Safety Officer
PU ..... Pick Up
PVC..... PolyVinyl Chloride
PWF ..... Pre-determined Wavelength Filters

R

R ..... Repeater
RC..... Route Clearance
REDP ..... Route Engineering Design Package
RIB ..... Rigid Inflatable Boat
RL ..... Rodent-Lightning Cable
ROV ..... Remotely Operated Vehicle
RPL ..... Route Position List

S

S..... Starboard
SA ..... Single Armor
SAT ..... Site Acceptance Test
SB ..... Splice Box
SCDE ..... Starboard Cable Drum Engine (also called CDES)
SD ..... Starboard Drum
SL..... Slim Line
SLD ..... Straight Line Diagram
SLLI..... System Load and Lay Instruction
SM..... Ship Splice - Millenia Jointing Technology
SOLAS ..... International Convention On Safety Of Life At Sea
SPA..... Special Purpose Application Cable
SPO..... Start Pay Out
SPSO ..... Ship Power Safety Officer
SRC..... System Repair Cable
STBD..... Starboard

T

TBD..... To Be Determined
TD ..... Touch Down
TDM ..... Touch Down Monitoring
TEICS..... Tyco Electronics Integrated Cable Systems

TEMS ..... TE SubCom Element Management System
TK ..... Tank
TS ..... Terminal Station
TS ..... Territorial Sea
TTR ..... Transmission Testing Room
TW ..... Tow Winch

U

USBL..... Ultra Short Base Line
UJ..... Universal Joint
UTC time.. Universal Time Coordinated

V

Vs..... Vessel Speed (usually in knots)

W

WD ..... Water Depth
WGS..... World Geodetic System
WOW..... Waiting On Weather
WP ..... Way Point
WMU ..... Wavelength Management Unit

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INTRODUCTION

1.1. Background

Marine Scotland has requested that TE SubCom perform a shipping and navigation assessment of the proposed passage of the Havfrue submarine fibre optic cable system through Scottish Territorial Seas. The report presents information on the proposed development relative to the baseline navigational activity and features for the area. Following this, an assessment of the impact of the proposed development on navigation is presented. The assessment forms part of the Havfrue submarine fibre optic cable system Marine Scotland licence submission.

1.2. Navigational Risk Assessment Purpose

The assessment forms part of the Havfrue submarine fibre optic cable system Marine Scotland licence submission.

Although many of the current NRA guidelines apply directly to Offshore renewables and fixed marine structures as opposed to submarine cables, this NRA has been undertaken in general accordance with the the Department of Energy and Climate Change (DECC) methodology and Marine Guidance Notice (MGN 543 & 371). It has omitted non relevant sections and includes the following.

- Overview of base case environment;
- Maritime traffic survey;
- Implications of cable installations;
- Assessment of navigational risk pre and post development of the proposed Project;
- Formal Safety Assessment (FSA);
- Implications on marine navigation and communication equipment;
- Identification of mitigation measures;
- Search and Rescue (SAR) planning; and
- Through life safety management.

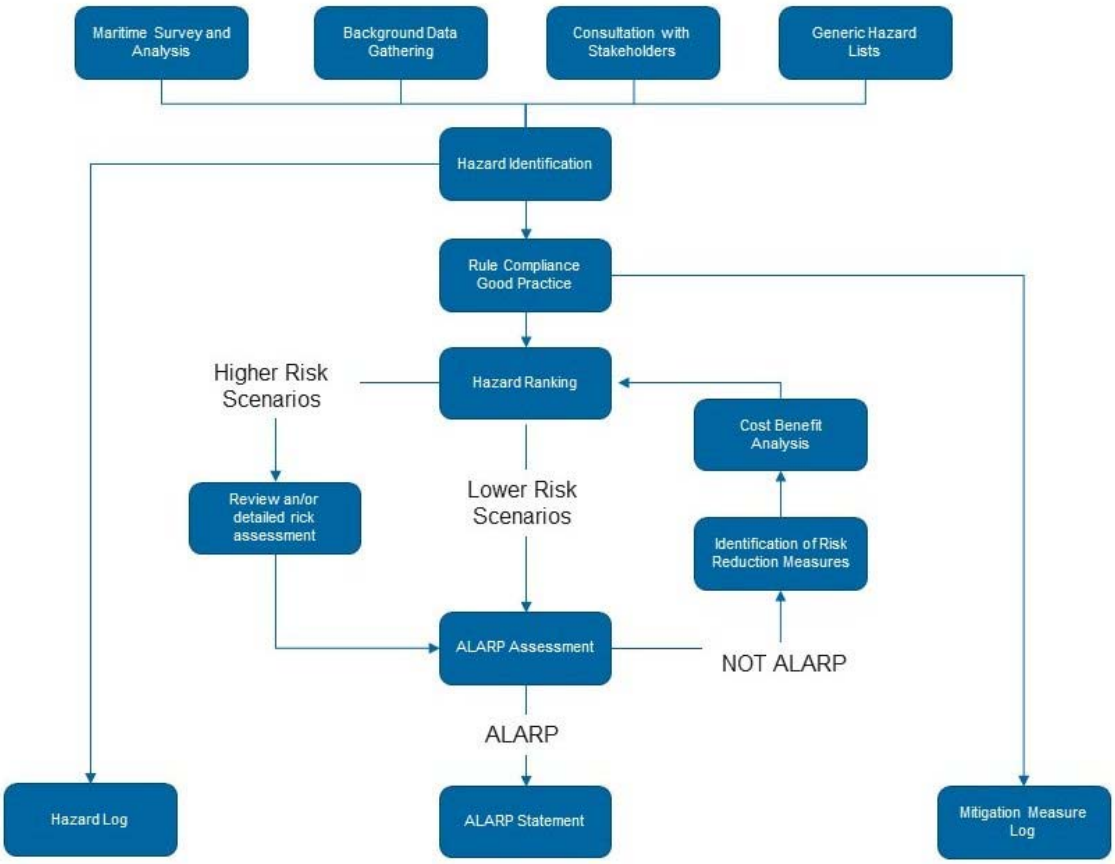
The assessment reviews the following phases:

- Pre-construction;
- Construction;
- Operation and maintenance; and
- Decommissioning.

1.3. NRA Methodology

Figure 1. shows an overview of the NRA methodology which was used in this study. This methodology was designed to meet the guidance described in Section 2.

Figure 1. .....Navigation Risk Assessment Methodology



2. GUIDANCE, LEGISLATION AND CONSULTATION

2.1. Primary Guidance

As previously stated, guidance notes for navigation risk assessment of submarine fibre optic cables systems do not exist. In their absence, guidance notes from similar type industries consulted and relevant sections adopted. The primary guidance documents used during the assessment are listed below:

- International Maritime Organisation (IMO) Guidelines for Formal Safety Assessment (FSA) – MSC/Circ. 1023 (IMO, 2002).
- Maritime and Coastguard Agency (MCA) Marine Guidance Notice 543 & 371 - Offshore Renewable Energy Installations Safety Response (2016) and Offshore Renewable Energy Installations (OREIs) Guidance on UK Navigational Practice, Safety and Emergency Response Issues (MCA, 2008a):
- Department of Energy and Climate Change (DECC) in Association with MCA Guidance on the Assessment of Offshore Wind Farms - Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms (DECC, 2005).

2.2. MCA Marine Guidance Notices 543 & 371

543 & 371 - Offshore Renewable Energy Installations Safety Response (2016) and Offshore Renewable Energy Installations (OREIs) Guidance on UK Navigational Practice, Safety and Emergency Response Issues (MCA, 2008a) highlights issues to be taken into consideration when assessing the effect on navigational safety from offshore renewable energy developments proposed within United Kingdom internal waters, territorial sea or Renewable Energy Zones (REZ). A checklist referencing the sections in this report which address MCA requirements accompany these guidelines.

Not all sections of this guidance notes are relevant to submarine fibre optic cable systems, however relevant sections were adopted.

2.3. DECC Methodology

DECC produced a Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms in association with the MCA and the Department for Transport (DfT) (DECC, 2005). Its purpose is to be used as a template by Developers in preparing their navigation risk assessments, and for Government Departments to help in the assessment of these.

The Methodology is centred around risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows that sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions.

The key features of the Marine Safety Navigational Risk Assessment Methodology are risk assessment (supported by appropriate techniques and tools), creating a hazard log, defining the risk controls (in a Risk Control Log) required to achieve a level of risk that is broadly acceptable (or tolerable with controls or actions), and preparing a submission that includes a claim, based on a reasoned argument, for a positive consent decision.

2.4. Formal Safety Assessment Process

The IMO Formal Safety Assessment process (IMO, 2002) approved by the IMO in 2002 under SC/Circ.1023/MEPC/Circ392 has been applied within this study. This is a structured and systematic methodology based on risk analysis and cost benefit analysis (if applicable).

There are five basic steps within this process:

1. Identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes);
2. Assessment of risks (evaluation of risk factors);
3. Risk control options (devising regulatory measures to control and reduce the identified risks);

4. Cost benefit analysis (determining cost effectiveness of risk control measures); and
5. Recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control measures).

3. FORMAL SAFETY ASSESSMENT PROCESS

The impact assessment uses information within the baseline assessment to assess impacts as per the Formal Safety Assessment process.

- Hazard log and risk ranking;
- Quantified navigational risk assessment for selected hazards;
- Base case and future case risk levels assessed for selected hazards;
- Emergency response review; and
- Assessment of mitigation measures.

The main part of the impact assessment covers the potential impacts to commercial vessels, fishing vessels and recreational vessels from the construction / installation and presence of the proposed cable. The impacts on emergency response, and navigational equipment are assessed.

3.1. Stakeholder Consultation

A range of stakeholders were consulted during the process. This was achieved principally through the Scoping Report to Marine Scotland and therefore covered within the Scoping Opinion. Additional consultation was held with ferry companies and fisheries organisations.

The bodies consulted included;

- Maritime Coastguard Agency
- Northern Lighthouse Board
- Ministry of Defence
- Orkney Fishermen's Association
- Scottish Fisheries Federation
- Roya Yachting Association
- Joint Nature Conservation Committee
- Marine Scotland

4. FIBRE OPTIC CABLE

4.1. Fiber Optic Cable Features

The Project will be engineered and designed using TE Subcom's industry-standard core cable. The materials utilized in the external-most layer in direct contact with the marine environment have extremely low water solubility and are inert in marine environments. Data transmission within the cable is via lightwaves through the optical fibers embedded in a buffer gel material inside a plastic tube. The buffer gel is a material that protects the optical fibers from shear stresses associated with movement inside the tube. Ultra-high strength steel wires are helically wrapped around the optical fibers and together they act as a pressure vessel that protects the fibers from stresses in excess of 100 megapascals (MPa). The interstices between the steel wires are filled with a water-blocking material which resists longitudinal water ingress. The cable design includes a conductor to carry both system power and the cable monitoring and maintenance signal. The power conductor is constructed by seam welding a copper tape around the high-strength wires. A thin layer of ethylene-acrylic acid copolymer plastic resin and a thick layer of polyethylene insulating jacket are coextruded over the copper sheath. The outer polyethylene jacket provides high-voltage insulation, abrasion resistance, and corrosion protection. The cable at this point is considered "Lightweight" or "LW". Cable types to be used in the Project include:

- SL21SPA, SL12SA, SL12DA,b,
- SL14SPA, SL14SA, SL14DA, and
- SL17LW.

Figure 2 provides diagrams of the cable layers and show that the outer diameter ranges from 14.6 to 28.8 mm (0.6 to 1.1 in) depending on cable type.

Additional layers of material are added to the basic core based on the expected seafloor geology and environment and/or the methodology employed to install it (i.e., buried or surface laid). Factors influencing the selection of a cable type will also be based on the Project's exposure to external aggression such as anchoring or fishing activity or based on the cable's footprint across a variety of seabed types. These seabed types range from soft, sandy flat seabed to hard, rock outcropping and seamounts.

Some cable systems may include sections of a Special Application (SPA) cable where a moderate risk of abrasion to the system cable exists due to either high bottom currents or rugged seabed. The SPA cable consists of the standard LW design with the addition of an abrasion resistant tape to the outer polyethylene surface. This SPA tape consists of chrome coated steel covered with an outer layer of High Density Polyethylene (HDPE).

Armored cable could be used in areas where the highest degree of protection is required to mitigate risks from high-energy environments and external aggression (e.g., rocky terrain, fishing activity, high risk of abrasion or crushing from anchoring). Armored cable is produced by wrapping layers of armor wire around a finished LW cable. The armor wires are coated with asphalt-soaked yarn. The criteria for selecting each type of armored cable and the natural progression of upgrading cable types are outlined in Table 1.

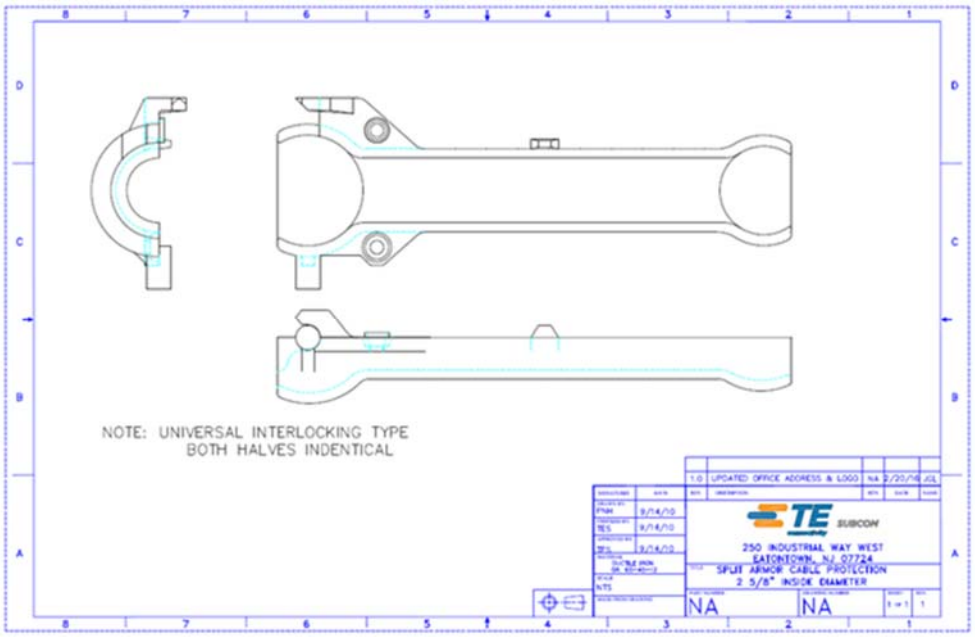
Articulated pipe, also referred to as split pipe, can be applied to the cable to protect the cable in areas where additional protection against high-energy conditions and external aggression is required and can be applied to conform to the seabed. It can also be used in shallow water, and surf zones, and in hard bottom areas within safe diving limits. Articulated pipe, once installed over the cable, results in an approximate outside diameter on the order of 200 mm (7.9 in) with an inside diameter of 670 mm (2 5/8 in). A diagram of articulated pipe over a cable is provided in Figure 2.

Figure 2. .....Components of Havfrue Cable Types (PBT = Polybutylene Terephthalate)

Table 1 . SL Cable Upgrade/Up Armor Progression

Cable Type	Selection Guidelines	Image
Light Weight (LW)	Used in most benign deep ocean environments to full ocean depth. Outer diameter can range from 17 to 21 mm (0.67 to 0.83 in).	
Double Armor (DA)	DA is typically used in the near shore portion of the cable where the risks from high-energy environments and external aggression are highest. Maximum deployment depth is typically 600 m (656 yd). Typically used in the following areas: High-energy environments (wave energy, fast currents) and in areas of megaripples/sandwaves (indicating sediment mobility) where buried cable may become exposed; Rock outcrops, and of less than reasonable sediment cover where abrasion is a risk; Pipeline crossings; and Where external aggression risks are identified near cable planned for surface lay.	

Figure 3.Diagram of Articulated Pipe Over a Cable



4.2. Environmental Characteristics of SL Cable Operating Current

SL cables (Figure 2), are designed to conduct system power for repeated cable systems with a maximum operating DC current of up to 10 amps. The extremely high insulating properties of the outer polyethylene jacket prevent current leakage. Therefore, environmental effects associated with current leakage are not expected.

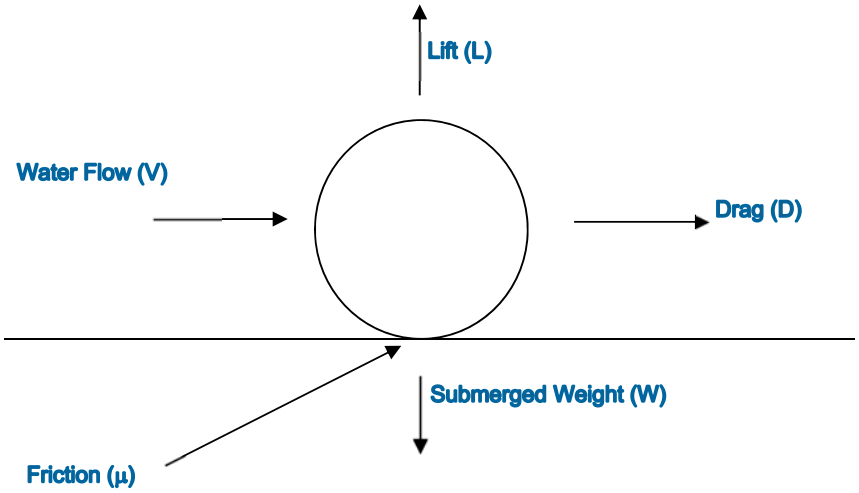
4.3. Environmental Characteristics from SL Cable Magnetic Fields

An extremely low magnetic field may be generated at the exterior of the SL cable surface during normal operation. The maximum magnetic field intensity is at the exterior cable surface and decreases inversely cubed with distance from the cable. The magnetic fields induced by cable powering are on the order of 30 to 38 microtesla (μT) at the cable surface. These values are lower than the background magnetic field of the earth (≈60 μT). The weak magnetic fields produced by SubCom's SL undersea cables are orders of magnitude below detectable thresholds for ecological receptors. Additionally, the proposed cable to be used during the Harvfrue cable system will be below detectable thresholds for all small craft navigation and communications equipment.

4.4. Surface Laid Cable Stability on Seafloor

The cable will be laid onto the seabed from a cable ship on the sea surface in a controlled manner such that the cable will lie on the seabed under a residual tension of between 3 and 5 kilonewtons. Forces acting on the cable on the seafloor are defined below (Figure 4).

Figure 4..... Forces Acting on the Cable on the Seafloor



The water velocity required to move a cable on the sea bed can be calculated using the formula below, where V is the water velocity required to initiate movement (m/s).

$$V = \sqrt{\frac{2gw}{d\rho\left(\frac{C_D}{\mu} + C_L\right)}}$$

g is gravity (m/s^2)

w is the cable weight in water (kg/m)

d is the cable diameter (m)

ρ is the density of sea water ($1020kg/m^3$)

C_D is the transverse drag coefficient = 1.2

μ is the coefficient of friction of cable / seabed = 0.3

C_L is the transverse lift coefficient = 1.2

The assumptions associated with this equation are that the water flow is perpendicular to the cable (worst case), that the coefficient of friction between cable and seabed is 0.3 (minimum expected) and the cable is free to move (no residual tension). Substituting the values for an example cable (d = 28 mm and w = 1.5 kg/m), the resulting value of V is 0.45 m/s. In practice, cables once installed do not move on the seafloor due to tension and the overall weight of the cable but anchors can be installed, if necessary along the cable route within safe diving limits to secure the cable to the seafloor.

5. PROJECT DESCRIPTION DETAILS

5.1. Project Description

The Havfrue Cable System (the Project) is a planned subsea cable system in the Atlantic and North Sea linking the countries of United States, Denmark, Ireland, and Norway. The Havfrue cable will be owned and operated by Optibulk Havfrue As (Optibulk), America Europe Connect 2 Limited (AEC), Edge Network Services Limited (Edge) and Google Infrastructure Bermuda Limited (Google). Subcom has been contracted to supply and install the system.

The Project involves laying a subsea fibre-optic cable (approximately 4 cm in diameter) across the seafloor. The cable will be buried, where conditions allow, out to the 1,500 m depth contour. Approximately 38 km of cable will cross the Scottish Territorial Sea (TS), with an additional 944 km crossing the UK Exclusive Economic Zone (EEZ). The cable will cross existing pipelines and cables in the UK EEZ but will not cross any in-service cables or pipelines within the Scottish TS. Rock protection will be installed at nine pipeline and cable crossings in the UK EEZ where this has been required by the asset owners.

The objective of the Project is to install a subsea fibre-optic system providing connectivity across the Atlantic and North Sea. The new system will increase telecommunication reliability and diversity between the regions and increase data transmission capacity and speeds, helping to satisfy the growing demand for transmission capacity in Europe and the USA.

The subsea cable installation, operation and decommissioning includes the following activities.

1. Cable Route Survey and Design
2. Pre-Lay Inspection and Owner Review
3. Pre-Installation (“Bottom”) Rock Placement
4. Cable Installation
    a. Route Clearance of Out-of-Service (OOS) Cables
    b. Pre-Lay Grapnel Run (PLGR)
    c. Main Lay
5. Post-Lay Inspection and Burial (PLIB)
6. Post-Installation (“Top”) Rock Placement
7. Operation, Maintenance and Repair
8. Retirement, Abandonment or Decommissioning

A detailed description of each activity is provided in Attachment B to the Marine Licence Application: Project Description and Method Statement.

5.2. Burial Risk Assessment

A burial risk assessment (BRA) or burial feasibility study (BFS) was carried out of the entire proposed cable route throughout the Scottish EEZ and TS. The BRA used geophysical and geotechnical survey data collected along the cable route to engineer the optimum cable corridor. The information consulted included seabed engineering properties which indicated the likelihood of cable burial.

Attachment H to the Marine Licence Application provides the detailed burial risk assessment findings for installation in Scottish TS, including expected burial category, expected minimum burial depths, tow tension, plough speed and most importantly, Seabed Geology Description as well as Burial Instruction and Warnings. This information is a fundamental component of the understanding of the burial risk and feasibility.

The results of this burial survey were provided to the Scottish Fisheries Federation (SFF) for their comment. Comments received from SFF indicated that they had no objection to the route.

The cable route is not located at any area of known anchorage. As a result, the potential for anchored vessels to damage the cable are very low.

6. EXISTING ENVIRONMENT

6.1. Cable Route through Scottish TS

The water depths along the planned cable route through the Scottish TS range from 97 m to 126 m through complex topography and moderate to strong water currents. A mapbook of substrate types crossed by the marine cable route within the Scottish TS accompanies the Marine Scotland Marine Licence application. Based on the seabed survey undertaken in August 2018 the seabed type along the proposed cable route includes:

- sand;
- subcropping rock or till;
- outcropping till; and
- rock.

6.2. Rock Installation Locations in the UK EEZ

The water depth in the area of the planned rock installations ranges from 110 m to approximately 140m. The seabed survey identified the following substrate types in the areas designated for rock installation:

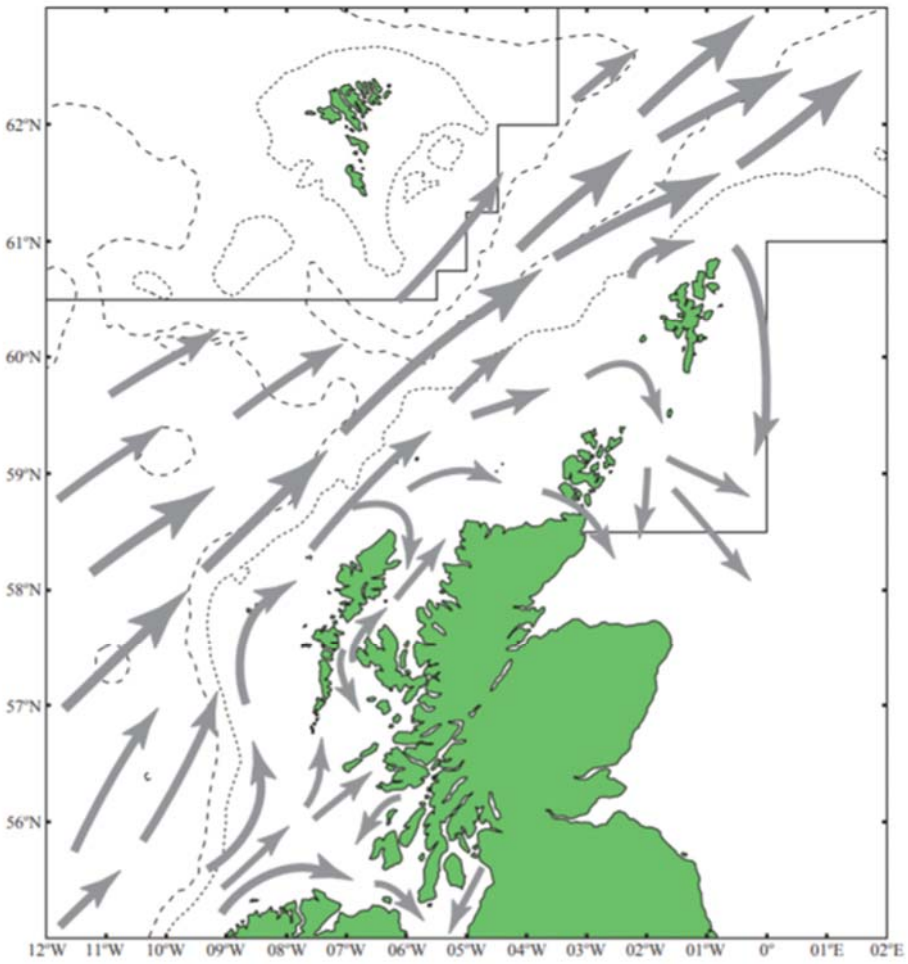
- sand; and
- subcropping rock or till.

6.3. Water Quality and Resource

The proposed cable route through the Scottish TS passes through an area of offshore marine water north of Fair Isle. Figure 5 shows the direction of movement of water through the Project area as coming from the south-west along the west coast of Scotland towards Shetland. The mainly wind-driven Fair Isle Current moves between Orkney and Shetland before turning south-eastwards and flowing into the North Sea (Turrell *et al*. 1990).

The offshore waters along the proposed cable route do not show significant anthropogenic contamination (Baxter *et al.* 2011).

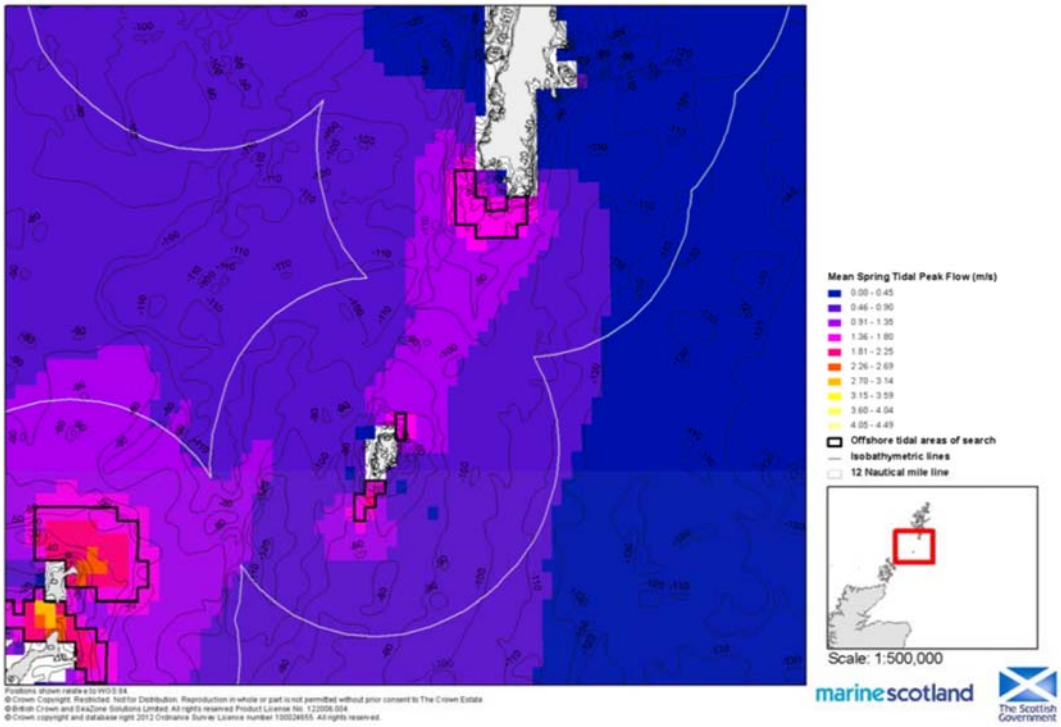
Figure 5. .....Movement of Water Currents through the Project Area



Source: JNCC, 2000 Bathymetry: short dash (200m isobath); long dash (1,000m isobath).

The Draft Regional Locational Guidance – Tidal Energy in Scottish Waters note that tidal resource is relatively smaller than regions like the Pentland Firth but still hold enough potential to be considered commercially viable for tidal energy units. Mean power density at Fair isle is 0.56 kWatt m-2 with a 0.32 kWatt m-2 mean at neap tide and a mean of 2.12 kWatt m-2 for spring tides. Mean spring peak flow is 1.6 ms-1 and the mean spring and mean neap ranges are 1.7 m and 0.8 m respectively. At Sumburgh Head the mean power density is 0.52 kWatt m-2 . The mean neap power density is 0.28 kWatt m-2 and that for the spring is 2.07 kWatt m2. Mean spring peak flow is of 1.6 ms-1 and the mean neap and spring tidal ranges are 0.53 m and 1.16 m respectively.

Figure 6. .....Fair Isle tidal energy resource



6.4. Noise

Ambient sea noise comprises a variety of individual sources, some of which are natural and some man-made. Natural noise sources include waves breaking, wind, rain and animal calls, while anthropogenic sources include general shipping, fishing vessels, recreational and military activities, seismic survey activities and drilling.

Anthropogenic sources in the Project area are predominantly generated from vessels transiting through the Fair Isle shipping channel and along the ferry routes. Fishing vessels will also generate noise and are not confined to charted shipping channels.

6.5. Biological Environment

Existing information has been used to support the description of the environment along with more detailed geophysical studies along the cable route. Other information sources include the Marine Habitat Classification for Britain and Ireland (JNCC, 2018), the Marine Scotland interactive map and the UK Offshore Energy Strategic Environmental Assessment (DECC, 2016).

6.6. Benthic Ecology

Based on the JNCC's predictive mapping the EUNIS (2007) broad habitat types along the proposed cable route include:

- deep-sea muddy sand in waters west of Scotland that are considered to be sparsely populated by benthic organisms;
- deep circalittoral and coarse sediment in the north and northeast that are considered to be quite diverse and generally characterised by robust infaunal polychaete and bivalve species; and
- deep circalittoral mud in areas of the northern North Sea to the east that are dominated by polychaetes but often with high numbers of bivalves such as *Thyasira* spp., echinoderms and foraminifera.

Around Fair Isle, there is relatively little in the way of subtidal sediments, other than coarse shell-gravels. Closer to the coast in sheltered regions the finer sediments are characterised by species such as the lugworm Arenicola marina and the sand-mason Lanice conchilega (Wilding et al., 2005).

The benthic flora and fauna around the Orkney Islands are dependent on the physical conditions, which vary considerably on a very local scale. In the deeper and exposed sublittoral, faunal crusts with the polychaete Pomatoceros triqueter, the barnacle Balanus crenatus and bryozoans may be present while dead man's fingers Alcyonium digitatum-dominated communities may be found on moderately exposed rock. Bryozoans, mussel beds (both Mytilus and Modiolus), brittle stars and faunal and algal encrusting species with the presence of the sea urchin Echinus esculentus form the characteristic species of these communities (Wilding et al., 2005).

6.7. Fish and Shellfish Ecology

The Project area supports spawning of a number of fish species. Although spawning and nursery grounds are likely to change to some degree year on year, depending on the variability of environmental parameters such as water temperature and food availability, the majority of these species are known to have nursery grounds within the Scottish TS and some also spawn there (Coull *et al* 1998).

Four fish species listed as threatened on the International Union for Conservation of Nature (IUCN) Red List may be found in the Scottish TS. Basking shark (*Cetorhinus maximus*), tope (*Galeorhinus galeus*) and porbeagle (*Lamna nasus*) are all listed as Vulnerable and may occur seasonally and in low numbers. Common skate (*Dipturus batis*) is listed as Critically Endangered and can be found at low density throughout the North Sea (CEFAS 2001, IUCN 2014).

6.8. Marine Mammals

A number of cetacean species listed on Annex II of the EC Habitats Directive are known to occur in the Project area, including the Scottish TS. Harbour porpoise are the most abundance cetacean species in the Scottish TS, however, previous surveys have indicated that the main population concentration shifted further south in 2005 (Hammond *et al* 2013). In addition to cetaceans, two species of seal breed within the UK EEZ, the harbour seal (also known as common seal, *Phoca vitulina*) and the grey seal (*Halichoerus grypus*). Harbour seals occur throughout the UK EEZ, with over 80% of the population occurring in the Scottish TS. Both seal species are listed within Annex II of the EC Habitats Directive.

Minke whales, Risso's dolphins and white-beaked dolphins have also been recorded in low abundances as present in the Project area (JNCC 2000).

6.9. Designated Sites

The proposed cable route does not pass through any designated sites in the Scottish TS. The route crosses two Marine Protected Areas in the EEZ. These are the West Shetland Shelf Nature Conservation Marine Protected Area (NCMPA) and the North-West Orkney NCMPA.

7. HUMAN ENVIRONMENT

7.1. Commercial Fisheries

The North Sea is a major fishing area for UK and international fleets. The main gear types used to target demersal species are otter trawls and seine nets. The demersal fishing effort over the whole continental shelf north of Scotland is high and is particularly high in areas northwest of the Northern Isles. The area between Fair Isle and Shetland supports a relatively high intensity of mobile demersal fishing effort (Vessel Monitoring System data, 2009 - 2013). Latest (2016) fisheries statistics from ICES rectangle 48E8 (1) show over 1,000 tonnes shellfish landed, around 20,000 tonnes pelagic species landed and over 2,000 tonnes demersal species landed.

Pelagic offshore fisheries in the area target herring, using purse seines and trawls, and mackerel, using trawlers. Both fisheries are active throughout the year, with peak landings in the summer and early autumn (MMO 2017). The pelagic fishing effort is high throughout the continental shelf area north of Scotland.

Table 2. Fishing Activity in the Project Vicinity

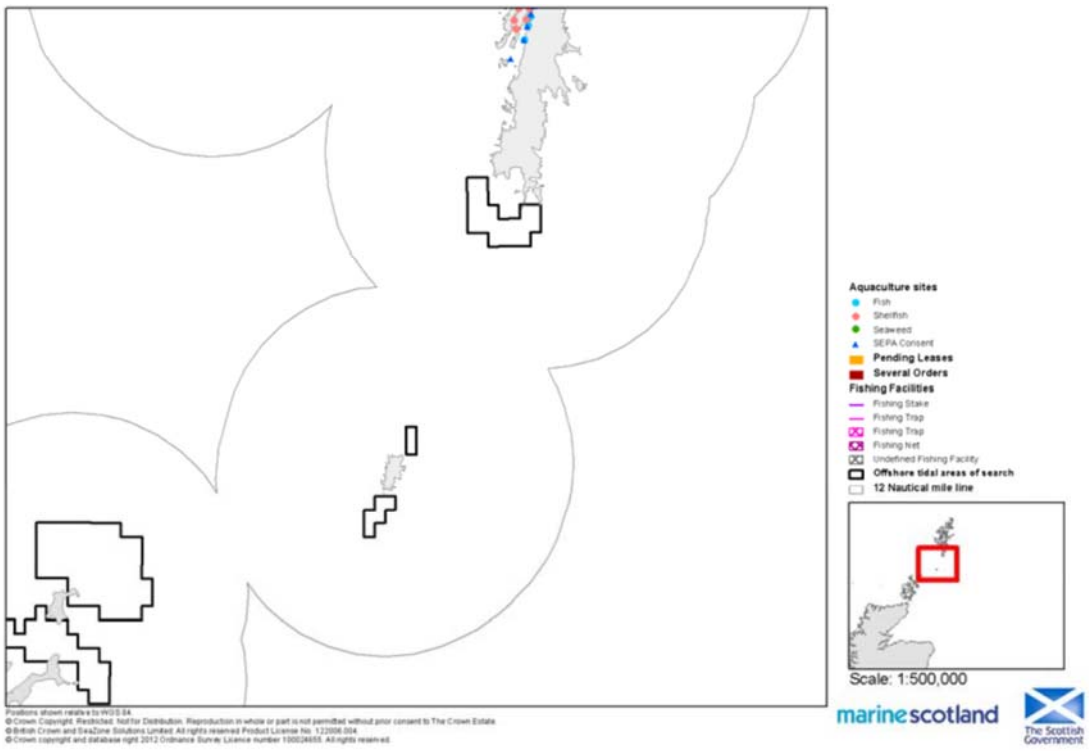
Gear Type	Bottom (Otter) Trawl	Seine Netting	Longlining	Set Nets	Mid-water trawling
Target Species	Flatfish, Nephrops, Shrimp, Queens, Lobster, Crab, Anglerfish, Megrim	Cod, Haddock, Whiting, Mackerel, Salmon, Sea Trout, Flatfish, Sprat	Cod, Haddock, Whiting, Flatfish, Halibut, Cod, Ling, Tusk and Skate in deeper water	Salmon, Sea Trout	Mackerel, Herring, Sprat, Saithe, Hake
Areas Fished	Throughout Project Area	Throughout Project Area	Throughout Project Area	Throughout Project Area	Throughout Project Area
Depths Fished (meters)	5-2,000	Any depth in mid water	Small lines 5-175 Great lines 175-300 (they have known to go to 1,100m targeting sablefish)	1.5-6	Any depth in mid water
Depth of seabed penetration (cm)	3-4	0	0	0	0
Season	Dependent on species targeted	Dependent on species targeted	Dependent on species targeted	Dependent on species targeted	Dependent on species targeted
Est. # Active Vessels (Scottish Fleet)	70 scallop dredgers, 116 inshore trawlers,	20	Limited numbers	Limited numbers	20

(1) ICES statistical rectangles are used for the gridding of data to make simplified analysis and visualisation. The cable route passes through ICES rectangle 48E8.

	79 offshore drawlers				

There are numerous fish and shellfish farm sites surrounding the majority of the Shetland islands with the exception of the south east and some north west areas. Shetland is responsible for producing 29% of Atlantic salmon, 65% of mussels for the table, 63% of mussels for on-growing and 0.8% of Pacific oysters for the table, however, no aquaculture sites are close to the proposed Havfrue development.

Figure 7. .....Fair Isle Acquaculture and Fishing Facilities



7.2. Shipping and Navigation

The Project area supports a moderate level of shipping traffic, largely comprised of merchant ships, supply vessels and tankers. Vessels using routes around the north of Scotland include vessels transiting from the Western Atlantic to the Baltic States and Russia, some of which will use the Fair Isle Channel. In addition, traffic using the Pentland Firth, Orkney Ports (Kirkwall), Shetland Ports (Sullom Voe) and Mainland Scotland Ports provides a relatively high intensity of shipping in the Project area (MMO 2014).

The proposed cable route passes through the Fair Isle Shipping Channel and crosses three ferry routes (Lerwick–Grutness–Fair Isle, Kirkwall – Lerwick and Aberdeen - Kirkwall – Lerwick). Sections 8.5 & 8.6 detail vessel density in the vicinity of the Project.

There are a number of current and proposed developments and infrastructure located within or in close proximity to the proposed cable route. Most of these are outside the Scottish TS; Table 3 presents details of these developments and their locations. The cable will not interrupt or cross any current or proposed developments within the Scottish TS.

Table 3. Pipeline and Power cable crossings in UK

Pipeline/Power cable/Umbilical Name (data source)	Maritime Jurisdiction	Latitude	Longitude
		WGS 84	
INS Shetland Island Gas Export System (SIRGE)	UK EEZ	59 29.1414N	000 33.5980W
INS Brent A --> St Fergus (FLAGS)	UK EEZ	59 26.9049N	000 21.6999W
INS Vesterled Trunkline	UK EEZ	59 16.0453N	000 35.4066E
INS Frigg - St Fergus 1 (FUKA)	UK EEZ	59 15.9993N	000 35.5599E
INS Scottish Area Gas Evacuation (SAGE)	UK EEZ	59 09.4257N	001 14.2648E
INS Devenick - East Brae Umbilical	UK EEZ	59 08.0356N	001 33.9763E
INS Devenick - East Brae Trunkline with 3" Methanol line piggy back	UK EEZ	59 08.0346N	001 34.0082E
INS Edvard Grieg - SAGE (Utsira High)	UK EEZ	59 08.0228N	001 34.3935E
INS Bruce - Forties Trunkline	UK EEZ	59 07.1650N	001 39.7875E

There are several inactive and producing hydrocarbon fields located north of the proposed cable route, towards the west of the Shetlands. There are also several fields located within close proximity to the proposed cable route, towards the east of mainland Scotland.

The proposed cable route follows a similar route to previously installed main grid and submarine cables around Scotland. There are several hydrocarbon pipelines connecting producing and inactive hydrocarbon fields to shore; however, the proposed cable route does not cross any of these throughout the Scottish TS. Although the proposed cable route does not cross any pipelines or in-service subsea cables within the boundaries of the Scottish TS there are crossings within the UK EEZ.

There are significant planned options for marine renewable energy operations in the form of tidal and wind energy to the north and south of the proposed cable route. South of Shetland, the proposed cable route also travels through an area that has the potential to be developed as part of the Marine Plan for Wave Energy in Scottish Waters.

The cable route will cross through a Ministry of Defence (MOD) Danger Area in the western EEZ. The Danger Area supports live firing activities along with international weapon exercises. Whilst firing activities are conducted, marine traffic and personnel are not permitted within the Danger Area as it provides a zone within which any shell fragments and ricochets are confined. The Danger Area is located outside the area of the initial scoping document, but was raised as an issue to address in the Scoping Opinion issued by Marine Scotland. The Project subsequently met with MOD and received concurrence that installation across the area would be acceptable once a deconfliction

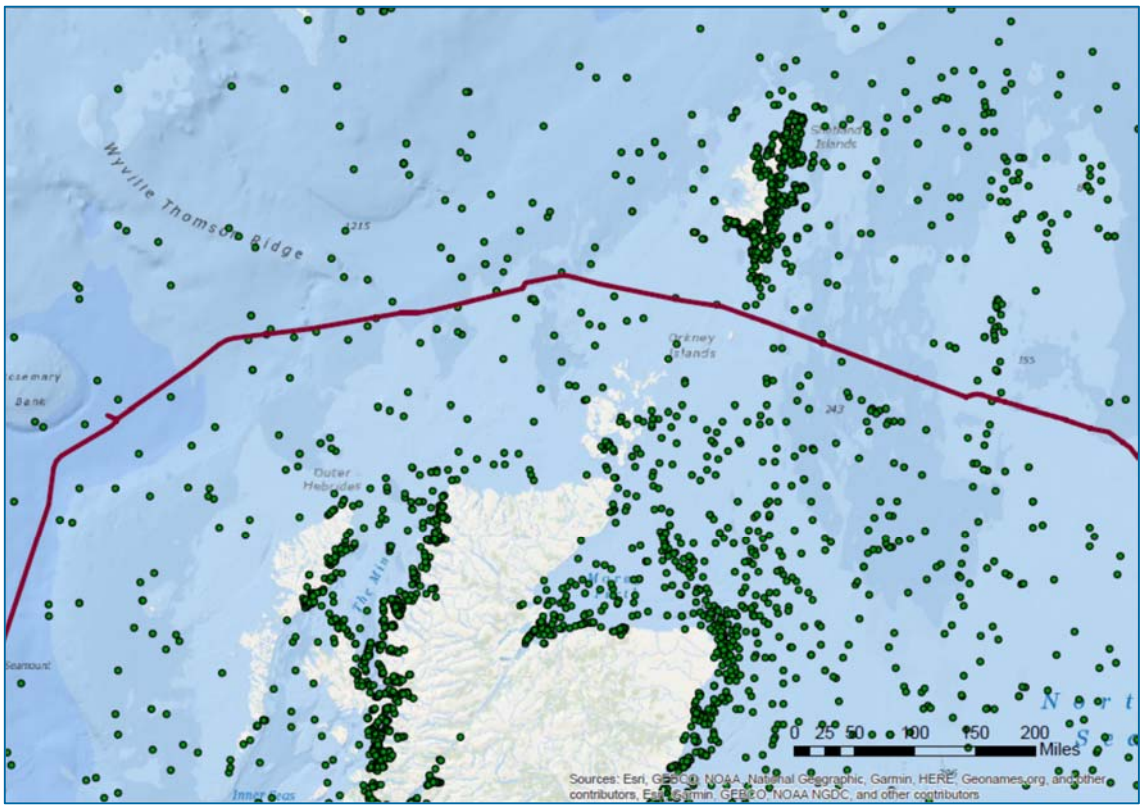
strategy was developed. This deconfliction strategy development is currently ongoing between Subcom and the Ministry of Defence.

7.3. Cultural Heritage

There is potential for prehistoric submarine archaeological remains to occur throughout the region, including within the Project area. Archaeological remains are more likely to have remained intact in deep water, sheltered submerged caves and gullies within sea lochs and enclosed bays. In shallower water or narrow offshore channels the strong currents, thin sediment cover and exposure to storms makes the survival of prehistoric remains and deposits less likely. There are a large number of ship and aircraft wrecks in the vicinity of the cable route through the Scottish TS, including both charted and uncharted sites.

The marine cable survey was conducted by the Project throughout UK TS and EEZ waters. No wrecks or significant obstructions were identified in the cable footprint or rock installation locations in UK waters.

Figure 8. .....Known shipwreck in the vicinity of the cable route



7.4. Unexploded Ordnance

It is planned to carry out Unexploded Ordnance (UXO) Surveys in advance of cable installation. All operations will fully adhere to the Ciria guidelines, *Assessment and management of unexploded ordnance (UXO) risk in the marine environment*, 2015.

It is anticipated that the survey will be undertaken by towed gradiometer array or ROV mounted gradiometer, at line spacing sufficient to identify the minimum estimated ferrous signature.

The outcome of the UXO survey is not yet complete. As such, no mitigation measures have been determined. However, options of avoidance and removal are the two preferred methods.

Details of proposed UXO survey areas are detailed below;

Table 4. Details of proposed UXO survey areas

NAME	LENGTH	GEOMETRY (WGS84, UTM)
UXO Area 1	1.44 km	LINESTRING(-3.0024000000 59.8225700000, -2.9785950000 59.8177250000)
UXO Area 2	989.89 m	LINESTRING(-2.8829133333 59.8068883333, -2.8654716667 59.8055700000)
UXO Area 3	314.51 m	LINESTRING(-2.8476533333 59.8038083333, -2.8421683333 59.8032316667)
UXO Area 4	721.45 m	LINESTRING(-2.8201683333 59.8009150000, -2.8075883333 59.7995900000)
UXO Area 5	551.07 m	LINESTRING(-2.5457483333 59.7726733333, -2.5359433333 59.7725400000)
UXO Area 6	1.465 km	LINESTRING(-2.5253750000 59.7723966667, -2.4994250000 59.7711550000)
UXO Area 7	1.1 km	LINESTRING(-2.4862550000 59.7701200000, -2.4670100000 59.7683016667)
UXO Area 8	837 m	LINESTRING(-2.3392366667 59.7537516667, -2.3247283333 59.7520633333)
UXO Area 9	1.699 km	LINESTRING(-2.3133683333 59.7496216667, -2.2839883333 59.7460516667)
UXO Area 10	1.964 km	LINESTRING(-2.2505250000 59.7451016667, -2.2162283333 59.7417866667)
UXO Area 11	365.99 m	LINESTRING(-2.1879200000 59.7380483333, -2.1815300000 59.7374266667)
UXO Area 12	767.95 m	LINESTRING(-2.1673033333 59.7363883333, -2.1536500000 59.7363183333)
UXO Area 13	822.43 m	LINESTRING(-2.1200366667 59.7341916667, -2.1054916667 59.7334366667)
UXO Area 14	897.09 m	LINESTRING(-2.0368350000 59.7259600000, -2.0211800000 59.7244316667)
UXO Area 15	226.58 m	LINESTRING(-2.0064333333 59.7241116667, -2.0024100000 59.7240233333)
UXO Area 16	1.307 km	LINESTRING(-1.9912316667 59.7236033333, -1.9680966667 59.7225983333)
UXO Area 17	1.468 km	LINESTRING(-1.8795933333 59.7162550000, -1.8537416667 59.7145116667)
UXO Area 18	2.342 km	LINESTRING(-1.8368066667 59.7139816667, -1.7958266667 59.7103600000)
UXO Area 19	200.02 m	LINESTRING(-1.7238800000 59.6999933333, -1.7205400000 59.6993816667)
UXO Area 20	321.14 m	LINESTRING(-1.3541850000 59.6347683333, -1.3487516667 59.6339083333)
UXO Area 21	556.8 m	LINESTRING(-1.2670650000 59.6192050000, -1.2576950000 59.6176416667)

UXO Area 22	1.15 km	LINESTRING(-0.4260900000 59.4591966667, -0.4063200000 59.4568950000)
UXO Area 23	1.747 km	LINESTRING(0.8003950000 59.2234833333, 0.8291533333 59.2181433333)
UXO Area 24	312.93 m	LINESTRING(1.1552200000 59.1587566667, 1.1603533333 59.1577866667)
UXO Area 25	1.191 km	LINESTRING(1.1776250000 59.1546700000, 1.1973600000 59.1512616667)
UXO Area 26	1.486 km	LINESTRING(2.1833116667 59.0426700000, 2.2082133333 59.0390300000)
UXO Area 27	725.76 m	LINESTRING(2.2256650000 59.0350883333, 2.2379766667 59.0336133333)
UXO Area 28	782.51 m	LINESTRING(2.2583116667 59.0305233333, 2.2713750000 59.0285250000)
UXO Area 29	200.35 m	LINESTRING(2.3007116667 59.0269750000, 2.3042000000 59.0269950000)
UXO Area 30	5.005 km	LINESTRING(2.5722716667 58.9780566667, 2.6548983333 58.9639783333)
UXO Area 31	1.472 km	LINESTRING(2.6920416667 58.9573716667, 2.7167200000 58.9538916667)

7.5. Burial Risk Assessment

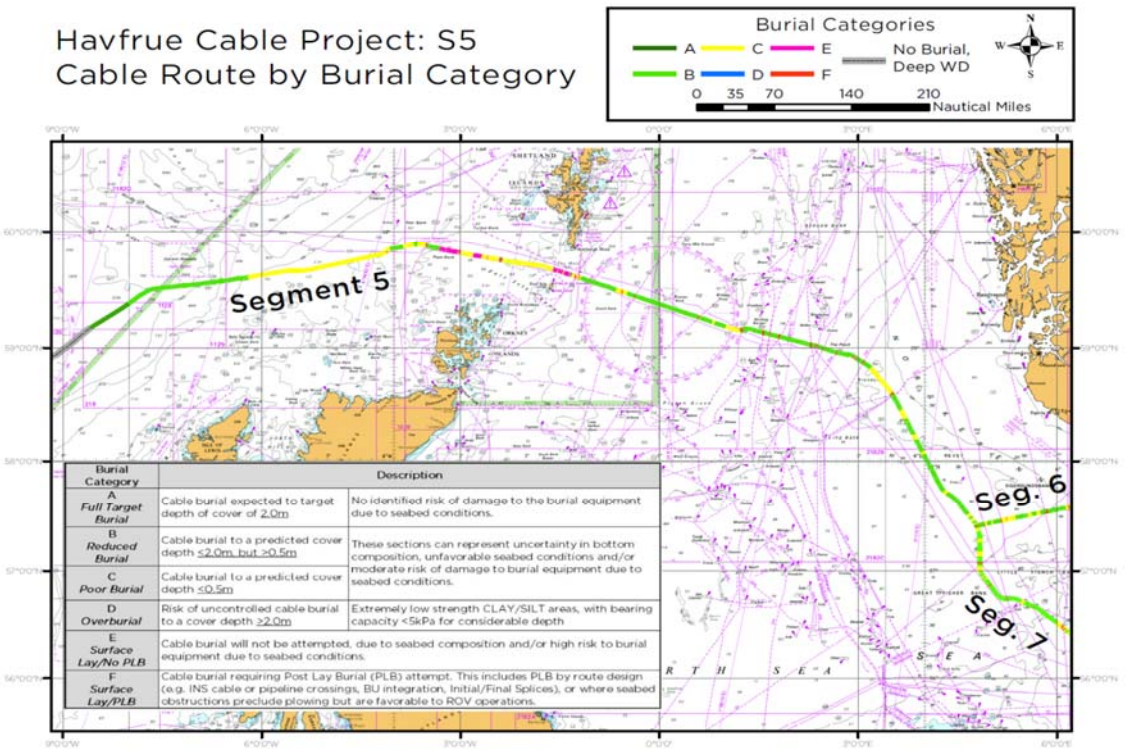
A burial risk assessment (BRA) or burial feasibility study (BFS) was carried out of the entire proposed cable route throughout the Scottish EEZ and TS. The BRA used geophysical and geotechnical survey data collected along the cable route to engineer the optimum cable corridor. The information consulted include seabed engineering properties which indicated the likelihood of cable burial.

The study indicates that there will be complete burial along the entire route, except in those areas where asset crossings are required. The results of this burial survey have been provided to the Scottish Fisheries Federation (SFF) for their comment. Comments received from SFF indicated that they had no objection to the route.

The cable route is not located at any area of known anchorage. As a result, the potential for anchored vessels to damage the cable are very low.

The BRA also serves to provide valuable information for any anchor penetration study. It contains details of the geotechnical properties of the seabed. These properties fundamental in determination of potential seabed anchor penetration studies.

Figure 9. .....Cable burial risk assessment



8. MARINE ACTIVITIES

8.1. Introduction

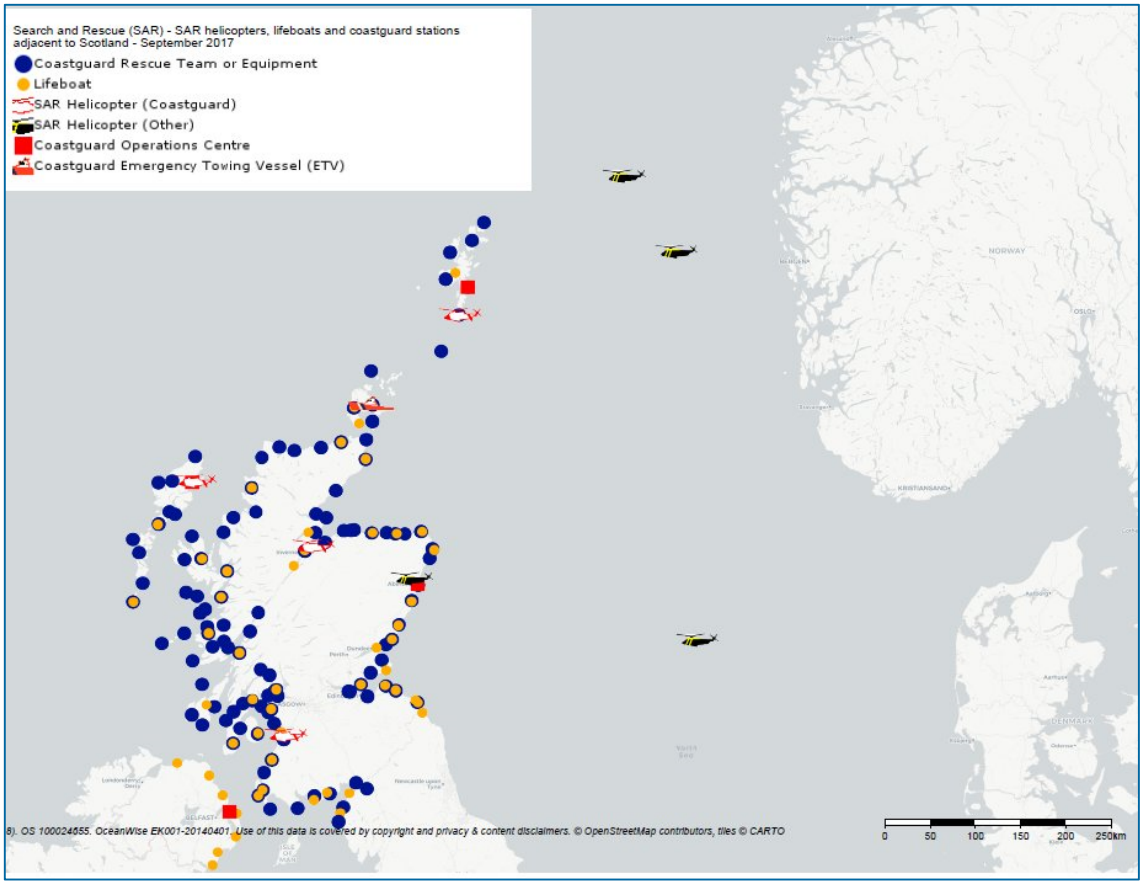
The following sections identify current response capabilities delivered by the UK emergency response providers.

8.2. MCA including HM Coastguard

At the time of writing, the HM Coastguard (HMCG), a division of the MCA, coordinates SAR through a network of 18 Maritime Rescue Coordination Centres (MRCC).

The Havfrue Project currently lies in the former Scotland and Northern Ireland Search and Rescue Region with the nearest MRCC to the proposed Project being Aberdeen. MRCC Aberdeen's area of responsibility covers the area south of Brora to the Scotland / England border.

Figure 10. .....SAR resources in the vicinity of the proposed cable route



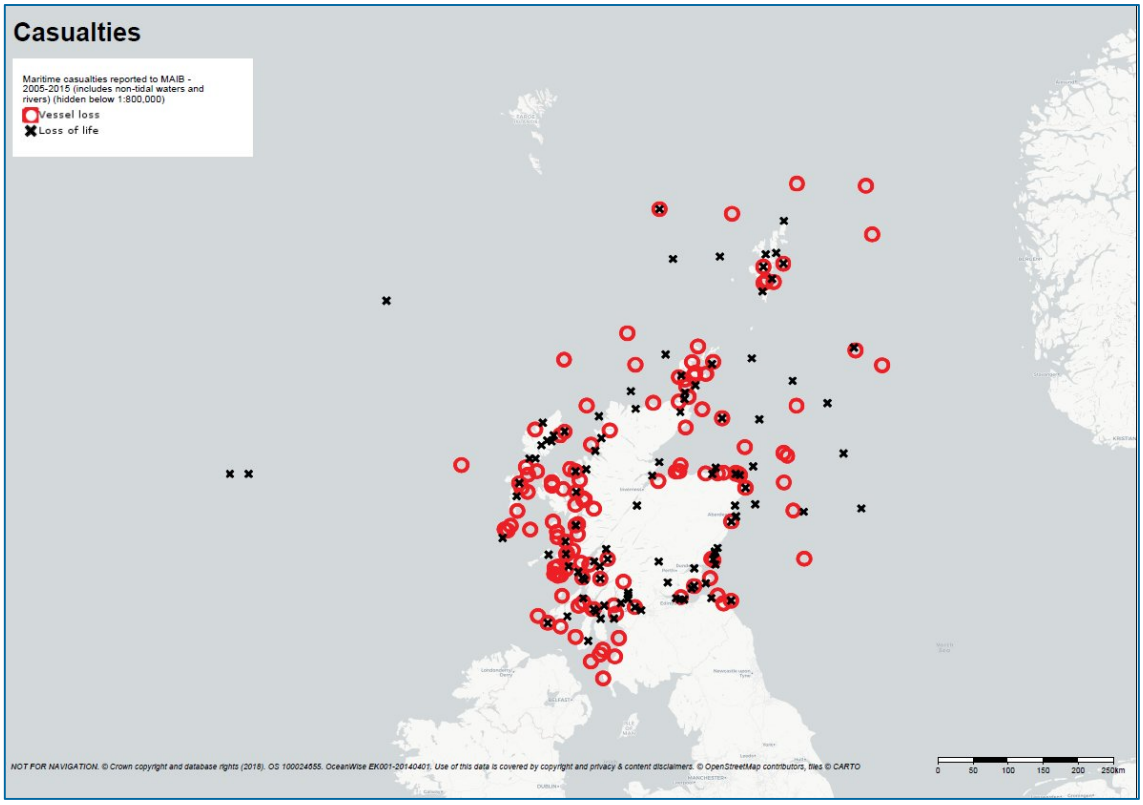
8.3. SAR Resources

A review of the assets in the vicinity of the Havfrue Project indicate that the closest SAR helicopter, lifeboat and coastguard base is located at Kirkwall, Orkney.
An additional SAR helicopter base is located at Sumburgh Airport on Shetland Island. Fair Isle has a coastguard rescue team and equipment.

8.4. Maritime Incidents

Around Scotland, the Marine Accident Investigation Branch (MAIB) of the Department for Transport examines and investigates all types of maritime casualties to, or on board, UK ships and on other ships within UK territorial waters. It does so with powers under The Merchant Shipping (Accident Reporting and Investigation) Regulations 2005. This point data includes all records with fatalities or where vessels were lost between 2005 and 2015. None were in the vicinity of the proposed Havfrue cable route.

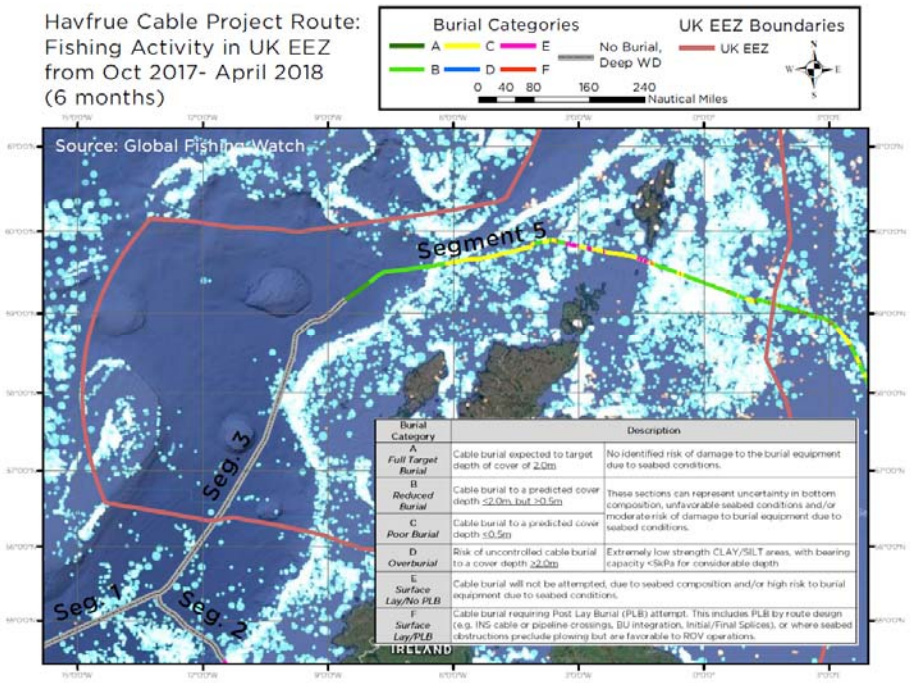
Figure 11. .....Maritime incidents in the vicinity of the proposed cable route (2005-2015)



8.5. Fishing Vessel Activity

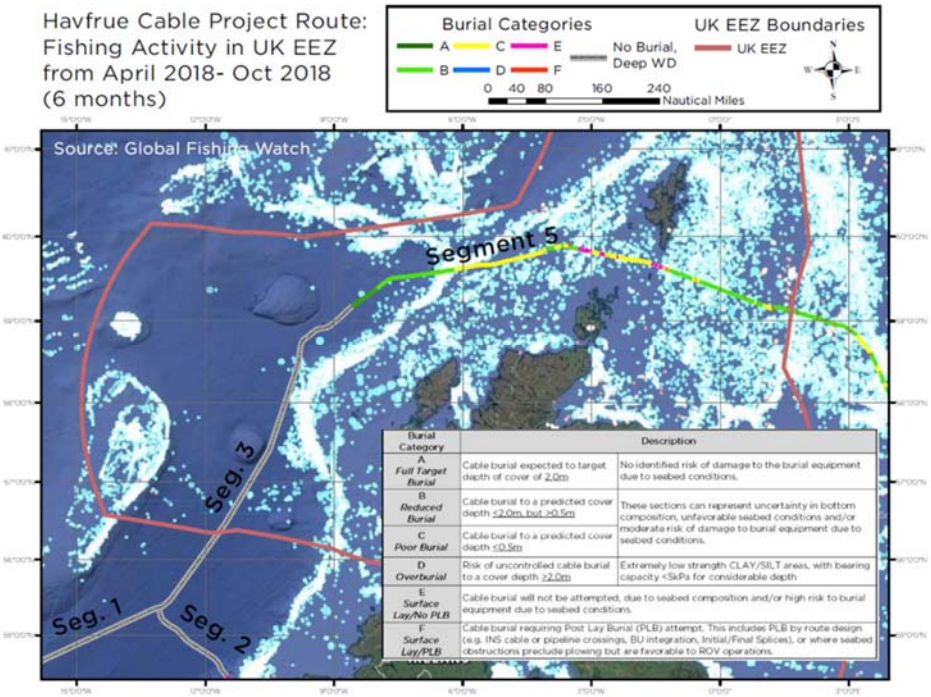
Subcom have reviewed data from a number of fisheries portals in an effort to determine fishing densities in the vicinity of the proposed cable route through the Scottish TS. Below are details of fishing densities for the period Oct 2017 to April 2018. The data illustrates the main fishing areas, with extensive fisheries to the east of the TS and smaller numbers to the west of the TS. The data illustrates that there is little direct east – west orientated fisheries traffic traveling through the Fair Isle channel.

Figure 12. .....Fishing vessel activity in the vicinity of the cable route Oct 2017 – April 2018



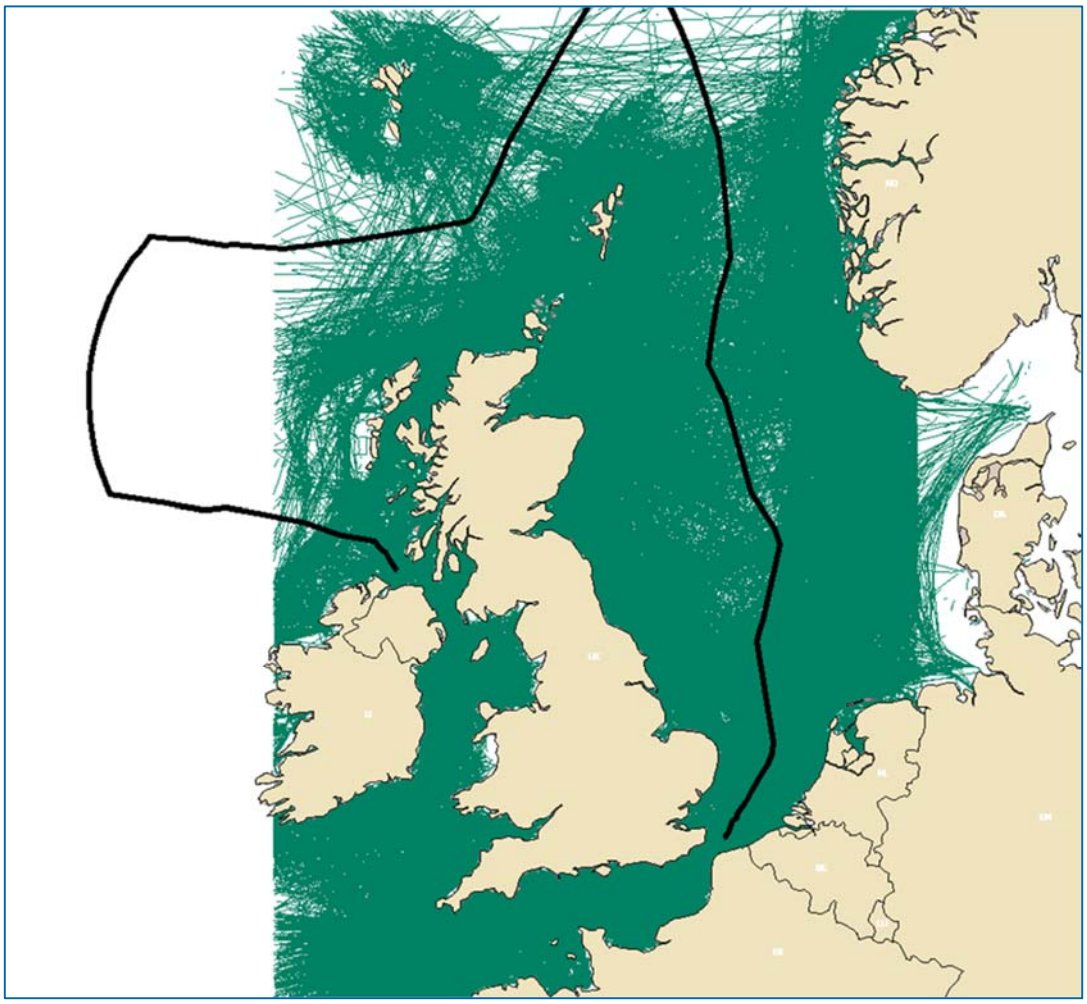
The additional figure below illustrates fishing densities for the period April to October 2018. This data illustrates the main fishing areas, with the main fisheries areas located to the east of the TS and smaller numbers to the west of the TS. The fishing activities routes along the west coast of Scotland and Shetland are clearly visible on the illustration. This data illustrates that there a little more direct east – west orientated fisheries traffic traveling through the Fair Isle channel.

Figure 13. .....Fishing vessel activity in the vicinity of the cable route April 2018 – Oct 2018



8.6. All Vessel Activity

Figure 14. .....ABPmer AIS vessel transit data (2015)



AIS vessel transit data for 2015 processed by ABPmer on behalf of the MMO, using data supplied by the Maritime and Coastguard Agency (MCA).

Following a methodology previously developed by ABPmer under MMO project number 1066, entitled 'Mapping UK Shipping Density and Routes from AIS Open Source Data and Methods'. This feature class contains vessel tracks or 'transits' derived from AIS-A and AIS-B positional data provided by the Maritime and Coastguard Agency (MCA). The transit lines represent the UK AIS-A and AIS-B 2015 data as continuous vessel tracks, generated from sequential vessel positions. This was achieved by plotting vessel positional data using MMSI identification numbers. The transit lines provide all ship type groups (STG), including the 'unknown' vessel type classifications.

This dataset contains the anonymised transit line data used to create the 2015 UK shipping density grid.

Ship type groups (STG):
0 - Unknown Vessels
1 - Non-Port service craft
2 - Port service craft
3 - Vessels engaged in dredging or underwater operations
4 - High Speed Craft
5 - Military or Law enforcement

6 – Passenger
7 – Cargo
8 – Tankers
9 - Fishing vessels
10 - Recreational vessels

Figure 15. .....AIS Activity in UK EEZ (2015)

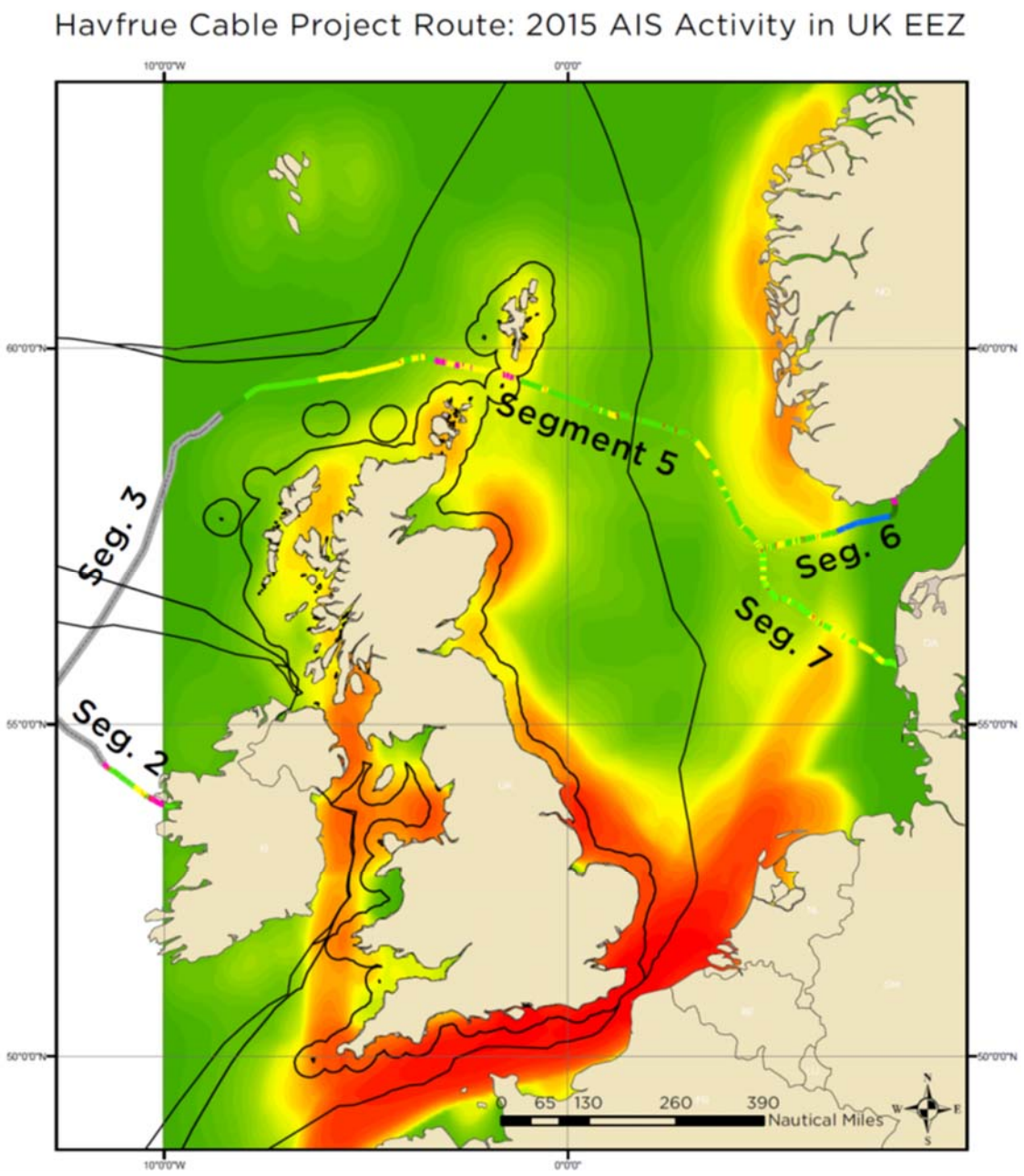
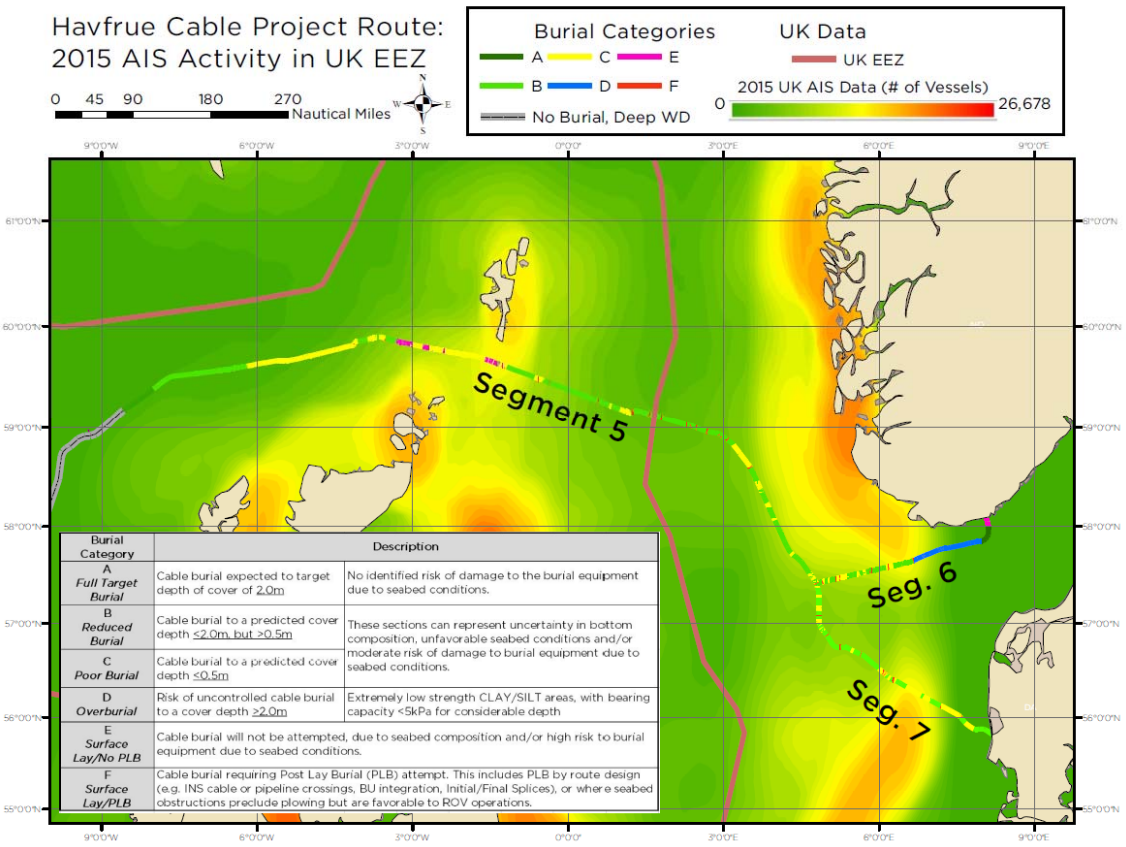


Figure 16. .....Vessel activity in the vicinity of cable project (2015)



8.7. RNLI Incident Records

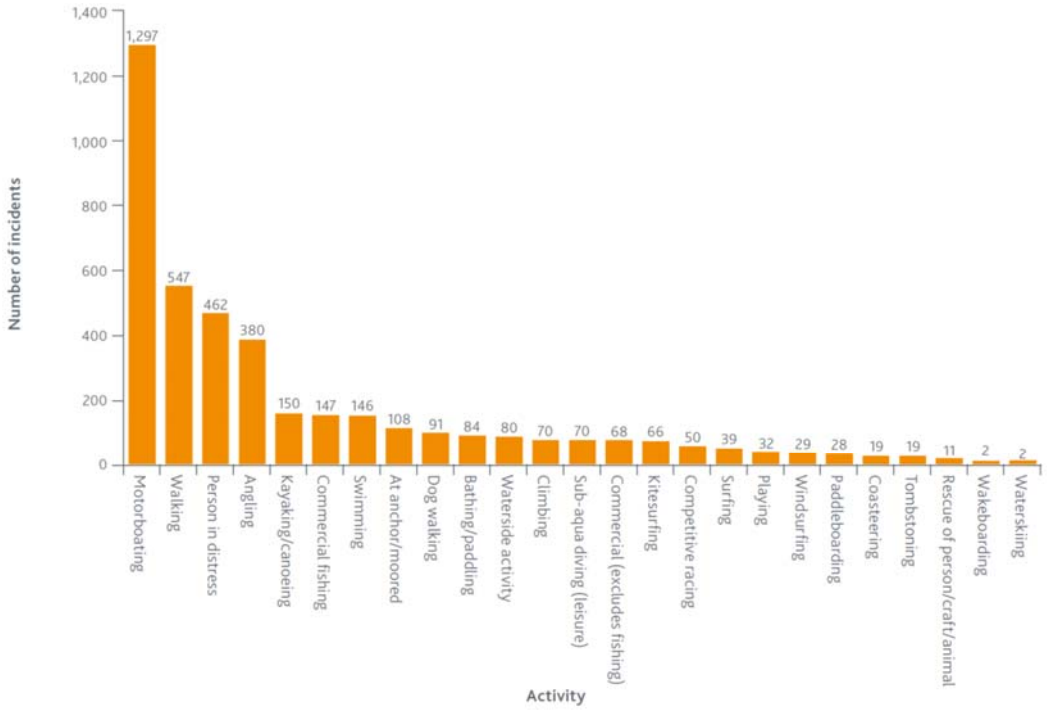
Below are details of RNLI incidents for 2017. They demonstrate that they had the 3rd lowest number of launches, although the coverage area was very large.

Region

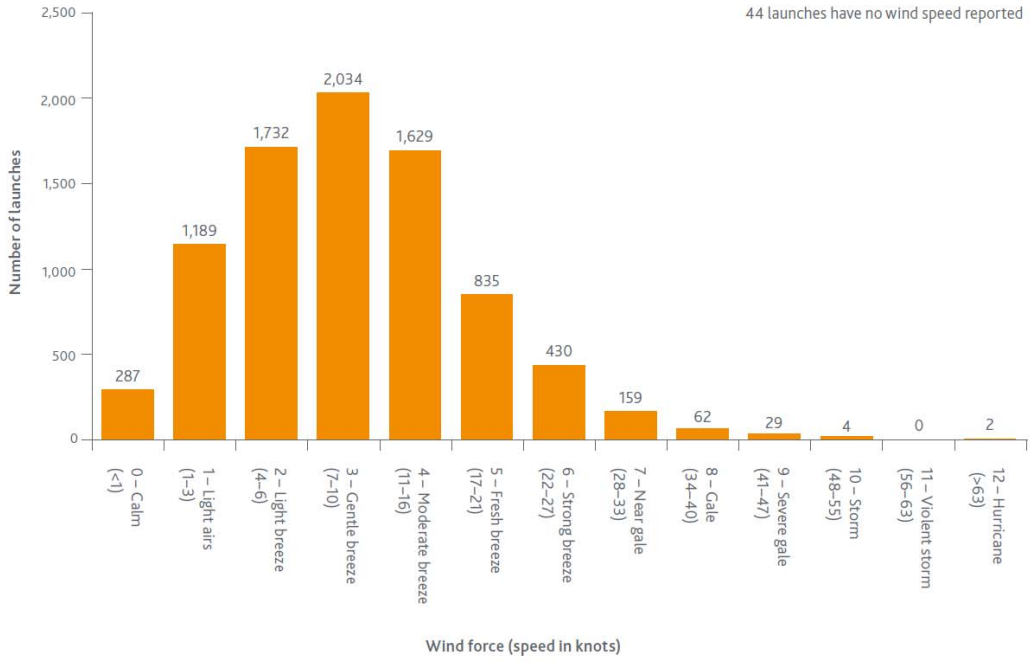
Region	Number of lifeboat stations	Number of lifeboats	Launches	People aided
South West	28	43	1,224	1,152
Wales and West	43	69	1,445	1,376
Ireland	51	65	1,145	1,388
Scotland	46	55	1,159	999
North and East	36	57	1,062	1,030
South East	34	54	2,389	2,101
On passage/other	n/a	n/a	12	26
Total	**238**	**343**	**8,436**	**8,072**

Distance to casualty (nautical miles)	ALB	ILB	RWC	IRH
0–6	1,538	4,888	2	52
7–10	372	278	10	4
11–15	235	77	11	1
16–20	108	16	2	1
21–25	36	9	0	0
26–30	15	1	0	0
31–35	10	0	0	0
36–40	10	4	0	0
41–45	6	1	0	0
46–50	5	0	0	0
51–55	1	0	0	0
56–60	0	0	0	0
61+	9	0	0	0
Rescue craft did not reach casualty	251	472	11	0

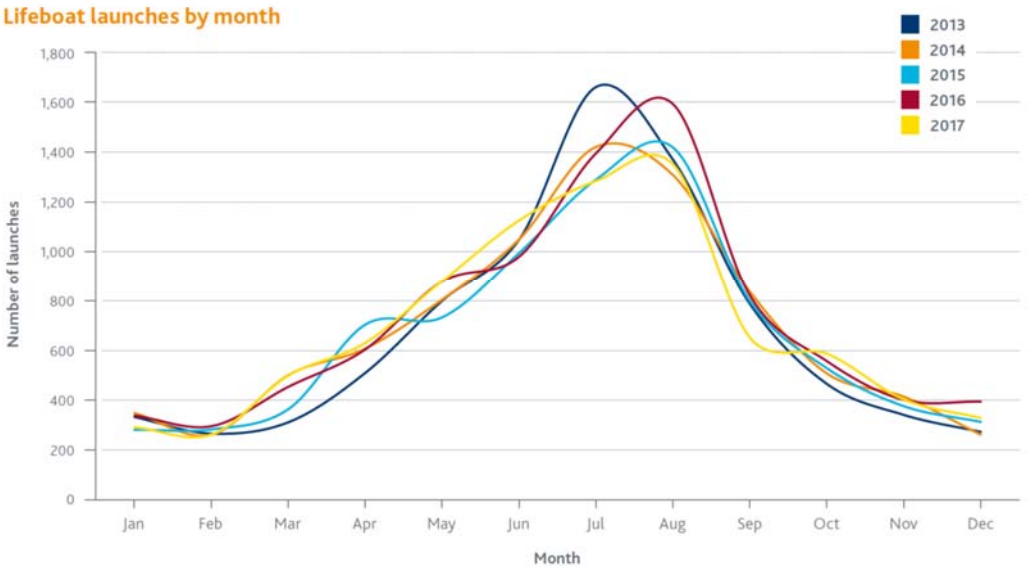
Casualty activities – top 25 incidents



Lifeboat launches in varying wind speeds



Lifeboat launches by month



2013–17

Year	Rescue craft	Launches	Lives saved	People aided
2013	ALB	2,389	52	3,006
	ILB	5,802	270	5,249
	IRH	96	3	129
	RWC	17	0	0
2013 Total		**8,304**	**325**	**8,384**
2014	ALB	2,407	102	3,307
	ILB	5,938	263	5,350
	IRH	95	3	63
	RWC	22	0	7
2014 Total		**8,462**	**368**	**8,727**
2015	ALB	2,492	86	3,003
	ILB	5,619	245	4,883
	IRH	94	17	87
	RWC	23	0	0
2015 Total		**8,228**	**348**	**7,973**
2016	ALB	2,606	74	3,689
	ILB	6,136	352	4,887
	IRH	78	5	61
	RWC	31	0	6
2016 Total		**8,851**	**431**	**8,643**
2017	ALB	2,596	Refer to Data collection section for explanation regarding absence of lives saved statistics in 2017	3,236
	ILB	5,746		4,750
	IRH	69		71
	RWC	25		15
2017 Total		**8,436**		**8,072**

ALB – all-weather lifeboat
ILB – inshore lifeboat
IRH – inshore rescue hovercraft
RWC – rescue watercraft

8.8. Recreational Activities

8.8.1. Recreational Angling

The main launch spots for charter based angling are Thurso in North Scotland and Stromness on Orkney (Radford et al., 2009). Wreck angling is popular in Scapa Flow and also on other wrecks found offshore from Orkney. Cod, pollack and mackerel, are the most popular target species in Caithness and Sutherland. There is some evidence, however, of sports fishing for rarer species such as porbeagle shark becoming more popular. In Orkney conger eel is found amongst the wrecks of Scapa Flow and is the most popular target species, followed by mackerel and bass (Radford et al., 2009).

A study by Radford et al. (2009) estimated the sea angling activity and economic value in eight regions of Scotland. Two of these regions, North Scotland and Orkney and Shetland fall within the North Region. As the areas in Radford et al. (2009) do not align with the North Region the values should only be taken as indicative values for comparison between areas. The total estimated regional sea angling activity and expenditure within these two regions is £11.2m in the North and £6.1m in Orkney and Shetland. In terms of employment, angling accounts for around 300 employees in the North Region and a further 145 in Orkney and Shetland.

8.8.2. Recreational Boating

Recreational boating along the North coast of Scotland and outlying islands of Orkney and Shetland is seen by many as the 'fringe' of recreational boating, but the number of berths available has increased in recent years, following a growth in demand from Scottish residents for home port facilities and to service a growing volume of visitors, many from overseas. The North is characterised by a significant proportion of demand that derives from visitors from outside Scotland, notably other Northern European countries, this overseas demand is notably present in Orkney and Shetland waters (Scottish Enterprise, 2010).

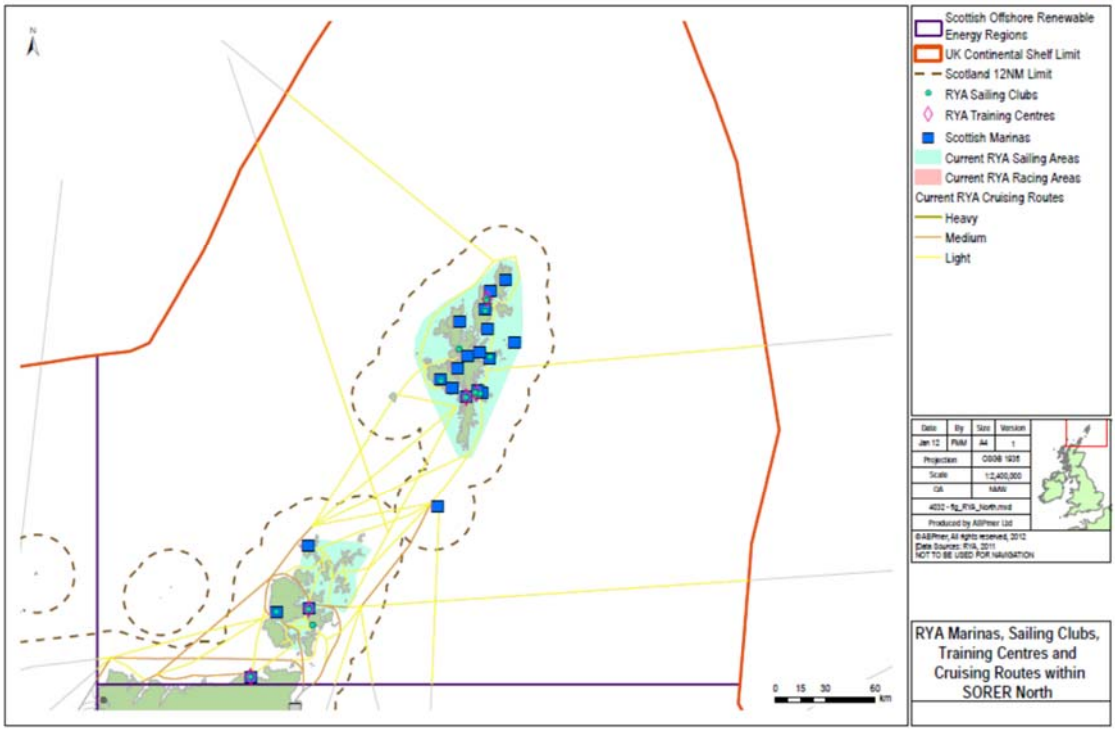
Informal cruising routes in the study area are shown in Figure 3.62. These include Wick Harbour (marina) and deep water anchorage either directly to the Shetland Isle or Fair Isle, or via Duncansby Head to the Orkney Isles, or along Scotland's Northern coastline. There are few facilities for recreational boaters cruising through Pentland Firth on passage to Cape Wrath and the

Hebrides, other than small anchorages, piers and jetties. The principal port of call along Scotland's Northern coast is Scrabster which provides a number of marine facilities. Recent marina developments have provided stopping points along the East Coast of Scotland, making progression to the Isles of Orkney and Shetland a more attractive proposition. The four main marina operators between Inverness and Shetland have grouped together to create the Viking Trail to encourage greater use of the new facilities and open up cruising routes to the Northern isles.

Until recently the Orkney Islands were viewed primarily as a stopping off point for sailors en route from Scandinavia to Scotland. However, after over £6 million of investment by Orkney Islands Council in breakwaters and pontoons, recreational boaters now have the choice of three marinas at Kirkwall (94 berths), Stromness (64 berths) and at a small marina and pontoon facility at Westray. Numerous islands have alongside jetty berthing available and there are also visitor moorings available at locations throughout the islands. The smaller islands are a haven for wildlife, and all have interesting flora and fauna. The net result is that Orkney is now viewed as a destination in its own right by cruising yachtsmen, be they on a circumnavigation of Scotland or Britain, or charterers taking a boat from the charter company based in Kirkwall, (Sail Scotland, 2011) and (Orkney Marinas, 2011).

An indicative estimate of the economic impact of sailing on this region is provided by the Scottish Enterprise (2010). It is estimated that the sailing area has a GVA of £7.9m with 1,792 pontoons and 224 moorings in the Region.

Figure 17. .....Recreational boating activity in Fair Isle



8.8.3. Diving

The most popular area for scuba diving in the region is around Scapa Flow in Orkney. This body of water is considered one of the finest wreck diving sites in Europe and has ranked among the top five wreck diving areas of the world (Jack Jackson, 2007; Baxter et al, 2011). While scuba diving has predominantly been based in Scapa Flow historically, it increasingly involves diving in other parts of Orkney (Jack Jackson, 2007; Visit Orkney, 2009) and also on Shetland. Recreational diving is predominantly charter based with an estimated 3,000 visiting divers annually (The Orkney Hyperbaric Trust). A limited amount of diving is also undertaken on the mainland in this region.

The Orkney Hyperbaric Trust was set up to increase diver safety within Orkney waters. Diving is an important industry in this region and is estimated to be worth at least £3m a year to the Orkney economy (The Orkney Hyperbaric Trust, 2008). The diving industry consists of military and police, commercial and archaeological and recreational, the latter accounting for approximately 25,000 of the dives made each year which are carried out from two dive boats, who take around 3,000 visiting divers/year, to dive sites such as the Scarpa Flow area. There are no diving sites in the vicinity of the proposed cable route.

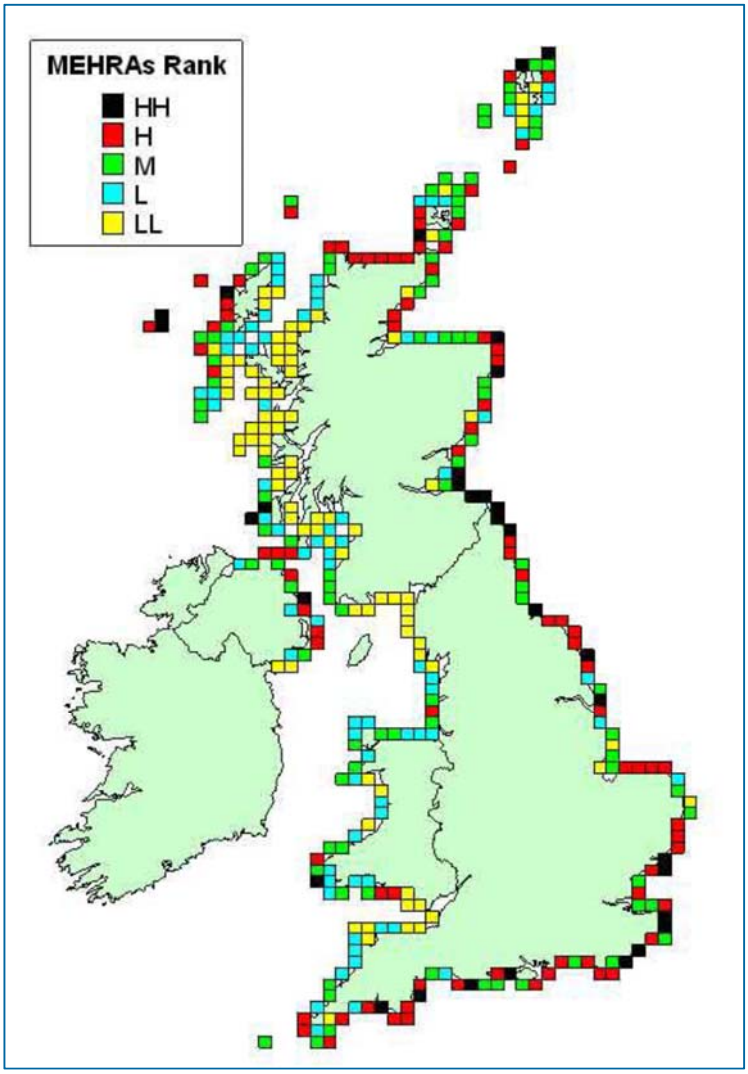
8.8.4. Sea Kayaking and Small Sail Boat Activity

Dinghy sailing clubs are located in Kirkwall, Orkney and in Northern Shetland. In terms of popularity, kayaking around Orkney and the North coast of Scotland is not considered as important as other regions such as the Inner Hebrides and East Grampian Coast (Land Use Consultants,

8.9. Marine Environmental High Risk Areas (MEHRAs)

Establishment of Marine Environmental High Risk Areas (MEHRAs) identifies no MEHRA along the proposed cable route. It does record that Fair Isle and southern Scotland are high ranking MEHRA’s.

Figure 18. .....MEHRAs Ranking for Coastal Cells



There are several high ranked cells - notably along the northern coastline of the Scottish mainland, and several medium ranked cells on the coasts of Orkney and Shetland. There are Areas to be Avoided and Precautionary Areas around the Shetland Islands, with further Areas to be Avoided around Fair Isle and the Orkney Islands. There is an advisory Traffic Separation Scheme in the Fair Isle Channel and there are voluntary reporting systems covering that Channel and the Pentland Firth. A UK Government Emergency Towing Vessel is stationed to cover the Fair Isle Channel. The western part of the area is within range of the Emergency Towing Vessel stationed at Stornoway. The IMO routeing measures were reviewed and extended, or applied, following the grounding of the

BRAER. The traffic survey for Duncansby Head found that the level of traffic and width of channel through the Pentland Firth precludes the creation of a traffic separation scheme in the area. It also recommended consideration be given to making the voluntary Mariners Reporting system (MAREP) mandatory (especially for vessels with hazardous loads) and to consider whether to ban tankers and vessels carrying hazardous cargoes apart from those accessing the Scapa Flow facilities. All of which would be subject to adoption of UK proposals by the IMO.

9. NAVIGATIONAL REGULATIONS, WARNINGS AND MARKINGS

9.1. Introduction

Throughout the project, operations vessels will comply with international marine navigational markings. Any additional requirements of MCA can also be followed.

9.2. Shipping Regulations

It has been confirmed that the proposed Havfrue works do not encroach on any recognised anchorage.

The Havfrue cable travels through the Fair Isle channel, an area with a vessel reporting system. In addition the Fair Channel has an IMO recognised.

The passage of the cable through the Fair Isle channel travels in the opposite direction to the IMO recommended passage direction. It is not predicted that this will be a significant issue.

9.2.1. Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs)

The 1972 Convention was designed to update and replace the Collision Regulations of 1960 which were adopted at the same time as the 1960 SOLAS Convention. All TE SubCom vessel adhere to these regulations.

The COLREGs include 41 rules divided into six sections: Part A - General; Part B - Steering and Sailing; Part C - Lights and Shapes; Part D - Sound and Light signals; Part E - Exemptions; and Part F - Verification of compliance with the provisions of the Convention. There are also four Annexes containing technical requirements concerning lights and shapes and their positioning; sound signalling appliances; additional signals for fishing vessels when operating in close proximity, and international distress signals.

Sound, shapes and light signals will be used by installation vessels during all operations. These are significant for both the cable laying vessel and any guard boats as they will be restricted in its manoeuvrability.

9.2.2. International Protocols, Conventions, Agreements, and Best Practices Standards

A summary of international protocols, conventions, agreements, and best practices standards are summarized within Table 5.

Table 5. .....International Legislation and Agreements Potentially Applicable to the Operations and Activities for the Installation of Havfrue Submarine Fiber Optic Cable

Conventions/ Agreements
United Nations Convention on the Law of the Sea (UNCLOS, 1982)
International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)
Convention on the Prevention of Marine Pollution by Waste and Other Substance Disposal (London Convention, 1972)
International Convention on High Sea Interventions in Cases of Shipwreck Oil Pollution, 1969

Conventions/ Agreements
Agreement for the Implementation of the UN Convention on the Law of the Sea Relating to the Conservation and Management of "Overlapping" Fish and Highly Migratory Fish Stocks, 2001
Convention on Biological Diversity, 1992
Cartagena Convention
Convention for the Protection of the World Cultural and Natural Heritage (Valetta World Heritage Convention), 1972
Convention on Wetlands of International Importance (Ramsar Convention), 1971
Stockholm Convention on Persistent Organic Pollutants, 2001
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1992)
Bonn Convention on the Conservation of Migratory Species of Wild Animals, 1979 (Bonn Convention)
Specially Protected Areas and Wildlife (SPAW)

9.2.3. United Nations Convention on the Law of the Sea, 1982 (UNCLOS)

UNCLOS establishes a comprehensive framework governing all ocean space. It includes provisions that govern inter alia the boundaries of national jurisdictions over the sea space: access to seas and oceans; protective measures of navigation and marine environment preservation; exploitation and conservation of living resources; scientific research missions; seabed mining activities and other types of exploitation of non-living resources; as well as dispute resolution.

UNCLOS urges its signatories to take measures and adopt laws and regulations necessary for the protection and preservation of the marine environment. Articles 192 and 193 of UNCLOS recognize the sovereign right of signatories to rational exploitation and sustainable development of living and non-living marine resources in their EEZ, in accordance with their environmental policy. Article 194 stipulates that signatories must take every necessary measure, in accordance with UNCLOS, to prevent, reduce, and control all sources of pollution of the marine environment.

These measures should include actions with maximum prevention from the following:

- Release of toxic, hazardous, or harmful substances;
- Pollution from ships and the safety of operations at sea;
- Pollution from installations and devices used for the exploration or exploitation of seabed and subsurface natural resources; and
- Pollution from installations and devices operating in the marine environment.

Additionally, and directly pertinent to the Project, Article 58 “Rights and Duties of Other States in the Exclusive Economic Zone” provides that in EEZs, all States, whether coastal or land-locked, enjoy, subject to the relevant provisions of this Convention, the freedoms referred to in Article 87 of navigation and overflight and of the laying of submarine cables and pipelines, and other internationally lawful uses of the sea related to these freedoms such as those associated with operation of ships, aircraft, and submarine cables and pipelines, and compatible with other provisions of this Convention.

As per Article 87, the high seas are open to all States, whether coastal or land-locked. Freedom of the high seas is exercised under the conditions laid down by this Convention and by other rules of international law. It comprises, inter alia, both for coastal and land-locked States: (a) freedom of navigation; (b) freedom of overflight; (c) freedom to lay submarine cables and pipelines, subject to Part VI; (d) freedom to construct artificial islands and other installations permitted under international law, subject to Part VI; (e) freedom of fishing, subject to the conditions

laid down in Section 2; (f) freedom of scientific research, subject to Parts VI and XIII. 2. These freedoms shall be exercised by all States with due regard for the interests of other States in their exercise of the freedom of the high seas and also with due regard for the rights under this Convention with respect to activities in the Area

Article 88 to 115 and other pertinent rules of international law apply to the EEZ in so far as they are not compatible with this Part. In exercising their rights and performing their duties under this Convention in the EEZ, States shall have due regard to the rights and duties of the coastal State and shall comply with the laws and regulations adopted by the coastal State in accordance with the provisions of this Convention and other rules of international law in so far as they are not incompatible with this Part.

Under UNCLOS, A coastal State may adopt laws to project cables (Article 21) in their TS and may establish conditions for cables or pipelines entering its territory or TS, but beyond the TS, on the continental shelf, the delineation of the course for the laying of such cables does not require the consent of a coastal State (Article 79). Article 112 provides for the right of all States to lay submarine cables and pipelines on the bed of the high seas beyond the continental shelf.

9.2.4. International Convention for the Prevention of Pollution from Ships (MARPOL 1973/78)

The MARPOL 1973-78 is an international agreement on the rules governing the different kinds of pollution generated by ships, including petroleum substances, waste, wastewater, noxious liquids, and hazardous substances as defined in the Convention. MARPOL 1973/78 is a consolidation of the International Convention for the Prevention of Pollution from Ships 1973 and the Protocol of 1978 relating to the 1973 International Convention for the Prevention of Pollution from Ships. As the 1973 Convention had not yet entered into force, the 1978 Protocol absorbed the 1973 Convention. As of 2012, there were 151 Contracting States to MARPOL 73/78 (Annex I/II), representing 98.91% of world shipping vessels (Asariotis and Lavelle, 2012).

The Convention prohibits the release of pollution from ships and provides measures for the prevention of pollution from these sources. The Convention also establishes a new set of standards for ships to minimize the discharge of pollutants generated by them. It describes a system of certification and inspection of ships and establishes an obligation to report pollution incident. The system aims at making the operations of defective boats difficult by prosecuting offenders and enforcing laws. Violation of the convention clauses is banned and stipulates that sanctions shall be provided by the law of the flag State or port, in accordance with the Convention.

The Convention includes 20 articles and five appendices, which include an additional six annexes. The MARPOL provides that Annexes I and II are binding on the parties, while Annexes III, IV, and V are voluntary and non-binding unless the parties have specifically agreed to them.

The annexes address the following topics:

- Annex I – Prevention of oil pollution;
- Annex II – Control of pollution by noxious liquid substances carried in bulk;
- Annex III – Prevention of pollution by harmful substances carried in packaged form;
- Annex IV – Prevention of pollution by sewage from ships;
- Annex V – Prevention of pollution by garbage from ships; and
- Annex VI – Prevention of air pollution from ships.

Havfrue countries have signed the MARPOL 1973/78; and are signatories for Annexes I through VI. The provisions of Annexes I, IV, V, and VI are relevant to Havfrue and are summarized in the following paragraphs.

9.2.4.1 Annex I (Prevention of Oil Pollution)

Annex I contains regulations for the prevention of pollution by oil by vessels. The criteria of Annex I apply to discharges from the machinery space bilges of all ships, except from those of tankers where the discharge is mixed with oil cargo residue. The discharge into the sea of oil or oily mixtures, as defined in an appendix to the Convention, is prohibited by the regulations of Annex I except when all the following conditions are satisfied:

- The ship is not within a Special Area;
- The ship is more than 12 nautical miles (nmi) (22 km) from the nearest land;

- The ship is en route;
- The oil content of the effluent is less than 15 parts per million (ppm); and

The ship has in operation an oil discharge monitoring and control system, oily water separating equipment, oil filtering system, or other installation required by this Annex.

These restrictions do not apply to discharges of oily mixture which, without dilution, have an oil content not exceeding 15 ppm. Different restrictions apply to discharges from the cargo area of an oil tanker (i.e., discharges from cargo tanks, including cargo pump rooms; and from machinery space bilges mixed with cargo oil residue).

Other key elements of Annex I include the requirements for a Ship Oil Pollution Emergency Plan (SOPEP) and an International Oil Pollution Prevention Certificate.

9.2.4.2 Annex IV (Prevention of Pollution by Sewage from Ships)

The international requirements for the prevention of sewage pollution from ships are contained in Annex IV. Annex IV of the MARPOL 1973/78 contains requirements for investigations, international certificates of sewage pollution prevention, wastewater treatment plants, wastewater discharge, reception facilities, and standard discharge connections.

Ships are not allowed to discharge wastewater at less than 6.4 km (4 mi) from the nearest land unless they are equipped with a licensed processing facility. At a distance of between 6.4 km and 19.3 km (12 mi) from the land, sewage must be crushed and disinfected before being discharged to the sea.

9.2.4.3 Annex V (Prevention of Pollution by Garbage from Ships)

The revised MARPOL Annex V, with an entry into force date of 1 January 2013 prohibits the discharge of all types of garbage into the sea unless explicitly permitted under the Annex. This Annex is applicable to all ships in the jurisdiction of the IMO and provides, when the vessel is located outside of special areas, among other things:

- No discharge of form of plastics (ropes, fishing nets, synthetic fibers, plastic bags, incinerated plastic ash, etc.), clinkers, cooking oil, floating dunnage, lining and packing materials, paper, rags, glass, metal, bottles, crockery, and similar refuse;
- Discharge allowed at 12 nm (22 km) or more:
  - food waste, not comminuted or ground, and
  - cargo residues either contained or not contained in water; cargo residues include those materials that cannot be recovered using commonly available techniques; cargo residues must not be harmful to the environment;
- Discharges allowed at 3 nmi (5 km) or more:
  - food waste, comminuted or ground to 25 mm (0.11 in) or less; and
  - cleaning agents and additives contained in cargo hold wash water may be discharged.

9.2.4.4 Annex VI (Prevention of Air Pollution from Ships)

MARPOL 1973/78 Annex VI (Chapter 3) outlines the requirements for control of emissions from ships, including ozone-depleting substances (regulation 12), NO_X (regulation 13), SO_2, PM_{10}, and $PM_{2.5}$ (regulation 14), volatile organic carbons (VOC) (regulation 15), shipboard incineration (regulation 16), reception facilities (regulation 17), and fuel oil availability and quality (regulation 18).

Under the Annex, shipboard incineration of the substances listed below is prohibited:

- Cargo residues listed in Annexes I, II, and III of MARPOL Convention and contaminated materials used for their packaging;
- Polychlorinated biphenyls (PCBs);
- Polyvinyl chloride (PVC);
- Plastics and garbage containing more than traces of toxic residues or heavy metals;

- Refined petroleum products containing halogen compounds; and
- Hazardous materials: paint waste, impregnated wood, batteries, expired drugs, aerosol cans, fluorescent tubes, chemical waste, or leftover paint.

For EU flagged vessels specifically: “Marine equipment” – approved incinerators according to Directive 96/98 EC as amended.

9.2.5. Convention on Biological Diversity (CBD), 1992

The Convention on Biological Diversity (CBD) is based on a summary prepared by the United Nations Environment Programme (UNEP) in 2010. The main objective of the CBD is to promote biodiversity conservation and sustainable use of genetic resources. The Convention is legally binding for its signatories and requires conservation and protection of biodiversity within their national jurisdiction and to coordinate their efforts with the signatory countries outside the jurisdiction.

9.2.6. Other Conventions, Protocols, and Agreements

The Havfrue countries are members of several major international organizations that are active in the field of natural resources conservation and sustainable development and these may need consideration by the Project. These organizations include:

- The International Union for Conservation of Nature (IUCN);
- The International Maritime Organization (IMO); and

Other conventions, protocols, and international agreements that may pertain to the Project include:

- International Convention on Civil Liability for Damage resulting from Oil Pollution, 1969 and 1992 (CLC 1969 and 1992);
- Convention on International Trade of Endangered Species (CITES); and
- International Convention for the Safety of Human Life at Sea (SOLAS).

9.2.7. The International Union for Conservation of Nature (IUCN)

The IUCN is composed of both government and civil society organizations. The IUCN has evolved into the world’s largest and most diverse environmental network that is the global authority on the status of animal and plant species and the conservation measures needed to safeguard these species and habitat. Two programs of the IUCN assess the conservation status of species, subspecies, varieties, and even selected subpopulations on a global scale to highlight taxa threatened with extinction, and thereby promote their conservation. This assessment mechanism is termed the IUCN’s Red List of Threatened Species™, which provides taxonomic and conservation status and distribution information on plants, fungi, and animals that have been globally evaluated using categories and criteria developed by the IUCN. This assessment system is designed to assign the relative risk of extinction for each species or population and to catalog those species facing a higher risk of global extinction. Species facing an elevated risk of extinction are classified as critically endangered, endangered, and vulnerable. The IUCN Red List also includes information on species that cannot be evaluated because of insufficient information (i.e., are data deficient) and on species or populations that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation measures (i.e., are considered near threatened). Species that are not considered to be threatened by extinction are classified as “least concern”.

9.2.8. International Maritime Organization

The IMO is the specialized agency within the United Nations with responsibility for the safety and security of shipping and the prevention of marine pollution by ships. IMO is the global standard-setting authority for the safety, security, and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted, and universally implemented. IMO measures cover all aspects of international shipping including ship design, construction, equipment, manning, operation, and waste disposal.

As part of its mandate, IMO maintains a database of countries worldwide that have signed conventions that are relevant to shipping safety and vessel-based environmental protection. The list below identifies those IMO-related conventions relevant to maritime shipping and vessel safety to which the Havfrue countries are signatories (IMO, July 2017).

IMO Related Conventions*

IMO Convention 48	MARPOL 73/78 (Annex I/II)
SOLAS Convention 74	MARPOL 73/78 (Annex III)
SOLAS Protocol 78	MARPOL 73/78 (Annex IV)
SOLAS Protocol 88	MARPOL 73/78 (Annex V)
SOLAS Agreement 96	MARPOL Protocol 97 (Annex VI)
LOAD LINES Convention 66	London Convention 72
LOAD LINES Protocol 88	London Convention Protocol 96
TONNAGE Convention 69	Intervention Convention 69
COLREG Convention 72	Intervention Protocol 73
CSC Convention 72	CLC Convention 69
CSC Amendments 93	CLC Protocol 76
SFV Protocol 93	CLC Protocol 92
Cape Town Agreement 2012	FUND Convention 71
STCW Convention 78	FUND Protocol 76
STCW-F Convention 95	FUND Protocol 92
SAR Convention 79	FUND Protocol 2003
STP Agreement 71	NUCLEAR Convention 71
Space STP Protocol 73	LLMC Convention 76
IMSO Convention 76	LLMC Protocol 96
INMARSAT OA 76	SUA Convention 88
IMSO Amendments 2006	SUA Protocol 88
IMSO Amendments 2008	SUA Convention 2005
Facilitation Convention 65	SUA Protocol 2005

*CLC = International Convention on Civil Liability for Oil Pollution Damage; COLREG = Convention on the International Regulations for Preventing Collisions at Sea; CSC = International Convention for Safe Containers; FUND = International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage; HNS = Connection with the Carriage of Hazardous and Noxious Substances by Sea; IMO = International Maritime Organization; IMSO = Convention on the International Maritime Satellite Organization; INMARSAT = Convention on the International Maritime Satellite Organization; LLMC = Convention on Limitation of Liability for Maritime Claims; LOAD LINES = International Convention on Load Lines; MARPPOL = International Convention for the Prevention of Pollution from Ships; NUCLEAR = Convention relating to Civil Liability in the Field of Maritime Carriage of Nuclear Material; OPRC = International Convention on Oil Pollution Preparedness, Response and Cooperation; SALVAGE = International Convention on Salvage; SAR = International Convention on Maritime Search and Rescue; SCTW = International Convention on Standards of Training, Certification and Watchkeeping for Seafarers; SOLAS = International Convention for the Safety of Life at Sea; SFV = Torremolinos International Convention for the Safety of Fishing Vessels; STP = Special Trade Passenger Ships Agreement; SUA = Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation; TONNAGE = International Convention on Tonnage Measurement of Ship.

9.3. Construction/Decommissioning

During the construction / decommissioning, working areas will be established. Notices to Mariners, Radio Navigational Warnings-NAVTEX and/or broadcast warnings will be promulgated in advance of and during construction /decommissioning.

9.4. General Navigation Safety

TE SubCom consider navigation safety one of the principal pillars to all projects. We continuously strive to ensure the safety of all marine users. We strive to complete this through the use of:

- Notice to Mariners
- Radio Navigation Warnings
- Kingfisher Bulletins

9.4.1. Notices to Mariners

Notices to Mariners are principally issued from the UK Hydrographic Office, Trinity House. They are also issued by private bodies to inform mariners of issues that affect the safety of navigation. They are issued by a variety of bodies such as Port authorities, Trinity House and offshore wind & marine project duty holders. These are disseminated by hosting on corporate websites, issuing to UKHO, Kingfisher Fortnightly Bulletin, local sailing clubs etc.

They are issued on a weekly basis and provide physical corrections to charts and associated publications. Also included within these corrections are Preliminary and Temporary NtoMs which indicate works about to commence and temporary changes to the charts. With regards to offshore developments UKHO will only update charts at significant intervals and will not provide a weekly construction update for charts. It is likely that a portion of the chart will be marked out with 'Construction in Progress' until it is fully completed, it will then have the site appropriately marked up. General advice on information flows (Chart Corrections and Radio Navigation Warnings) concerning the UKHO may be found in Chapter 4 of NP100.

Admiralty Notices to Mariners are promulgated in Weekly Editions of Admiralty Notices to Mariners and these may be accessed on the UKHO website at www.ukho.gov.uk/msi.

The primary objective of a NtoM should be to provide clear, accurate and timely information to any sea user who may need to be informed of relevant navigational safety information. A NtoM should therefore aim to be:

- Timely: Issued as far ahead of the specified activity as possible
- Specific: Deal only with individual issues of navigation safety and not contain historic background information on the project
- Dated: Commencement/expiry/renewal dates should be clearly stated
- Targeted: Content, style and language of the NtoM should take account the audience
- Concise: Only including information relating to navigational safety
- Accessible: The NtoM should readily accessible online and provided to UKHO NtoM should be issued to at least the following:
    - MCA through the relevant MRCC
    - UKHO
    - Trinity House
    - Kingfisher Fortnightly Bulletin
    - Relevant Port Authorities
    - RYA

9.4.2. Radio Navigation Warnings

These are issued by the UKHO and follow a similar format to the a NtoM in that they will only be issued if the UKHO feel it is appropriate and the subject represents a significant risk to the Mariner. They will not be project updates.

9.4.3. Kingfisher Bulletin

The Kingfisher Bulletin works across all offshore industries to keep the fishing industry up to date with information relating to the latest hazards, planned developments, new structures being installed and zones created. SubCom use the Subsea cable template for all subsea cable related operations.

9.5. Visual and Noise Intrusion

No significant visual intrusion is predicted for this project. The vessel will traverse sufficiently far from the shore to negate the possibility of any terrestrial visualisation of the operations. TE SubCom always adhere to Colregs and so correct vessel lighting will be employed.

Noise intrusion is not predicted to be a significant factor on this project. Standard vessel operation adhere to the IMO ANNEX 1, RESOLUTION MSC.337(91) code on Noise levels. Similarly, subsea operations will not create low frequency noise sources which may be harmful to marine mammals.

10. DATA SOURCES FOR RISK ASSESSMENT

10.1. Introduction

This section summarises and describes the main data sources used in assessing the baseline shipping activities relative to the Havfrue Project.

10.2. Baseline Data Summary

The main data sources used in this assessment are detailed in section and they are listed below:

- Maritime Traffic Survey Data based on ABPMER
- Fishing Data.
- Satellite vessel monitoring system (VMS) data for 2011-2012, from Marine Management Organisation (MMO). (Satellites record the positions of fishing vessels of 15m length and over a minimum of every two hours.)
- Maritime Incident Data.
- Marine Accident Investigation Branch (MAIB) data for 2005-2015.
- Royal National Lifeboat Institution (RNLI) data for 2017
- Marine Environmental High Risk Areas (MEHRA) (DfT, 2006).
- Marine Scotland

10.3. Maritime Traffic Survey

Baseline shipping activity was assessed using a combination of Automatic Information System (AIS) track data and recorded vessel densities and routes. Data were analysed for four periods which encompassed seasonal fluctuations in shipping activity and accounted for a range of tidal conditions.

A 10nm buffer surrounding the initial cable route was used for analysis of the AIS data, hereafter referred to as the Study Area.

10.4. Recreational Activity

The RYA and the CA represent the interests of recreational users including yachting and motor cruising. In 2005 the RYA, supported by Trinity House Lighthouse Service (THLS) and the CA, compiled and presented a comprehensive set of charts which defined the cruising routes, general sailing and racing areas used by recreational craft around the UK coast. This information was published as the UK Coastal Atlas of Recreational Boating and has been subsequently updated (RYA, 2009). The latest edition of GIS shapefiles from 2016 showing cruising routes, sailing and racing areas has been used in this assessment.

The RYA has also developed a detailed position statement (RYA, 2013) based on analysed data for common recreational craft; this, along with extensive consultation, were used to inform the NRA.

10.5. Fishing Activity

Fishing vessel data were extracted from the AIS data recorded during two successive 6 month periods in 2017. In addition, longer term data on fishing vessel sightings were received from Marine Scotland Compliance, and satellite monitoring data were obtained from the MMO. These were used to validate the survey data presented in the baseline assessment.

11. FORMAL SAFETY ASSESSMENT

11.1. Introduction

The impact assessment is based on the IMO Formal Safety Assessment process (IMO, 2002) approved by the IMO in 2002 under SC/ Circ.1023/MEPC/Circ392.

As indicated within the IMO FSA guidelines and the DECC guidance on risk assessment methodology (DECC, 2005), the depth of the assessment should be commensurate with the nature and significance of the problem. Within the assessment of proportionality consideration was given to both the scale of the development and the magnitude of the risks/navigational impact.

From review it was concluded that the Project is a small-scale development with low potential to impact navigational safety. As a result, the content and methods of the risk assessment were responsive to this and included the following:

- Comprehensive Hazard Log

- Risk Ranking

- Detailed and quantified Navigational Risk Assessment for selected hazards

- Preliminary search and rescue overview

- Preliminary emergency response overview

- Comprehensive risk control/mitigation measures log

The key maritime hazards associated with the Havfrue Project were identified. The following hazards were discussed:

1. Powered vessel collision with installation or support vessels;
    a. Merchant ship (e.g., oil & gas);
    b. Fishing vessel; and
    c. Recreational vessel.
2. Drifting vessel collision with installation or support vessels;
3. Vessel-to-vessel collision due to avoidance of installation or support vessels
4. Fishing interaction with midwater cables;
5. Fishing interaction with cables on seabed;
6. Vessel anchor interaction with subsea equipment;

11.2. Hazard 1: Powered Vessel Collision with installation or support vessels (or vice versa)

Installation or support vessel will be restricted in manoeuvrability and under col regs, approaching vessel must alter course.

- Installation or support vessel may be able to alter course if collision imminent
- Installation or support vessel will have restricted manoeuvrability lighting and symbols.
- It was noted that the cause of a powered collision could be inadequate passage planning, such as autopilot and failure to adhere to bridge keeping or Radar.
- It is expected that steaming vessels would seek to maintain an adequate clearance during passage, whether there are safety zones in place or not. The concept of safety zones is not new and that vessels operating off the coast of the UK, especially oil & gas industry vessels are used to these zones being in place around fixed and mobile oil installations, including many subsea installations.
- Overall, it was agreed there is always potential for a collision but the frequency is expected to be quite rare. In terms of consequences,

- Information should be included in Maritime Safety Information (MSI) broadcasts routinely made by the MCA for the area.

11.3. Hazard 2: Drifting Vessel Collision with Installation or support vessel

A vessel which loses power in the vicinity could drift towards the site under the influence of the prevailing conditions (wind and wave) and collide with installation or support vessel.

- There is not always good holding ground for anchoring in the vicinity of the cable route.
- Installation or support vessel may be able to alter course if collision imminent
- Prevailing current direction in the area would mean that drifting vessel would travel westerly or easterly.

11.4. Hazard 3: Vessel-to-vessel collision due to avoidance of installation or support vessels

- Displaced traffic increases congestion outside of the cable route. This can lead to a change (increase) in vessel-to-vessel encounters and ultimately collisions. For this project, the small footprint and the distance from shore (beyond 12nm) means the impact should be limited.
- Mitigation possible in the form of: Marking and Lighting; AIS Transceiver; Raising awareness of the Project; Communications with fishermen; Maritime Safety Information broadcasts; Notices to Fishermen; Fisheries Liaison; Sharing of information within industry; Liaison with Recreational Sailing Community; Liaison with MSF; Up-to-date charts; Kingfisher publications; Emergency contact available 24hrs per day; ERCP; Watchkeeping; Passage planning by vessels; Compliance with Colregs.

11.5. Hazard 4.Fishing Interaction with midwater cables

- Unless buried, fishing vessel gear will have the potential to interact with midwater cables;
- SFF highlighted the necessity to make fishermen aware of the exact position of cable via awareness charts (paper and electronic) issued by Kingfisher / FishSafe, as well as more generally via UKHO chart updates.
- Particular risk when crossing known assets
- Fishermen have recommended use of rock pre and post installation rock berms. The use of these has been agreed.
- Additional risk of interaction in areas where no cable burial possible – Non burial areas have been identified. SFF have commented that mitigation in the form of cable awareness and PLIB is required for these areas.

11.6. Hazard 4: Vessel Anchor Interaction with Subsea Equipment

- Unless buried, fishing vessel gear will have the potential to interact with midwater cables;
- SFF highlighted the necessity to make fishermen aware of the exact position of cable via awareness charts (paper and electronic) issued by Kingfisher / FishSafe, as well as more generally via UKHO chart updates.
- Particular risk when crossing known assets
- Fishermen have recommended use of rock pre and post installation rock berms. The use of these has been agreed.
- Additional risk of interaction in areas where no cable burial possible – Non burial areas have been identified. SFF have commented that mitigation in the form of cable awareness and PLIB is required for these areas.

11.7. Vessel Anchor Interaction with Subsea Equipment

- Vessel anchors have the potential to interact with midwater and seabed cable.
- There have been no recent reports of dragged anchor incidents in the area so this is an uncommon event.

11.8. Hazard Ranking Methodology

The ranking of the risks associated with the various hazards was subsequently carried out based on the discussion at the Workshop and review of the baseline data and other consultation. This was circulated to attendees after the meeting for feedback. A risk matrix was used based on the frequency and consequence categories shown below.

Table 6. Risk Ranking

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

Table 7. Risk Ranking and description

Rank	Description	People	Environment	Property	Business
1	Negligible	No Injury	<£10k	<£10k	<£10k
2	Minor	Slight Injury	Tier 1: Local assistance required	£10k-£100k	£10k-£100k
3	Moderate	Multiple moderate or single serious injury	Tier 2: Limited external assistance required	£100k-£1M	£100k-£1M Local publicity
4	Serious	serious injury or single fatality	Tier 2: Regional assistance required	£1M-£10M	£1M-£10M National publicity
5	Major	More than 1 fatality	Tier 3: National assistance required	>£10M	>£10M International publicity

The four consequence scores were averaged and multiplied by the frequency to obtain an overall ranking (or score) which determined the hazard's position within the risk matrix shown below.

Table 8. frequency vs consequence table

Connsequences					
5					
4					
3					
2					
1					
	1	2	3	4	5

Frequency

Where:

Table 9. Definition of risk region

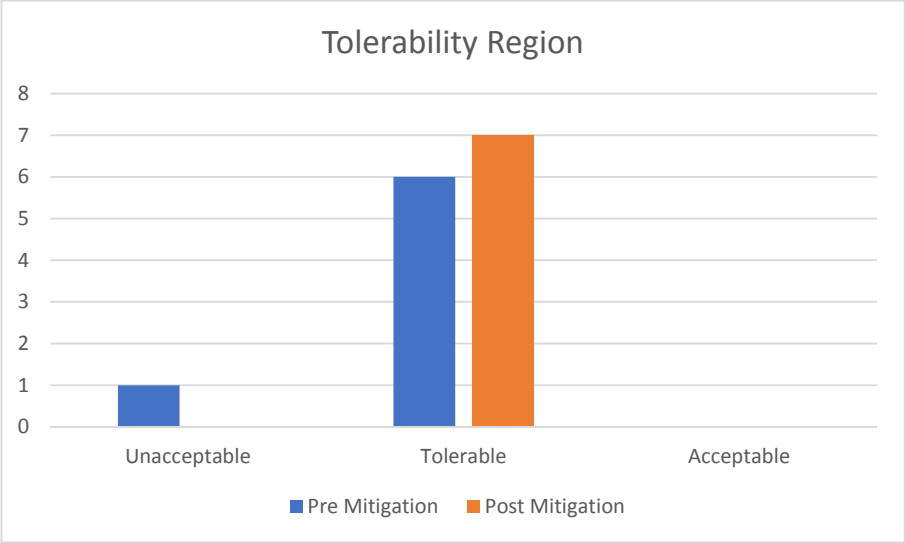
	Broadly Acceptable Region (Low Risk)	Generally regarded as insignificant and adequately controlled. None the less the law still requires further risk reductions if it is reasonably practicable. However, at these levels the opportunity for further risk reduction is much more limited.
	Tolerable Region (Intermediate Risk)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate control measures are in place, residual risks are as low as is reasonably practicable (ALARP) and that risks are periodically reviewed to see if further controls are appropriate.
	Unacceptable Region (High Risk)	Generally regarded as unacceptable whatever the level of benefit associated with the activity.

The hazard was ranked by expected risk (based on the estimated frequency versus consequence) with no (or basic) mitigation measures applied, and residual risk following application of industry standard measures and additional mitigation identified during consultation and at the Hazard Review Workshop.

11.9. Risk Rankings

The final hazard log contained a total of 7 navigational hazards (due to Hazard 1 being considered under three different vessel types) with the following overall breakdown by tolerability region presented in the Figure 15 below.

Figure 19. Pre and Post mitigation tolerability



Six other hazards were identified as being Tolerable before mitigation. However, there is still a requirement that such risks are properly assessed and appropriate control measures are put in place to ensure the residual risks are ALARP. The potential mitigation measures identified for each hazard are listed in Appendix A.

One hazard, fishing interaction with the seafloor and midwater cables, was assessed as being Unacceptable pre-mitigation. Potential mitigation measures
identified at the workshop for this hazard are listed below:

- Abandon gear in event of snag;
- Raising awareness of the project;
- Maritime Safety Information broadcasts;
- Notices to Fishermen;
- Fisheries Liaison;
- FishSAFE;
- Sharing of information within industry;
- Up-to-date charts;
- Kingfisher publications;
- Issue Notices to Mariners;
- Emergency contact available 24hrs per day;
- Emergency Response Cooperation Plan;
- AIS Monitoring;
- Guard vessel in period between mooring and turbine installation;
- Temporary buoyage in the period between mooring and turbine installation; and
- Exclusion of fishing in area of mooring lines and anchors.

By applying the appropriate mitigation, the risk was assessed to reduce to a Tolerable (ALARP) level. Eight other hazards were identified as being Tolerable before mitigation. However, there is still a requirement that such risks are properly assessed and appropriate control measures are put in place to ensure the residual risks are ALARP. The potential mitigation measures identified for each hazard are listed in Appendix A.

12. CONSTRUCTION AND DECOMMISSIONING IMPACTS

12.1. Introduction

This study has focused primarily on the installation phase of the Project, however, it is recognised that there will be additional temporary impacts during the decommissioning phase. In general, the same hazards apply as during the installation and decommissioning phases.

12.2. Construction, Maintenance and Decommissioning

During the construction and decommissioning phases there will be an increased level of vessel activity along the cable route.

The main navigational hazard associated with these phases of the Project which have been identified over and above those associated with all phases (i.e., where the same risk control measures and emergency response will apply during all phases) is work vessel collision with another vessel, which could either be another Project vessel or a passing vessel. To date, there have been relatively few such incidents and the consequences have been minor, mainly resulting in minor damage to vessels and injuries to personnel.

13. RISK MITIGATION AND MONITORING

This section summarises the risk mitigation measures which are planned for the Havfrue Project. This is divided into standard industry practice measures listed in Table 10, which are generally carried out for project and additional, Project-specific (enhanced) mitigation measures which have been identified during the course of the NRA, listed in Table 11.

Table 10. .....Standard Industry Mitigation Measures

Standard Industry Practice
Adverse Weather: There will be adverse weather working policies and procedures for periods of construction and maintenance.
Cable Protection: Appropriate cable protection to be installed along the cable route, informed by a BFS study which will be submitted to the MCA prior to installation.
Chart Marking: The Project will be depicted on Admiralty Charts produced by the UKHO.
Emergency Response Cooperation Plan: An ERP will be prepared for the Project following the template provided by the MCA. This will be submitted to the MCA for approval prior to construction.
Equipment and Training for Site Personnel: Site personnel will be suitably equipped and trained for work offshore including in fire fighting, first aid and offshore survival.
Fisheries Liaison: The FLO (Fishing Liaison Officer) best practice guidance for fisheries liaison will be followed, including the establishment of a fishing liaison plan. An FLO has been appointed for the Project and will continue in this role during construction.
Inspection and Maintenance: There will be appropriate inspection and maintenance procedures in place for all elements of the Project.
Kingfisher Charts and FishSAFE: Details of the Project will be included in updated Kingfisher fishermen's awareness charts (paper and electronic) and on FishSAFE electronic safety devices which give and audible alarm when vessels are close to hazards.
Maritime Safety Information (MSI) Broadcasts: HM Coastguard will be informed of work at the site to allow them to issue MSI broadcasts as appropriate.
Notice to Mariners: Notices to Mariners will be issued prior to the start of construction and where necessary during work at the site.

Table 11. .....Project Specific Mitigation Measures

Project Specific Mitigation Measures
AIS on Work Vessels: All vessels working at the site will broadcast on AIS.
Targeted Circulation of Information: Information on the Project will be circulated directly to local ports, ship operators (including the Marine Safety Forum representing oil industry vessels), fishermen and recreational organisations (including relevant international organisations).
Towing Vessel Availability: The Project is located in an area of above average towing vessel activity due to the oil and gas industry bases at Shetland. This will be given consideration within the ERP to ensure benefit is obtained in the event of a drifting scenario.

13.1. Future Monitoring

AIS traffic monitoring will be carried out of the Project area. The data can also be used to identify any vessels operating in a hazardous manner and provide evidence which can be passed to the MCA for follow-up action (if appropriate).

14. CONCLUSION AND RECOMMENDATIONS

A Navigation Risk Assessment for the Havfrue fibre optic cable project has been carried out using guidance notes from the MCA and DECC. This included extensive baseline data collection to obtain information on the vessel activities in the vicinity of the Project.

This identified that the area is used by transiting merchant vessels, with the majority associated with fishing activities.

There is limited recreational vessel activity in the vicinity of the Project due to its offshore location. However, there are occasional transits by yachts which pass in the vicinity.

The potential hazards to this vessel activity posed by the Project have been assessed based on consultation, a Hazard Review and quantitative risk modelling. Based on this assessment it is considered that the risks are broadly acceptable or tolerable with appropriate mitigation. Details on the planned control measures are listed in this report.

Further consultation with regulator and stakeholders, will be carried out to agree the details of the measures that will be implemented, to ensure the mitigation is effective and the final project is ALARP.

Appendix A

Id	Phase	Hazard	Description	Possible Causes	Pre Mitigation			Potential Mitigation Measures	Pre Mitigation		
					Frequency	Consequence	Risk		Frequency	Consequence	Risk
1a	All	Powered Vessel Collision with installation or support vessels (or vice versa)	Merchant vessel collides with installation or support vessel whilst steaming. Most passages are by fishing and oil & gas industry vessels to / from Shetland.	Adverse weather; Poor visibility; Radar interference; Manoeuvring error; Steering gear failure; Navigational aid failure; Equipment failure; Lack of awareness; Lack of experience; Lack of passage planning; Human error; Fatigue; Watchkeeper failure.	3	3	9	Marking and Lighting; AIS Monitoring; Raising awareness of the Project; Maritime Safety Information broadcasts; Sharing of information within industry; Liaison with MSF; Up-to-date charts; Emergency contact available 24hrs per day; ERCP; Guard vessel during construction; Watchkeeping;	2	3	6
1b	All	Fishing vessel collision with installation or support vessels (or vice versa)	Fishing vessel collides with installation or support vessels whilst steaming. Mostly local (Scottish) vessels operating in the area	Adverse weather; Poor visibility; Radar interference; Manoeuvring error; Steering gear failure; Navigational aid failure; Equipment failure; Lack of awareness; Lack of experience; Lack of passage planning; Human error; Fatigue; Watchkeeper failure; Non-AIS (below 15m length).	3	4	12	Notices to Fishermen; Fisheries Liaison; Kingfisher Publications; Marking and Lighting; AIS Transceiver and reliable coverage; Raising awareness of the Project; Maritime Safety Information broadcasts; Sharing of information within industry; Up-to-date charts and almanacs; Emergency contact available 24hrs per day; ERCP; Watchkeeping; Passage planning by vessels;	2	4	8
1c	All	Recreational vessel collision with installation or support vessels (or vice versa)	Yacht collides with installation or support vessels whilst steaming or under sail. Relatively infrequent transits of the area by vessels crossing between Scotland and Scandinavia. Likely to be lower speed impact but craft less robust.	Adverse weather; Poor visibility; Radar interference; Manoeuvring error; Steering gear failure; Navigational aid failure; Equipment failure; Lack of awareness; Lack of experience; Lack of passage planning; Human error; Fatigue;Watchkeeper failure; Non-AIS (majority).	2	4	8	Liaison with Recreational Sailing Community; Marking and Lighting; AIS Transceiver and reliable coverage; Raising awareness of the Project; Maritime Safety Information broadcasts; Sharing of information within industry; Up-to-date charts and almanacs; Emergency contact available 24hrs per day; ERCP; Watchkeeping; Passage planning by vessels	2	4	8
2	All	Drifting vessel collision with installation or support vessels (or vice versa)	Vessel loses power or drags anchor and drifts with wind and or tide towards installation or supporting vessels	Vessel emergency; Adverse weather; Manoeuvring error; Equipment failure; Lack of awareness; Lack of experience; Human error	3	4	12	Start engines by dragged anchor vessel; ERCP; AIS Monitoring; Towing vessel availability (above average); Marking and Lighting; Emergency shutdown system.	2	3	6

3	All	Vessel-to-vessel collision due to avoidance of installation or support vessels	Displaced traffic increases congestion outside of the cable route. This can lead to a change (increase) in vessel-to-vessel encounters and ultimately collisions. For this project, the small footprint and the distance from shore (beyond 12nm) means the impact should be limited.	Adverse weather; Poor visibility; Radar interference; Manoeuvring error; Steering gear failure; Navigational aid failure; Equipment failure; Lack of awareness; Lack of experience; Lack of passage planning; Human error; Fatigue; Watchkeeper failure; Failure to comply with Colregs.	3	4	12	Marking and Lighting; AIS Transceiver; Raising awareness of the Project; Communications with fishermen; Maritime Safety Information broadcasts; Notices to Fishermen; Fisheries Liaison; Sharing of information within industry; Liaison with Recreational Sailing Community; Liaison with MSF; Up-to-date charts; Kingfisher publications; Emergency contact available 24hrs per day; ERCP; Watchkeeping; Passage planning by vessels; Compliance with Colregs.	2	4	8
4	All	Fishing interaction with mid water cable	Fishing gear interacts with mid water cable when being laid.	Adverse weather; Manoeuvring error; Equipment failure; Lack of awareness; Lack of experience; Human error; Fatigue; Fishing vessels attracted to site; Non-AIS (smaller vessels).	4	4	16	Abandon gear in event of snag; Marking and Lighting; AIS Transceiver; AIS Monitoring; Raising awareness of the Project; Communications with fishermen; Maritime Safety Information broadcasts; Notices to Fishermen; Fisheries Liaison; FishSAFE; Sharing of information within industry; Up-to-date charts; Kingfisher publications; Issue Notices to Mariners / NAVTEX; Emergency contact available 24hrs per day; ERCP	3	4	12
5	All	Fishing interaction with cable on seabed	Fishing gear interacts with cable on seabed.	Inadequately protected cable; Adverse weather; Manoeuvring error; Steering gear failure; Equipment failure; Lack of awareness; Lack of experience; Human error; Fatigue; Watchkeeper failure; Fishing vessels attracted to cable route	3	4	12	Burial Protection Index (BPI) study; Cable protection, e.g. burial; Abandon gear; Raising awareness of the Project; Communications with fishermen; Maritime Safety Information broadcasts; Notices to Fishermen; Fisheries Liaison; FishSAFE; Sharing of information within industry; Up-to-date charts; Kingfisher publications; Notices to Mariners; Emergency contact available 24hrs per day; ERCP; AIS Monitoring; Guard vessel during cable laying; Periodic surveying of cable route.	2	4	8

6	All	Vessel Anchor interaction with subsea cable	Vessel anchor interacts with cable. Cable route is not near a traditional anchorage area. There is a risk of a transiting vessel anchoring in an emergency.	Dragged anchor; Adverse weather; Steering gear failure; Equipment failure; Lack of awareness; Lack of experience; Human error; Fatigue; Watchkeeper failure.	3	3	9	Anchoring by drifting vessel (good holding ground); Start engines by dragged anchor vessel; Burial Protection Index (BPI) study; Cable protection, e.g. burial; Anchor Watch / Guard Zone by vessel at anchor; Marking and Lighting; Raising awareness of the Pilot Park Project; Communications with fishermen; Maritime Safety Information broadcasts; Notices to Fishermen; Fisheries Liaison; Sharing of information within industry; Up-to-date charts; Kingfisher publications; Notices to Mariners ERCoP; AIS Monitoring; Towing vessel availability (above average).	2	3	6