Navigation Risk Assessment Update

Fall of Warness

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On behalf of:	European Marine Energy Centre (EMEC)
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1. Introduction

1.1 Background

Anatec have been commissioned by EMEC to update the Navigation Risk Assessment (NRA) of the tidal device test facility in the Fall of Warness (FoW) off the coast of the island of Eday in the Orkney Islands.

The original FoW NRA was published in May 2005 (Ref. i), with a further update carried out in October 2005 (Ref. ii).

This update takes into account the latest vessel activity data as well as guidance and experience available since the original NRA, including publications by the MCA (Refs. iii and iv) and DECC (Ref. v). (The DECC guidance is intended for offshore wind farms but much is relevant to other offshore renewable energy installations.)

1.2 Objectives

The main aims of this study were as follows:

- Analyse the latest metocean data available for the cable berths.
- Update the baseline assessment of vessel activity in the Fall of Warness lease area using the latest available data sets for:
    - Shipping
    - Fishing Vessels
    - Recreational Vessels
- Review the historical maritime incidents that have occurred in the area in recent years.
- Review the Search and Rescue resources in the vicinity which may be called upon in the event of a maritime incident
- Review the navigational risks associated with the cable berths, including the two new cables being installed in 2010 as well as the five existing berths.
- Assess the under keel clearance issue and the risk of collision with submerged tidal devices at each of the cable berths based on the updated vessel activity information and metocean data.

Devices could be installed at any location within the lease area. For the purpose of this generic study the seven cable berths have been used to investigate the issues, as these are the most probable locations for development.

1.3 Data Sources

The main data sources used in the study are as follows:

- AIS Shipping Data
- Vessel Logs from Monitoring on Eday
- Government Fishing Surveillance Data
- RYA UK Coastal Atlas Data

The above data sources were supplemented by consultation with local and national stakeholders representing the different vessel activities.

1.4 Abbreviations

The following abbreviations are used in this report:

AIS	-	Automatic Identification System
ATBA	-	Area To Be Avoided
ATON	-	Aid to Navigation
BTA	-	British Tug-owners Association
CA	-	Cruising Association
EMEC	-	European Marine Energy Centre
ETV	-	Emergency Towing Vessel
FoW	-	Fall of Warness
GPS	-	Global Positioning System
GRT	-	Gross Registered Tonnage
HAT	-	Highest Astronomical Tide
HF	-	High Frequency
H_s	-	Significant Wave Height (m)
IALA	-	International Association of Lighthouse Authorities
ICES	-	International Council for the Exploration of the Seas
ICORELS	-	International Committee for the Reception of Large Vessels
IMO	-	International Maritime Organisation
LAT	-	Lowest Astronomical Tide
m	-	Metre
MCA	-	Maritime and Coastguard Agency
MFA	-	Marine and Fisheries Agency
MGN	-	Marine Guidance Note
MHWS	-	Mean High Water Springs
MHWN	-	Mean High Water Neaps
MLWN	-	Mean Low Water Neaps
MLWS	-	Mean Low Water Springs
MRCC	-	Maritime Rescue Coordination Centre
MSL	-	Mean Sea Level
NLB	-	Northern Lighthouse Board

nm	-	Nautical Mile (1nm ≡ 1,852metres)
NRA	-	Navigation Risk Assessment
OFA	-	Orkney Fisheries Association
OIC	-	Orkney Islands Council
OREI	-	Offshore Renewable Energy Installation
PIANC	-	Permanent International Association of Navigation Congresses
PLN	-	Port Letter Number
RNLI	-	Royal National Lifeboat Institution
RYA	-	Royal Yachting Association
SAR	-	Search and Rescue
SCADA	-	Supervisory Control And Data Acquisition
SFF	-	Scottish Fishermen's Federation
SFPA	-	Scottish Fisheries Protection Agency
SPFA	-	Scottish Pelagic Fishermen's Association
UHF	-	Ultra High Frequency
UKC	-	Under Keel Clearance
VHF	-	Very High Frequency
VTS	-	Vessel Traffic Service

2. Site Details

2.1 Location Overview

The tidal power test site is located at the Fall of Warness, to the southwest of Isle of Eday. The life of the site is estimated to be approximately 20 years.

The facility currently offers five existing test berths (numbered 1-5) at water depths (at LAT) ranging from 13m to 46m. The cables run from the substation which lies just above the beach at Caldale, through the beach, and along the seabed, terminating at the berth positions. Two new cables (numbered 6 & 7) are planned to be installed during 2010 at water depths of 33m LAT.

The following figures present general and detailed overviews of the area.

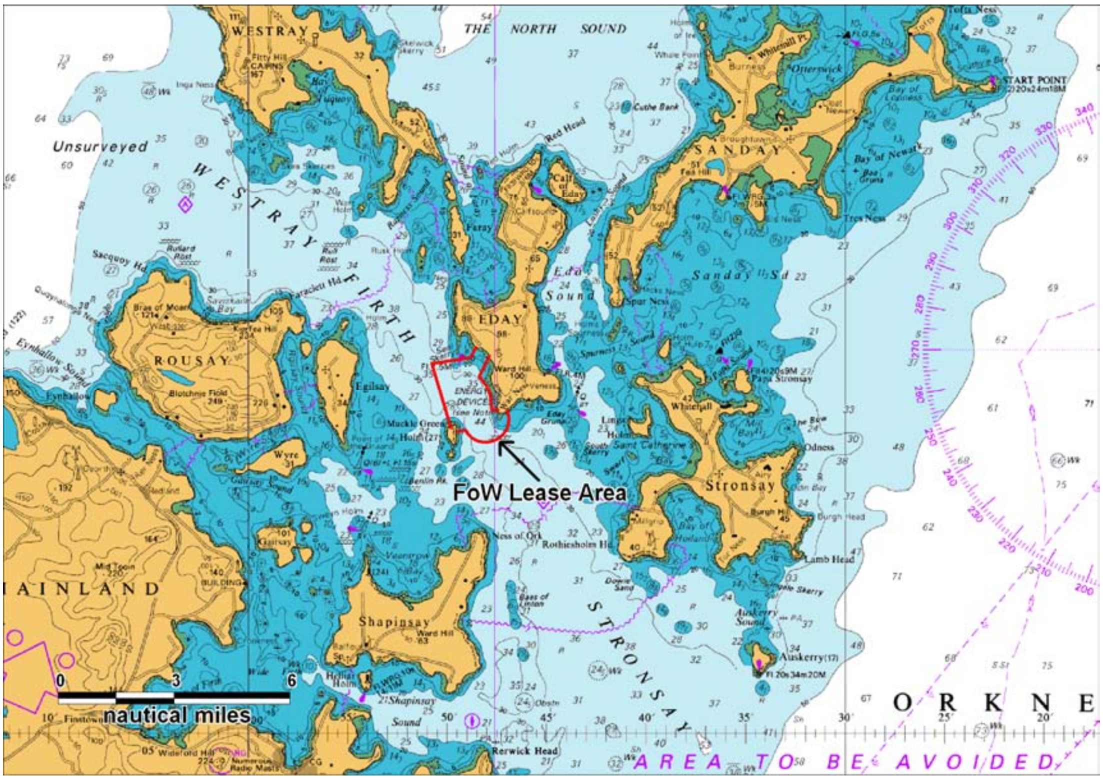

Figure 2.1 Overview of Fall of Warness Tidal Site Lease Area

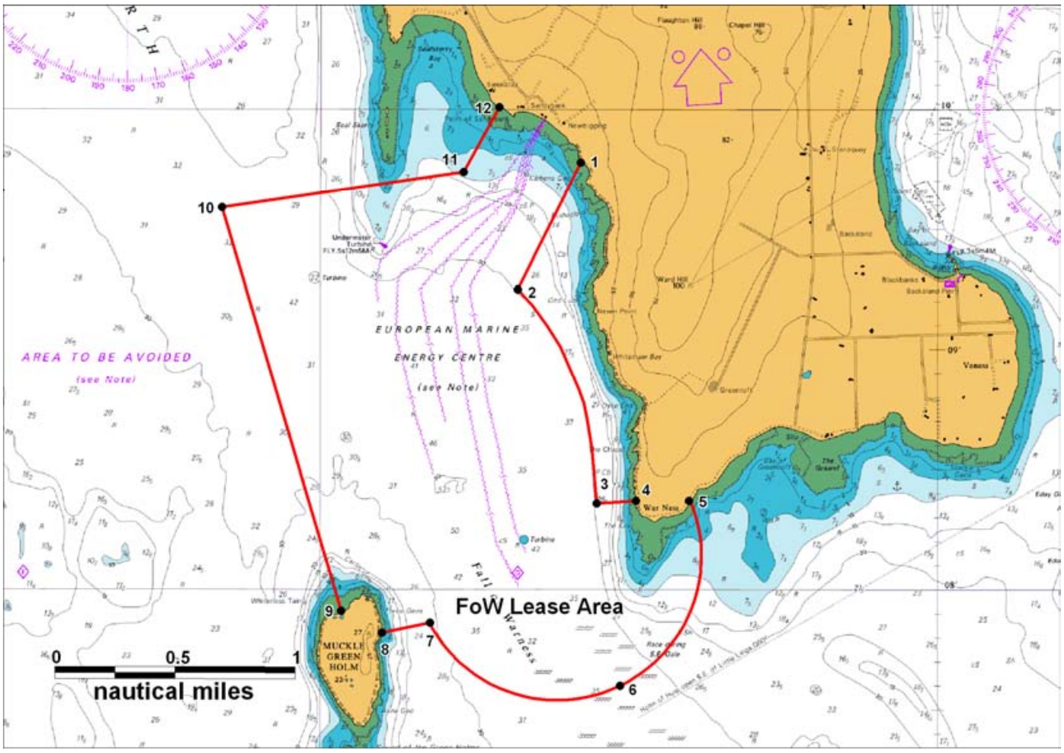

Figure 2.2 Detailed Chart of the Fall of Warness Tidal Site Lease Area

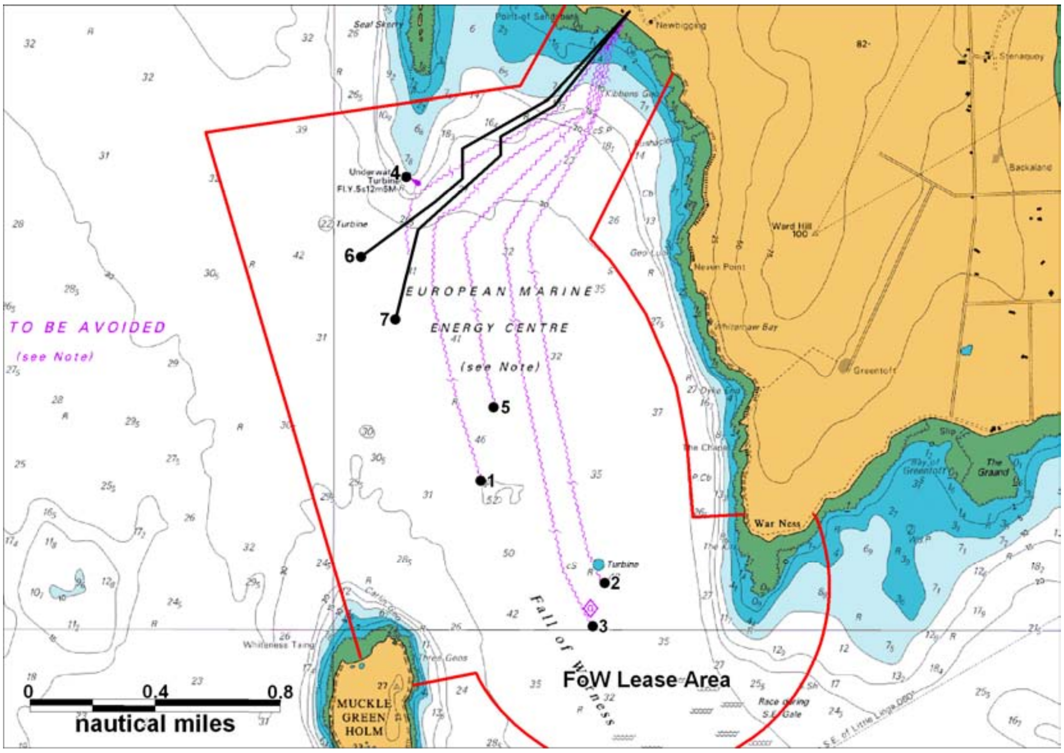

Figure 2.3 Detailed Chart of Cable Berths at Fall of Warness

Perimeter coordinates of the lease area are presented in Table 2.1.

Table 2.1 Fall of Warness Lease Area (Lat/Long WGS84)

Point	Coordinates
1	59° 09.78’N, 002° 47.89’W
2	59° 09.25’N, 002° 48.40’W
3	59° 08.36’N, 002° 47.76’W
4	59° 08.37’N, 002° 47.44’W
5	59° 08.37’N, 002° 47.01’W
6	59° 07.60’N, 002° 47.57’W
7	59° 07.86’N, 002° 49.11’W
8	59° 07.82’N, 002° 49.50’W
9	59° 07.91’N, 002° 49.83’W
10	59° 09.59’N, 002° 50.80’W
11	59° 09.74’N, 002° 48.84’W
12	59° 10.01’N, 002° 48.55’W

Details of the positions and water depths at the cable berths are presented in Table 2.2.

Table 2.2 Coordinates and Water Depths of Cable Berths

Berth	Coordinates	Water Depth at LAT (m)
Cable 1	59°08.479’N, 002°49.080’W	49.1
Cable 2	59°08.150’N, 002°48.307’W	42.6
Cable 3	59°08.012’N, 002°48.379’W	40.9
Cable 4+	59°09.199’N, 002°49.533’W	13.3
Cable 5	59°08.712’N, 002°49.000’W	44.7
Cable 6*	59°09.192’N, 002°49.828’W	33.1
Cable 7*	59°08.994’N, 002°49.613’W	33.5

+ Cable 4 is routed to the OpenHydro platform.
* Cables 6 and 7 to be installed in 2010.

2.2 Device Details

The tidal test facility was established in 2006 to allow developers of tidal energy conversion devices to test and evaluate their devices under monitored and validated conditions.

The intention is not to limit the devices to be installed at the test facility to a single type but to facilitate testing of a number of different types. The following four generic device types were assumed in the previous NRA:

1. Type 1: Bottom sited, gravity device
2. Type 2: Mid-water, buoyant, moored device
3. Type 3: Pile mounted, surface piercing device
4. Type 4: Surface moored device

Brief descriptions of these generic types of devices are presented below:

<u>Type 1 – Bottom Sited Gravity Device</u>

The assumed characteristics of a bottom sited device are:

- Turbine mounted on or within a framed structure seated on a plinth with the generator and control equipment be mounted on the structure
- The structure would be sited on a prepared area of seabed
- The assumed dimensions of the device would be L25m x W25m x H25m (The height includes any plinth structure and is assumed to be the height above any charted depth)
- The mass of such a device would be between 500 and 1000 tonnes

<u>Type 2 – Mid-water Buoyant, Moored Device</u>

The assumed characteristics of the mid water buoyant device are:

- Wing shaped buoyant body with un-shrouded turbine(s) of, approximately, 18m diameter, mounted in nacelles
- Moored to the seabed by a multi-legged, tensioned mooring system probably using rock anchors (as opposed to embedment anchors)
- A degree of movement, in so far as allowed by the mooring, necessary to ensure optimum positioning in both flood and ebb tides
- The mass of such a device would be between 60 and 100te

<u>Type 3 – Pile Mounted, Surface Piercing Device</u>

A pile mounted, surface piercing device is assumed to comprise:

- A monopile sited in charted depths between 25 and 30m and protruding some 9m above Mean Sea Level (approximately 7m above HAT)
- 2 un-shrouded turbines, approximately 20m in diameter, mounted on arms or mounts either side of the monopile
- Turbine nacelles and associated generators/gearboxes etc. which can be raised above the sea-level for maintenance
- Blade tips approximately 6m below the surface at LAT and rotating at approximately 12 rpm (when in operating mode)
- A control and equipment cabin surmounting the pile
- Appropriate marking, lighting and aids to navigation

<u>Type 4 – Buoyant Surface Device</u>

The buoyant surface device is assumed to consist of:

- A buoyant body some 25m in length with a diameter of 4m
- A single point mooring about which the device will swing
- Un-shrouded turbine(s) positioned on arms(s) extending from the underside of the buoyant body
- Turbines approximately 15m in diameter
- The draught of the device would be 25m
- The device would be equipped with appropriate marking, lighting and aids to navigation
- The mass of the device is estimated to be in the order of 100 – 200te.

2.3 Metocean Data

Metocean data was supplied by EMEC for the project in the form of wind and wave data at three-hourly intervals over a 20 years modelling period (1986-2005) for each of the seven cable berths (Ref. vi). Local tidal and visibility data were also analysed. The results are presented in the subsections below.

2.3.1 Wave Data

The significant wave height and maximum wave height probability distributions were calculated based on the 20 years of three-hourly data. The results for each of the cable berths are presented in Table 2.3 and Table 2.4.

Table 2.3 Significant Wave Height Probability Distribution for the 7 Cables

Significant Wave Height (m)	Cable Berth						
	1	2	3	4	5	6	7
0-0.5	21.9%	24.1%	24.1%	20.5%	22.7%	20.2%	20.9%

Significant Wave Height (m)	Cable Berth						
	1	2	3	4	5	6	7
0.5-1	38.7%	38.5%	38.8%	37.7%	37.9%	38.4%	38.4%
1-1.5	22.6%	21.8%	21.7%	22.1%	21.9%	22.4%	22.3%
1.5-2	11.2%	10.1%	9.8%	12.2%	11.4%	12.2%	12.0%
2-2.5	4.2%	3.9%	3.8%	5.5%	4.5%	5.1%	4.9%
2.5-3	1.1%	1.3%	1.3%	1.6%	1.4%	1.4%	1.3%
3-3.5	0.2%	0.3%	0.3%	0.4%	0.3%	0.3%	0.3%
3.5-4	0.0%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%
4-4.5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table 2.4 Maximum Wave Height Probability Distribution for the 7 Cables

Maximum Wave Height (m)	Cable Berth						
	1	2	3	4	5	6	7
0-0.5	3.2%	3.7%	3.6%	2.6%	3.3%	2.4%	2.7%
0.5-1	19.1%	20.7%	20.7%	18.5%	19.7%	18.2%	18.6%
1-1.5	21.7%	22.0%	22.2%	20.9%	21.4%	21.5%	21.4%
1.5-2	17.0%	16.6%	16.7%	16.7%	16.5%	17.0%	17.0%
2-2.5	13.1%	12.8%	12.9%	12.6%	12.7%	12.8%	12.7%
2.5-3	9.8%	9.2%	8.9%	9.7%	9.4%	9.8%	9.8%
3-3.5	6.7%	6.2%	6.0%	7.3%	6.9%	7.3%	7.2%
3.5-4	4.3%	3.8%	3.7%	4.9%	4.4%	4.8%	4.7%
4-4.5	2.6%	2.4%	2.3%	3.3%	2.8%	3.1%	3.0%
4.5-5	1.4%	1.4%	1.4%	1.7%	1.5%	1.7%	1.6%
5-5.5	0.7%	0.7%	0.7%	0.9%	0.8%	0.8%	0.7%
5.5-6	0.3%	0.3%	0.4%	0.5%	0.4%	0.4%	0.4%
6-6.5	0.1%	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
6.5-7	0.1%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
7-7.5	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
7.5-8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

The significant wave height is below 1m over 50% of the time and below 2m over 90% of the time for all cable berths.

The maximum wave height is below 1.5m over 50% of the time and below 4m over 90% of the time for all cable berths.

The average and highest significant and maximum wave heights modelled over the 20 years at each cable berth are presented in Table 2.5.

Table 2.5 Average and Maximum Wave Heights over 20 Years (3-Hourly Data)

Cable	Significant Wave Height (m)		Maximum Wave Height (m)	
	Average	Maximum	Average	Maximum
1	0.96	3.70	1.90	7.18
2	0.94	3.95	1.86	7.63
3	0.94	4.11	1.85	7.94
4	1.01	3.89	1.99	7.25
5	0.97	3.83	1.91	7.41
6	1.00	3.75	1.97	7.31
7	0.99	3.73	1.95	7.28

The average significant wave height tended to be around 1m with the highest value around 4m. The average maximum wave height was approximately 2m with highest values of 7-8m.

The highest waves are at the most southerly berths 2 and 3 which are in the most constricted part of the flow between War Ness and Muckle Green Holm.

Modelled wave direction data for the site was also analysed. The mean wave direction was distributed into 12 x 30 direction sector bands centred on 0 , 30 , etc. The most common wave directions were from the NW and SE although the distribution was location dependent to an extent. A typical distribution is presented in Figure 2.4.

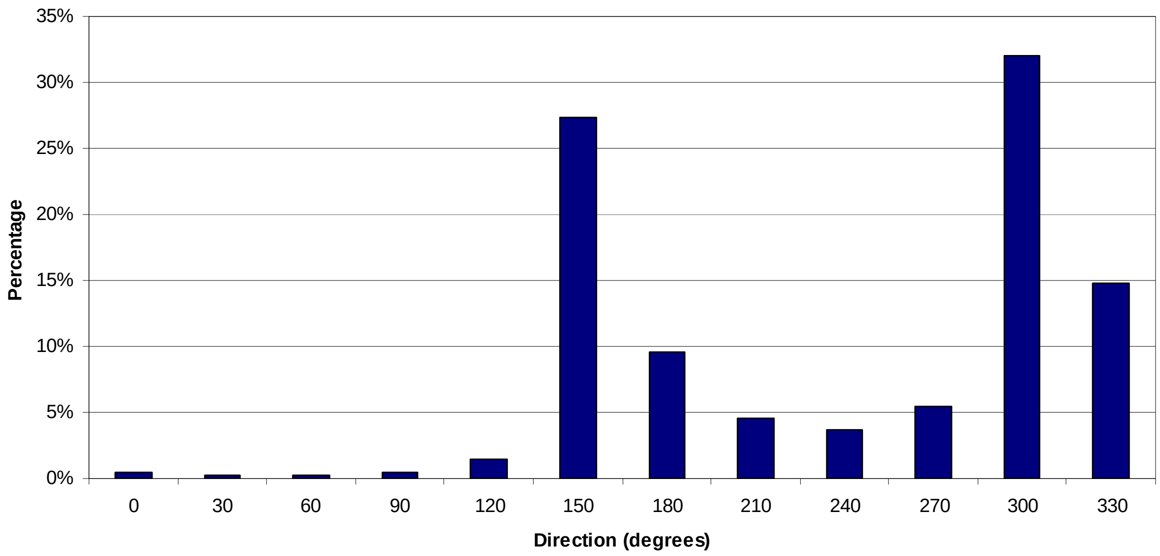

Figure 2.4 Mean Wave Direction Distribution for Cable 3 (Direction from)

The data also provided information on average and peak wave periods. The minimum, average and maximum values over the modelled 20 year period at each cable berth are presented in Table 2.6.

Table 2.6 Mean and Peak Wave Periods – 20 Years

Cable Berth	Mean Wave Period (s)			Peak Wave Period (s)		
	Minimum	Average	Maximum	Minimum	Average	Maximum
1	2	4.3	14.1	2	8.1	18.1
2	1.9	4.2	13.9	2.1	7.6	18
3	1.9	4.2	13.8	1.8	7.6	18.1
4	2	4.6	14.4	2.2	8.9	18.7
5	2	4.3	14	2	7.9	18.1
6	2	4.4	14.2	2.1	8.4	18.4
7	2	4.4	14.2	2.1	8.3	18.4

The average mean wave period over the 20 years was in the range 4-5 seconds and the average peak wave period, i.e., for higher waves, ranged from 7-9 seconds. These average periods correspond to approximate wave lengths of 30m (based on mean) and 100m (based on peak).

2.3.2 Wind Data

The average wind direction and speed distributions did not vary significantly across the different berths. Results are presented in Figure 2.5 and Figure 2.6 (modelled for cable berth 5). It can be seen that the predominant wind directions have southerly and westerly components. The average wind speed was approximately 8 m/s.

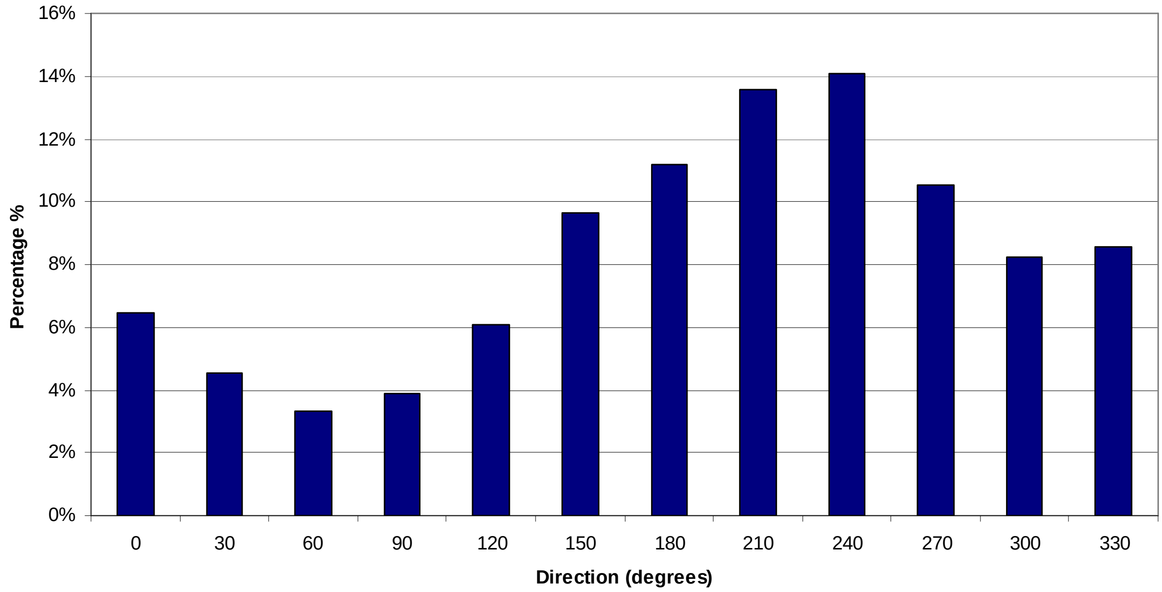

Figure 2.5 Average Wind Direction Distribution – FoW Berth 5

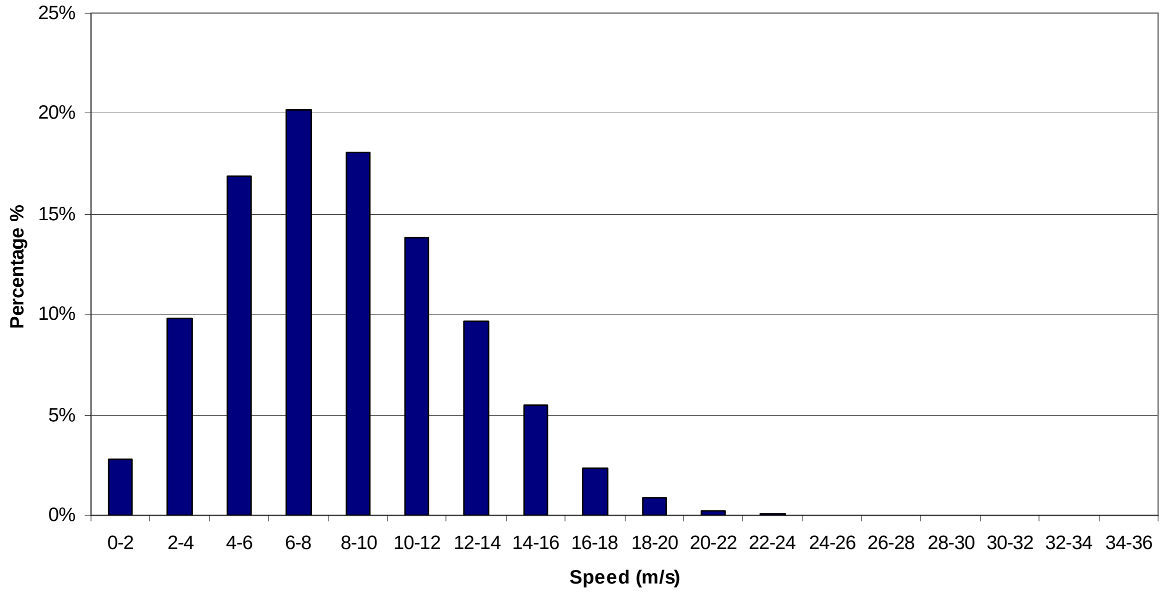

Figure 2.6 Average Wind Speed Distribution - FoW Berth 5

2.3.3 Tidal Data

The tidal height variations at the nearest available location to the site are presented in Table 2.7.

Table 2.7 Tidal Levels referred to Datum of Soundings (Loth, Sanday)

Tidal Level	Height above LAT (m)
Mean High Water Springs (MHWS)	3.1
Mean High Water Neaps (MHWN)	2.5
Mean Sea Level (MSL)	2.0
Mean Low Water Neaps (MLWN)	1.5
Mean Low Water Springs (MLWS)	0.9

In terms of tidal speeds and directions, the Fall of Warness lies between the Westray Firth and Stronsay Firth, which together form the main channel through the Orkney Islands for the flooding and ebbing tide. As such, the site exhibits strong tidal flows in both directions.

Based on Admiralty Chart 2562, the flood tide tends to run from NW to SE with peak mean spring rates of 7.2 knots and peak mean neap rates at 2.8 knots. The ebb tide runs from SE to NW with peak mean spring and neap rates of 6.5 and 2.5 knots, respectively. Full details are shown in Figure 2.7.

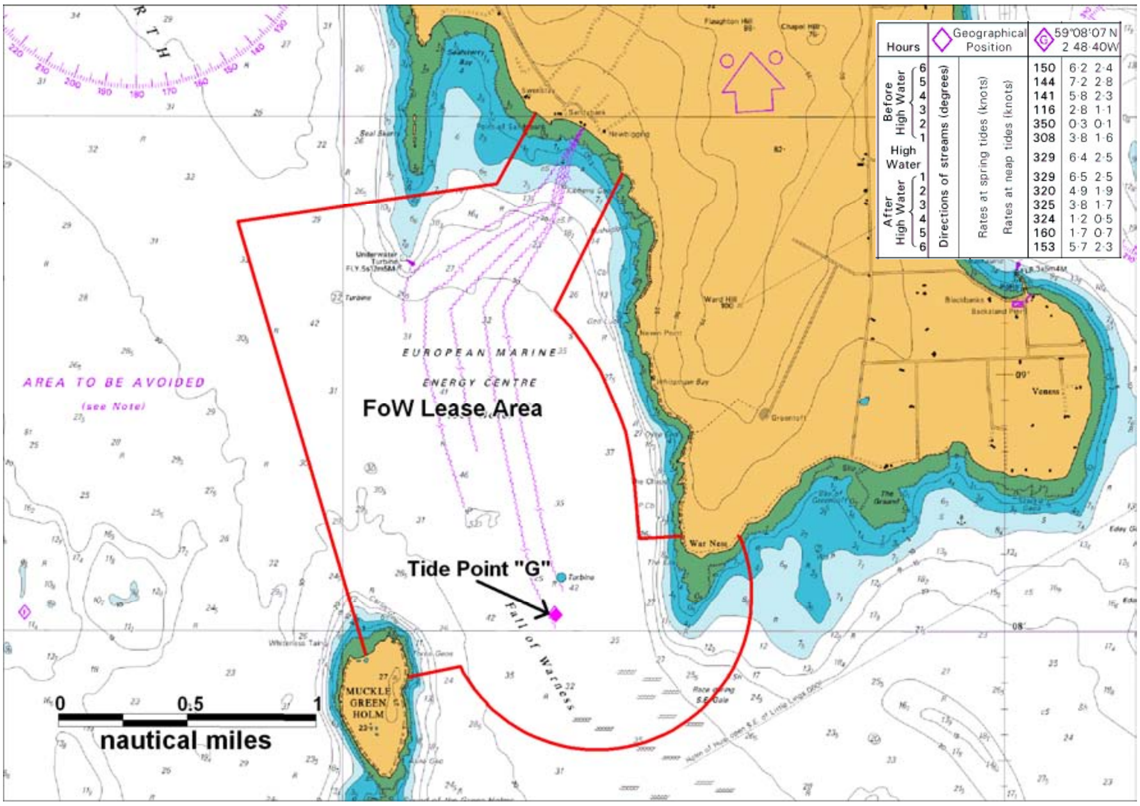

Figure 2.7 Tidal Stream Data for Fall of Warness (Tide Point "G")

2.3.4 Visibility

Mean visibility data based on daily measurements at Kirkwall Weather Station (1996-2007) are presented in Figure 2.8. On the majority of days the mean visibility was in the range 10-20km. There were just 4 days recorded with a mean visibility of less than 1km.

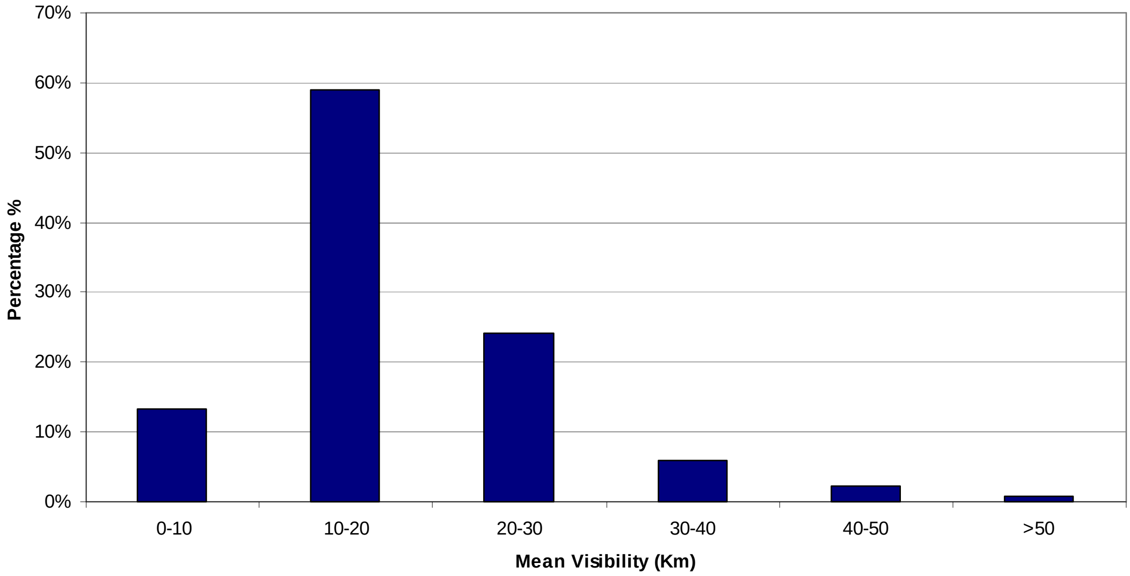

Figure 2.8 Mean Visibility Distribution using Kirkwall Weather Station Data

Whilst this indicates the probability of fog lasting all day is low, there will have been periods during other days when visibility temporarily dropped below 1km.

The Pilot Book for North Scotland (Ref. vii) indicates there is an average of 45 days per year with fog at Kirkwall, where fog is defined as visibility of less than 1km. An averaged monthly plot based on 11 years of measurements is presented in Figure 2.9. Sea fog is mainly encountered between April and September with warm moist air from the South.

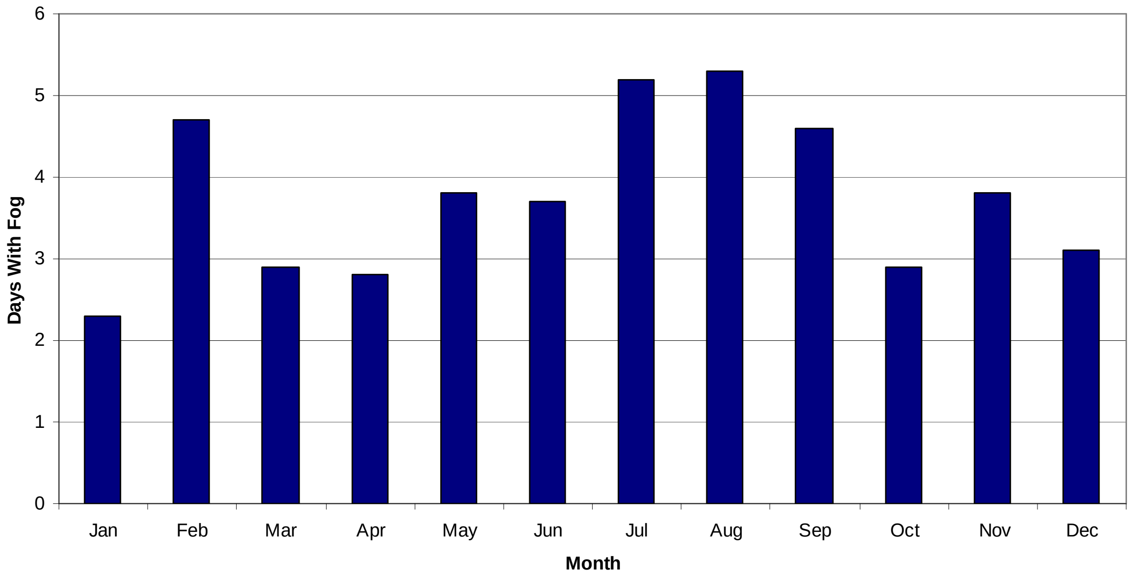

Figure 2.9 Average Number of Days with Fog per Month for Kirkwall

3. Consultation

Widespread consultation on the Fall of Warness development was carried out during the original Navigation Risk Assessment in 2005 (Ref. i).

During this update, further consultation has been carried out with the following organisations representing the different local users / stakeholders:

- Maritime and Coastguard Agency (MCA)
- Northern Lighthouse Board (NLB)
- OIC Marine Services (including Ferries)
- Orkney Fisheries Association (OFA)
- Scottish Fisheries Protection Agency (SFPA)
- Orkney Fishermen's Society
- Orkney Creel Fishermen's Association
- Scottish Pelagic Fishermen's Association (SPFA)
- Scottish Fishermen's Federation (SFF)
- Marine Laboratory, Aberdeen
- Local Fishermen
- Local RYA, Cruising Association and Sailing Club Representatives
- Orkney Sea Kayaking Association
- Kirkwall Kayakers Club
- Orkney Surf Club
- Orkney Dive Boat Operators' Association

It was generally recognised that the Fall of Warness site has been established since 2006 and is well known to local mariners, as well as being marked on charts and referred to in sailing directions, etc.

Specific consultation feedback is provided where appropriate within the document.

4. Shipping Activity Analysis

4.1 Introduction

This section presents shipping data for the Fall of Warness tidal site. This is based predominantly on AIS data. AIS is now fitted on the vast majority of commercial ships operating in UK waters including all ships of 300 GT and upwards engaged on international voyages and all passenger ships. It is also carried by a proportion of small vessels voluntarily, including some fishing and recreational vessels.

4.2 AIS Analysis – Lease Area

Twelve weeks of AIS survey was analysed for the location; six weeks from summer 2009 (June-July) and six weeks from winter 2010 (February-April).

Plots of the tracks recorded on AIS within five nautical miles of the site during the summer and winter survey periods, colour-coded by vessel type, are presented in Figure 4.1 and Figure 4.2, respectively.

Inter-island passenger ferries represented the vast majority of tracks during each period, followed by "other" ships and cargo vessels. The main passenger ferries recorded were *Earl Thorfinn*, *Earl Sigurd* and *Varagen*.

The main "other" ship was the *Valkyrie* which was working at the FoW site on behalf of a developer during the summer period.

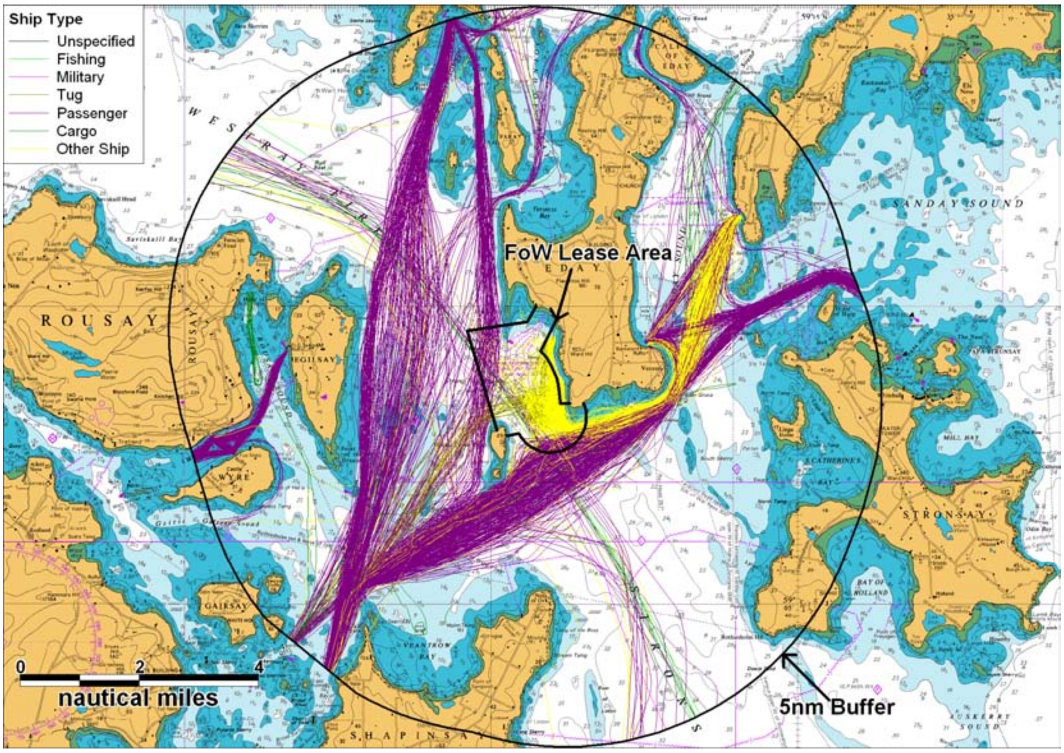

Figure 4.1 AIS Tracks by Type - Six Weeks in Summer 2009

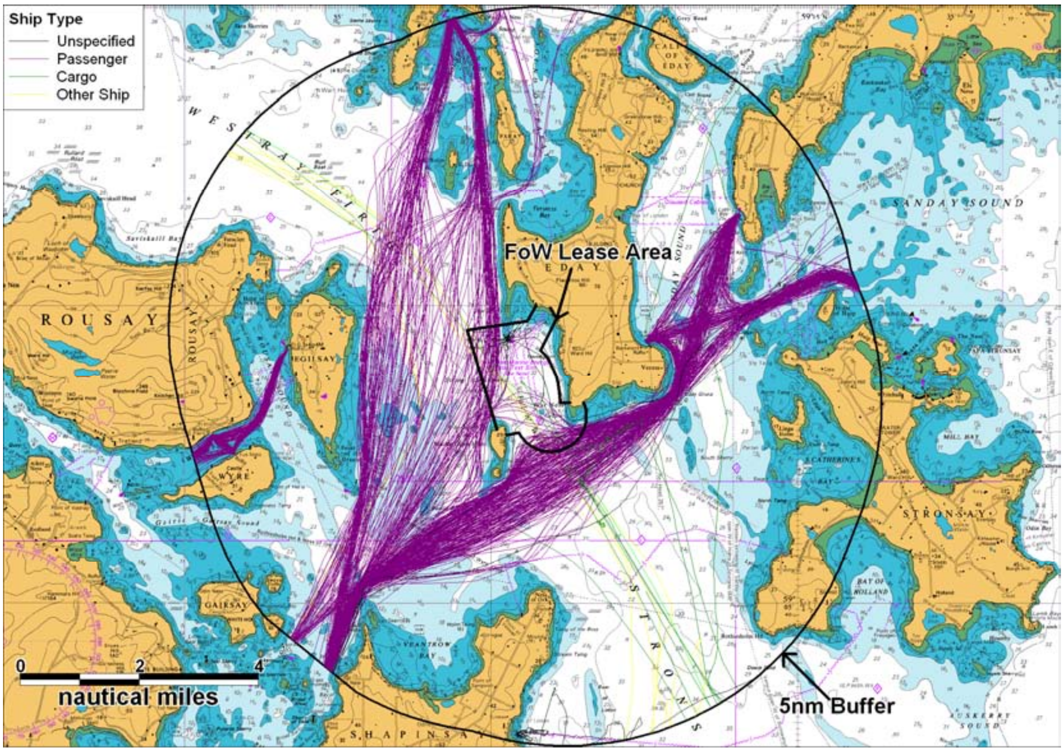

Figure 4.2 AIS Tracks by Type –Six Weeks in Winter 2010

During summer, an average of 7 vessels per day in total passed within 5nm of the tidal site with a maximum of 11 vessels. During winter, an average of 4-5 vessels per day passed within 5nm with a maximum of six. Plots of the busiest days in summer and winter are presented in Figure 4.3 and Figure 4.4 respectively.

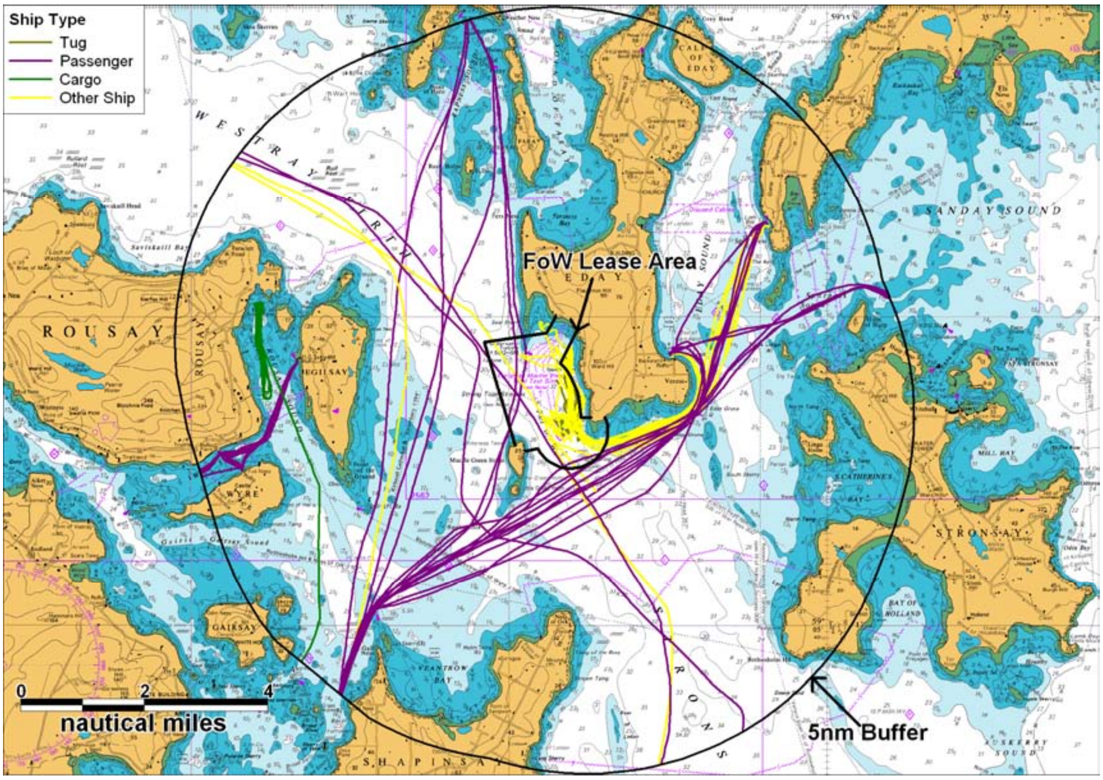

Figure 4.3 Busiest Summer Day (15 June 2009)

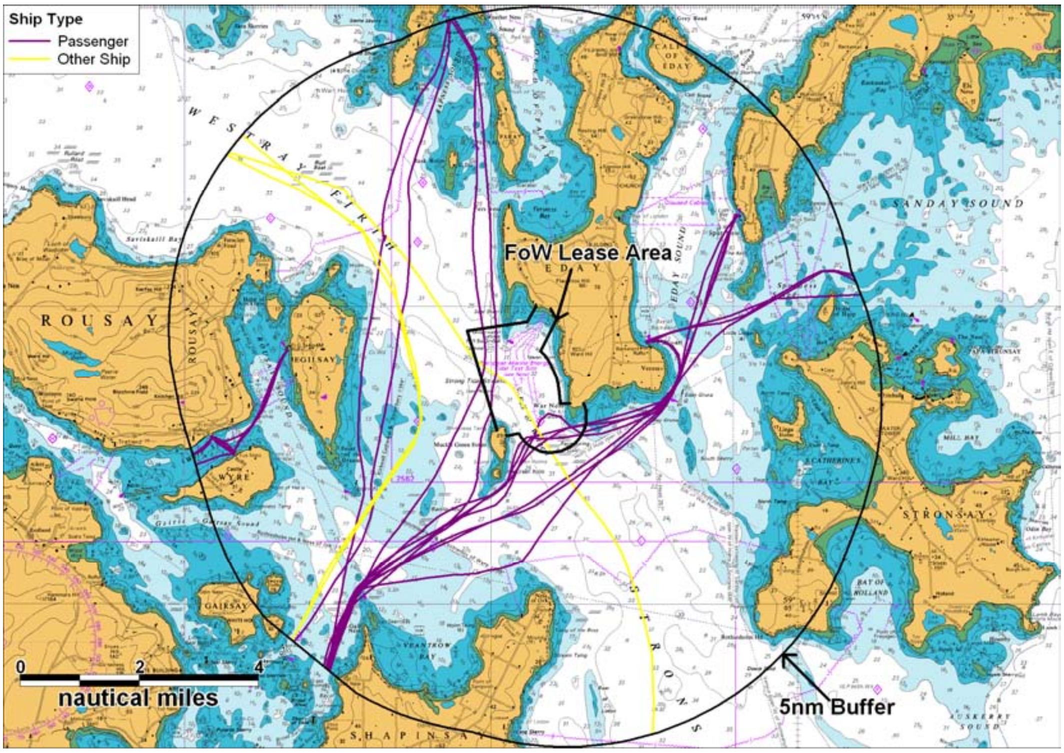

Figure 4.4 Joint Busiest Winter Day (24 March 2010)

More detailed plots of the tracks relative to the FoW lease area during summer and winter, colour-coded by vessel type, length and draught, are presented in Figure 4.5 to Figure 4.10.

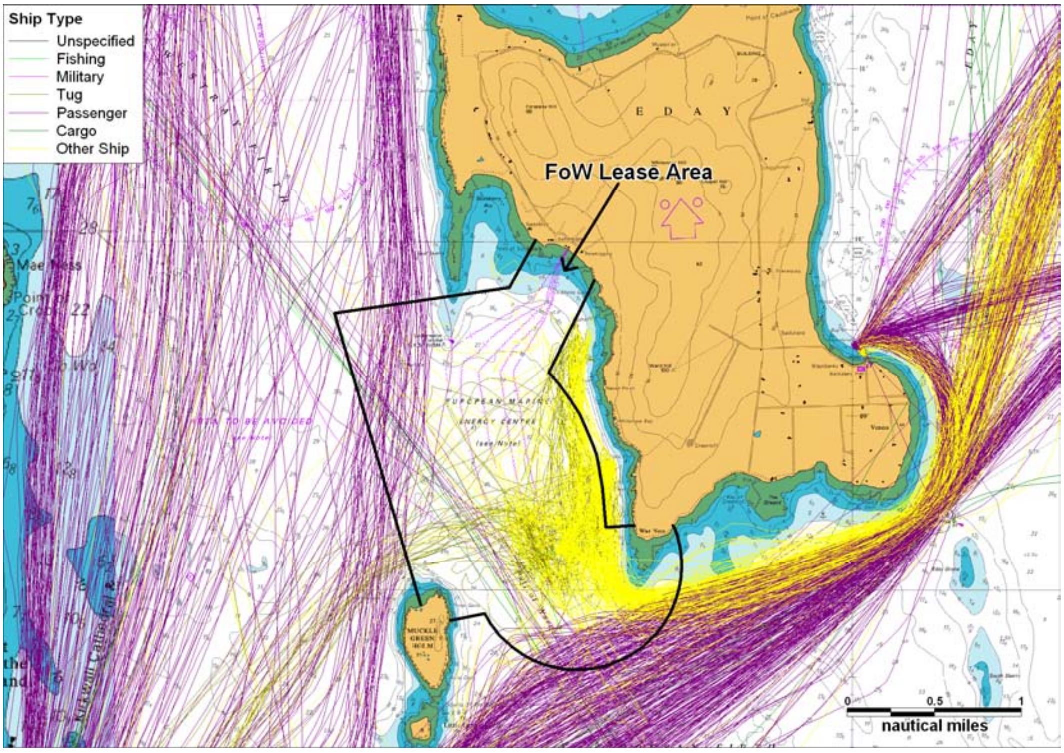

Figure 4.5 Detailed Plot of Summer 2009 AIS Tracks

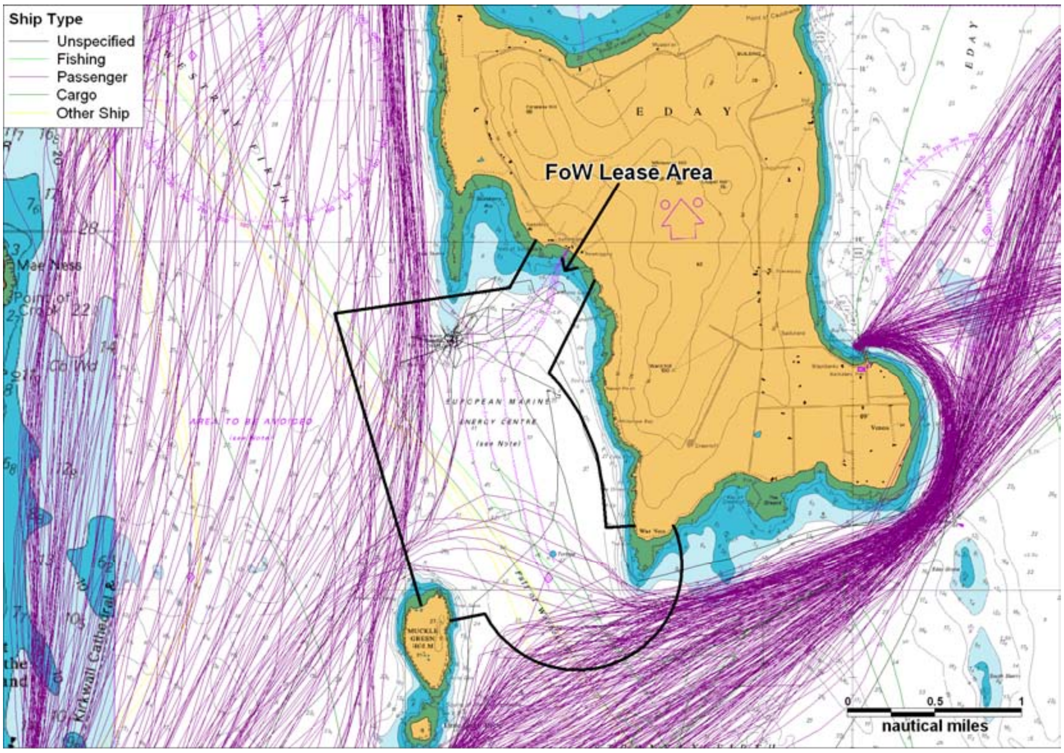

Figure 4.6 Detailed Plot of Winter 2010 AIS Tracks

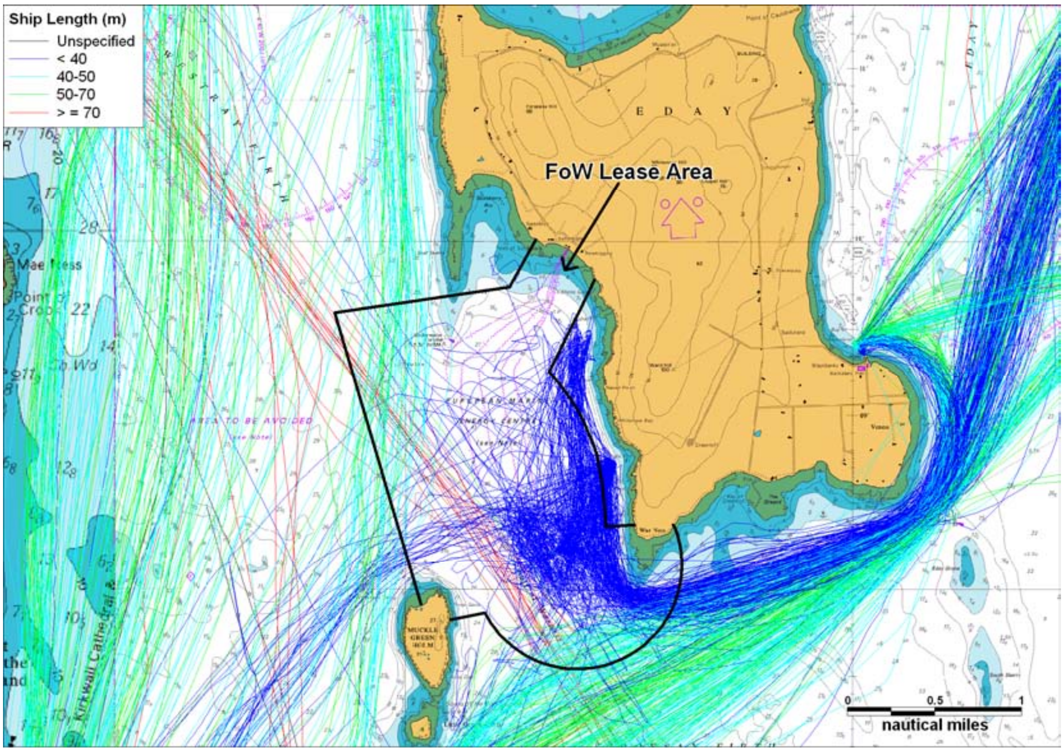

Figure 4.7 Detailed Plot of Summer 2009 AIS Tracks by Length

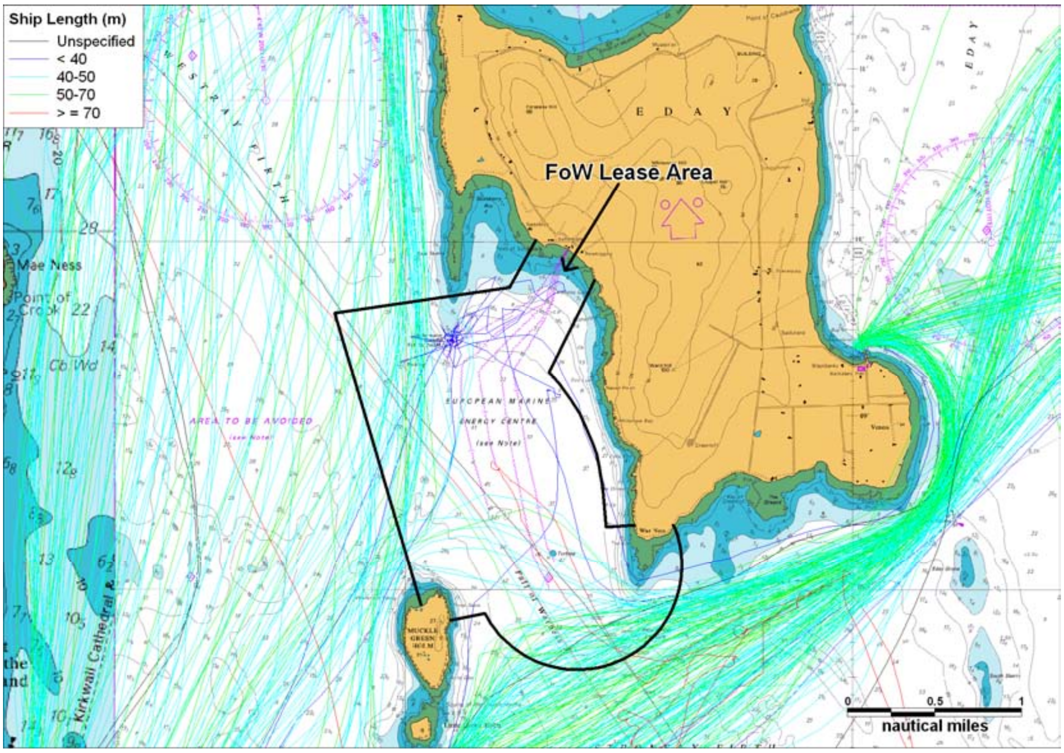

Figure 4.8 Detailed Plot of Winter 2010 AIS Tracks by Length

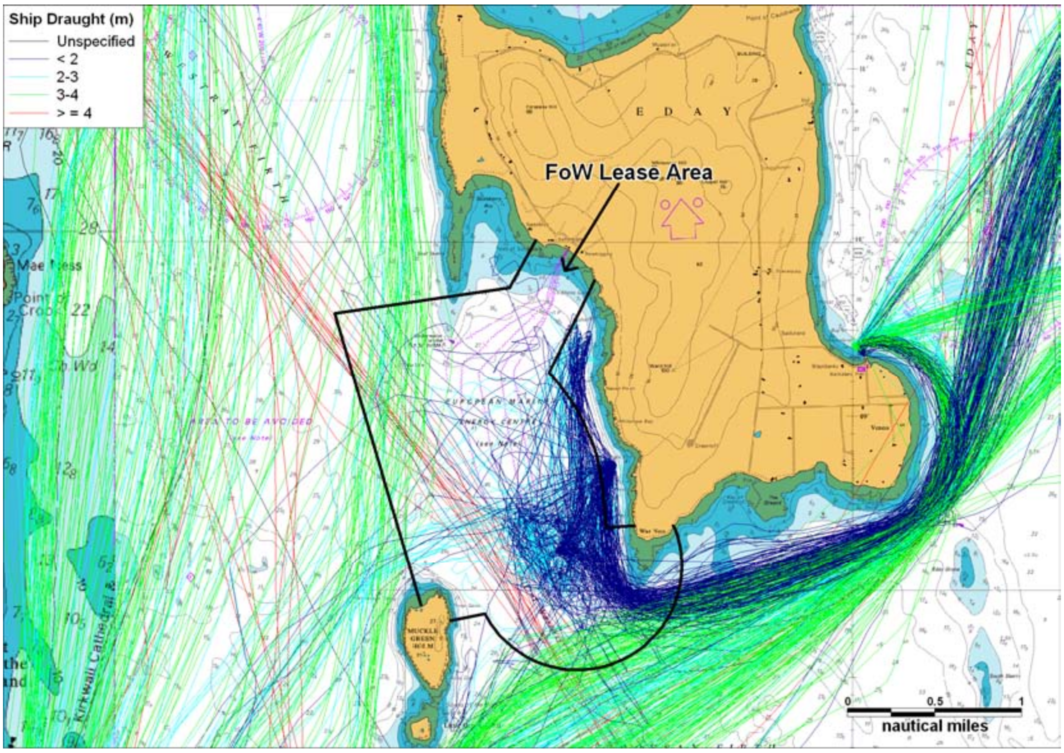

Figure 4.9 Detailed Plot of Summer 2009 AIS Tracks by Draught

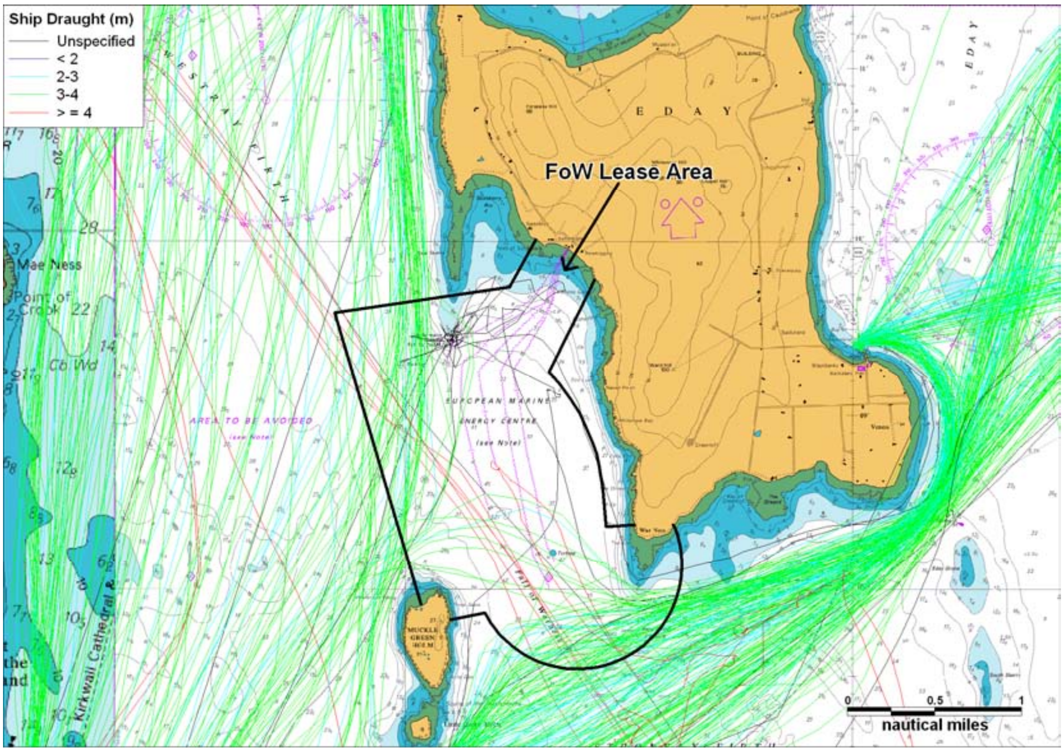

Figure 4.10 Detailed Plot of Winter 2010 AIS Tracks by Draught

More detailed analysis has been carried out of the tracks passing within the lease area. Vessels identified to be working at the Fall of Warness site (i.e., associated with the development) were excluded (*Valkyrie, Sarah Grey* and *Uskmoor*).

During summer, an average of 2.9 vessels per day passed within the lease area compared to just over 2 per day during winter.

The ship type distribution based on the AIS data is presented in Figure 4.11.

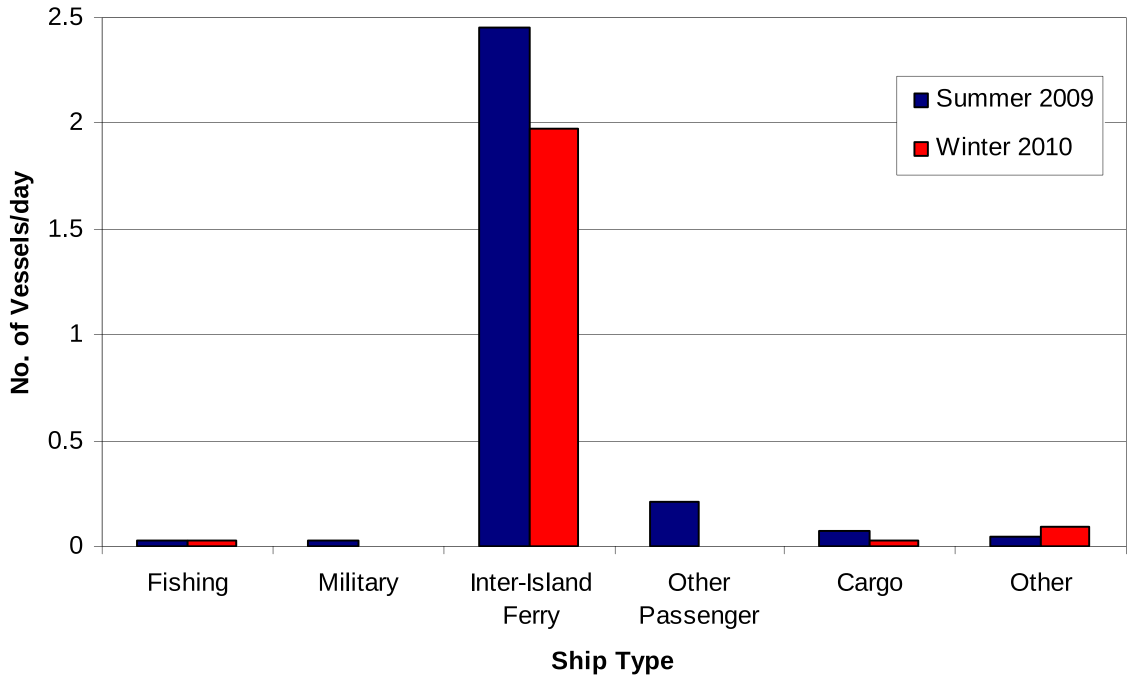

Figure 4.11 Ship Type Distribution passing within the FoW Lease Area

The vast majority of vessels that passed within the lease area were inter-island ferries. A list of all vessels that made three or more transits of the lease area is presented below.

Table 4.1 List of Regular Vessels passing within the FoW Lease Area

Name	Type	Destinations	Length (m)	Draughts (m)	Transits (12 Weeks)
Earl Thorfinn	Inter-Island Ferry	North Isles - Kirkwall	45	3	69
Earl Sigurd	Inter-Island Ferry	Westray	45	3.2	66
Varagen	Inter-Island Ferry	North Isles - Kirkwall	49.9	2.9	52
Maersk Fetcher	Offshore Tug/Supply	Aberdeen – West of Shetland	82.5	5.0 - 5.7	4
Minna	Fisheries Patrol	'Patrol'	47.7	4	3

Length and draught distributions of vessels passing within the lease area are presented in Figure 4.12 and Figure 4.13.

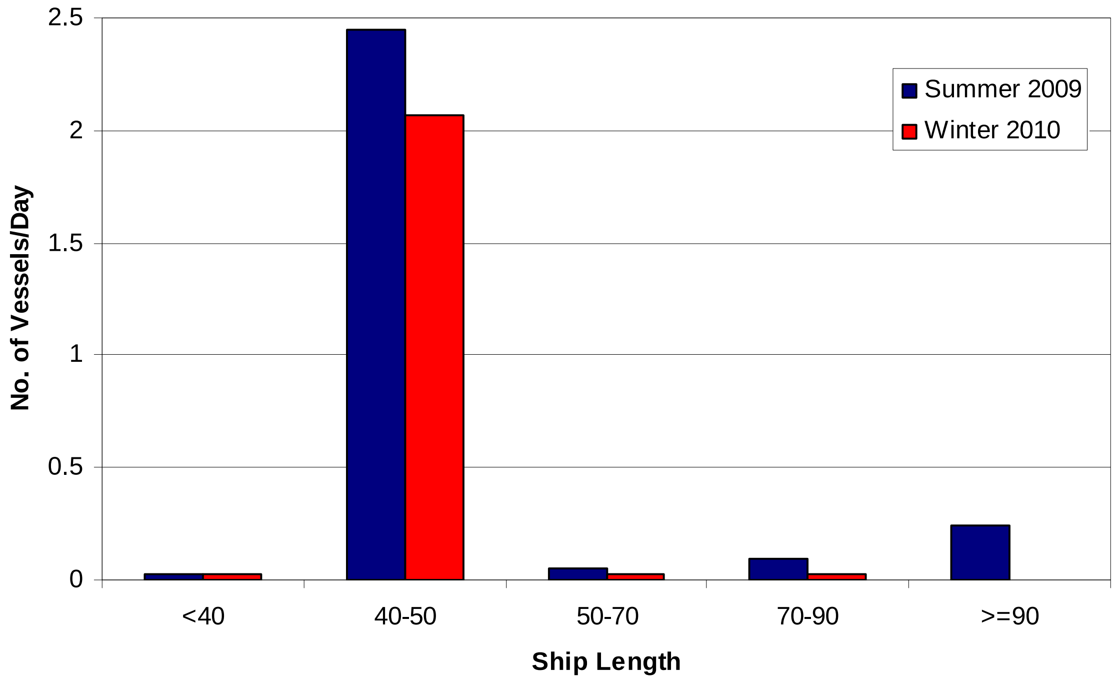

Figure 4.12 Ship Length Distribution passing within the FoW Lease Area

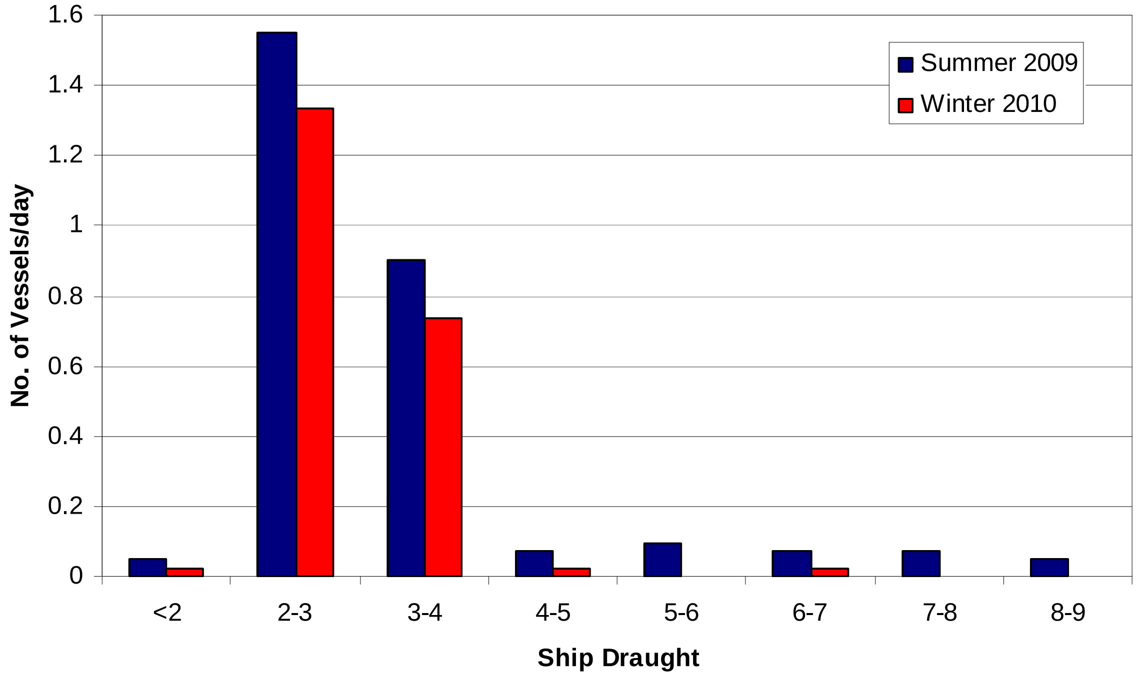

Figure 4.13 Ship Draught Distribution passing within the FoW Lease Area

During the summer survey, the average length of vessel passing within the lease area was 57.4m and the longest vessel recorded was the passenger cruise ship *Albatros* at 205m. The average draught of vessel passing within the lease area during summer was 3.4m and the vessel with the deepest draught was the passenger cruise ship *Saga Rose* at 8.3m.

During winter, the average length of vessel passing within the lease area was 46.6m and the longest vessel was the offshore tug/supply ship *Maersk Fetcher* at 82.5m. The average draught of vessel passing within the lease area during winter was 3.1m and the vessel with the deepest draught was the Coastguard tug *Anglian Sovereign* at 6.6m.

The destinations of vessels tracked within the lease area during summer and winter are presented in Figure 4.14. The main destinations in each case were Kirkwall and the North Isles, dominated by the Orkney inter-island ferries which operate all-year round.

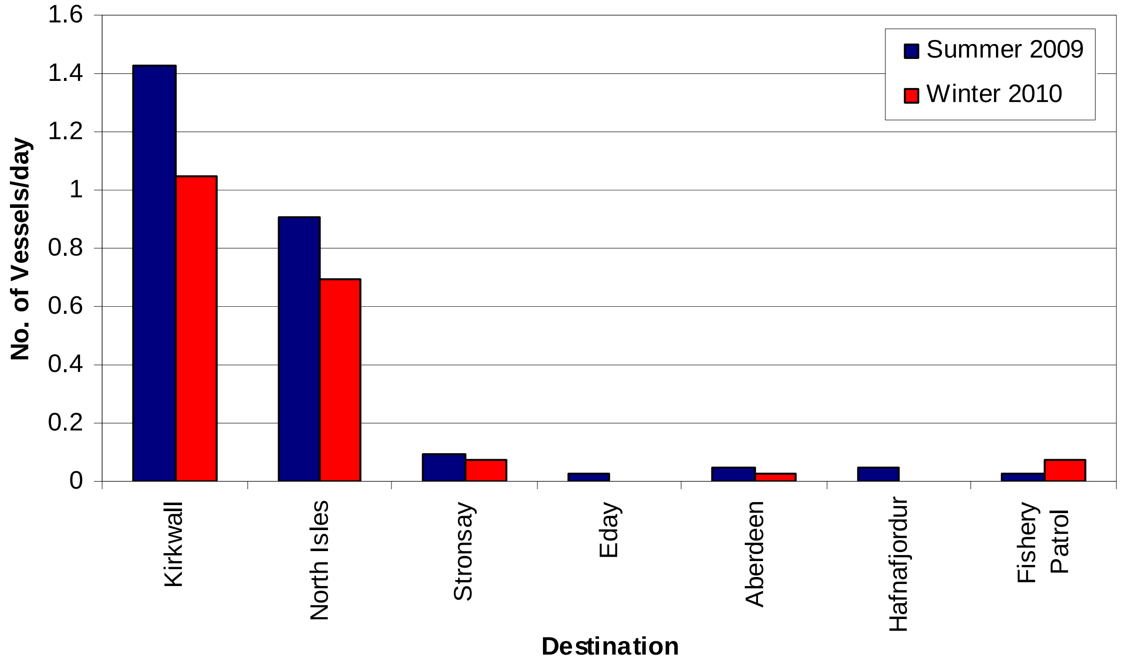

Figure 4.14 Main Destinations of Vessels passing within the FoW Lease Area

The speed distribution of vessels passing within the lease area is presented in Figure 4.15.

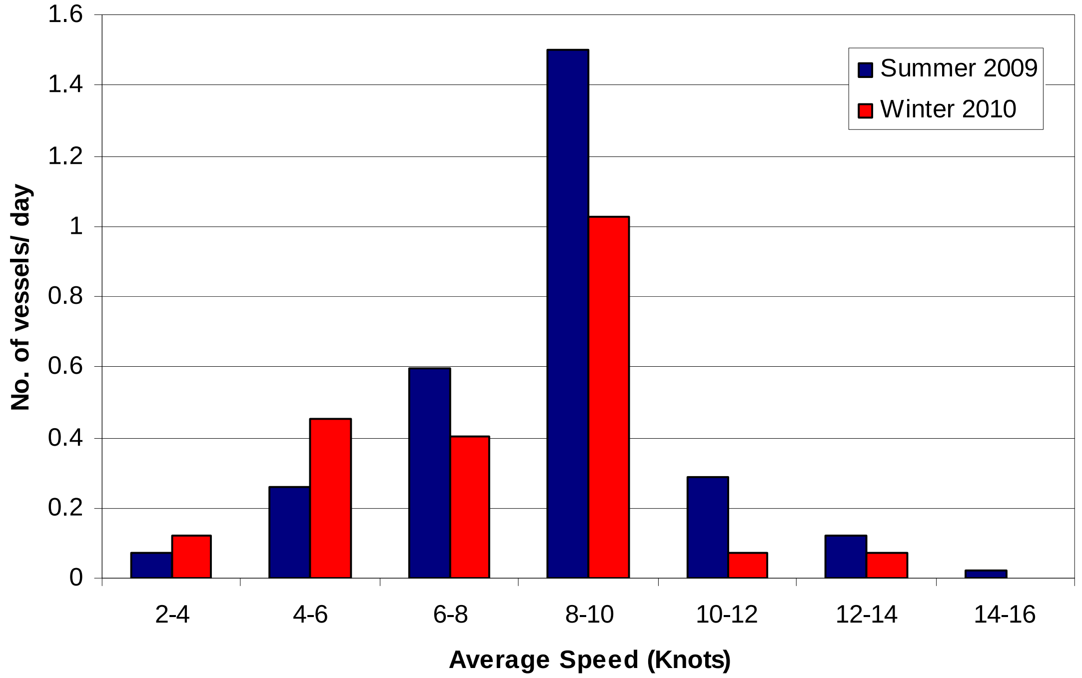

Figure 4.15 Speed Distribution of Vessels passing within the FoW Lease Area

The average speed of vessels passing within the lease area was 8.5 knots in summer and 7.6 knots in winter. The passenger cruise ships in summer are the main reason for the higher average speed.

4.3 AIS Analysis – Cable Berths

4.3.1 Traffic Overview

Detailed plots of the AIS tracks relative to the cable berths over the summer and winter periods are presented in Figure 4.16 and Figure 4.17 (excluding vessels associated with the FoW development).

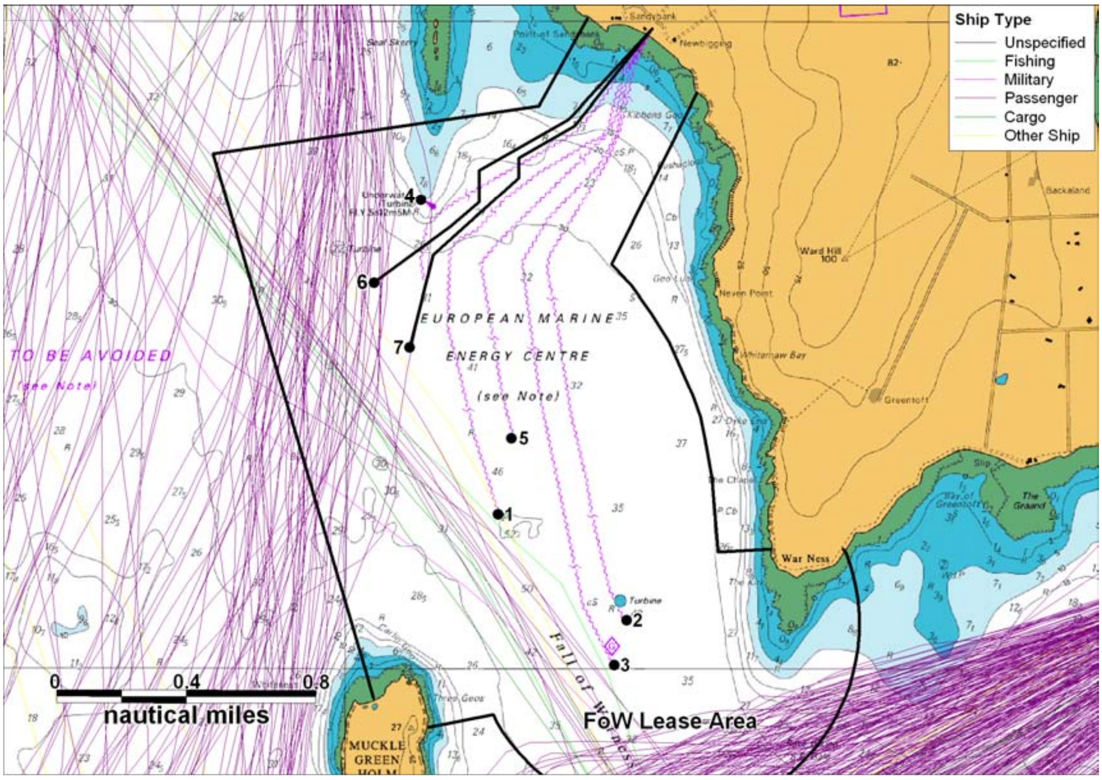

Figure 4.16 AIS Tracks relative to Cable Berths (Summer 2009)

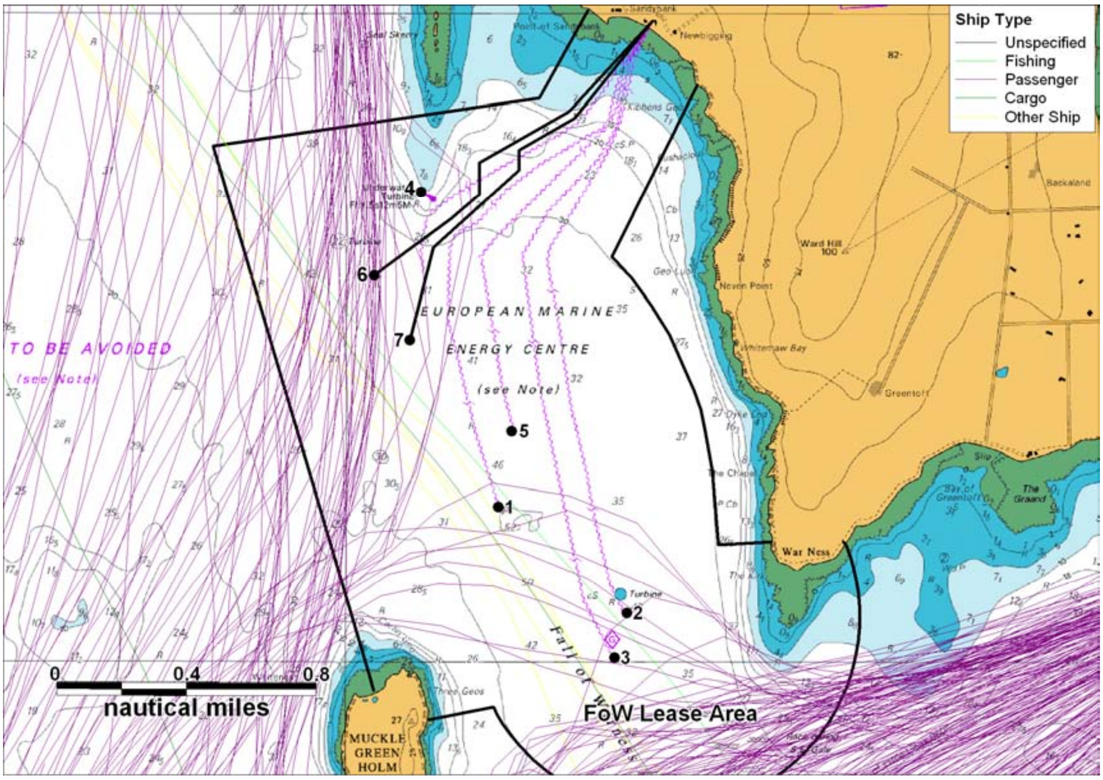

Figure 4.17 AIS Tracks relative to Cable Berths (Winter 2010)

All the cable berths have ships passing within 500 metres. Traffic can be divided into the following two main types:

- Inter-island Ferries
- NW-SE Transiting Traffic

A more detailed description of the two types of shipping traffic passing the cable berths is presented below.

4.3.2 Inter-Island Ferries

Cables berths 1, 2 & 3 are exposed to ferries operating between Kirkwall and Loth in Sanday when they transit north of Muckle Green Holm. This passage was used approximately 8 times during the six-week winter survey period but none in summer. Consultation with OIC Marine Services, including ferry representatives, highlighted that the routeing pattern varies between summer and winter. This winter route will have been chosen to reduce vessel motions in the prevailing wave and tidal conditions

Cable berths 4, 6 & 7 are exposed to ferries operating between Kirkwall and Rapness, Westray, particularly when the ferries are taking a more inshore route passing close to Eday, which tends to happen more frequently in winter. Three ferries were tracked passing east of the OpenHydro platform on Berth 4, two in winter and one in summer. The summer tracked passed very close to the platform (within approximately 60m).

Most ferries passed to the west of Berth 4. The introduction of Cables 6 and 7 will increase the potential interaction of these ferries with the site.

Details on the three inter-island ferries in the area (*Earl Thorfinn*, *Earl Sigurd* and *Varagen*) are listed in Table 4.1. Their draughts broadcast on AIS ranged from 2.9 to 3.2 metres.

4.3.3 NW-SE Transiting Traffic

During the summer and winter periods, several vessels were tracked on AIS heading NW-SE via the Fall of Warness, transiting between the Westray Firth and Stronsay Firth.

A plot of the combined tracks recorded during the 12 weeks is presented in Figure 4.18. It can be seen that the cable berths towards the outer (western) part of the site are most exposed to this traffic, in particular, the existing berths 1, 2 & 3 and to a lesser extent the new berths 6 & 7.

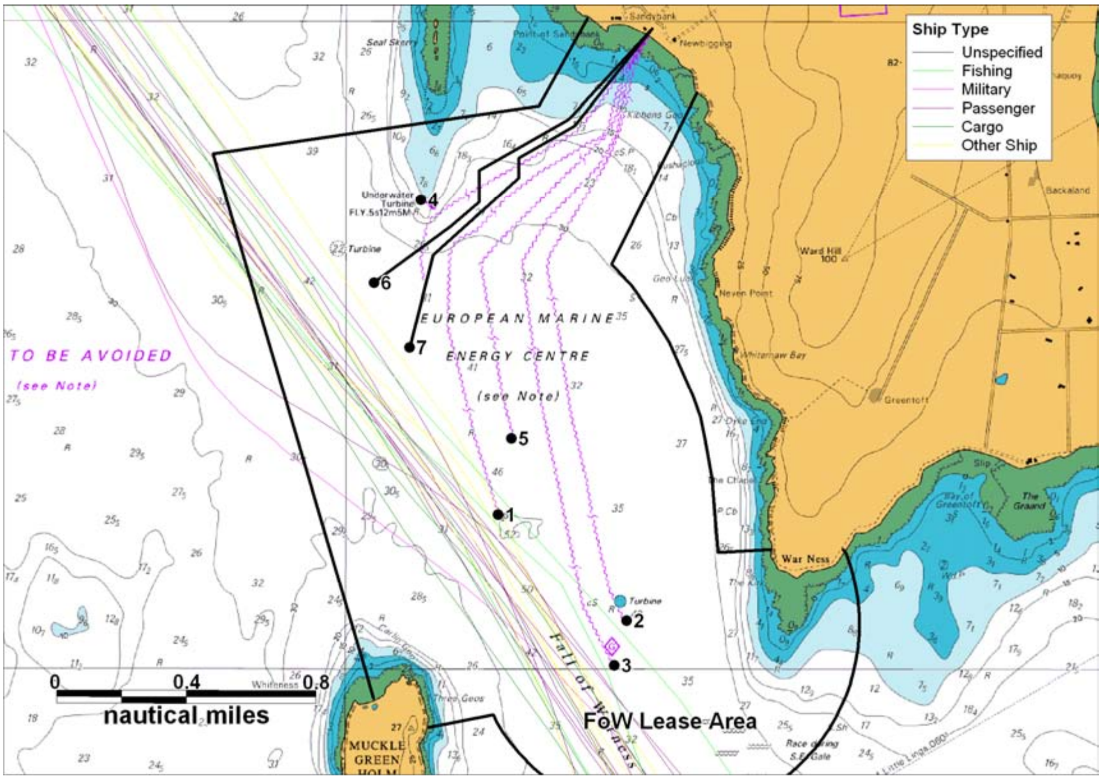

Figure 4.18 Tracks heading NW-SE via Fall of Warness (Summer & Winter)

A total of 23 transits were recorded over the 12 weeks, 17 in summer and 6 in winter. Details of the transiting vessels are provided in Table 4.2.

It can be seen the traffic includes some relatively deep-draught cruise ships and fishing vessels of 7m and above.

Table 4.2 List of Tracks Transiting NW-SE via Fall of Warness

Name	Type	Destination	Length (m)	Actual Draught (m)	Transits (12 Weeks)
Maersk Fetcher	Offshore Tug/Supply	Aberdeen – West of Shetland	82.5	5.0 - 5.7	4
Minna	Fisheries Patrol	Unspecified	47.7	4.0	3
Saga Rose	Passenger	Killybegs - Liverpool	188.9	8.3*	2
Astor	Passenger	Hafnarfjordur	176	6.2	2
National Geographic Explorer	Passenger	Kirkwall	108.6	5	2
Jura	Fisheries Patrol	Unspecified	84	5.6	1
Lord Nelson	Yacht	Kirkwall	52.2	4.1	1
Albatros	Passenger	Reykjavik	205	7.5	1
Marco Polo	Passenger	Heimaey	176	8.0	1
Pathway	Fishing	Unspecified	66.6	7.75*	1
Solstice	Stern Trawler	Rockall	24	Unknown	1
Discovery	Passenger	Kirkwall	168.7	7.5*	1
Sachsen	Military	Unknown	143	6.8	1
Norlantean II	Stern Trawler	Unknown	27.8	5.12*	1
Anglian Sovereign	Anchor Handling Tug Supply	Coastguard Patrol	67.4	6.6	1

* For these vessels the 'actual' draught broadcast on AIS were unspecified or in error, therefore, the design draughts of the vessels have been listed.

The NW-SE vessel type distribution during each survey period is presented below.

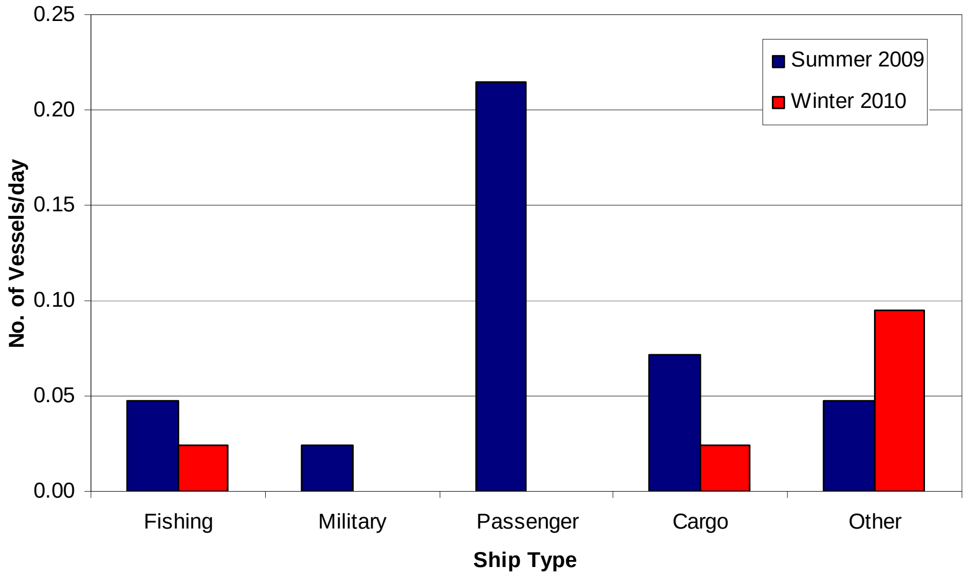

Figure 4.19 Vessel Type Distribution for NW-SE Transiting Tracks

The most common type of vessel was passenger cruise ships. These only transited during the summer period, with 9 transits in total (1.5 per week).

This figure is reasonably in-line with data available from OIC Marine Services for scheduled cruise ship visits in 2010. This indicates approximately 30 transits of the Fall of Warness are possible during the period between mid-April and mid-September, based on the stated departure and destination ports, e.g., vessels between Kirkwall and Iceland, Faroes or the Shetland Islands.

Miscellaneous types of vessels (cargo, military and other) made 10 transits in total over the 12 weeks (5 in summer, 5 in winter). AIS is believed to fully represent this traffic, therefore, the number of annual movements is estimated to be 40-50.

Fishing vessels made three transits in total (2 summer, 1 winter). However, only a small proportion of fishing vessels carry AIS and hence the tracking is not comprehensive. More information on fishing vessel activity at the site is presented in Section 5.

A single yacht was tracked on AIS. However, carriage of AIS is not mandatory onboard yachts hence the data are not comprehensive. More information on recreational vessel activity at the site is presented in Section 6.

4.4 Encounters

An assessment of ship-to-ship encounters has been carried out by replaying at high-speed one week of the AIS data collected in June 2009. The following figure presents the tracks of vessels during encounters within 5nm of the lease area, where an encounter has been defined as vessels passing within 1nm of each other.

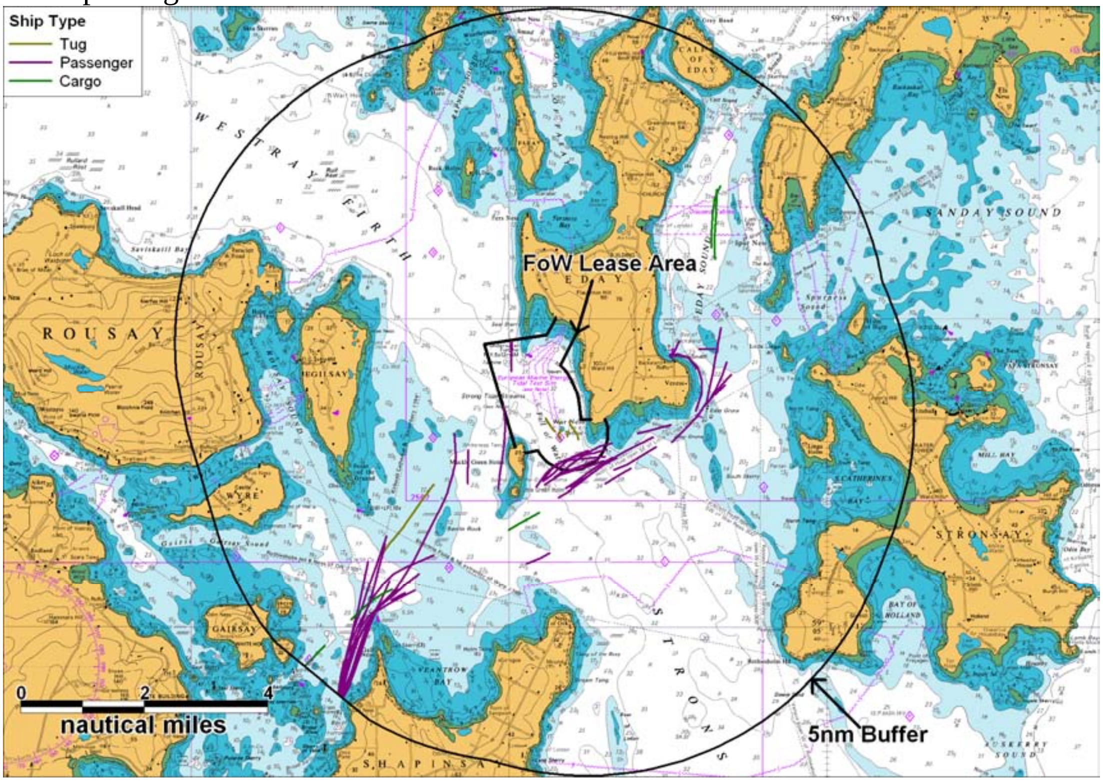

Figure 4.20 Encounter Tracks by Type within 5nnm of Lease Area

It can be seen that there were a number of encounters in and around the lease area. These were mainly ferries encountering vessels working within the FoW site. Overall, it may be concluded that the area is not busy in terms of shipping traffic.

4.5 Additional Data

The 12 weeks of seasonally weighted AIS data is considered to be representative of the shipping activity at Fall of Warness.

Consultation with OIC Marine Services, including ferry representatives, highlighted the importance of assessing both summer and winter ferry routeing, which has been done and identified different routeing patterns.

The cruise ship visit information for 2010 available from OIC Marine Services indicated that the number of movement of cruise ships during the summer AIS survey was representative and in-line with expectations.

A review of the watchkeeper logs at Eday collected between 2005 and 2009 indicated no other significant shipping activity in the vicinity of the site. (These logs are described in more detail in the next section.)

5. Fishing Vessel Activity Analysis

5.1 Introduction

This section reviews the fishing vessel activity at the Fall of Warness tidal site. Section 5.2 presents the latest available surveillance data (sightings and satellite). However, this information is not comprehensive for the fishing activity at the site, especially smaller, near-shore vessels. Therefore, additional information is presented in Section 5.3 based on vessel monitoring from Eday, local consultation with fisheries stakeholders and AIS tracking.

5.2 Surveillance Data

5.2.1 Overview of Statistics

Fisheries statistics in the UK are reported by ICES statistical Rectangles and Subsquares. The Fall of Warness lease area is located within ICES Subsquare 47E7/3, as shown in Figure 5.1. The four closest Subsquares have been analysed as part of the baseline fishing assessment.

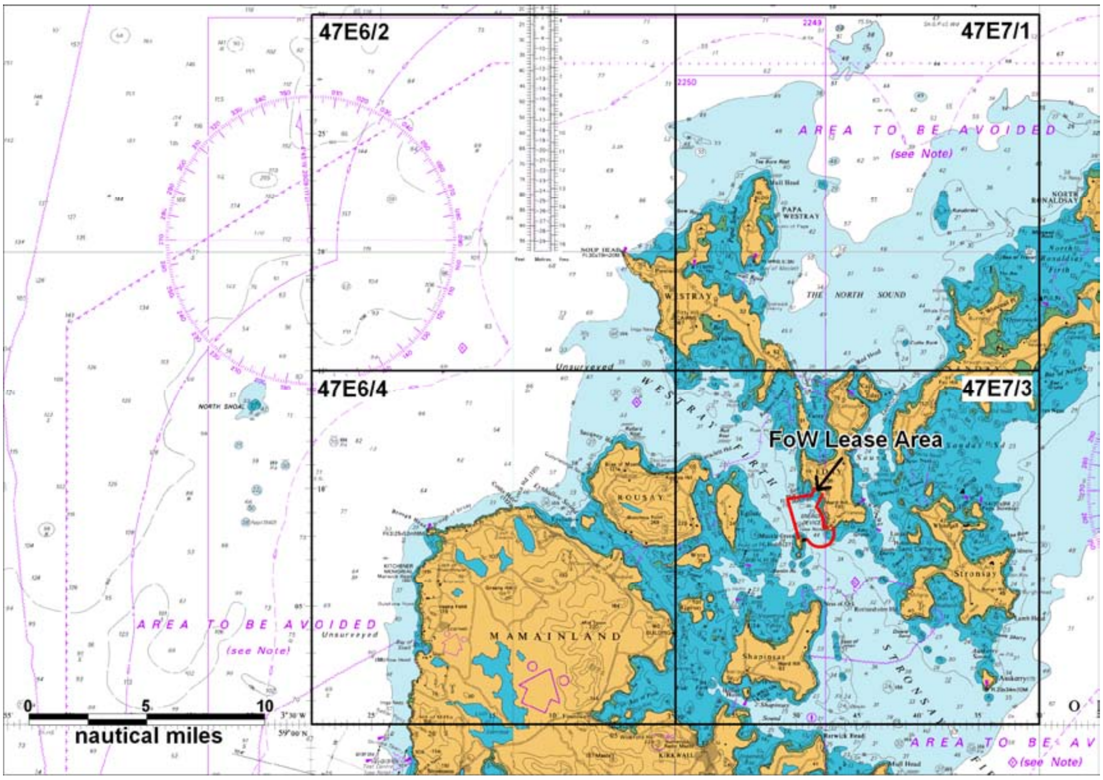

Figure 5.1 ICES Subsquares encompassing the FoW Lease Area

Sightings data were analysed for the five-year period 2005-09. This data is collected through the deployment of patrol vessels, surveillance aircraft and the sea fisheries inspectorate. Each patrol logs the positions and details of fishing vessels within the area being patrolled. All vessels are logged, irrespective of size, provided they can be identified by their Port Letter Number (PLN). This is not always possible for small, inshore vessels and hence these may be under-represented in the data. Analysis of the sightings data is presented in Section 5.2.2.

Satellite data records the positions of fishing vessels of 15m length and over every two hours. Data has been analysed for 2006 (all nationalities) and 2008 (UK only), which at the time of writing are the latest available. Analysis of the satellite tracking data is presented in Section 5.2.3.

5.2.2 Sightings Analysis

The numbers of fishing vessel sightings, surveillance patrols and hence average sightings per patrol within each ICES Subsquare surrounding the lease area in the five-year period 2005-09 are presented in Table 5.1 and Figure 5.2.

Table 5.1 Average Sightings per Patrol (2005-09)

ICES Subsquare	Sightings	Patrols	Sightings per Patrol
47E6/2	223	530	0.42
47E6/4	74	519	0.14
47E7/1	79	355	0.22
47E7/3	39	341	0.11

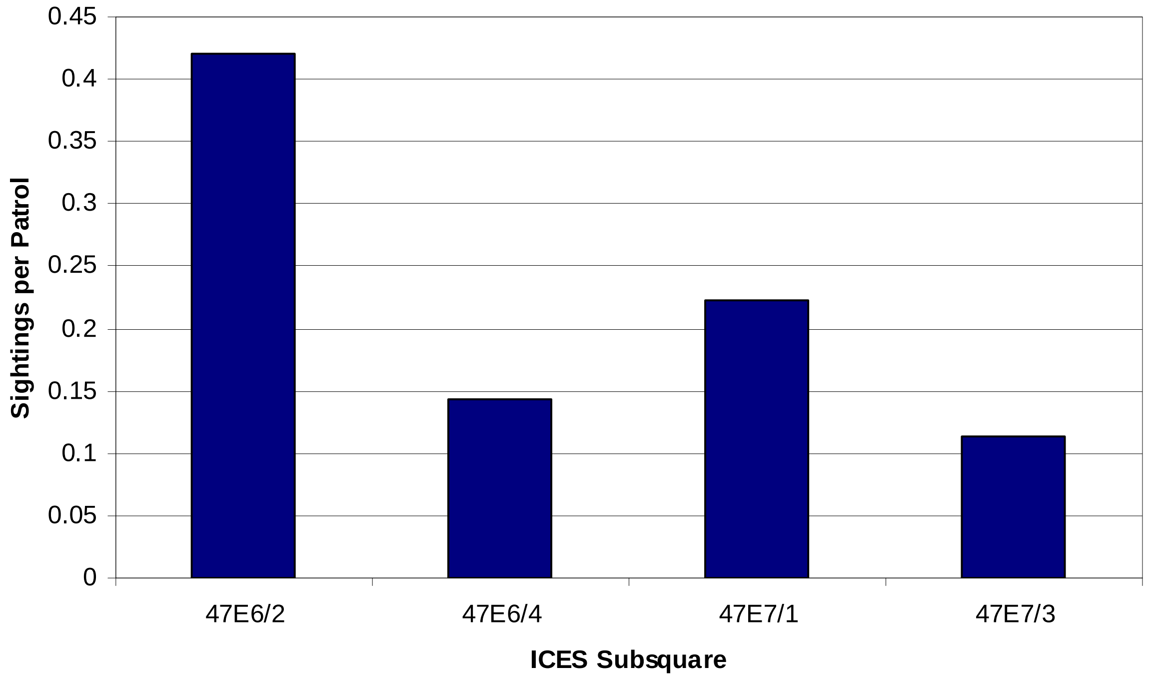

Figure 5.2 Average Fishing Vessel Sightings per Surveillance Patrol (2005-09)

Subsquare 47E6/2 had the highest average sightings per patrol at 0.44 vessels. Subsquare 47E7/3, which contains the FoW lease area, had the lowest activity at 0.11 (approximately one vessel per nine patrols).

A plot of the vessel sighting locations colour-coded by nationality is presented in Figure 5.3. When viewing the figure it should be noted that the number of patrols varied per Subsquare.

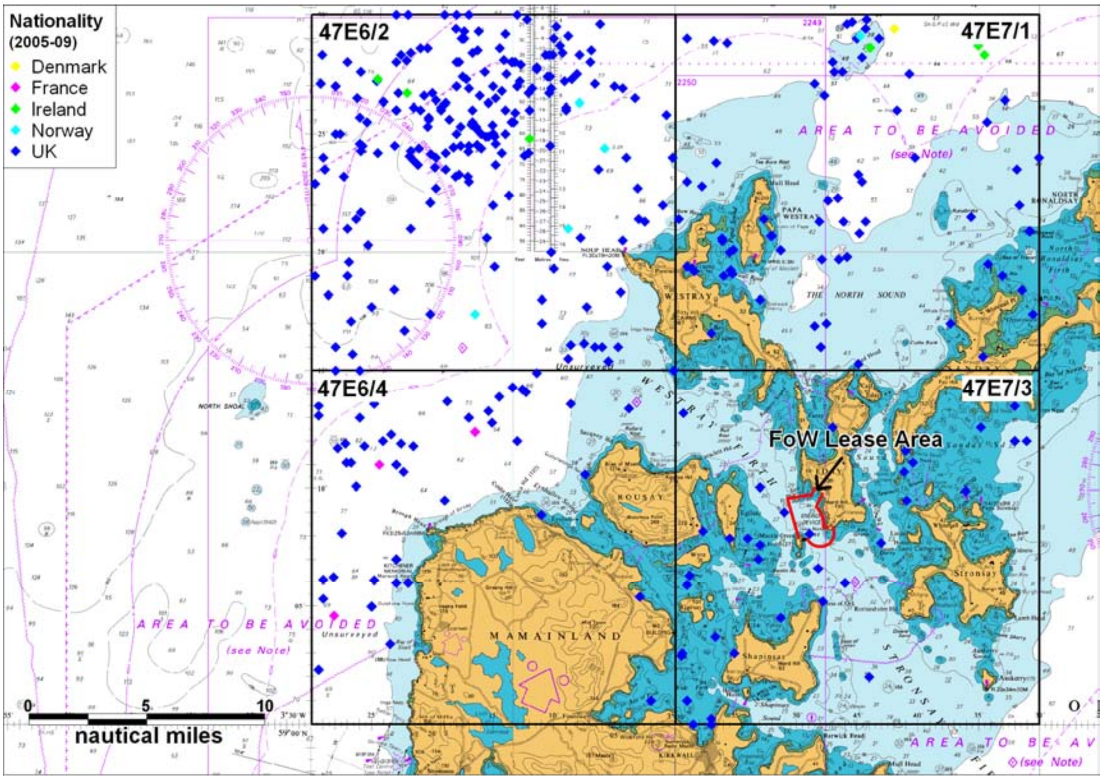

Figure 5.3 Fishing Vessel Sightings by Nationality (2005–09)

The vast majority of fishing vessels sighted were UK registered (95%) including the one vessel sighted within the FoW lease area, and all vessels within Subsquare 47E7/3 containing the lease area.

The fishing vessel sightings colour-coded by gear type are presented in Figure 5.4.

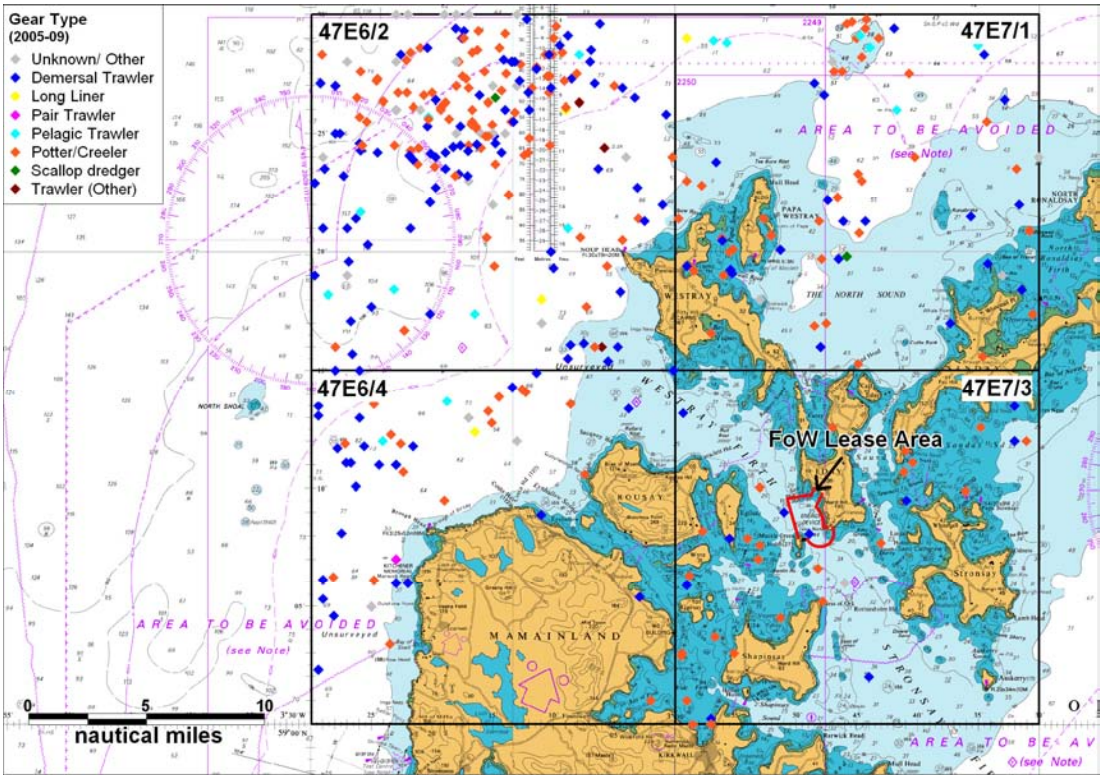

Figure 5.4 Fishing Vessel Sightings by Gear Types

The overall breakdown by gear type and the distribution per ICES Subsquare are presented in Figure 5.5 and Figure 5.6 respectively.

The most common gear type was potter/creeler, accounting for 48% of all sightings and 66% within Subsquare 47E7/3 containing the lease area. Demersal trawlers were the next most common type.

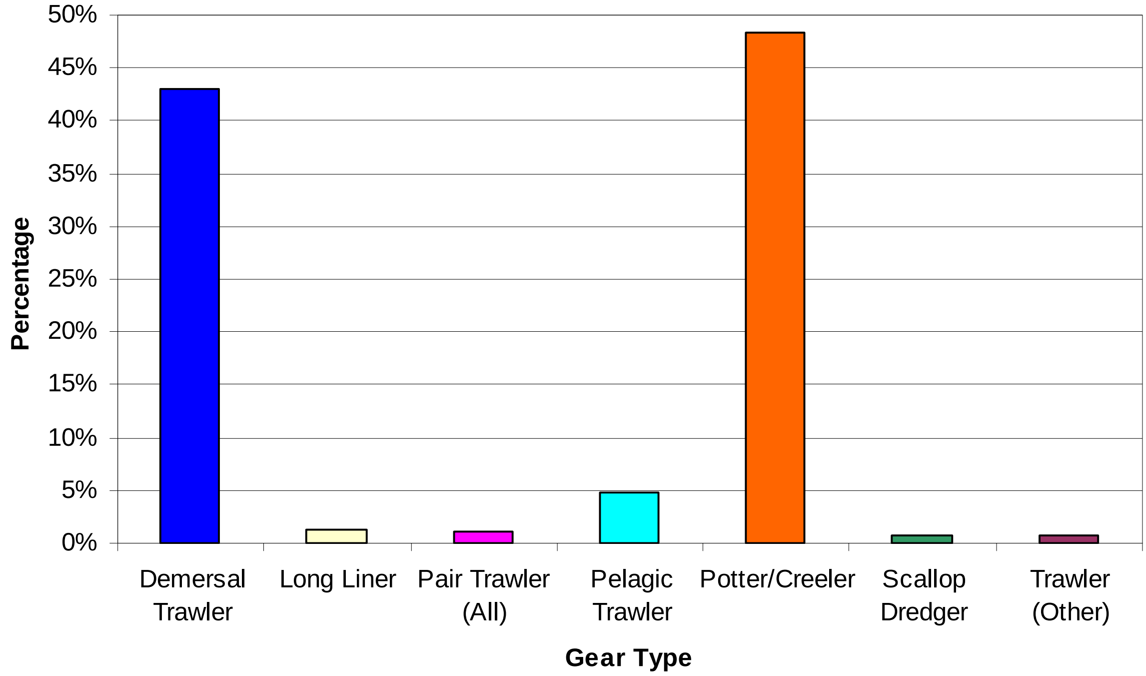

Figure 5.5 All Sightings Distributed by Gear Type

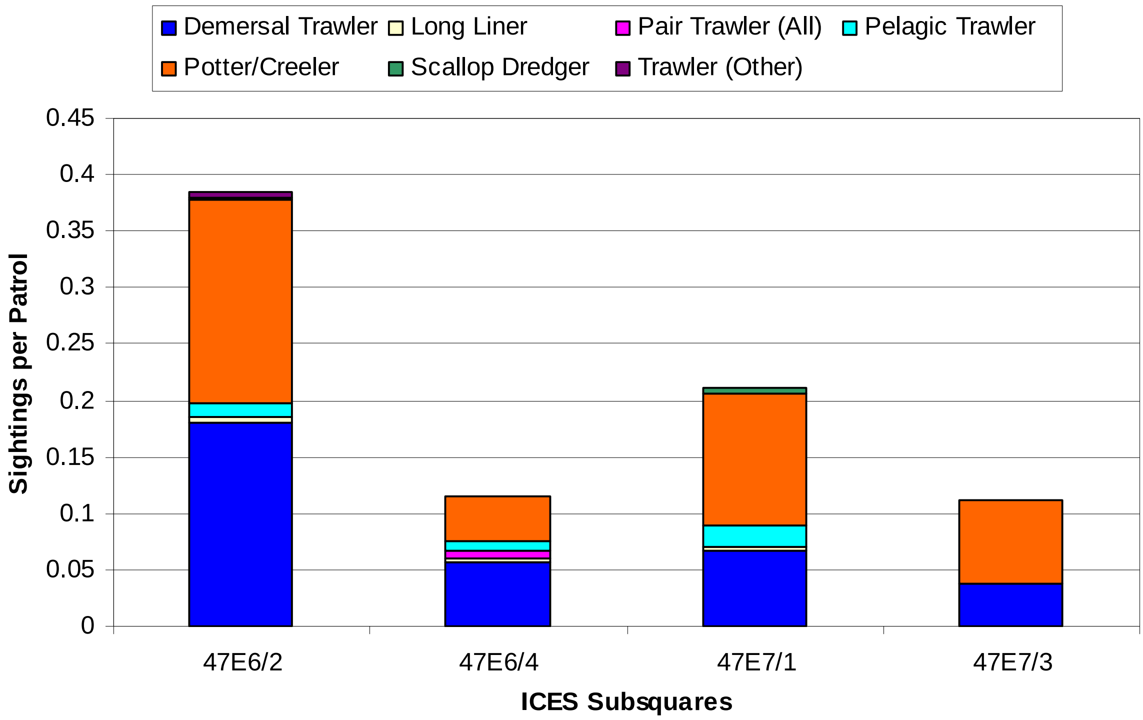

Figure 5.6 Gear Type Distribution per ICES Subsquare

The fishing vessels colour-coded by activity when sighted are presented in Figure 5.7.

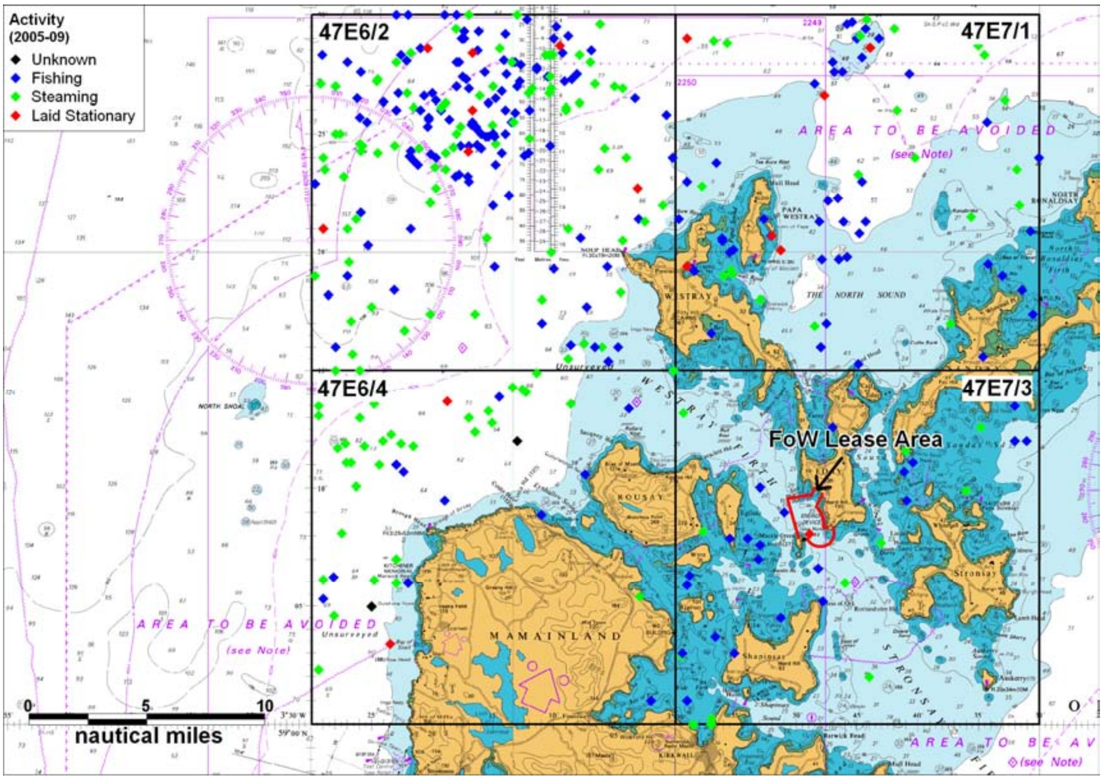

Figure 5.7 Fishing Vessel Sightings by Activity

52% of identified vessels sighted were engaged in fishing, i.e., gear deployed, 42% were steaming (transiting to/from fishing grounds) and 5% were laid stationary (vessels at anchor or pair vessels whose partner vessel is taking the catch whilst the other stands by).

Within Subsquare 47E7/3 containing the lease area, 63% of the vessels sighted were engaged in fishing, 34% were steaming and 3% were laid stationary.

5.2.3 Satellite Data Analysis

Satellite data covers fishing vessels of 15m length and over. The 2006 data are the latest available which includes UK and foreign vessels of 15m length and over. Figure 5.8 confirms that the majority of vessels operating in the FoW area are UK-registered.

There were 21 positions recorded within the FoW lease area made by 17 unique vessels. Speeds indicate these vessels were transiting through the area.

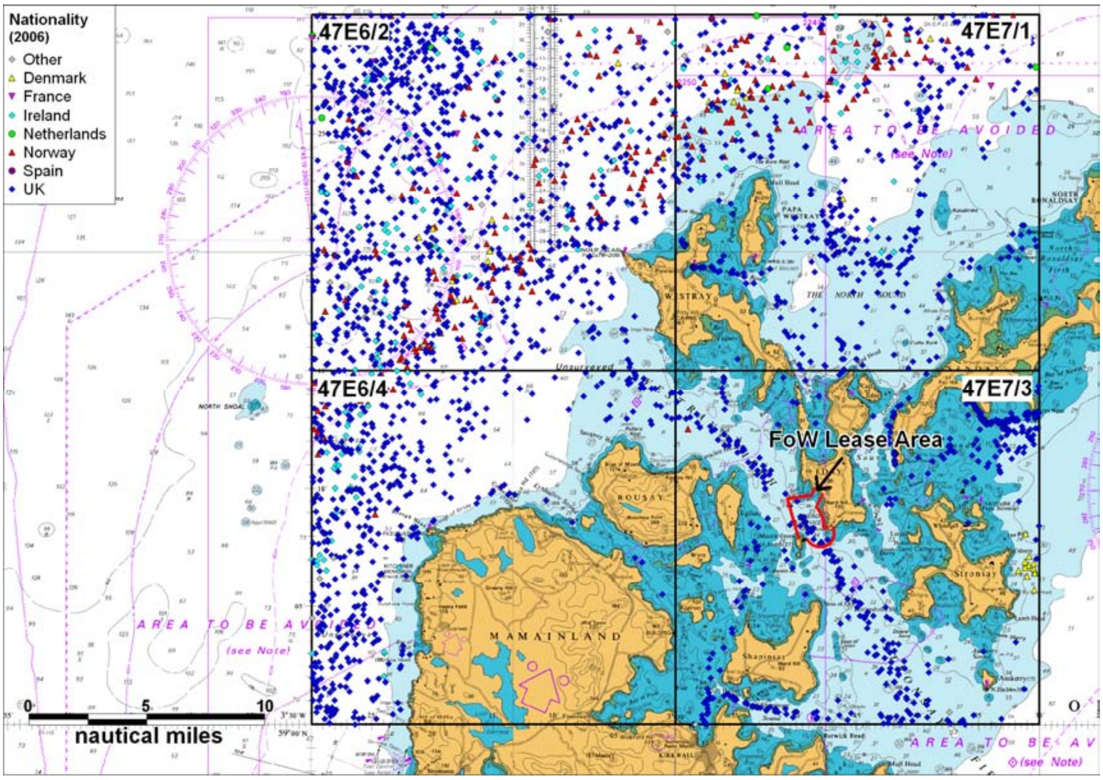

Figure 5.8 Chart of Satellite Fishing Vessel Positions by Nationality (2006)

The latest available satellite data for UK vessels are from 2008. The fishing vessel satellite positions recorded in 2008, colour-coded by vessel type (where available), is presented in Figure 5.9.

The gear type of the vast majority of the vessels logged was not specified. The small proportion that were logged were creelers, gill netters or otter trawlers.

There was significant fishing vessel activity at the Fall of Warness site during 2008. However, discussions with EMEC and the SFPA identified that this was from fishing vessels (*Shalimar* and *Radiance*) employed to work as guard vessels on the site, rather than on passage or engaged in fishing.

Excluding this site activity, the fishing vessels recorded by satellite were mainly transiting NW-SE between the Westray Firth and Stronsay Firth via the Fall of Warness, similar to the 2006 pattern.

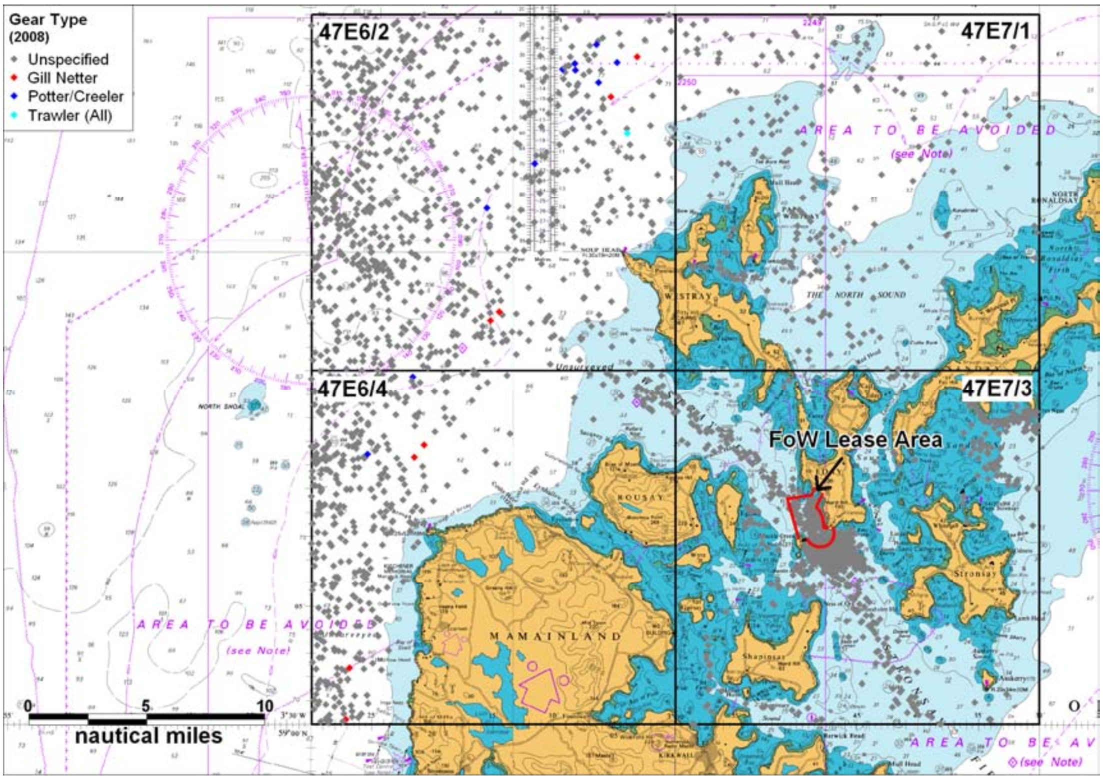

Figure 5.9 Chart of UK Fishing Vessel Satellite Positions by Type (2008)

5.3 Additional Information

The surveillance data is not comprehensive for the FoW area due to its inshore location and its use by small, local vessels. Therefore, additional information has been obtained from the AIS survey, vessel logs during watchkeeping on Eday and consultation with the following:

- Orkney Fisheries Association (OFA)
- Scottish Fisheries Protection Agency (SFPA)
- Orkney Fishermen’s Society
- Orkney Creel Fishermen’s Association
- Scottish Pelagic Fishermen’s Association (SPFA)
- Scottish Fishermen’s Federation (SFF)
- Marine Laboratory, Aberdeen
- Local Fishermen

The AIS tracking identified three transits by fishing vessels in 12 weeks. A plot of these tracks is presented in Figure 5.10. At present, AIS is only mandatory for fishing vessels of 45m overall length and above, although a proportion of fishing vessels carry it voluntarily (two of the three vessels tracked in the survey were below 45m, see Table 4.2).

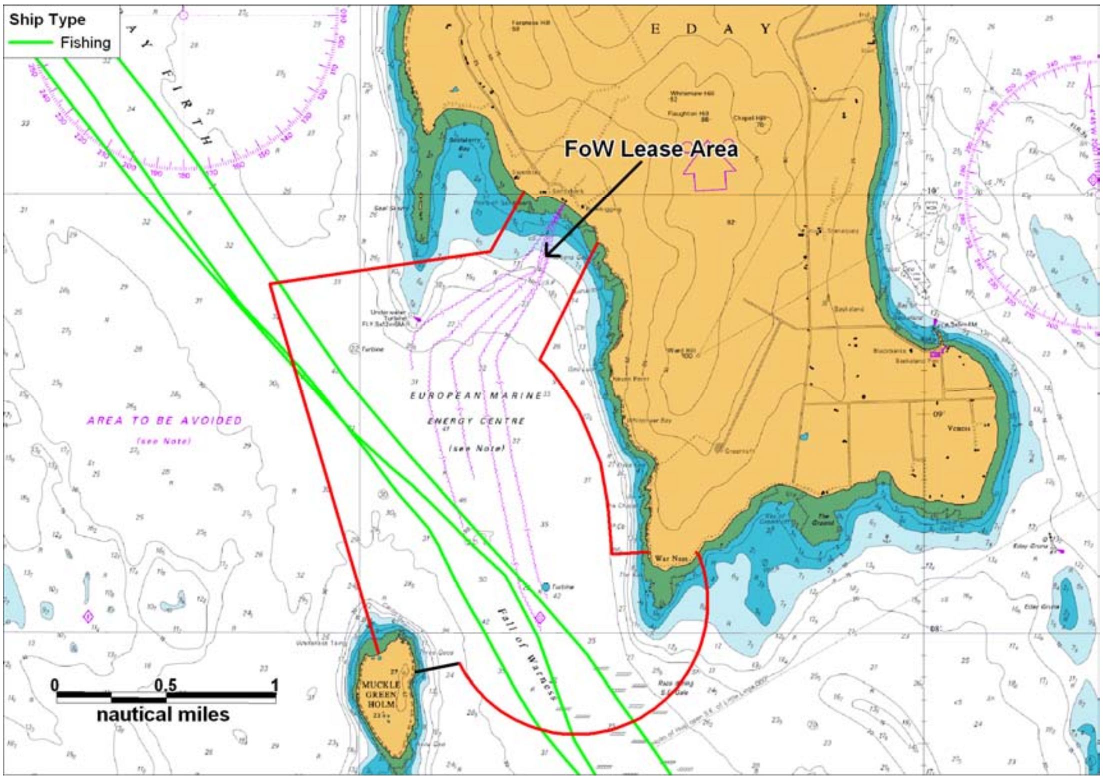

Figure 5.10 Fishing Vessels recorded on AIS (12 weeks)

The AIS activity is similar to that of the larger vessels being tracked by satellite (see Section 5.2.3). Consultation with the SPFA and the OFA indicated that the Fall of Warness is a transit route for pelagic trawlers en route to and from fishing grounds, e.g., West of Shetland. The vessel draughts vary but when fully loaded (typically when heading home from the fishing grounds transiting SE through the channel) some vessels can be as deep as 8.2m.

Fishing patterns and hence usage of the channel varies significantly depending upon the movement of shoals but it was estimated by SPFA that there would be less than 20 passages per year.

A visual log of vessel activity at FoW is maintained by a local resident on Eday employed by EMEC for 20 hours per week (5 x 4 hour blocks). The log is carried out during daylight hours (times vary) with vessels identified using binoculars and a telescope from a vantage point set slightly back from the cliff's edge overlooking the site. Although this data represents only a fraction of the week (approximately 12%) it has been carried out since summer 2005 and provides a substantial data set.

Based on the four full years of logs between 2006 and 2009 (approximately 4,000 hours), a total of 44 fishing vessels were identified transiting NW or SE between the Westray Firth and Stronsay Firth via Fall of Warness, including several vessels within the SPFA. This corresponds to an estimated 92 vessels per year taking into account watchkeeping time. This higher number of annual movements, including all transiting fishing vessels, is considered to be the best-estimate.

Details of a cross-section of fishing vessels logged on the NW-SE route by the Eday watchkeeper, and/or members of the SPFA which potentially use the route, are presented in Table 5.2.

Table 5.2 Fishing Vessels Heading NW or SE via Fall of Warness

Name	PLN	Length (m)	GRT	Draught (m)
Genesis	BF 505	27.47	362	3.26
Pathway	PD 165	66.6	2,194	7.75
Deeside	BCK 595	24.35	216	3.96
Prowess	CY 720	60.2	1,332	6.4
Unity	FR 165	44.9	814	4.1
Valhalla	FR 268	18.6	131	3.5
Morning Dawn	PD 359	44.98	565	3.83
Charisma	LK 362	70.7	2,424	8.2

As well as transiting fishing vessels, consultation with fisherman and fisheries associations during preparation of this update and the previous NRA, indicated that creeling takes place off Eday. This tends mainly to be close inshore within the 15 metre contour, with occasional deployment out to 30 metres.

The EMEC vessel monitoring logs from Eday were reviewed to assess the level of creeling activity. Over the four-year period 2006-09 representing approximately four thousand hours of observations, 610 records were made of 28 different creelers.

Vessels are logged when initially sighted and again each hour when they are in the area. This suggests an average of approximately 3 hours of creeling during the 20 hours of watchkeeping per week.

The number of unique creelers observed during each four-hour period is presented in Figure 5.11. There was one watchkeeping period in which four different vessels were sighted and eight in which three vessels were sighted, out of an estimated 1,000 periods. In over two-thirds of periods, no creelers were sighted.

It is noted the watchkeeping only takes place in daylight when creeling activity would be expected to be highest.

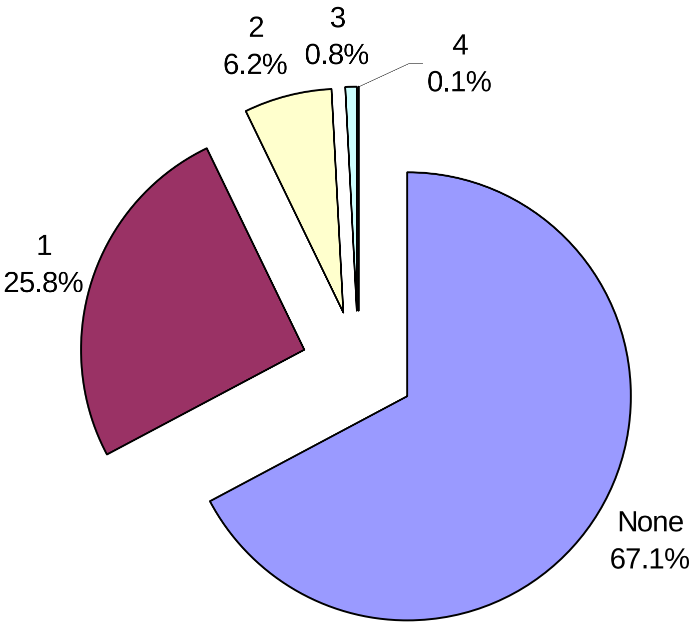

Figure 5.11 Numbers of Different Creelers observed per Period(2006-09)

The majority of creelers were observed to be operating in Sealskerry Bay on the west coast of Eday. Transiting vessels were mostly hugging the Eday coast heading to and from Sealskerry Bay. A minority of creeling activity was logged close to the east coast of Muckle Green Holm.

Details of a selection of creelers identified to be regularly operating off Eday in the past four years are presented in Table 5.3. The vessels tend to be small craft of typically less than 12 metres in length and draughts below 3m. From consultation it is understood the larger local vessels tend to fish further offshore. Draughts of the larger vessels are up to about 3m.

Table 5.3 Selection of Creelers operating off Eday near the FoW

Name	PLN	Length (m)	GRT
Lady K	K1	9.13	4.9
Serene	K65	9.89	11.8
Merdina II	K20	10.55	5.1
Queline	K1138	11.9	20.1
Crystal Sea	K18	7.93	4.6

The monthly distribution of creeler sightings between 2006 and 2009 is presented in Figure 5.12.

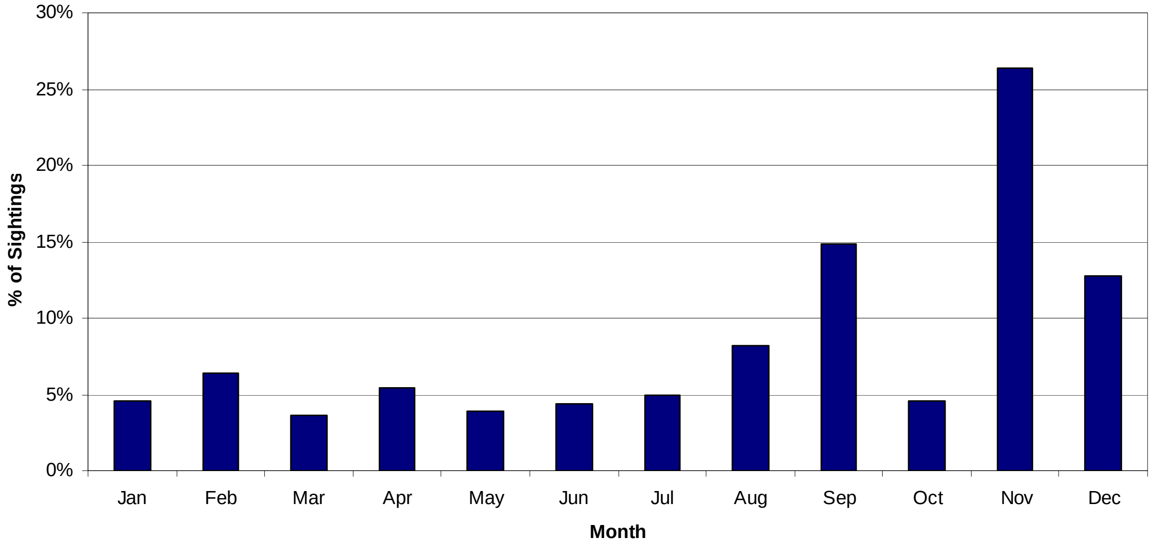

Figure 5.12 Monthly Distribution of Creeler Sightings

This pattern was verified during consultation with local stakeholders which suggested the market is highest towards the end of the year (run up to Christmas and New Year) and continues into the start of the New Year. In better weather (summer) vessels tend to fish further offshore, e.g., west of Westray.

The watchkeeper logs also identified limited diving activity for shellfish near the Eday shore in the second half of 2009. This was mainly by the *Millennium* PE1088, length 8.88m, 3.92 tonnes (home port South Ronaldsay).

6. Recreational Vessel Activity Analysis

6.1 Introduction

This section reviews recreational vessel activity at the Fall of Warness site based on information published by the Royal Yachting Association (RYA), vessel monitoring from Eday and consultation with local stakeholders.

6.2 RYA Coastal Atlas

Historically there has not been a database of recreational use of the UK's marine environment. As a response to the lack of information, the RYA, supported by the Cruising Association (CA), started to identify recreational cruising routes, general sailing and racing areas. This work was based on extensive consultation and qualitative data collection from RYA and Cruising Association members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. The consultation was also sent to berth holder associations and marinas.

The results of this work were initially published in Sharing The Wind (Ref. viii) and updated in the Coastal Atlas (Ref. ix).

The reports note that recreational boating, both under sail and power is highly seasonal and highly diurnal. The division of recreational craft routes into Heavy, Medium and Light Use is therefore based on the following classification:

- Heavy Recreational Routes: - Very popular routes on which a minimum of six or more recreational vessels will probably be seen at all times during summer daylight hours. These also include the entrances to harbours, anchorages and places of refuge.
- Medium Recreational Routes: - Popular routes on which some recreational craft will be seen at most times during summer daylight hours.
- Light Recreational Routes: - Routes known to be in common use but which do not qualify for medium or heavy classification.

Summary plots of the recreational sailing activity and facilities in North East Scotland are presented in Figure 6.1 and Figure 6.2. This is based on data from the Coastal Atlas (Ref. ix).

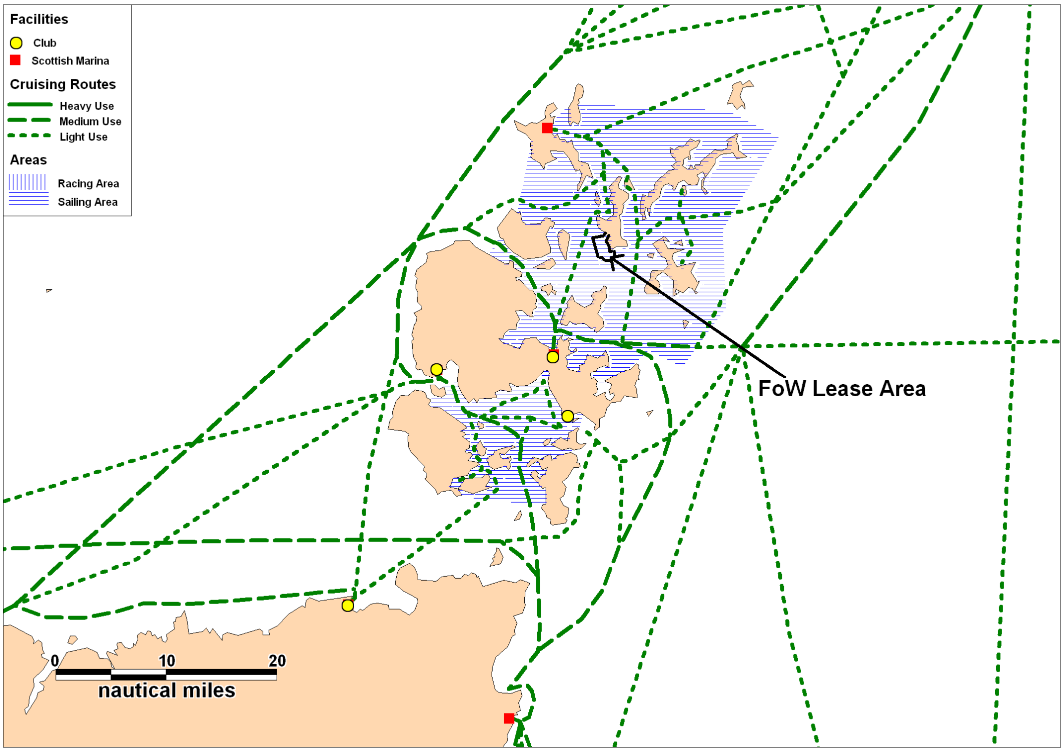

Figure 6.1 Recreational Information for NE Scotland

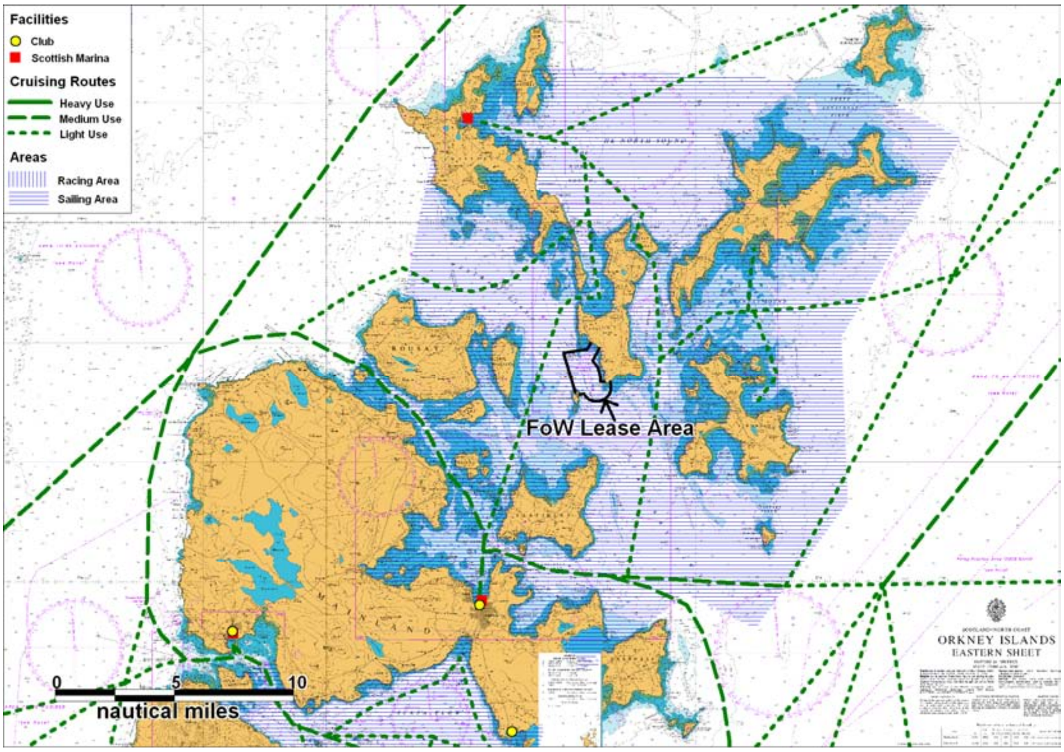

Figure 6.2 Recreational Information for Fall of Warness Tidal Site

Based on the RYA published data, it can be seen that the lease area is located within the general sailing area around Orkney. There are no cruising routes passing through the Fall of Warness. There are two light-use cruising routes passing to the east and west as follows:

- Route passing east of Eday (2nm from FoW lease area) transiting between Kirkwall and islands to the north (e.g., Sanday, Stronsay and Westray) via Eday Sound.

- Route passing west of Muckle Green Holm (0.7nm from FoW lease area) transiting between Kirkwall and Westray via the Sound of Faray.

It should be noted that the cruising routes are indicative and can vary with weather and sea conditions.

6.3 Marinas and Clubs

In terms of facilities, there are three marinas and three clubs for recreational vessels located in the Orkney Islands. The nearest club is the Orkney Sailing Club based in Kirkwall.

Details of the three marinas on Orkney are provided below:

1. Kirkwall Marina is located at a distance of 10nm southwest of the lease area. It is a 95 berth marina within the harbour and is accessible at all states of tide, all year facility and excellent shelter. It allows a maximum draught of 2.7m and maximum boat length of 29m.

2. Stromness Marina is located at a distance of 17.6nm southwest of the lease area. It is a 64 berth marina within the harbour. It allows a maximum draught of 2.0m and maximum boat length of 20m.

3. Westray Marina is at a distance of 10.7nm northwest of the lease area. It allows a maximum draught of 3.0m and maximum boat length of 20m.

Recent visitor information for all three marinas in 2008-2009 obtained during consultation is presented below.

Table 6.1 Visitor Information for Orkney Marinas (2008-09)

Visitor Information	2008	2009
Total Tickets Issued	549	586
Total Number on board	1551	1784
Number of Boat Nights	7878	11086

Visitor Information	2008	2009
14-28 Day tickets Purchased	43	101
6 Month Tickets Purchased	15	19

There are also 119 local and other boats tied up to the piers at various parts of the island (based on consultation with local Cruising Association and RYA representatives).

A breakdown of the marinas visitor data by nationality is presented in Figure 6.3.

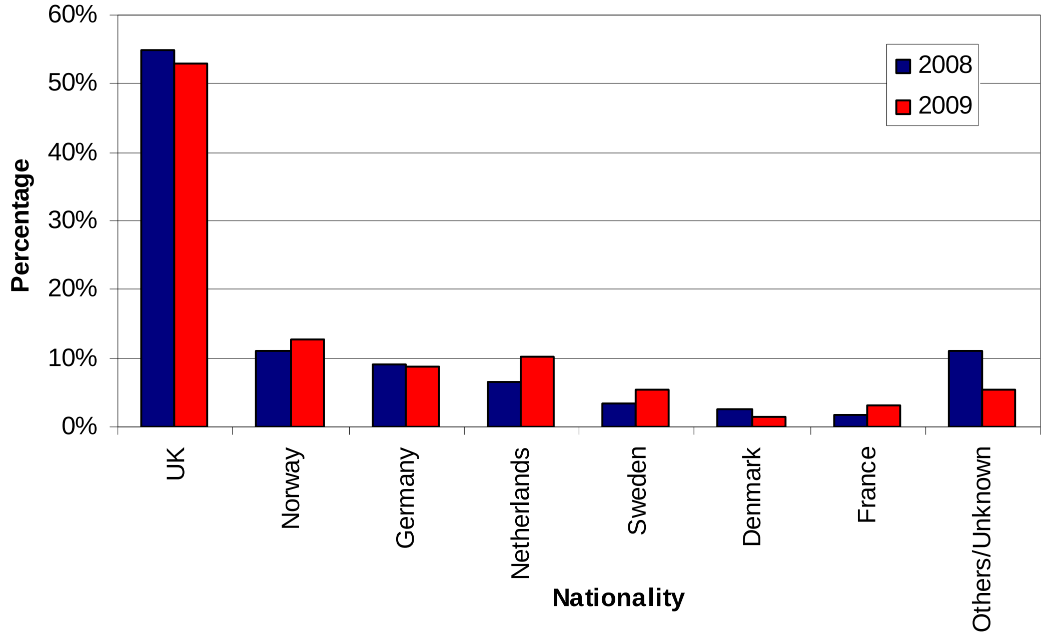

Figure 6.3 Nationality Breakdown for Three Orkney Marinas

The majority of recreational visitors were from the UK followed by Norway, Germany and Netherlands.

It can be seen that there was an increase in visitors from 2008 to 2009. Based on consultation, the trend in recreational vessel activity around the Orkney Islands is generally upwards. However, plans to establish a new marina at Stronsay are currently on hold.

6.4 Additional Data

Consultation with recreational stakeholders during the project confirmed that the Fall of Warness area is not popular with recreational users due to the strong tides. This was confirmed by reference to nautical almanacs and sailing directions, which recommended small recreational vessels avoid the area in general.

Only one yacht was observed on AIS over the 12 weeks transiting the area NW-SE (*Lord Nelson*, 52.2m long, 4.1m draught). However, AIS carriage is not mandatory for recreational vessels.

A small number of recreational craft (13 in total) were logged transiting the Fall of Warness during watchkeeping from Eday in the four-years between 2006 and 2009 (approximately 1,000 watchkeeping periods). Details are as follows:

- 2 Yachts
- 11 Pleasure Boats / Cruisers (mainly speed boats)

Two of the vessels identified by name are available for charter for leisure angling (*Charles Ann*) and wildlife tours (*Nicky Tam*). Each has only been logged on one day over the four years.

It is likely these types of small vessels using the area will only be doing so in favourable conditions, i.e., daylight, good weather and low sea state.

Consultation with the Orkney Dive Boat Operators' Association (ODBOA) identified no issues with the FoW site. These dive boats, which are hired by tourists for diving trips and occasionally angling, do not tend to pass through the Fall of Warness. They mainly keep to the west or east, similar to the cruising routes shown in Figure 6.2.

Consultation with kayaker organisations and Orkney Surf Club identified no activity near the Fall of Warness site.

7. Historical Incidents

7.1 Introduction

This section reviews maritime incidents that have occurred in the vicinity of the Fall of Warness lease area in recent years.

The incident analysis is intended to provide a general indication as to whether the area of the development is currently low or high risk area in terms of maritime incidents.

Data from the following sources has been analysed:

- Marine Accident Investigation Branch (MAIB)
- Royal National Lifeboat Institution (RNLI)

(It is noted that the same incident may be recorded by both sources.)

Information from EMEC on incidents that have occurred at the site since development started in 2006 is also presented.

7.2 MAIB

All UK-flagged commercial vessels are required to report accidents to MAIB. Non-UK flagged vessels do not have to report unless they are within a UK port/harbour or within UK 12 mile territorial waters and carrying passengers to or from a UK port (including those in inland waterways). There are no requirements for non-commercial recreational craft to report accidents to MAIB. However, the MAIB will record details of significant accidents of which they are notified by bodies such as the Coastguard, or by monitoring news and other information sources for relevant accidents. The Maritime and Coastguard Agency, harbour authorities and inland waterway authorities also have a duty to report accidents to MAIB.

The locations[1] of accidents, injuries and hazardous incidents reported to MAIB within 5nm of the lease area between January 1994 and 8th March 2010 are presented in Figure 7.1, colour-coded by type.

[1] MAIB aim for 97% accuracy in reporting the locations of incidents.

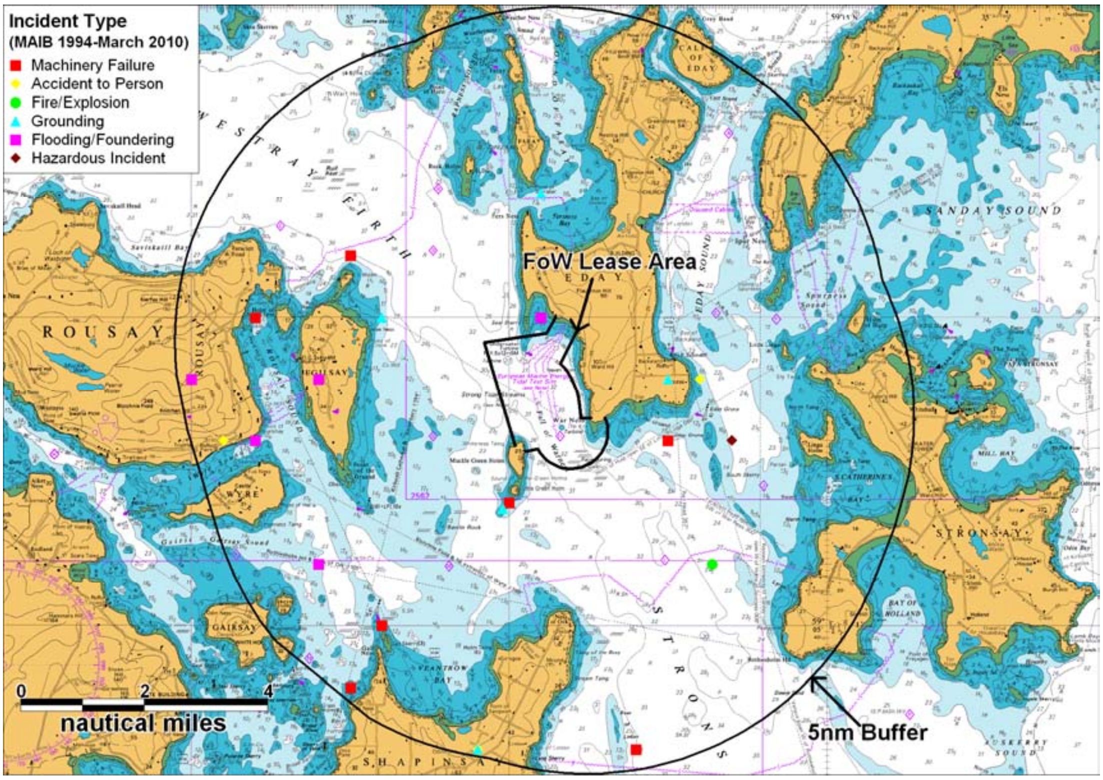

Figure 7.1 MAIB Incident Locations by Type within 5nm of Lease Area

A total of 27 incidents were reported within 5nm of the lease area, corresponding to an average of 1-2 per year.

The overall distribution by incident type and year is presented in Figure 7.2 and Figure 7.3, respectively.

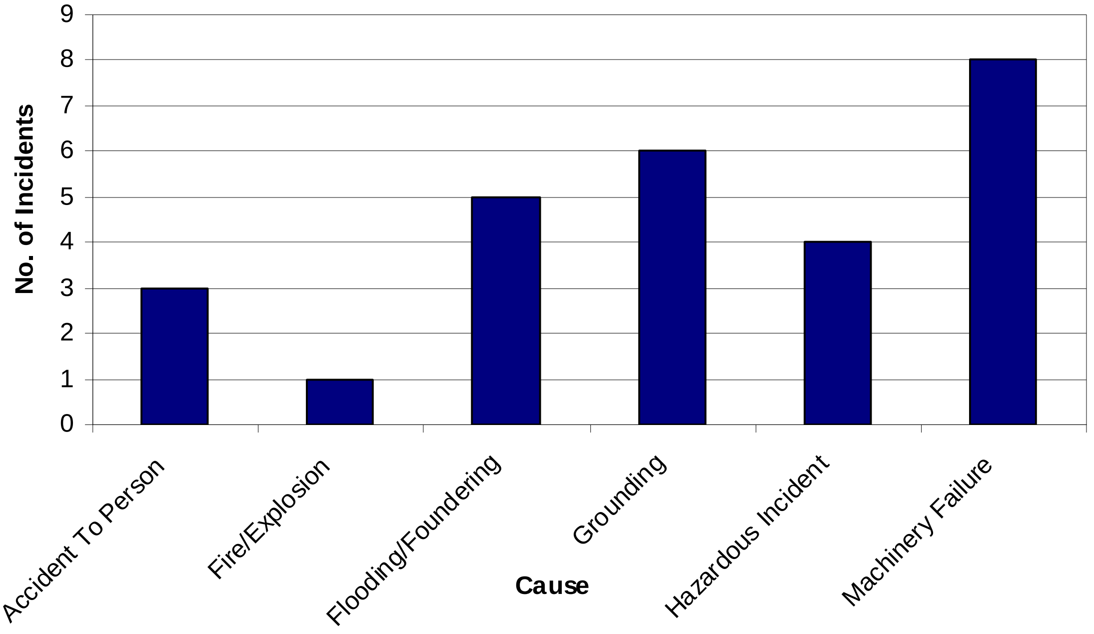

Figure 7.2 MAIB Incidents by Type within 5nm of Site (1994-March 2010)

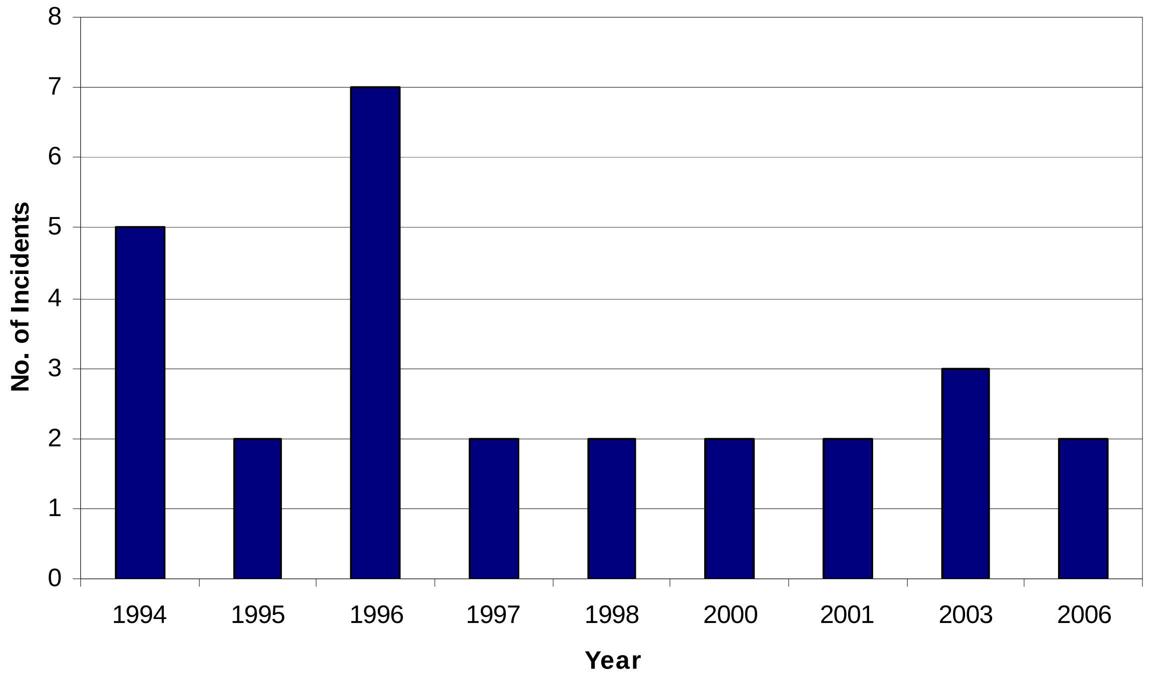

Figure 7.3 MAIB Incidents by Year within 5nm of Site (1994- March 2010)

There were no incidents reported within the FoW lease area. However, one incident occurred approximately 500m to the north. This involved a fishing vessel of 9.9m length which suffered flooding due to a broken sea discharge water pipe in August 2000.

7.3 RNLI

Data on RNLI lifeboat responses within 5nm of the lease area in the ten-year period between 2000 and 2009 have been analysed. A total of 16 launches were recorded by the RNLI (excluding hoaxes and false alarms).

Figure 7.4 presents the geographical location of incidents colour-coded by casualty type.

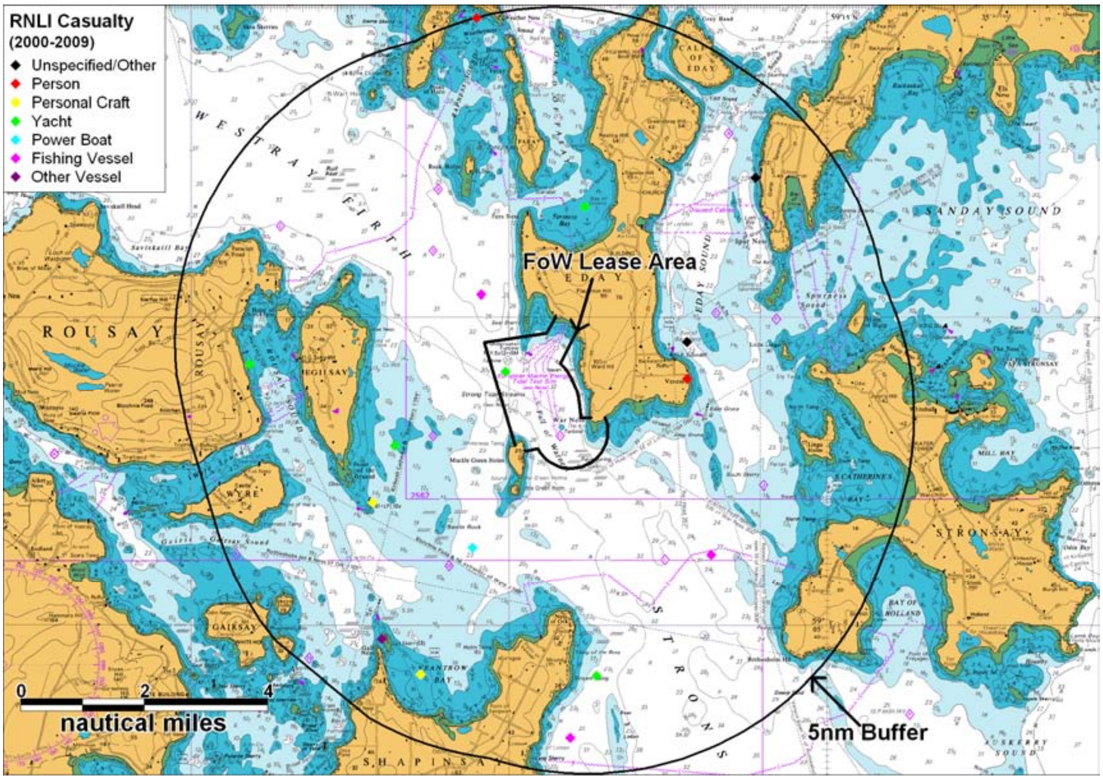

Figure 7.4 RNLI Incidents by Casualty Type within 5nm of FoW Lease Area

The overall distribution by casualty type is summarised in Figure 7.5. The most common vessel types involved were yachts (31%) and fishing vessels (19%).

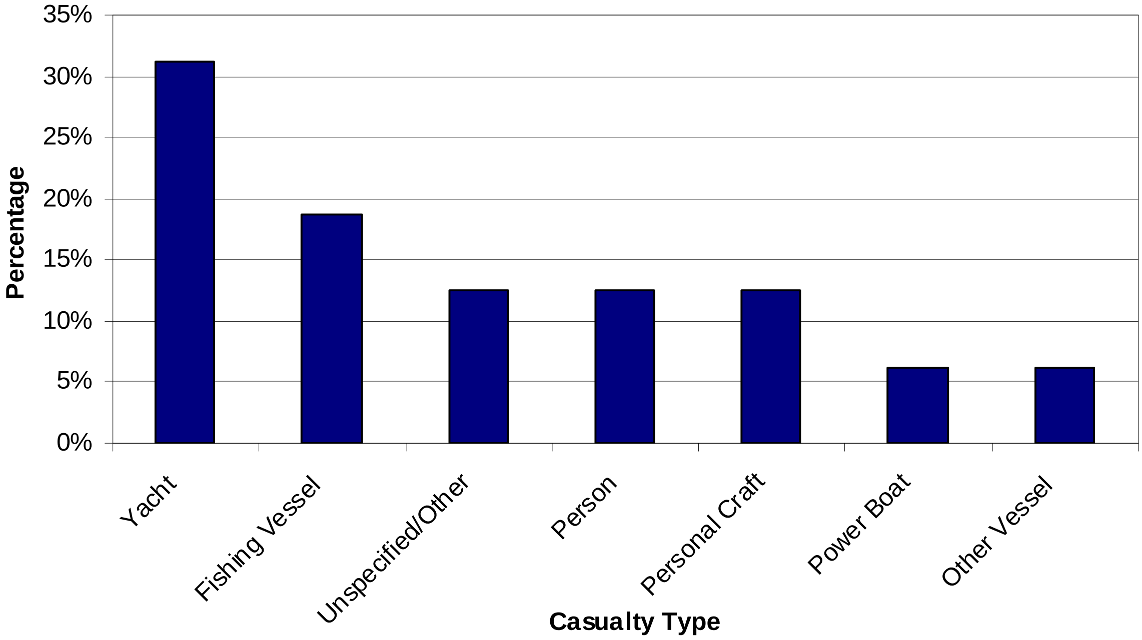

Figure 7.5 RNLI Incidents by Casualty Type within 5nm of Lease Area (2000-09)

A chart of the incidents colour-coded by cause is presented in Figure 7.6.

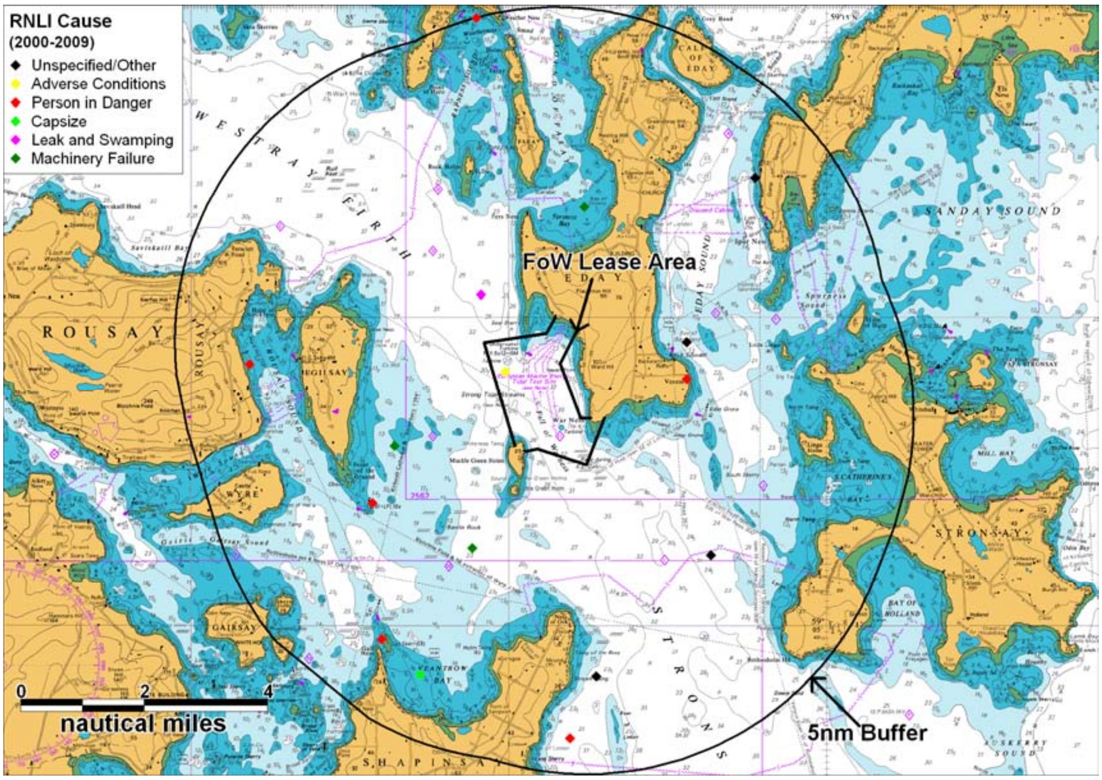

Figure 7.6 RNLI Incidents by Cause within 5nm of Lease Area

The reported causes are summarised in Figure 7.7. The two mains causes were person in danger (44%) and machinery failure (19%).

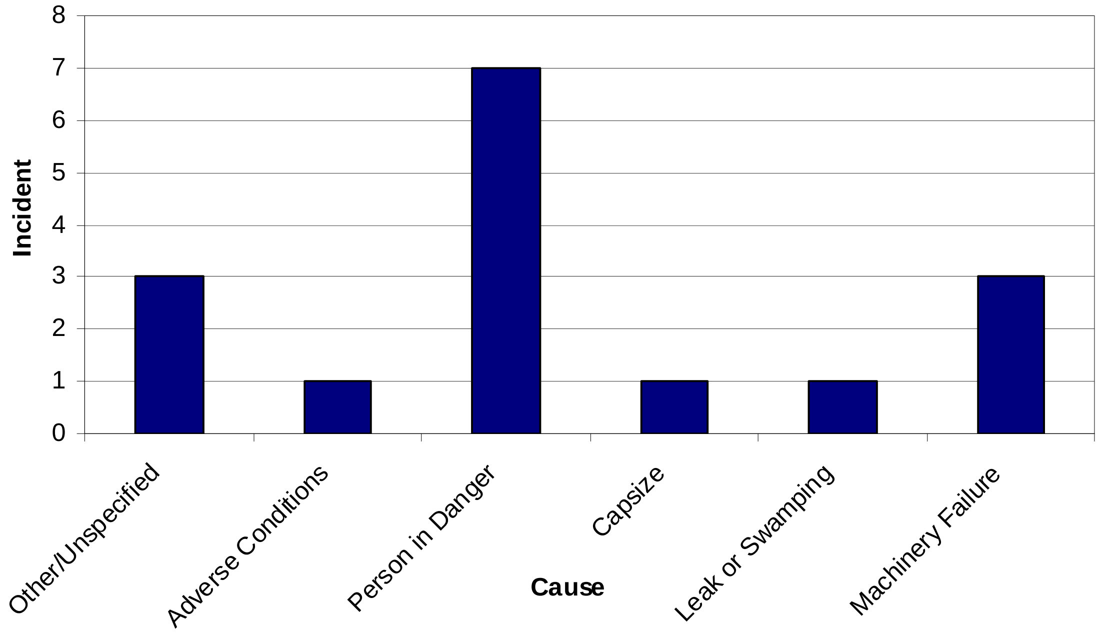

Figure 7.7 RNLI Incidents by Cause within 5nm of Lease Area (2000-09)

The annual rate of incidents in the past ten years is summarised in Figure 7.8.

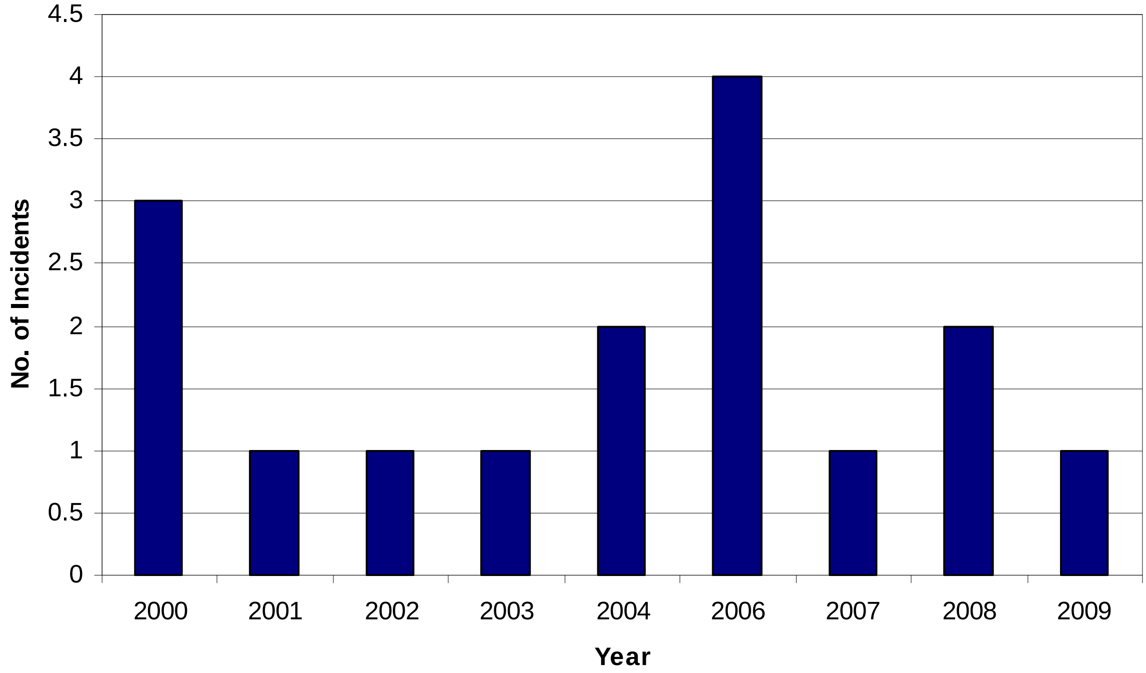

Figure 7.8 RNLI Incidents by Year within 5nm of Lease Area (2000-09)

There was one incident recorded within the lease area over the 10 years analysed. On 18th June 2004 a yacht (with auxiliary engine) experienced adverse conditions. The Kirkwall all-weather lifeboat (ALB) responded although it did not require to give assistance.

All responses to incidents within 5nm of the Fall of Warness site were made by the Kirkwall station ALB.

7.4 EMEC

EMEC have operating experience at the Fall of Warness site since 2006. In the four years of operation there have only been two incidents of note:

- Developer damaged a cable with an anchor (which required a cable repair).
- Guard vessel challenged a fishing vessel which was approaching with no-one on the bridge.

8. Search and Rescue (SAR) Resources

8.1 Introduction

This section summarises the Search and Rescue resources in the vicinity of the Fall of Warness site which may be called upon in the event of a maritime incident.

8.2 SAR Helicopters

The closest SAR helicopter base is located at Sumburgh in Shetland, operated by the MCA, approximately 64nm to the NE of the FoW lease area. This base has Sikorsky S-92 helicopters with a top speed of 165 knots and a radius of action up to 270nm, which is well within the range of the lease area. One helicopter is available at 15 minutes readiness between 0800 and 2200 hours. Between 2200 and 0800 hours, one helicopter is held at 45 minutes readiness.

Up to 19 passengers can be carried, however this is dependent on weather conditions and the distance of the incident from the helicopter's operating base. All SAR helicopters are equipped with VHF (Marine and Air Band), UHF and HF radios. They are also capable of homing to all international distress frequencies.

Figure 8.1 MCA Sumburgh relative to the FoW Lease Area

Based on the above information, the day-time response to the lease area will be in the order of 50 minutes. At night time this will increase by 30 minutes to approximately 1 hour 20 minutes due to the additional response time at the base. It is noted that these calculation are based on still air and will vary depending on the prevailing conditions.

8.3 RNLI Lifeboats

The Royal National Lifeboat Institution maintains a fleet of over 400 lifeboats of various types at 235 stations round the coast of the UK and Ireland. The RNLI stations in the vicinity of the FoW lease area are presented in Figure 8.2.

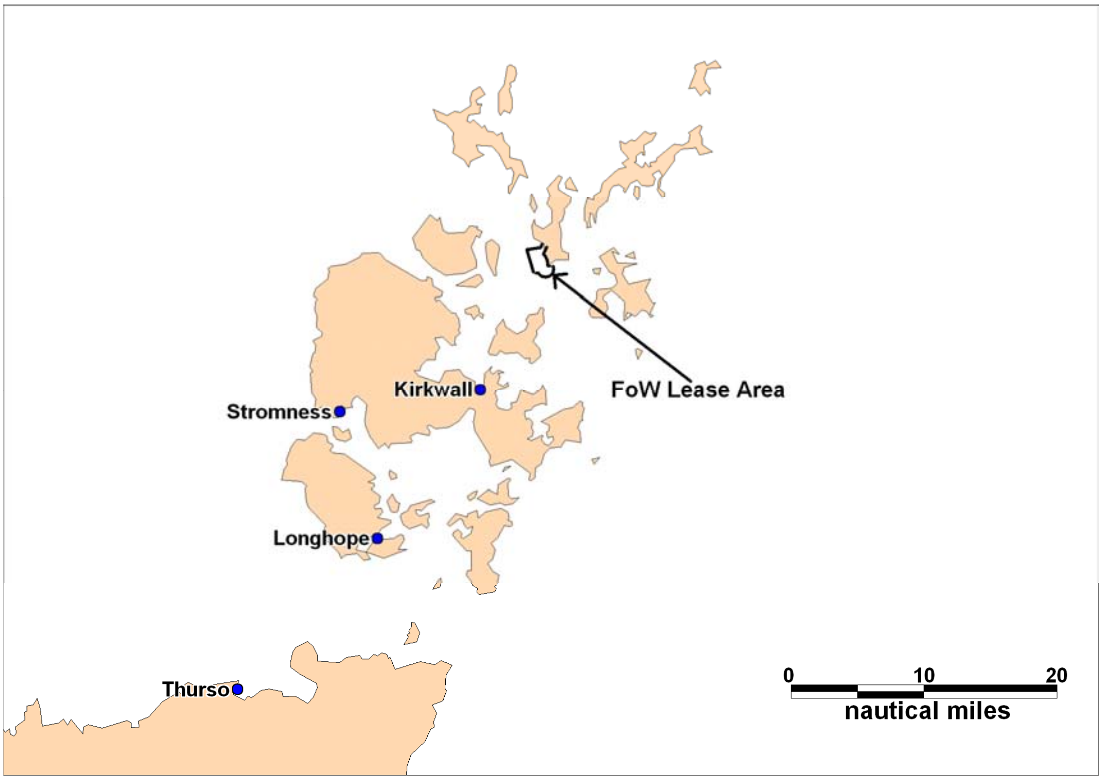

Figure 8.2 RNLI Stations closest to the Fall of Warness

At each of these stations crew and lifeboats are available on a 24-hour basis throughout the year. Table 8.1 provides a summary of the facilities at the stations closest to the FoW.

Table 8.1 Lifeboats at RNLI Stations near the Fall of Warness

Station	Lifeboats	ALB Spec	Distance to Site Boundary
Kirkwall	ALB	Severn	9.5nm
Stromness	ALB	Severn	17.8nm
Longhope	ALB	Tamar	22.9nm

Thurso	ALB	Severn	38.3nm

It was seen from the RNLI incident review presented in Section 7.3 that it would normally be the Kirkwall all-weather lifeboat responding to an incident at the Fall of Warness.

The Severn class lifeboat has a speed of 25 knots, range of 250nm and can operate in all-weather. All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

Response times vary but an average declared by RNLI is 14 minutes for all-weather lifeboats. This is the time from callout, i.e., first intimation from Coastguard to the lifeboat station to launch. The time for an all-weather lifeboat to reach the FoW lease area would therefore be approximately 40 minutes from Kirkwall (total time from callout to being on scene).

8.4 Coastguard Stations

HM Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

HM Coastguard co-ordinates SAR through its network of 18 Maritime Rescue Co-ordination Centres (MRCC). A corps of over 3100 volunteer Auxiliary Coastguards around the UK coast form over 400 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

All of the MCA’s operations, including SAR, are divided into three geographical regions. The East of England Region covers the East and South Coasts of England from the Scottish border down to the Dorset/Devon border. The Wales and West of England Region extends from Devon and Cornwall to cover the coast of Wales, North West England and the Moray Firth. The Scotland and Northern Ireland Region covers the remainder of the UK coastline including the Western Isles, Orkney and Shetland.

Each region is divided into six districts with Maritime Rescue Co-ordination Centre (MRCC), which co-ordinate the Search and Rescue response for maritime and coastal emergencies within each district’s boundaries.

The FoW lease area lies within the Scotland and Northern Ireland Region with the nearest rescue coordination centre being Shetland MRCC. MRCC Shetland’s area of responsibility provides search and rescue coverage in Shetland Islands, Fair Isle and the Orkney Islands.

8.5 Salvage

MCA charters four Emergency Towing Vessels (ETVs) to provide emergency towing cover in winter months in the four areas adjudged to pose the highest risk of a marine accident: the Dover Strait, the Minches, the Western Approaches and the Fair Isle Channel.

One of these, the *Anglian Sovereign* which covers the Fair Isle Channel, is frequently anchored in Inganess Bay, which is approximately one hour steaming time from the Fall of Warness site. It was recorded during the AIS winter survey heading from Inganess Bay through the Stronsay Firth and Westray Firth via the Fall of Warness.

Each MRCC also holds a comprehensive database of harbour tugs available locally, e.g., Scapa Flow. Procedures are also in place with Brokers and Lloyd's Casualty Reporting Service to quickly obtain information on towing vessels that may be able to respond to an incident.

MCA has an agreement with the British Tug-owners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should MCA request assistance from any local harbour tug as part of the response to an incident.

8.6 SAR Liaison

Developers should consult with the RNLI station at Kirkwall and the MCA about the devices to be deployed and provide any further information requested to assist SAR efforts. This may include:

- Precise location details
- Device details and illustrations
- Information on the feasibility of braking turbines (where relevant)
- Information on the buoyancy of device parts
- Emergency contact details.

From the Eday watchkeeper vessel logs, it is noted that the Kirkwall ALB has visited the Fall of Warness site.

9. Risk Review

9.1 Introduction

This section reviews the navigational hazards associated with the Fall of Warness site, including the two new cables planned in 2010, based on the updated baseline information.

9.2 General Review of Risks

The Fall of Warness test site was originally chosen by EMEC in part because it has low vessel activity.

The waters around the Orkney islands including the Fall of Warness lease area (but excluding the Pentland Firth and Scapa Flow) have been designated by the IMO as an Area To Be Avoided (ATBA). All vessels over 5,000 gross tonnes carrying oil or other hazardous cargoes in bulk are advised to avoid the area, including the Fall of Warness.

Smaller vessels are advised to avoid the Fall of Warness site in Sailing Directions (Ref. vii and x) and Nautical Almanacs due to the hazardous conditions than can occur, including the strong tidal flows and violent turbulence.

The MCA have published guidance to mariners operating in the vicinity of offshore renewable energy installations (OREI) (Ref. iv). The guidance notes that, unlike wind farms, systems using tidal energy may not be clearly visible to the mariner. Some installations are totally submerged while others may only protrude slightly above the sea surface. The guidance describes the main types of tidal energy converters and the various methods by which devices can be fixed to the seabed. Two options are provided, in simple terms, for mariners operating in OREI areas:

a. Avoid the OREI area completely
b. Navigation around the edge of the OREI

The choice will be influenced by a number of factors including the vessel's characteristics (type, tonnage, draught, manoeuvrability etc), the weather and sea conditions. The MCA do not provide guidance on a safe distance at which to pass an OREI, as this depends upon individual vessels and conditions. However where there is sufficient sea room it is prudent to avoid the area completely (option (a) above). The MGN concludes that, although OREIs present new challenges to safe navigation around the UK coast, proper voyage planning, taking into account all relevant information, should ensure a safe passage and the safety of life and the vessel should not be compromised.

It is further noted that the site is now well-established, having been operational since 2006. Chart markings and notes already warn mariners about the EMEC development at Fall of Warness using the following wording:

Extensive testing of tidal energy devices, both above and below the surface, takes place in this area. Mariners should exercise caution whilst navigating in this area and obtain local knowledge

The devices at the site are also marked as per Northern Lighthouse Board (NLB) requirements, based on IALA Recommendation 0-131 on the marking of offshore wave and tidal energy devices.

The above measures mean that all local mariners and visiting mariners with up-to-date Admiralty Charts, awareness charts, sailing directions, etc., should be well aware of the FoW site.

EMEC's operational experience indicates limited incidents associated with the site, and the historical review indicated very few maritime incidents in the past 10-15 years.

It is noted that a full hazard review, including a Hazard Identification Workshop involving local stakeholders, was carried out in 2005 as part of the original NRA and addendum in 2005 (Ref. i and ii). This reviewed the risks associated with generic types of devices as described in Section 2.2 and listed below:

1. Type 1: Bottom sited, gravity device
2. Type 2: Mid-water, buoyant, moored device
3. Type 3: Pile mounted, surface piercing device
4. Type 4: Surface moored device

For all devices there will be risks during construction, maintenance and decommissioning, when there will be additional vessels at the site associated with the development, some of which may have restricted manoeuvrability.

During normal operations, the risk is dependent upon the type of device, whether submerged (Types 1 & 2), surface piercing (Type 3) or on the surface (Type 4). Surface devices are the most straightforward to assess as they present a fixed target. These can be modelled on a device specific basis using the following inputs:

- Device location
- Device details and dimensions
- Vessel activity data
- Metocean data

For submerged devices, as well as the above inputs, more detailed information is required for modelling under keel clearance, including:

- Wave Heights
- Tidal Heights
- Squat
- Surge

These factors are discussed in greater detail in Section 10.

The risk of a device suffering mooring failure and losing station also needs to be considered. This is device and location-specific and should be assessed on a project basis.

Appropriate mitigation measures to help control navigation risks are also dependent to an extent on the device type and location. These are discussed further in Section 11.

The following sections review the potential risks to shipping, fishing vessels and recreational vessels from the Fall of Warness tidal power site in more detail.

9.3 Shipping Risks

As discussed above, the site is well-established and should be well known to passing shipping. This section reviews the risks for the two main types of shipping traffic in the area:

- Inter-island Ferries
- NW-SE Transiting Traffic

9.3.1 Inter-Island Ferries

The shipping survey and consultation with the ferry operator (OIC Marine Services) highlighted that the inter-island ferries in the area have to alter their passage to adapt to the prevailing conditions. Therefore, all the cable berths may be exposed to ferries passing in proximity at different times of the year and in different sea and tidal conditions.

The introduction of Cables 6 and 7 will increase the potential interaction of Kirkwall-Westray ferries with the site. Berth 6 is approximately 270m further west of Berth 4, whilst Cable 7 is 60m west.

The majority of ferry tracks currently pass to the west of these new berths, and the existing Open Hydro turbine at Cable Berth 4, as they keep west of Muckle Green Holm and Seal Skerry. However, some ferries were observed passing to the east of Berths 6, 7 and occasionally Berth 4, presumably seeking more sheltered conditions further east. In one transit the minimum passing distance to the OpenHydro platform at Berth 4 was less than 60m.

The main concern expressed by the ferry operator during consultation was the obstruction that can be caused during installation and maintenance. It was commented that once the device is in place with 10m or above under keel clearance, it is not a problem for the ferries. (See Section 10 for a detailed assessment of under keel clearance.)

It was pointed out that in winter, the majority of passages are in darkness and conditions can be very difficult. Most major installation and maintenance work on the site would be expected to be in the better summer weather when daylight is longer.

Surface installations would be a potential risk of collision all-year round but these can be marked and lit.

9.3.2 NW-SE Transiting Traffic

The AIS survey tracked 19 ships (excluding fishing and recreational vessels) in 12 weeks heading NW-SE via the Fall of Warness when transiting between the Westray Firth and Stronsay Firth.

Taking into account the seasonality of cruise ship movements, the annual number of ship transits is estimated to be 70-75 per year, with the majority in summer due to cruise ships (estimated at 30 transits per year based on the 2010 cruise liner list published by OIC Marine Services).

Based on the ship tracks recorded during the 12 week survey, devices on the cable berths towards the outer (western) part of the site are most exposed to shipping collision risk, in particular, the existing berths 1 & 3 and to a lesser extent the new berths 6 & 7.

All merchant ships during the survey, including passenger cruise ships during the summer, kept to the west of all the existing cables. This indicates that mariners are taking heed of the chart marking and associated cautionary note and avoiding the site.

Prudent ship Masters are likely to avoid the area in rough sea conditions in any case. For example, cruise ships, which transit the area for sight-seeing opportunities, are unlikely to expose their passengers to very severe sea states if it can be avoided.

Given the low frequency of transits and the observed passage planning to the west of the cables, the base case risk of collision is considered to be low.

In terms of future case shipping, consultation with OIC Marine Services identified that extension of the pier at Hatston, Kirkwall, is being considered. This is primarily aimed at the renewables support market and in particular it is expected that the proposed site in Westray Firth would likely be supported from here, and possibly the site at Costa Head. Both are tidal sites being developed by SSE Renewables. This could create an increase in traffic past the Fall of Warness. As a by-product it could potentially lead to more cruise ships and potentially more supply vessel calls to Kirkwall via the Fall of Warness.

9.4 Fishing Vessel Risks

As with commercial shipping described above, transiting fishing vessels heading NW / SE via the Fall of Warness would be exposed to tidal devices on berths 1 & 3 and to a lesser extent the new berths 6 & 7. One of the three fishing vessels tracked during the AIS survey passed over the cables to berths 1 and 3, which also brought it in proximity to berth 2 (within 100m). Based on consultation and the review of vessel logs maintained by the watchkeeper at Eday, there are an estimated 90-95 fishing vessel transits NW or SE per annum

These vessels would be exposed to collision risk from surface devices at any of these berths. Under keel clearance is an issue for fishing vessels, especially the larger trawlers drawing 7-8m (see Section 10). This was the main issue raised during consultation for both the larger trawlers transiting NW-SE and the larger of the creelers operating off the coast of Eday (draughts up to 3m).

Again, it is noted that prudent skippers are likely to avoid the area in unfavourable conditions. During consultation, the SPFA emphasised that their members would never transit the area in severe sea states.

Creeling activity off the coast of Eday tends mainly to be close inshore within the 15 metre contour, with occasional deployment out to 30 metres. Based on the water depths at the cable berths, only a device at Cable 4 would currently be exposed.

Vessels could also be exposed when transiting to and from pots. Based on the watchkeeper logs, most vessels were hugging the west coast of Eday when transiting to and from the Sealskerry Bay area either from the south or the north. A small proportion of vessels were logged crossing the lease area between Eday and north or south of Muckle Green Holm.

From the logs, an average of 3 hours of creeling activity was recorded weekly between 2006 and 2009 based on 20 hours of watchkeeping. In over two-thirds of watchkeeping periods (of four hours) no creelers were recorded

It is noted the watchkeeping only takes place in daylight when creeling activity would be expected to be highest.

In addition to creelers, one small fishing vessel (8.9m length) has been observed diving for shellfish near the Eday shore during the second half of 2009.

9.5 Recreational Vessel Risks

From the consultation and baseline activity review, the Fall of Warness area is not popular with recreational users due to the strong tides. Only 13 vessels were recorded in approximately 1,000 watchkeeping periods.

Transits are most likely to be made in daylight and good weather conditions. It is noted that one incident was recorded by the RNLI involving a yacht (with auxiliary engine) experiencing adverse conditions in the area which prompted the launch of the Kirkwall lifeboat. This was in late afternoon in mid-June 2004. The wind at the time of the incident was recorded as Beaufort Force 6 (strong breeze).

Overall, the risk of interaction of recreational vessels with a tidal device at the FoW site is considered to be low. The risk is likely to be highest for vessels visiting the area lacking in local knowledge.

The site is mentioned in Sailing Directions, such as those published by the Clyde Cruising Club (Ref. x), for which up-to-date amendments can be accessed online. Two recent amendments to these Directions are listed below:

> *The Orkney Islands are the base of the European Marine Energy Centre and floating and submerged experimental testing devices may be encountered...…some are of a transient nature and may not be shown on charts or referred to in these Sailing Directions. All should be given a good berth.*

> *An energy device (Fl.Y 5M) has been established bearing 313° from War Ness at a distance of approximately 1.6M. Insert rectangular symbol and Lt. on plan.*

10. Detailed Under Keel Clearance Review

10.1 Introduction

This section reviews the factors affecting vessel under keel clearance (UKC) at the Fall of Warness site, which can be used as input to device-specific collision risk assessments for submerged tidal devices (Types 1 and 2) planned for the site.

The factors that need to be assessed are:

- Device Elevation
- Water Depth at LAT
- Tidal Height Variations
- Surge
- Sounding Accuracy
- Vessel Draughts
- Wave-induced Vessel Motion
- Squat

Based on the maximum elevation of the device above the sea bed, the gross under keel clearance in calm water can be calculated for the different vessels identified to be passing near the site.

Even if this is positive in all tidal states for the largest vessels (i.e., cruise ships of up to 8.6m) when static, it is necessary to estimate the net UKC taking into account dynamic factors.

Each of these factors is discussed in more detail below.

10.2 Device Elevation

The elevation of the device above the seabed is required, which is device-specific. It is noted the elevation may vary, e.g., rotating turbines. In this case it is recommended the maximum elevation is assumed. If the device can be braked when non-operational or in an emergency to provide greater clearance, this can be taken into account within the modelling.

10.3 Water Depth at LAT

This is available for the seven cable berths. Site-specific data will be required for planned deployments in any other parts of the FoW lease area.

10.4 Tidal Height Variations

Tidal levels and their effect on water depths at the site are presented in Table 10.1 and illustrated in Figure 10.1 and Figure 10.2 for the deepest and shallowest berths based on the water depth and tidal information presented in Section 2.

It can be seen that the tidal variations are more of a factor for shallow berths, such as Berth 4, as opposed to deeper berths, such as Berth 1.

The tidal data comes from Loth on Sanday, which is within 5nm of the lease area. However, location-specific for the precise device location is preferred for device-specific NRAs.

Table 10.1 Tidal Levels referred to Datum of Soundings LAT

Tidal Level	Height above LAT (m)	Water Depth (m)	
		Cable 1	Cable 4
Highest Astronomical Tide (LAT)	3.5*	52.6	16.8
Mean High Water Springs (MHWS)	3.1	52.2	16.4
Mean High Water Neaps (MHWN)	2.5	51.6	15.8
Mean Sea Level (MSL)	2.0	51.1	15.3
Mean Low Water Neaps (MLWN)	1.5	50.6	14.8
Mean Low Water Springs (MLWS)	0.9	50	14.2
Lowest Astronomical Tide (LAT)	0.0	49.1	13.3

* Estimated based on tidal range.

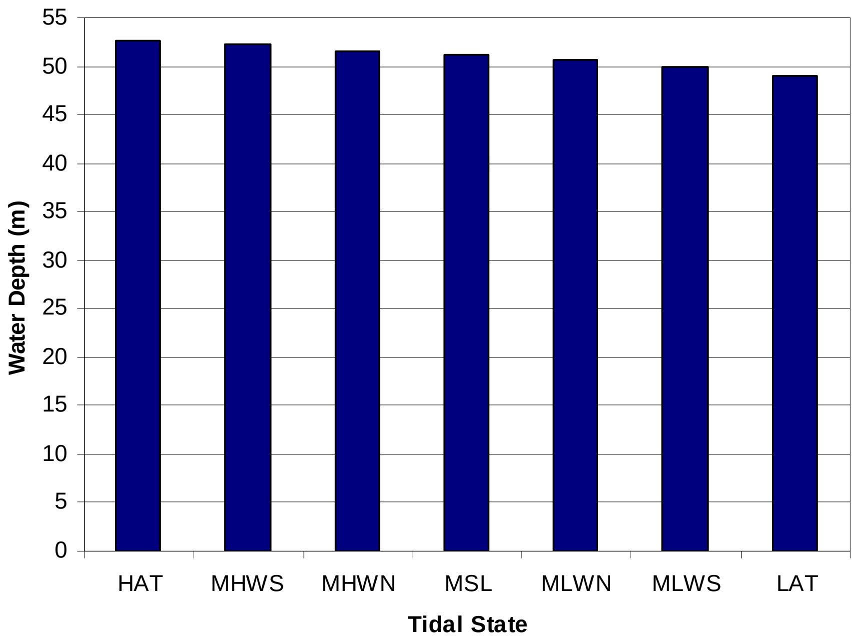

Figure 10.1 Water Depth at Berth 1 based on Tidal Variations

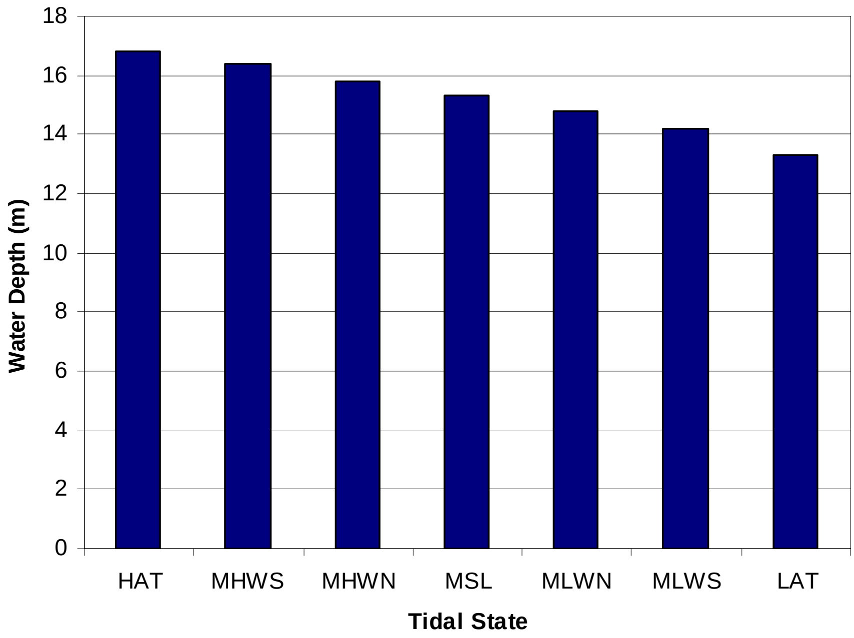

Figure 10.2 Water Depth at Berth 4 based on Tidal Variations

The height of MHWS is the average throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest (approximately once a fortnight). The height of the MLWS is the average height obtained by the two successive low waters during the same period. MHWN and MLWN are similar averages when the range of tide is at its least (neaps). These values vary from year to year in a cycle of approximately 18.6 years.

Highest and Lowest Astronomical Tides (HAT and LAT) are the highest and lowest levels that can be expected to occur under average meteorological conditions and under any combination of astronomical conditions. They are not extreme levels, as certain meteorological conditions can cause a higher or lower level. The level under these circumstances is known as a ‘storm surge’ (‘negative surge’ in the case of a level lower than LAT). More information on surge is provided below.

10.5 Surge

Sea level is lowered by high barometric pressure and raised by low pressure. Negative surges in high pressure are most frequent in estuaries and areas of shallow water.

The largest negative surge recorded in the North Sea occurred in December 1982 caused by an area of unusually low pressure to the west of Scotland and strong southwesterly winds. Water levels fell by more than 1m along much of the east coast and by over 2m in the

Thames Estuary (more than 1m for a period of just over 12 hours). In the North Sea most storm surges occur between September and April. The average number of negative surges per year (height at least 0.6m lower than predicted) in the twenty year to 1988 in the southern North Sea was 15 (compared to 19 positive surges of a similar order in the same period).

The frequency and magnitude of negative surges at the more northerly Fall of Warness site, which is linked to the Atlantic by the Westray Firth and the North Sea by the Stronsay Firth, is likely to be lower than in the North Sea.

10.6 Sounding Accuracy

The water depth information for the Fall of Warness area is based on a multibeam survey carried out by the MCA in 2004-05 to International Hydrographic Organisation (IHO) Order 1 standard.

This standard implies a depth accuracy of 0.5m plus 1% of the water depth. The water depths at the different cable berths range from 13-49m, which implies allowances of 0.6-1.0m for possible inaccuracies. (It is noted these could be positive or negative.)

This factor has to be applied on a location-specific basis.

10.7 Vessel Draughts

The draughts of vessels were obtained from the baseline data, including the AIS survey, cruise ship list, Eday watchkeeper vessel logs and consultation.

Based on this information, draught distributions for NW-SE transiting cruise ships, fishing vessels and miscellaneous (other) ships, are presented in Figure 10.3.

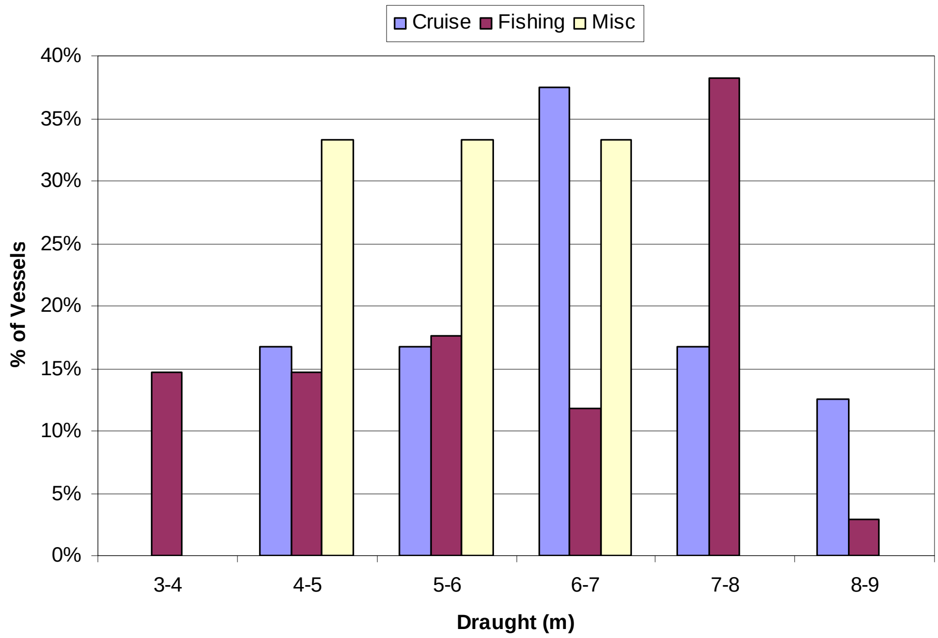

Figure 10.3 Vessel Draught Distributions transiting Fall of Warness (NW / SE)

Cruise ships and fishing vessels have the deepest draughts, with the maximum draught being 8.56m for the *Mona Lisa* cruise ship, which is visiting in summer 2010 and may use the Fall of Warness when travelling between Kirkwall and Reykjavik. (Note: This conservatively assumes maximum draught; the actual draught when transiting the site may be lower.)

For the inter-island Orkney ferries, the draughts broadcast on AIS when passing the site were in the range 2.9-3.2 metres.

For local fishing vessels and recreational craft, draughts may be assumed to be up to 3m.

10.8 Wave Motion

The area is subject to wave action and ships will experience heave, roll and pitch motions which combine to produce vertical displacements of the hull. The magnitude of the vertical displacement is dependent upon several factors including the height and period of the waves, the vessel type, dimensions and speed, the relative vessel heading to the waves and the water depth.

From research, accurately predicting ship response is very complicated. The seakeeping models used by naval architects are very difficult to apply and require a high level of specialised knowledge for useful interpretation and application. A lack of data results in difficulty in verifying proposed models to predict the motion of a ship induced by waves.

For this study, results from field measurements and recommendations from literature have been reviewed and conservatively adapted for the vertical wave-induced motions component.

The Permanent International Association of Navigation Congresses (PIANC, Ref. xi) recommends a value of 0.3 to 0.5 times the ships' draft for minimum depth clearance requirements in channels influenced by waves, where the higher value is for wave above 1m and wave periods and directions are unfavourable.

Figure 10.4 provides an example of results from a large field measurement program in a high-wave-energy entrance channel. Data were collected over a 2-year period at the mouth of the Columbia River, USA (Ref. xii). The average ratio of ship bow/stern response amplitude to wave amplitude on each transit varied between about 0.5 and 2.0 over 29 instrumented voyages.

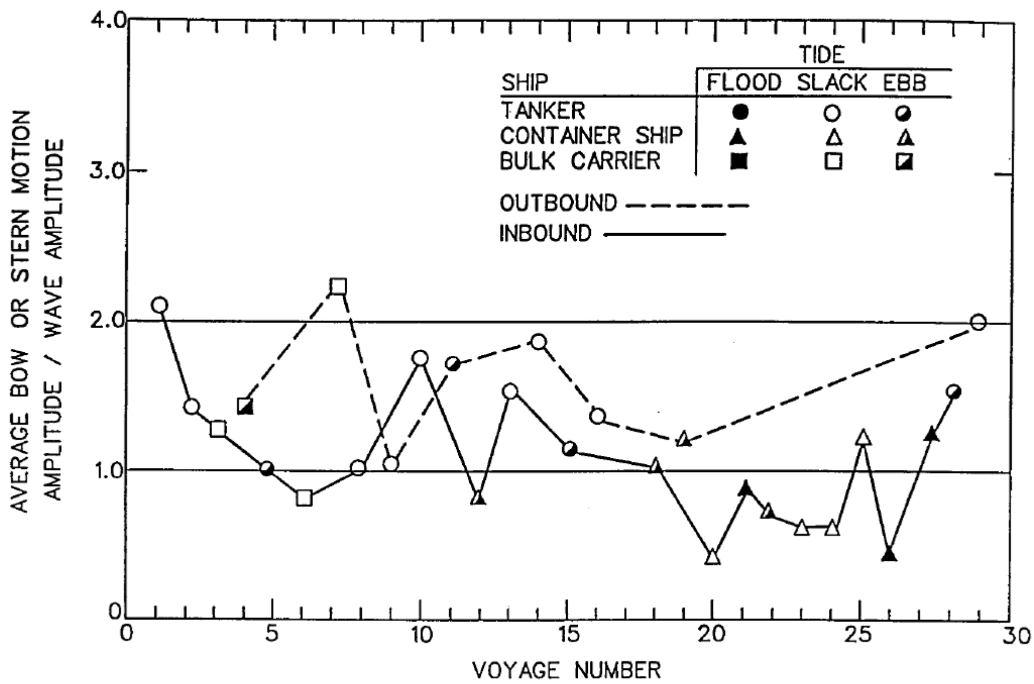

Figure 10.4 Ship Motion Response Field Trial

The US Army Corp of Engineers (Ref. xiii) recommends a wave motion value equal to 1.2 times the incident wave height (i.e., 2.4 times the wave amplitude) be used in channel design, which is in-line with the extreme measurements from the Columbia Review trials.

Wave effects tend to increase as the wave heights increase and decrease with longer vessel lengths. Maximum ship response occurs with wave lengths equal to or nearly equal to the ship length. Based on the site wave data (see Section 2.3.1), fishing vessels and inter-island ferries will normally be more affected than large cruise ships, which matches visual observations from the lookout on Eday.

To account for the wave motion at the site, 1.2 times the significant wave height has been assumed for all vessels. This means that relative to their static draughts, fishing vessels will generally be more affected by wave-induced vertical motion than cruise ships, in-line with the local observations.

The probability distribution for significant wave height is location-specific. Information based on analysis of 20 years modelled data for each of the cable berths is presented in Section 2.3.1. An example distribution for Cable Berth 1 is presented in Figure 10.5.

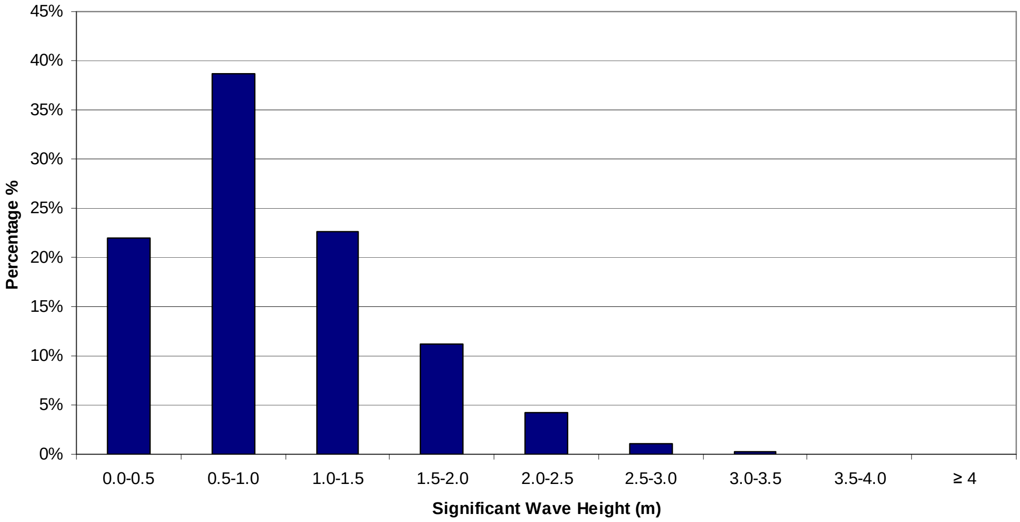

Figure 10.5 Significant Wave Height Distribution – FoW Berth 1

It should also be recognised that whilst significant wave height measures the average height of the highest one-third of waves, vessels passing the site could encounter higher waves. The maximum wave height in the modelled data (3-hourly intervals over 20-years) was almost 8m.

The probability of encountering a wave larger than the significant height increases as the total number of encounters increases. For example, approximately, 1 in 2,000 waves will be twice the significant height (Ref. xiv). The rate of encounter depends on the wave period as well as the vessel heading versus the wave direction. However, vessels will only be exposed to under keel risk for a very short time when passing immediately over a submerged device (approximately 1-3 wave encounters on average). Therefore, the significant wave height probability distribution is considered reasonable to obtain a best-estimate, although the probability of higher waves should be used to investigate extreme scenarios.

10.9 Squat

Squat is the name generally applied to the difference between the vertical positions of a vessel moving and stopped. It is made up of:

- Settlement: General lowering in the level of a moving vessel, which causes the level of the water round her to be lower than would otherwise be the case. It increases as depth decreases and speed increases. It is only appreciable when depths is less than seven times the draught, but increases significantly when the depth is less than two and a half times the draught.

- Change of Trim: Normally causes the stern of a moving vessel to sit lower in the water than when she is stopped. It varies with speed.

This phenomenon occurs in deep, open-water situations, such as out at sea as well as in shallow water. However, the effect is greatly increased in shallow, restricted water, such as in navigation channels.

Squat in the Fall of Warness area will be influenced by the ship's speed and under keel clearance above the sea bed, the latter of which is location-dependent.

The deepest draught cruise ships and fishing vessels have draughts of around 8-9m and tend to be traversing water depths above 30m, hence, the water depth is more than three times the draught. For the inter-island ferries and local fishing vessels, the ratio is 10 or over across most of the site.

Using an empirical squat formula developed by ICORELS (1980) (Ref. xv), squat was estimated to be approximately 0.5m for the fast cruise ships, travelling at higher speeds of 15-20 knots through the 30-50m contour. For fishing vessels, squat is not as significant and a small allowance of 0.1m is considered appropriate, based on discussions with the SPFA.

10.10 Conclusions

Based on the above discussion, it is considered appropriate to take into account the following factors to provide a conservative "best-estimate" of the under keel clearance of vessels passing over the cable berths in order to model the sub-surface collision risk:

- Device Elevation
- Water Depth at LAT
- Tidal Height Variations (based on spring range, MHWS to MLWS)
- Vessel Draughts
- Wave-induced Vessel Motion (based on significant wave height)
- Squat

Sounding accuracy and surge are not considered in obtaining a best-estimate as these can be positive or negative, i.e., increase or reduce the under keel clearance.

This result is considered most appropriate in modelling the collision risk to ensure risk mitigation measures can be considered in a proper context.

However, if seeking to estimate the "worst case" scenario, for example to design the device in order to effectively eliminate the risk of a sub-surface collision, it would be appropriate to perform a sensitivity assessment based on the following additional (or substituted) factors:

- Tidal Height Variations (based on full range, HAT to LAT)
- Sounding Accuracy (worst case negative value dependent on water depth)
- Surge (worst case negative value, say -2m)
- Wave-induced Vessel Motion (based on maximum wave height)

The risk assessment needs to be performed on a device and location-specific basis, taking into account the factors above.

However, to illustrate the results, a range of UKC values have been calculated for Cable Berth 1 based on the overall draught distributions of the following vessel types:

- Cruise ships
- Fishing vessels transiting NW-SE
- Miscellaneous (other) ships transiting NW-SE
- Inter-island Ferries

Figure 10.6 and Figure 10.7 present the best-estimate and worst-case UKC ranges for each vessel type based on the current water depth at the berth (49.1m LAT). This assumes the vessel is in a wave trough when passing over the site.

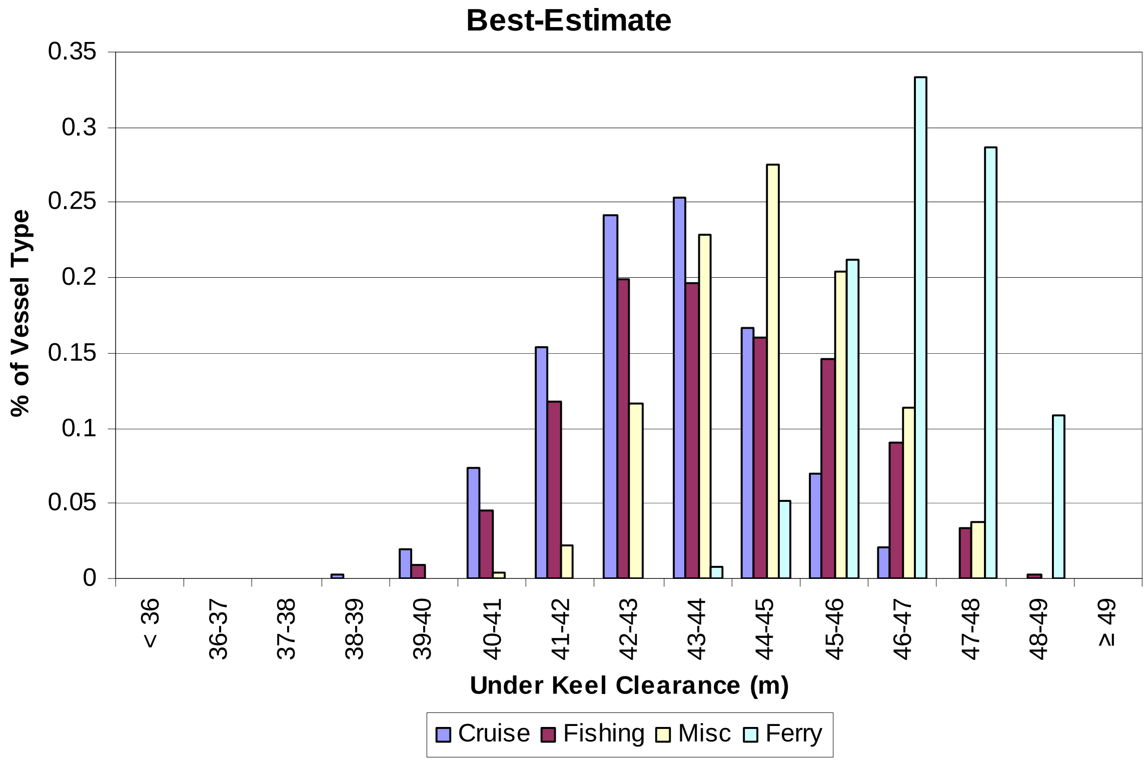

Figure 10.6 “Best-Estimate” UKC - Example Results for FoW Cable Berth 1

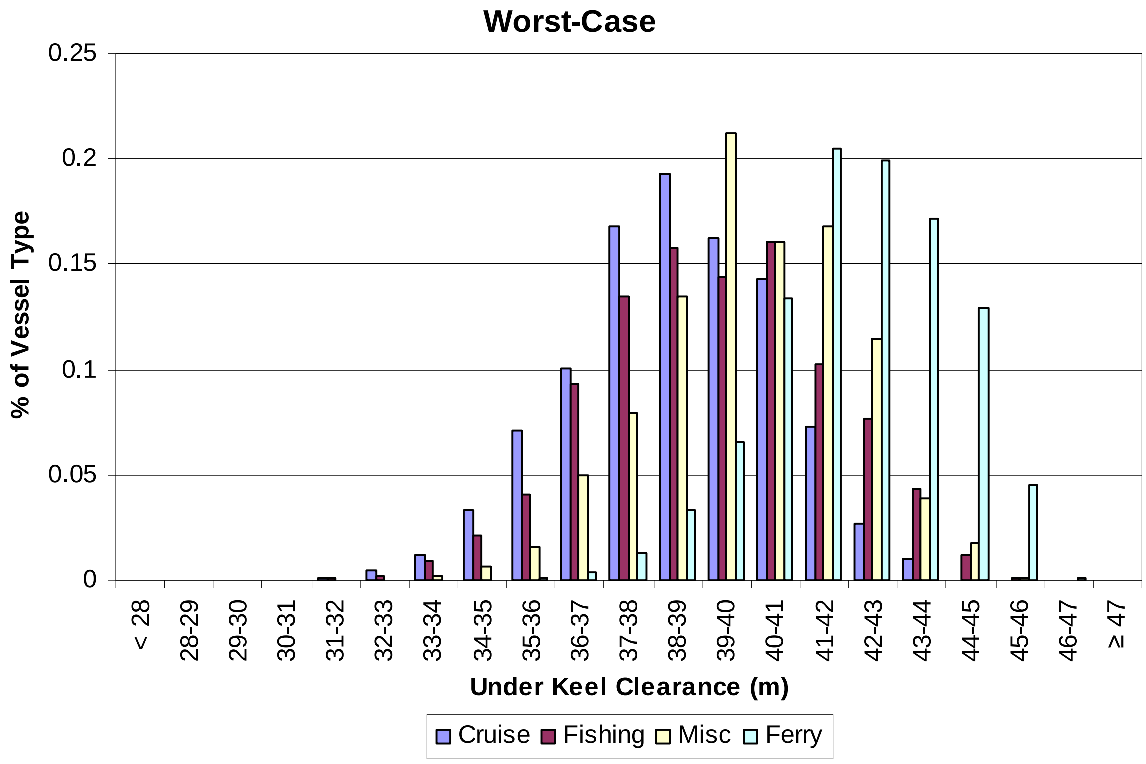

Figure 10.7 "Worst-Case" UKC - Example Results for FoW Cable Berth 1

The "best-estimate" results indicate that the risk to a device at berth 1 would be very low provided it did not project more than 36m above the sea bed, i.e., at least 13m below the water level at LAT.

The "worst-case" results indicate the risk could be practically eliminated if the device at berth 1 did not project more than 28m above the sea bed, i.e., at least 21m below the water level at LAT.

The above numbers (13m and 21m) would not vary greatly for the cable berths 2, 3, 5, 6 and 7, however, location-specific inputs are required to obtain precise results per berth. At berth 4 the water level at LAT is only 13.3m, therefore, these submerged depths are not achievable. However, the largest cruise ships and fishing vessels are highly unlikely to transit over berth 4.

To model the actual collision risk at any cable berth for a device-specific NRA, details on the device dimensions are required (which may vary with depths). The vessel movements data also has to be re-analysed for the specific location, i.e., numbers, types, sizes, speeds, passing distances and squat. Location-specific metocean data and tidal heights should be applied, where available.

11. Mitigation Measures

11.1 Introduction

This section discusses mitigation measures that may be considered to minimise the navigation risk associated with tidal devices deployed at the Fall of Warness site. Many of these are already standard practice at the site. Others may be appropriate on a device-specific basis.

Prevention is the most effective mitigation measure and, as previously noted, the site was chosen by EMEC partly because it has low vessel activity. It is within an Area To Be Avoided (ATBA), designated by the IMO, which applies to all vessels over 5,000 gross tonnes carrying oil or other hazardous cargoes in bulk.

Any new devices deployed on the site also benefit from the site having been established since 2006. Charts and other nautical publications already highlight the Fall of Warness development to mariners.

11.2 Chart Markings

The EMEC FoW site has been established since 2006, therefore, most vessels navigating in the area should have access to charts showing the site. This allows vessels to plan their passage taking into account the test site.

The new cables and berths (numbered 6 and 7) will be added to charts in due course.

When devices are installed, their nature will be displayed on the chart, e.g., surface platform or submerged turbine with "worst case" clearance depth below chart datum.

This is considered to be very effective mitigation as it provides information to mariners to allow them to plan a safe passage before leaving port, or revise the passage plan en route if necessary, taking into account the clearance, as well as the vessel draught, the tide and the sea state.

11.3 Marking and Lighting

The devices at the site are marked as per Northern Lighthouse Board (NLB) requirements, based on IALA Recommendation 0-131 on the marking of offshore wave and tidal energy devices.

NLB consider each deployment on a case-by-case basis, therefore, this is ultimately a device-specific issue.

In general, buoyage in strong tidal streams, such as the Fall of Warness area, may not be appropriate. If structures are permanently above the surface, such as OpenHydro, these can be marked and lit with no need for buoys.

11.4 EMEC Procedures

EMEC have procedures in place to manage activities at the site which to date have been successful with only one anchor damage accident recorded on the site. The EMEC standards include:

- Task Risk Assessment
- Permit to Work
- Permit to Access Site
- Hazard Identification Reporting
- Maritime Safety Information (described in Section 11.5)

11.5 Information Circulation

EMEC's Maritime Safety Information procedure ensures the appropriate authorities, e.g., UKHO, OIC Marine Services (Harbours and Ferries) and Shetland Coastguard, are informed of works being carried out in waters within EMEC's test site areas and of the installation of any permanent (or semi-permanent) structure such that the information is promulgated through appropriate channels to mariners.

Information on the new cables should also be provided to Kingfisher Information Services, who produce paper and electronic awareness charts for fishermen. This will ensure it is automatically included on FishSafe devices carried by larger fishing vessels passing through the area, which means they will receive a warning if passing in the vicinity.

In addition to this, targeted information about developments, including under keel clearance issues (Type 1 and 2 devices) can be circulated to vessels using the area. The local vessels (inter-island ferries and fishermen), can be targeted via OIC Marine Services and the various fisheries associations.

The schedule for cruise ships visiting Orkney tends to be known in advance and is regularly updated on the OIC Marine Services website. Information can be issued to vessels that could potentially use the Fall of Warness via ship operators, agents and/or OIC Marine Services.

11.6 Device Monitoring

Developers are required by the regulators and their consultees to produce an independent structural verification report for their device. It is a contractual requirement that a report that certifies the integrity of the structural design of the device and its foundation for the conditions expected at the site, e.g., tested to withstand 50-year return period. The report shall be provided by an independent accreditation agency of recognised international standing and reputation.

Nevertheless, consequences and emergency response procedures should a device (or any part of a device) lose station need to be developed on a device-specific basis. This should take into account alerting of the potential hazard via position monitoring systems, e.g., SCADA system, and availability of a 24-hour emergency contact so that information can be promptly passed to the Coastguard. This will ensure local warnings are issued, especially in the case of buoyant device parts which could pose a risk to vessels.

11.7 Construction, Maintenance and Decommissioning

During these activities, it is important that vessels working at the site adhere to guidelines and are watchful of the passing traffic in the area, particularly the regular ferries and local fishing vessels. Site vessels should avoid obstructing passing traffic as far as practicable.

Consultation should be carried out with OIC Marine Services prior to specific works at the site involving vessels of restricted manoeuvrability.

11.8 Guard Vessel

A dedicated guard vessel could be stationed at the site to monitor vessel traffic on radar and AIS and intervene in the event of a vessel approaching on a potential collision course.

Such guard vessels have been employed on the site in the past to protect equipment, and there is one recorded incident of a guard vessel intervening in the case of an errant fishing vessel.

The cost of a permanent guard vessel is unlikely to be justified on a cost-benefit basis. Also the vessel being in the area would be exposed to other maritime risks, including vessel-to-vessel collision risk, which could negate any benefit in reducing the device collision risk.

Guard vessels may be appropriate during installation activities when there could be other vessels in the area, restricted in manoeuvrability, which could pose a collision risk to passing vessels.

It is important that any vessels employed to guard the site follow appropriate guidelines as comments received during consultation indicated some issues in the past.

11.9 Vessel Monitoring (Recorded)

AIS data is continuing to be collected by EMEC, covering the Fall of Warness site, which covers a good proportion of the larger vessels exposed to collision (though not all). This can be monitored in the lead up to a device being installed at FoW as well as during operation. Any change in routeing patterns and/or new vessels operating in the vicinity should be identified and appropriate action taken, e.g., contact vessels. The watchkeeper logs should also be reviewed for the same purpose.

One example of a potential change would be the extension of the pier at Hatston, Kirkwall, which is being considered by OIC Marine Services. This could change the levels and composition of traffic heading via the Fall of Warness.

11.10 Vessel Monitoring (Live)

Real-time monitoring of the AIS feed could be setup, either on Orkney or remotely. Guard zones could be established around devices to alarm based on set criteria, such as a vessel entering the area with a specified minimum draught. Tide and wave data could also be fed into the system to make the alarm criteria more sophisticated based on under keel clearance.

To be effective, this would require regular (preferably constant) monitoring as well as a means to contact vessels, e.g., VHF. Scapa VTS have coverage but the area is outside the Harbour Limits and hence not actively watched.

This measure is documented for consideration on a device-specific basis, but may not be cost-effective, especially as not all vessels at risk of collision currently broadcast on AIS.

11.11 Aid to Navigation (ATON)

AIS can be used as an Aid to Navigation on physical surface devices. In addition, a shore-based AIS could be configured to transmit AIS messages indicating the existence of an apparent (‘virtual’) ATON at a location even though there is no physical ATON there. This could transit information about a device location to passing vessels equipped with AIS.

This should be considered on a device-specific basis in consultation with NLB.

11.12 Control Turbines

For devices with either submerged or surface-piercing turbines, the technical feasibility of stopping the turbine blades in the most favourable position to minimise risks to passing vessels should be investigated.

This may provide additional under keel clearance in certain circumstances which could mitigate the subsurface collision risk for vessels.

11.13 SAR Liaison

As noted in Section 8.6, developers should liaise with the RNLI and the MCA about the devices to be deployed and provide any further information requested to assist SAR response.

12. Conclusions

This study has revised the navigation risk assessment for the Fall of Warness tidal power site.

The work has included updating the baseline vessel activity using the latest available data sets, analysing new metocean data for each of the cable berths, carrying out fresh consultation, reviewing historical maritime incidents in the area and reviewing Search and Rescue resources in the vicinity. The two new cable berths planned for installation in 2010 have also been considered.

In general, the navigational risks associated with the five existing and two planned cable berths are considered to be relatively low. This is in part due to the original site selection, which took into account the local traffic features, as well as the fact the site has now been established since 2006.

The local vessels in the area, such as inter-island ferries, have good awareness of device locations and in the case of submerged devices, are likely to avoid passing directly over the locations.

Transiting vessels on the key NW-SE route tend to already pass to the west of the site when passing west of the cable berths, as advised by the cautionary note on the chart.

Prudent mariners will only navigate via the Fall of Warness in appropriate conditions and ensuring adequate under-keel clearance at all times, making due allowance for all the factors that may affect the depth beneath their keels. For example, cruise ships, which transit the area for sight-seeing opportunities, are unlikely to expose their passengers to very severe sea states if it can be avoided. It is noted that cruise ships are only expected to transit the area during summer months when waves are lower.

Mitigation measures to help minimise the navigational risks associated with devices were reviewed in Section 11, including SAR liaison.

Detailed information on the factors affecting under keel clearance of the different vessels using the area in different metocean conditions has been provided to assist in device-specific collision risk assessments of submerged devices at any of the cable berths. To model the actual collision risk at any cable berth for a device-specific NRA, details on the device dimensions are required along with the vessel movements data and metocean data re-analysed for the specific deployment location.

13. References

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