Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 3

Appendix 13.1 - Navigation Risk Assessment

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Sheringham Shoal and Dudgeon Extension Projects

Navigation Risk Assessment

for ES

Prepared by	Anatec Limited
Presented to	Equinor New Energy Limited
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Revision Number	Date	Summary of Change
00	30/10/2020	Draft for PEIR
01	08/12/2020	Updates following initial review.
02	07/09/2021	ES Updates.
03	08/11/2021	Updates following additional internal review.
04	08/12/2021	Further pre application updates.
05	14/06/2022	Updates following layout changes.
06	14/07/2022	Further internal updates.
07	23/08/2022	Final updates pre submission.

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Abbreviations Table

Abbreviation	Definition
µPa	Micropascal
AC	Alternating Current
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ALB	All-Weather Lifeboat
ARPA	Automatic Radar Plotting Aid
ATBA	Area to be Avoided
AtoN	Aid to Navigation
BEIS	Department of Business, Energy, and Industrial Strategy
BMAPA	British Marine Aggregate Producers Association
BSU	Federal Bureau of Maritime Casualty Investigation
BWEA	British Wind Energy Association
CA	Cruising Association
CBA	Cost Benefit Analysis
CCTV	Closed Circuit Television
CHIRP	Confidential Human Factors Incident Reporting Programme
COLREGS	International Regulations for Preventing Collisions at Sea
CoS	Chamber of Shipping
CRO	Coastguard Rescue Officer
CRT	Coastguard Rescue Team
CTV	Crew Transfer Vessel
dB	Decibel
DC	Direct Current
DCO	Development Consent Order
DD(D)MM	Degree Decimal Minutes
DECC	Department for Environment and Climate Change
dML	Deemed Marine Licence
DEP	Dudgeon Extension Project
DF	Direction Finding
DfT	Department for Transport
DSC	Digital Selective Calling
EIA	Environmental Impact Assessment

Abbreviation	Definition
EMF	Electromagnetic Field
ERCoP	Emergency Response Co-operation Plan
ES	Environmental Statement
ESI	Electrical Systems Infrastructure
FSA	Formal Safety Assessment
GIS	Geographical Information System
GLA	General Lighthouse Authority
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HMCG	Her Majesty's Coastguard
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IHO	International Hydrographic Organisation
ILB	Inshore Lifeboat
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IRPA	Individual Risk per Annum
ITAP	Institut für technische und angewandte Physik
JRCC	Joint Rescue Co-ordination Centre
kHz	Kilohertz
km	Kilometre
km^2	Square kilometres
kt	Knot
LAT	Lowest Astronomical Tide
LOA	Length Overall
LOGGS	Lincolnshire Offshore Gas Gathering System
m	Metre
MCZ	Marine Conservation Zone
mm	Millimetre
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario

Abbreviation	Definition
MEHRA	Marine Environmental High Risk Areas
MEPC	Marine Environment Protection Committee
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MOD	Military of Defence
MRCC	Maritime Rescue Co-ordination Centre
MSC	Maritime Safety Committee
MSI	Maritime Safety Information
MW	Megawatt
NAVTEX	Navigational Telex
nm	Nautical Mile
nm^2	Square Nautical Miles
NRA	Navigation Risk Assessment
NSIP	Nationally Significant Infrastructure Project
NtM	Notice to Mariners
O&G	Oil and Gas
OOW	Officer of the Watch
OREI	Offshore Renewable Energy Installations
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm
PDE	Project Description Envelope
PEIR	Preliminary Environmental Information Report
PEXA	Practice and Exercise Areas
PLA	Port of London Authority
PLL	Potential Loss of Life
REZ	Renewable Energy Zone
RNLI	Royal National Lifeboat Institution
Ro Ro	Roll on Roll Off
RYA	Royal Yachting Association
SAR	Search and Rescue
SEP	Sheringham Extension Project
SOLAS	Safety of Life at Sea

Abbreviation	Definition
SONAR	Sound Navigation Ranging
SOS	Secretary of State
SOV	Service Operations Vessel
TCE	The Crown Estate
TOA	Technical & Operational Analysis
TSS	Traffic Separation Scheme
RYA	Royal Yachting Association
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
VHF	Very High Frequency
VTS	Vessel Traffic Scheme
WT	Wind Turbines

1 Introduction

1.1 Background

1. Anatec was commissioned by Equinor New Energy Limited (hereafter referred to as Equinor) to undertake a Navigation Risk Assessment (NRA) for the proposed Sheringham Shoal (SEP) and Dudgeon Extension Projects (DEP) consisting of the two wind farm sites, and the offshore export cable corridor. This NRA presents information on the proposed projects relative to the existing and estimated future navigational activity and forms the technical appendix to Chapter 13 Shipping and Navigation of the Environmental Statement (ES).

2. It is noted that a preliminary NRA was included within the Preliminary Environmental Information Report (PEIR). The NRA submitted at ES stage has been updated based on relevant Section 42 feedback received in response to the PEIR consultation (see Section 4.4).

1.2 Navigation Risk Assessment

3. An important aspect of the Environmental Impact Assessment (EIA) for offshore projects is the NRA which is required under Marine Guidance Note (MGN) 654 (MCA, 2021). In line with this guidance, the NRA includes:

- Overview of the existing environment;
- Emergency response overview;
- Consultation overview;
- Vessel traffic survey;
- Implications of Offshore Wind Farms (OWFs) including position of wind turbine;
- Implications for marine navigational, communication and position fixing equipment;
- Assessment of marine risk pre and post wind farm;
- Any required monitoring; and
- Formal Safety Assessment (FSA).

4. The key output of the NRA is the FSA, which will inform the impact assessment to be undertaken within Chapter 13 Shipping and Navigation of the ES.

2 Guidance and Legislation

2.1 Legislation

5. Planning policy on offshore renewable energy Nationally Significant Infrastructure Projects (NSIP), specifically in relation to shipping and navigation is contained in the NPS for Renewable Energy Infrastructure (EN-3, Department for Environment and Climate Change (DECC), 2011), summarised in ES Chapter 2 Policy and Legislative Context and Chapter 13 Shipping and Navigation.

2.2 Primary Guidance

6. The primary guidance documents used during the NRA are the following:

- MGN 654 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Response including annexes (MCA, 2021); and
- Revised Guidelines for FSA for use in the Rule-Making Process (International Maritime Organization (IMO), 2018).

7. MGN 654 highlights issues that shall be considered when assessing the effect on navigational safety from offshore renewable energy developments, proposed in UK internal waters, territorial sea, or Renewable Energy Zones (REZs).

8. The MCA require that their methodology (Annex 1 to MGN 654) is used as the template for preparing all NRAs. The methodology is centred on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk associated with the relevant project to be judged as broadly acceptable or tolerable with mitigation. Within the NRA both base and future case levels of risk have been identified, and what measures are required to ensure the future case remains broadly acceptable or at most tolerable. Further detail on the use of the IMO FSA process is included within Section 3.1.

2.3 Other Guidance

9. Other guidance documents used during the NRA are as follows:

- MGN 372 (Merchant and Fishing) OREIs: Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2008);
- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA, 2021);
- IALA Guideline G1162 The Marking of Offshore Man-Made Structures (IALA, 2021);
- The Royal Yachting Association's (RYA's) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy (RYA, 2019); and
- Standard Marking Schedule for Offshore Installations (DECC, 2011a).

3 Navigational Risk Assessment Methodology

10. This section details the approach and methodology taken within the NRA. It is noted that in agreement with the MCA, a single NRA has been produced for both the SEP and DEP, however there is clear distinction made throughout between the two where appropriate.

3.1 Formal Safety Assessment Methodology

11. A shipping and navigation receptor can only be affected by an impact if there exists a pathway through which an impact can be transmitted between the source activity and receptor. In cases where a receptor is exposed to an impact, the overall severity of consequence to the receptor is determined. This process incorporates a degree of subjectivity, and as such the FSAs presented for shipping and navigation receptors in this NRA have considered multiple criteria as follows:

- Baseline data and assessment of data;
- Expert opinion;
- Level of stakeholder concern;
- Time and/or distance of any deviation;
- Number of transits of specific vessel and/or vessel type; and
- Lessons learnt from existing offshore developments.

12. It is noted that, with regards to fishing vessels, the methodology and FSA has been applied to impacts of relevance to fishing vessels in transit. A separate methodology and FSA have been applied in Chapter 12 Commercial Fisheries to consider commercial impacts on fishing vessels. Safety impacts which are directly related to deployed fishing gear (as opposed to fishing vessels in transit) are assessed in Chapter 13 Shipping and Navigation.

3.2 Formal Safety Assessment Process

13. The IMO FSA process (IMO, 2018) as approved by the IMO in 2018 under Maritime Safety Committee (MSC) – Marine Environment Protection Committee (MEPC).2/circ. 12/Rev.2 will be applied to the impact assessment within this NRA, which will inform Chapter 13 Shipping and Navigation.

14. The FSA process is a structured and systematic methodology based upon risk analysis and Cost Benefit Analysis (CBA) (if applicable) to reduce impacts to As Low as Reasonably Practicable (ALARP). There are five basic steps within this process as illustrated by Figure 3.1 and summarised in the following list:

- Step 1 – Identification of hazards (a list is produced of hazards prioritised by risk level specific to the problem under review);
- Step 2 – Risk assessment (investigation of the causes and initiating events and consequences of the more important hazards identified in step 1);

- Step 3 – Risk control options (mitigations identification of measures to control and reduce the identified hazards);
- Step 4 – CBA (identification and comparison of the benefits and costs associated with the risk control options identified in step 3); and
- Step 5 – Recommendations for decision-making (defining of recommendations based upon the outputs of steps 1 to 4).

Figure 3.1 Flow chart of the FSA methodology

3.2.1 Hazard Workshop Methodology

15. A key tool used in the NRA process is the Hazard Workshop which ensures that all risks are identified and qualified in discussion with relevant consultees. A Hazard Workshop was therefore held in August 2021 (see Section 4.5), the output of which was used to produce the hazard log (Annex A). Table 3.1 and Table 3.2 define the severity of consequences and the frequency of occurrence rankings that have been used to assess impacts within the hazard log.

Table 3.1 Severity of Consequence Ranking Definitions

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No perceptible impact.	No perceptible impact.	No perceptible impact.	No perceptible impact.

Rank	Description	Definition			
		People	Property	Environment	Business
2	Minor	Slight injury(s).	Minor damage to property i.e., superficial damage.	Tier 1 local assistance required.	Minor reputational impact – limited to users.
3	Moderate	Multiple minor or single serious injury.	Damage not critical to operations.	Tier 2 limited external assistance required.	Local reputation impacts.
4	Serious	Multiple serious injury or single fatality.	Damage resulting in critical impact on operations.	Tier 2 regional assistance required.	National reputation impacts.
5	Major	More than one fatality.	Total loss of property.	Tier 3 national assistance required.	International reputational impacts.

Table 3.2 Frequency of Occurrence Ranking Definitions

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely unlikely	1 per 100–10,000 years
3	Remote	1 per 10–100 years
4	Reasonably probable	1 per 1–10 years
5	Frequent	Yearly

16. The severity of consequence and frequency of occurrence are then used to define impact significance via a risk matrix approach as shown in Table 3.3. The tolerability of an impact is defined as Broadly Acceptable (low risk), Tolerable (intermediate risk) or Unacceptable (high risk), as defined in Table 3.4.

Table 3.3 Tolerability Matrix

Severity of Consequence						
	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency of Occurrence				

Table 3.4 Significance Definitions

Significance		Description
	Unacceptable (high risk)	Safety risks are unacceptable (high risk) and cannot be managed via mitigation. Unacceptable risks are not considered ALARP.
	Tolerable (intermediate risk)	Safety risk is tolerable (intermediate risk) and can be ALARP if appropriate mitigation (embedded or additional) is in place to control or monitor risk. Note any mitigation required must be secured for the risk to be ALARP.
	Broadly Acceptable (low risk)	These risks are low consequence and / or low frequency with embedded mitigations in place.

17. Once identified, the tolerability of an impact will be assessed to ensure it is ALARP. Further risk control measures may be required to further mitigate an impact in accordance with the ALARP principles. Unacceptable risks are not considered to be ALARP.

3.3 Methodology for Cumulative Effect Assessment

18. All impacts identified and assessed within the FSA process are also assessed for potential cumulative effects taking into account other cumulative developments. Given the varying status and location of developments, a tiered approach to other cumulative developments has been taken, with tier classification depending on:

- Project status;
- Proximity to project (a maximum extent of 100nm has been considered);
- Likely level of cumulative effect; and
- Data confidence.

19. The tiers utilised are summarised in Table 3.5, which includes the criteria required for a development to be placed within each tier. Projects within tiers 1-3 have then been assessed as part of the cumulative routeing scenario (see section 17and 18.7). Tier 4 projects have not been considered given the uncertainty in the project progression and the distance from the wind farm sites.

Table 3.5 Cumulative Tier Summary

Tier	Minimum Project Status	Definition	Minimum Data Confidence	Assessment Approach
1	Operational, under construction, consented or under determination	▪ May impact a main route identified as passing within the study area (See section 5.3) ▪ OWF within 50 nautical miles (nm) of the wind farm sites ▪ Surface Oil & Gas (O&G) asset within 10nm of the wind farm sites	Medium	Quantitative cumulative re-routeing of main routes
2	Operational, under construction, consented or under determination	▪ May impact a main route identified as passing within the study area (See section 5.3) ▪ OWF within 100nm of the wind farm sites	Medium	Quantitative cumulative re-routeing of main routes
3	Scoped, or application expected	▪ Unlikely to impact upon a main route identified as passing within the study area (See section 5.3) ▪ Within 100nm of the wind farm sites	Low	Qualitative assumptions of routeing only
4	Pre Scoping	▪ Further than 100nm from the wind farm sites	Low	Not considered (screened out)

3.4 Assumptions

20. The shipping and navigation baseline and subsequent impact identification has been undertaken based upon the information available and responses received at the time of preparation of the NRA. It has been assessed based upon a conservative scenario, in particular noting that the locations of the structures will not be finalised until post consent.

4 Consultation

21. This section sets out the consultation undertaken to date as part of the NRA process. This process has considered consultation requirements and recommendations within the *Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI) (MCA, 2013)*.

4.1 Scoping Opinion

22. A Scoping Report was submitted to the Planning Inspectorate in October 2019. Key outputs of the subsequent Scoping Opinion of relevance to shipping and navigation are summarised in Table 4.1.

Table 4.1 Scoping Opinion Summary – Shipping and Navigation

Consultee(s)	Key Points Raised	Where Addressed
Secretary of State (SOS)	EIA should assess impacts to marine navigation equipment, marine aggregate dredger transits, and adverse weather routeing. Impacts to navigation from scour / sediment transport should also be assessed.	▪ Effects on navigational equipment are assessed in Section 16 ▪ Marine aggregate dredger transits are assessed in Section 18.6.3 ▪ Adverse weather routeing is assessed in Section 15.3 ▪ Effects arising from scour / sediment transport are assessed in Section 21.1.6
SOS	10% increase in (future case) traffic should be justified.	See Section 18.1
SOS	Shipping and Navigation and Commercial Fishing chapters to state what “size” of safety zones will be used	See Section 20.1
MCA	Given significant amount of through traffic to major ports, and a number of important shipping routes in close proximity, attention needs to be paid to routeing, particularly in heavy weather ensuring shipping can continue to make safe passage without large-scale deviations	Post wind farm routeing is assessed in Section 18.6.2. Adverse is considered specifically within Section 15.3
MCA	A Navigational Risk Assessment will need to be submitted in accordance with MGN 543[1] (and MGN 372) and the MCA Methodology for Assessing the Marine Navigation Safety & Emergency Response Risks of OREI. Should include MGN 543[1] Checklist.	▪ This NRA complies with the latest version of this guidance (MGN 654) as per Section 2 ▪ A completed MGN 654 checklist is available within Annex A
MCA	Cumulative and in combination effects[2] on shipping routes should be considered, taking into account proximity to other wind farm developments, the impact on navigable sea room and include an appropriate assessment of the distances between wind farm boundaries and shipping routes as per MGN 543[1].	Post wind farm routeing is assessed in Section 18.6.2. Cumulative assessment of routeing is provided in Section 18.7.

[1] Superseded by MGN 654 in April 2021.
[2] In combination effects for shipping and navigation are considered the same as cumulative.

Consultee(s)	Key Points Raised	Where Addressed
MCA	[MCA] note that a vessel traffic survey will be undertaken to the standard of MGN 543[3]. This must consist of at least 28 days and include seasonal data (two x 14-day surveys) collected from a vessel-based survey using Automatic Identification System (AIS), radar and visual observations to capture all vessels navigating in the study area (See section 5.3).	See Section 7. The approach to marine traffic data collection has been agreed with the MCA and complies with the most up to date MCA guidance (MGN 654).
MCA	The turbine layout design will require MCA approval prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue (SAR) aircraft operating within the site. As such, MCA will seek to ensure all structures are aligned with the current layout designs of Dudgeon and Sheringham Shoal wind farms, in straight rows and columns, and with at least two lines of orientation. Any additional navigation safety and/or SAR requirements, as per MGN 543[3] Annex 5, will be agreed at the approval stage.	As per Section 2, this NRA complies with the most up to date MCA guidance (MGN 654). The layout and any SAR requirements will be agreed with the MCA post consent.
MCA	Attention should be paid to cabling routes and where appropriate burial depth for which a Burial Protection Index study should be completed and, subject to the traffic volumes, an anchor penetration study may be necessary. If cable protection are required e.g. rock bags, concrete mattresses, the MCA would be willing to accept a 5% reduction in surrounding depths referenced to Chart Datum. This will be particularly relevant where depths are decreasing towards shore and potential impacts on navigable water increase.	As per Section 3, a Cable Burial Risk Assessment will be undertaken to determine cable protection requirements, and there will be full MGN 654 compliance in all regards, including changes to water depths.
MCA	Particular consideration will need to be given to the implications of the site size and location on SAR resources and Emergency Response Co-operation Plans (ERCoP). Attention should be paid to the level of radar surveillance, AIS and shore-based Very High Frequency (VHF) radio coverage and give due consideration for appropriate mitigation such as radar, AIS receivers and in-field, Marine Band VHF radio communications aerial(s) (VHF voice with Digital Selective Calling (DSC)) that can cover the entire wind farm sites and their surrounding areas. A SAR checklist will also need to be completed in consultation with MCA.	The layout and any SAR requirements will be agreed with the MCA post consent. This will include the completion of a SAR checklist as required under MGN 654.
MCA	MGN 543[3] Annex 2 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full density data set, and survey report to the MCA Hydrography Manager. Failure to report the survey or conduct it to Order 1a might invalidate the NRA if it was deemed not fit for purpose.	Equinor will comply with all aspects of MGN 654 as per Section 2, including hydrographic survey requirements (Annex 4 of MGN 654).

[3] Superseded by MGN 654 in April 2021.

Consultee(s)	Key Points Raised	Where Addressed
Ministry of Defence (MOD)	The Scoping Report makes reference to the lighting of the Dudgeon OWF and the MOD's Lighting Guidance is listed as a data source. In the interests of air safety, the SEP and DEP areas should be fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order 2016. The MOD would need to confirm the specification of the lighting to be used.	Lighting and marking will be agreed with all relevant stakeholders post consent as per Section 20.Note: The MODs lighting guidance is reference in Chapter 15 Aviation and Radar.
Trinity House	NRA should include: ▪ Comprehensive vessel traffic analysis in accordance with MGN 543[4]. ▪ The possible cumulative and in-combination effects on shipping routes and patterns should be fully assessed, with particular reference to the current operational Dudgeon, Sheringham Shoal and Race Bank OWFs. ▪ Any proposed layouts should conform with MGN 543[4] and again consideration should be given to the layouts of the current Dudgeon and Sheringham Shoal OWFs. The SEP layout should align with the current site, however, as the Dudgeon OWF site has a less uniform layout, early consideration surrounding the DEP layout and risk mitigation measures will be required. ▪ If any structures, such as met masts, offshore platforms, accommodation platforms or other transmission assets, lie outwith the actual wind farm turbine layout, then additional risk assessment should be undertaken.	▪ Marine traffic analysis is presented in Section 14; ▪ Cumulative assessment of routeing is provided in Section 18.7; and ▪ The layout and any SAR requirements will be agreed with the MCA post consent.
Trinity House	The wind farms need to be marked with marine Aid to Navigation (AtoN) by the developer in line with IALA Recommendation O-139. Noted that buoys may be necessary in addition to structure marking, particularly during the construction phase. All marine navigational marking (required to be provided and maintained by the developer) should be agreed with Trinity House. This will includes meeting availability requirements and the reporting thereof.	As per Section 3, lighting and marking with be defined in agreement with Trinity House and in line with IALA O-139 / G1162. All availability and reporting requirements will be met.
Trinity House	Any monitoring equipment, including met masts and LIDAR or wave buoys must also be marked as required by Trinity House.	As per Section 3, lighting and marking with be defined in agreement with Trinity House.
Trinity House	A decommissioning plan, which includes a scenario where on decommissioning and on completion of removal operations an obstruction is left on site (attributable to the wind farm) which is considered to be a danger to navigation and which it has not proved possible to remove, should be considered. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation, the continuing cost of which would need to be met by the developer/operator.	See Section 22.1.

[4] Superseded by MGN 654 in April 2021.

Consultee(s)	Key Points Raised	Where Addressed
Trinity House	The possible requirement for navigational marking of the export cables and the vessels laying them. If it is necessary for the cables to be protected by rock armour, concrete mattresses or similar protection which lies clear of the surrounding seabed, the impact on navigation and the requirement for appropriate risk mitigation measures needs to be assessed.	As per Section 3, a Cable Burial Risk Assessment will be undertaken to determine cable protection requirements. Navigational marking will be agreed with Trinity House as per Section 20.

4.2 Consultee Meetings

23. Details of meetings held with key stakeholders are summarised in Table 4.2. This includes reference to where the points raised have been incorporated or addressed within the NRA.

Table 4.2 Key Stakeholder Meetings

Consultation Type	Summary	Where Addressed
Meeting with MCA / Trinity House – 25/09/2018	A single (i.e., combined) NRA will be produced for both extension projects.	n/a
	Irregular areas, i.e., area divided in several smaller shapes represents challenges with respect to lighting and marking.	The final layout will be agreed with MCA post consent, including the need for any additional mitigations. Lighting and marking will be agreed with all key stakeholders including Trinity House and MCA (see Section 3).
	Preference for extensions to be one area as supposed to several.	The final layout will be agreed with MCA post consent, including the need for any additional mitigations.
	Preference for layout which has a minimum of two lines of orientation, with turbines in straight lines. Alignment issues between Dudgeon and extension were noted in this regard.	The final layout will be agreed with MCA post consent, including the need for any additional mitigations.
	MCA and Trinity House stated required dimensions of shipping corridors should be calculated as per MGN 543[5] Annex 3.	See Section 18.4.

[5] Superseded by MGN 654 in April 2021.

Consultation Type	Summary	Where Addressed
	Noted that a "first come first serve" principle in place regarding assessment of cumulative effects towards other lease holders.	A “tiered” approach to cumulative assessment has been undertaken as per Section 3.3.
Virtual meeting with MCA / Trinity House – 15/06/2020	MCA stated good to see rows and columns of structures with no isolated / protruding turbines within the indicative layouts shown.	The final layout will be agreed with the MCA post consent and will comply with the Layout Rules (see Section 3).
	In terms of SAR, alignment, and lighting / marking perspectives, there was greater concern over DEP than SEP.	The final layout will be agreed with the MCA post consent and will comply with the Layout Rules. Lighting and marking will be agreed with all key stakeholders including MCA and Trinity House (see Section 3).
	MGN 543 update referenced by MCA, but agreed current version will be considered, noting no notable changes expected.	NRA complies with latest version of relevant MCA guidance (MGN 654) as per Section 2.
	MCA and Trinity House both content with impacts to be assessed (which have been identified based on Scoping Report and subsequent Scoping Opinion).	Agreed impacts are assessed in Section 21.
	MCA and Trinity House content with proposed approach to marine traffic data (summer 2020 survey supplemented with long term data and consultation; additional survey late 2020 / early 2021).	Agreed approach utilised as per Section 7.
	Trinity House noted some alterations to operational lighting and marking of existing sites may be necessary to account for the extensions.	Lighting and marking will be agreed with all key stakeholders including Trinity House (see Section 3).
	MCA noted that as required under MGN 543[6], radio surveys should be undertaken pre and post construction for the extension projects.	There will be full MGN 654 compliance as per Section 3.
Virtual meeting with Cruising Association (CA) – 17/09/2020	Content with approach to NRA and marine traffic data.	Agreed approach utilised as per Section 3 and Section 7.
	Concerns over increases / squeezing of traffic between the extension projects leading to rise in encounters / collision risk to recreational vessels. Noted that traffic in the area would be coming in bands associated with tidal times in the Humber.	Collision risk is assessed within Section 21.1.3.

[6] Superseded by MGN 654 in April 2021.

Consultation Type	Summary	Where Addressed
	Queries over effect of COVID situation on July / Aug 2020 traffic survey.	See Section 7. The approach to marine traffic data collection has been agreed with the MCA, and includes consideration of additional data sources (including long term pre COVID marine traffic data).
	Queried potential for any routeing measures in the area to assist with traffic management, and noted that marked routes (using buoyage) were helpful.	As per Section 21.1.3, appropriate mitigation in relation to increased and encounters collision risk will be discussed with the MCA.
Virtual meeting with RYA – 30/09/2020	Content with approach to NRA and marine traffic data.	Agreed approach utilised as per Section 3 and Section 7.
	Concerns for these sites were generally around under keel clearance and snagging.	Underkeel clearance is assessed within Section 21.1.6. Cable interaction is assessed within Section 21.1.5.
	Queries over whether MGN 543 will be utilised as it stands. It was confirmed this was the case given the updates have not yet been confirmed / published.	The ES NRA complies with latest version of relevant MCA guidance (MGN 654) as per Section 2.
	Noted the importance of considering both elements (density grids and boating areas) of the RYA Coastal Atlas and to be aware the density grids are based on AIS only.	The RYA Coastal Atlas has been considered in full (see Section 5.2).
	Pleased to see that the summer survey was undertaken in July and August and was content with the marine traffic survey approach.	Agreed approach utilised as per Section 7.
	Noted that recreational vessels were currently transiting in areas used by commercial vessels (i.e., area between the sites) and extensions may therefore increase collision risk.	Collision risk is assessed within Section 21.1.3.
Virtual meeting with Chamber of Shipping (CoS) – 06/10/2020	Queried alignment with the existing turbines.	The final layout will be agreed with the MCA post consent and will comply with the Layout Rules (see Section 3).
	Queried whether any future updates to MGN 543 would be incorporated / complied with noting these updates are out for consultation. Content with approach to NRA and marine traffic data.	NRA complies with latest version of relevant MCA guidance (MGN 654). Agreed approach utilised as per Section 3 and Section 7.
	Pleased to see that seasonal variation (or lack thereof) was being captured via the assessment of 12 months of AIS to supplement the marine traffic survey data.	Agreed approach to marine traffic data collection utilised as per Section 7.

Consultation Type	Summary	Where Addressed
	Queried whether marine aggregate dredging presence in the area would be assessed, and whether the British Marine Aggregate Producers Association (BMAPA) routes would be considered.	See Sections 15.4 and 18.6.3.
	Queried whether post wind farm routeing would consider both sites being built.	The scenario where both sites are built has been considered as per Section 18.6.2.
Virtual meeting with P&O Ferries – 09/07/2021	Pride of York and Pride of Bruges have been sold since 2019, however chartered vessels are being used on the same routes, and Mean Route Positions and schedules have not changed. There have been no transit reductions on any routes (including those associated with Teesside) since 2019. On this basis P&O confirmed content with baseline assessment.	Noted, and incorporated into assessment.
	Stated no navigational safety concerns with regards to reduced searoom (P&O vessels navigate more restricted areas than would be the case here). Primary P&O concern is around the potential for additional journey distances over the life of the wind farm leading to increased cost.	Post wind farm routeing is considered in Section 18.6.2. Impacts associated with deviations and displacement are assessed within Section 21.1.1.
	Noted related concern over "indirect" impacts from SEP and DEP, in particular from deviations taken to avoid wind farm traffic both near the wind farm sites and in port approaches.	Deviations associated with project traffic are considered in Section 18.5. Impacts associated with deviations and displacement are assessed within Section 21.1.1.
	Stated consideration of shipping routes during the site design process could help with deviations and the commercial impacts.	As per Section 20, the layout will be designed in consultation with MCA and Trinity House.
	Suggested procedures / commitments in relation to project vessel routeing would be beneficial in terms of limiting a need to deviate. In particular, consideration of crossing angles with existing shipping routes. Noting COLREGS compliance, specified routeing for wind farm vessels would limit the need for P&O vessels to deviate.	Deviations associated with project traffic are considered in Section 18.5. The Navigation Management Plan has been included as additional mitigation within the impact assessment (see Section 21.1.1).
Virtual meeting with CoS – 16/07/2021	Noted comments had been provided on the The Crown Estate (TCE) in 2018 on the proposed extension areas before they were awarded to developers. These have been reiterated in the CoS Section 42 response.	Points raised have been addressed within NRA where appropriate (see Section 4.4).

Consultation Type	Summary	Where Addressed
	Due to the levels of traffic within the area, the layout of the array within the red line boundary needs to consider the volume of traffic within the area. This should include consideration of low use / adverse weather routeing.	Annex B provides assessment of long term AIS data to ensure a comprehensive understanding of the baseline. Adverse weather routes are considered in Section 15.3.
	CoS consider the navigational risk on a holistic basis to be the main concern within the area. Particularly, the loss of navigable sea room increasing the encounters in the area and therefore the collision risk	Loss of searoom is considered in Section 18.4. Collision risk is assessed quantitatively within Section 19.2.2.1, and considered within the impact assessment in Section 21.1.3.
	Stated that whilst the minimum passing distance of 1 nm assumed in the NRA was suitable for assessment purposes, other sources (e.g., Witherby Guide) recommend 2 nm.	This has been considered within the assessment of available searoom in Section 18.4.
	Agreed that marine coordination controlling and promulgating the movements of project vessels to ensure they did not encounter commercial vessels would partially mitigate the searoom impact.	The Navigation Management Plan is discussed in Section 18.5 and have been considered as additional mitigation within the impact assessment (see Section 21.1.1).
	Noted that strict application of the "corridor" width calculations provided within MGN 654 and assumed within the PEIR NRA means additional loss of sea room is not accounted for.	Loss of searoom is considered in Section 18.4.
	The cumulative reduction in sea room is the primary CoS concern	Cumulative post wind farm routeing is assessed within Section 18.7. Cumulative assessment of impacts including deviation and collision risk is provided in Section 21.2.
	It was agreed that the "corridor" calculations as they stood would be retained in the application NRA, however additional text would be added to make it clear the additional areas of searoom that could be lost (assuming full build out).	Loss of searoom is considered in Section 18.4, noting text has been expanded post PEIR.
	Noted the potential for increased passing distances to account for radar interference issues.	Impacts associated with Radar are considered in Section 16.7.

Consultation Type	Summary	Where Addressed
	CoS were content with the post wind farm routing, assuming concerns over loss of sea room were also made clear in the NRA.	Post wind farm routeing is considered in Section 18.6.2 and loss of searoom is considered in Section 18.4.
	In terms of preferred / "primary" mitigation, CoS would recommend consideration of changes to site boundaries with a view to maximising the available space between the sites.	As per Section 20, the layout will be designed in consultation with MCA and Trinity House.
Virtual meeting with CoS – 10/02/2022	Summary of post PEIR NRA updates to CoS.	n/a

4.3 Regular Operators Outreach

24. Marine traffic data (see Section 14) was used to identify regular users of the area around the wind farm sites. A request for consultation was sent these operators (see Annex E). The substantive responses received are summarised in Table 4.3.

Table 4.3 Regular Operator Consultation Summary

Operator	Vessel Type/s	Comment Summary	Where Addressed
DFDS (commercial ferries)	Passenger, cargo	The area is utilised by DFDS vessels on adverse weather routes, but no significant impacts are expected.	Adverse weather routeing is assessed in Section 15.3.
Furetank	Tankers	Queried what safety zones would be utilised.	See Section 20.1.
Whitaker Tankers	Tankers	No impacts are expected.	Noted.
Sentinel	Oil and gas	Stated no comments on the project.	Noted.
P&O	Passenger, cargo	Noted that routes would require to deviate to avoid the SEP wind farm site, and that this would lead to increased distance and fuel costs.	Deviation / displacement impacts are assessed within Section 21.1.1.
Boston Putford	Oil and gas	Noted that routes would be required to deviate and that this may cause increases in levels of traffic in other areas. Also, the site is particularly close to the Perenco Waveney platform and could cause restricted access to this platform. Indicated that Boston Putford vessels would likely not transit through the array.	Deviation / displacement impacts are assessed within Section 21.1.1. Access / proximity issues associated with O&G assets are assessed within Chapter 16 Petroleum Industry and Other Marine Users of the ES.

Operator	Vessel Type/s	Comment Summary	Where Addressed
Essberger	Tankers	Deviations will be limited on an individual basis, but will have cumulative effect in terms of emissions. Further, the deviations may lead to a concentration of shipping activity in certain areas, leading to increased collision risk.	Deviation / displacement impacts are assessed within Section 21.1.1., and collision risk is assessed in Section 21.1.3.
Stena Lines	Cargo	Certain routeing will be required to deviate, and the reduction in sea room may lead to increased collision risk. Indicated that Stena vessels would not transit through the array.	Deviation / displacement impacts are assessed within Section 21.1.1., and collision risk is assessed in Section 21.1.3.
GEFO	Tanker	Anticipate limited / manageable deviation.	Deviation / displacement impacts are assessed within Section 21.1.1.

4.4 Section 42 Responses

25. Responses received to the PEIR under Section 42 deemed of relevance to shipping and navigation are summarised in Table 4.4.

Table 4.4 Section 42 Responses

Consultee(s)	Key Points Raised	Where Addressed
MCA	"We note in section 5.4 that an additional 14-day traffic survey (radar, AIS and visual) will be conducted post-PEIR in order to meet the required survey guidelines in MGN 654 (28-day). We note in sections 19.2.4 that consequence scoring will be completed post-PEIR and we also note under section 21 that "the hazard workshop has not yet been undertaken and that impacts will need to be agreed with stakeholder post PEIR but pre-ES submission". We expect the NRA to be updated with the additional data incorporated and MCA will provide further comments once completed."	The additional marine traffic data is assessed within Section 14. As per Section 5.1 the data is considered MGN 654 compliant. Hazard Workshop discussions are summarised in Section 4.5, and the agreed Hazard Log is provided in Annex A.
MCA	We appreciate the early opportunity to comment on the draft MGN 543 checklist, and we can discuss the elements further as the project progresses. A new version of the checklist is available following the recent publication of MGN 654 which will need to be used for the NRA update. We are content at this stage with regards to the process you have undertaken in order to comply with MGN 654 and its annexes, and we welcome the work undertaken for addressing the guidance and recommendations so far.	The updated NRA is MGN 654 compliant (see Section 2) and includes an updated MGN 654 checklist (Annex A).
MCA	The turbine layout design will require MCA agreement prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue aircraft operating within the site. As such, MCA will seek to ensure all structures are	The final layout will be agreed with MCA and SEP and DEP will comply with MGN 654 and annexes - see Section 20.

Consultee(s)	Key Points Raised	Where Addressed
	aligned in straight rows and columns, including any platforms. Any additional navigation safety and/or Search and Rescue requirements, as per MGN 654 Annex 5, will be agreed at the approval stage.	
MCA	We are aware of a proposed seaweed farm west of the Sheringham Shoal wind farm site which we would expect to be assessed within the NRA update for potential impacts to traffic deviations.	Considered within the cumulative assessment of routeing (see Section 18.7).
MCA	MGN 654 Annex 4 requires that hydrographic surveys should fulfil the requirements of the International Hydrographic Organisation (IHO) Order 1a standard, with the final data supplied as a digital full density data set, and survey report to the MCA Hydrography Manager. This information will need to be submitted, ideally at the EIA Report stage	Relevant data will be provided as per MGN 654 checklist (Annex A).
MCA	Export cable routes, cable burial protection index and cable protections are issues that are yet to be fully developed. However due cognisance needs to address cable burial and protection, particularly close to shore where impacts on navigable water depth may become significant. Any consented cable protection works must ensure existing and future safe navigation is not compromised. The MCA would accept a maximum of 5% reduction in surrounding depth referenced to Chart Datum. Where burial depths are not achieved consultation will need to take place with MCA regarding the locations, impact and potential risk mitigation measures.	As per Section 20, Equinor will comply with all requirements of MGN 654 including in relation to underkeel clearance.
MCA	Safety zones during the construction, maintenance and decommissioning phases are supported, however it should be noted that operational safety zones may have a maximum 50m radius from the individual turbines. A detailed justification would be required for a 50m operational safety zone, with significant evidence from the construction phase in addition to the baseline NRA required supporting the case.	Approach to safety zones is summarised in Section 20.1. Any safety zones applied for would be accompanied with a detailed safety case.
MCA	An Emergency Response Cooperation Plan is required to meet the requirements of MGN 654 Annex 5 and will need to be in place prior to construction. The ERCoP is an active operational document and must remain current at all stages of the project including during construction, operations & maintenance and decommissioning. A SAR checklist will be discussed as the project progresses to track all requirements detailed in MGN 654 Annex 5.	As per Section 20, Equinor will comply with all requirements of MGN 654 including in relation to creation of an ERCoP.
Trinity House	Suggest that the Sustainable Seaweed Limited Norfolk proposed seaweed farm project should be assessed in the “In-Combination” section of the Navigation Risk Assessment.	Considered within the cumulative assessment (see Section 18.7 and 21.2).
Trinity House	Trinity House would welcome earliest possible consultation regarding proposed layouts.	As per Section 20, the layout will be designed in consultation with MCA and Trinity House.
CoS	Referenced and reiterated CoS response to TCE as part of the Round Three Extension consultation. **Sheringham Shoal:** *The Chamber does not have any specific navigational concerns at this stage given the insufficient*	Loss of searoom is considered in Section 18.4. Collision risk is assessed quantitatively within Section 19.2.2.1, and considered

Consultee(s)	Key Points Raised	Where Addressed
	information provided on layout or placement of potential turbines, however, would like to raise some concerns over the potential significant loss of sea room from proposed extension, particularly when viewed in combination with the proposed extension for Race Bank of which the boundaries overlap. Smaller vessels and vessels with shallow drafts would be particularly affected since they choose to separate their routeing from larger vessels thereby reducing any risk of collision. Accordingly, the reduction in sea room would likely force them to re-route onto tracks with larger vessels thereby increasing congestion and collision risk. The Chamber has concerns that a significant level of commercial traffic intersects with the eastern boundary and that an extension to the red line boundary would result in further constriction of that commercial traffic as vessels maintain what they consider a safe navigational distance from any turbines or navigational marks. Hence the Chamber recommends a boundary change. ***Dudgeon:*** *The Chamber does not have any specific navigational concerns at this stage given the insufficient information provided on layout or placement of potential turbines however has serious navigational concerns over the suitability of western extent of the northern element to Dudgeon extension and the intersection with a high density route. Accordingly, the Chamber objects to the full extent of the boundary due to the constriction of safe navigational searoom and does not consider the site suitable. With regard to the southern proposed extension, the area is used regularly by traffic travelling in a northwest-southeast direction and also traffic in a north south direction. Accordingly, this traffic would be required to deviate into alternative routeing, increasing the frequency of traffic in existing routes and risk should the extension be granted. The Chamber has specific concerns over the southwest corner with the highest density of commercial traffic and objects to the present boundary with a strong recommendation for a boundary change to prevent significant vessel channel constriction and loss of safe navigational searoom.*	within the impact assessment in Section 21.1.3.
CoS	Poorly planned proliferation of OWFs could become an existential threat to the safety of navigation for commercial shipping and the cumulative impact of OWFs in the UK EEZ is having a significant impact on the flexibility and efficiency of shipping routes.	Cumulative assessment is provided in Section 18.7 and 21.2.
CoS	Concern with the extremely strict interpretation of the MCA corridor width guidance chosen and the use of minimum angle required.	Loss of searoom including discussion of the MGN 654 corridor width guidance is considered in Section 18.4, noting text has been expanded post PEIR.
CoS	The Chamber believes that for the long term safe co-location of OWFs and commercial shipping, it is incorrect for developers to foresee the safe distance that mariners transit off OWFs as area for development, as this simply pushes further commercial vessels into ever closer passing's, increasing collision risk.	Post wind farm routeing methodology is provided in Section 18.6.1. Loss of searoom including in relation to passing distances is assessed in Section 18.4.

Consultee(s)	Key Points Raised	Where Addressed
CoS	The Chamber, for purposes of Search and Rescue, along with navigational safety, wish to see at least one line of orientation maintained between the existing OWFs and the proposed developments. Furthermore, within the proposed SEP and DEP, the Chamber wishes to see two lines of orientation as set out within MGN 654 unless a sufficient safety case can be presented to the MCA.	As per Section 20, Equinor will comply with all requirements of MGN 654 including in relation to layout design. The final layout will be agreed with MCA and Trinity House.
CoS	The Chamber trusts that as MGN 654 has now been released following extensive consultation with industry that the developer will be making the proposal in full compliance with it at DCO.	The updated NRA is MGN 654 compliant (see Section 2) and includes an updated MGN 654 checklist (Annex A).
CoS	As the Chamber has found customary with such proposals, the documentation uses a dataset of Marine Accident Investigation Branch (MAIB) accidents for a ten-year period (2008-2017). The Chamber, having consulted with the MAIB and been informed that digital spatial data exists and is accessible for developers dating back to 1992. The Chamber considers that a single 10-year period to be an unnecessarily short period for accident data to be used and that it may not accurately reflect historic accidents and safety to navigation	As discussed with CoS in post PEIR meeting (see 4.2) a total of 20 years of MAIB data has been considered – see Section 13.1.
CoS	Recommendations that the wind farm site boundaries be reframed so as to provide more safe navigable sea room, or that commitments be made to the same effect.	As per Section 20, the layout will be designed in consultation with MCA and Trinity House. As discussed in Section 9.2, a worst-case approach has been taken to buildable area at NRA stage to ensure a safe and viable layout can be agreed.
Essberger	Stated that the reduction in searoom between the projects "should not endanger the safety of navigation in a significant way and we are ready to accommodate this arrangement".	Available searoom is considered in Section 18.4.

4.5 Hazard Workshop

26. As required under the MGN 654 (MCA, 2021) Annex 1 MCA Methodology, a Hazard Log has been created for SEP and DEP in liaison with relevant stakeholders via a Hazard Workshop. The Hazard Workshop was held virtually on the 10th August 2021, and was attended by the following organisations:

- Associated British Ports Humber;
- CoS;
- Cobelfret;
- DFDS;
- IOG;
- MCA,
- National Federation of Fisherman's Organisations;
- P&O Ferries;
- Perenco;
- RYA; and
- Stena Lines.

27. A summary of the key discussion points is provided in Table 4.5, noting that the full Hazard Log is provided in Annex A.

Table 4.5 Hazard Workshop – Key Points Raised

Point Raised	Where Addressed
Queries over whether the nearby Sustainable Seaweed would be included within the cumulative assessment within the NRA.	Considered within the cumulative assessment (see Section 18.7 and 21.2).
Queries over whether fishing gear snagging would be assessed within the ES.	Impacts are considered within Chapter 12 Commercial Fisheries (commercial) and Chapter 13 Shipping and Navigation (safety).
General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern. The CoS reiterated concerns over general loss of sea room on a cumulative basis but also specific sections of the wind farm sites (as per previous CoS consultation – see Section 4.2).	Loss of searoom is considered in Section 18.4. Post wind farm routeing is considered in Section 18.6.2. Impacts associated with deviations and displacement are assessed within Section 21.1.1.
Operators agreed it was unlikely commercial vessels would transit through the wind farm sites. O&G vessels do so under certain circumstances at other projects, however it was considered unlikely they would so in the case of SEP and DEP.	This aligns with worst-case NRA approach to Post wind farm routeing (see Section 18.6.1) whereby it is assumed commercial vessels will not enter the wind farm sites.
The general consensus was that the management of project vessels via marine coordination to ensure that impacts on third party movements were minimised would be of benefit.	Marine coordination including general vessel management procedures are considered as embedded mitigation (see Section 20). However a Navigation Management Plan is discussed in Section 21.3.1.1 and has been included as additional mitigation within the impact assessment to mitigate impacts associated with vessels crossing between the wind farm sites(see Section 21.1.1).
Concerns raised at a cumulative level over reduction of searoom leading to increased need to emergency anchor or engage salvage tugs.	This has been considered as part of the Hazard Log process (see Annex A).
No direct impacts foreseen on ports or port operations.	Noted.
Queries from O&G operators around pipeline access.	This is assessed within Chapter 16 Petroleum Industry and Other Marine Users.
Requested that details of visual logs from the surveys are provided within the NRA.	These are provided in Annex D.
Noted that the “General Boating Areas” of the RYA Coastal Atlas will provide good indication of non AIS traffic. The intersection between these areas and the offshore export cable corridor should be considered in regards to potential for underkeel interaction.	The RYA Coastal Atlas is shown relative to the offshore export cable corridor in Section 14.2.2.8. Underkeel clearance is considered within Section 21.1.6, including consideration of the RYA Coastal Atlas.

Point Raised	Where Addressed
Concerns over impacts to recreational users were largely around nearshore areas including port approaches and centred on project vessel traffic and underkeel clearance.	Impacts associated with project vessel traffic are considered in Sections 21.1.1 and 21.1.3.2. Underkeel clearance is considered within Section 21.1.6
Suggested mitigations of relevance to recreational users were maintenance of aids to navigation and effective / targeted promulgation of information to relevant clubs and organisations. Targeted promulgation of information was also recommended for fishing vessels.	Targeted promulgation of information has been considered as additional mitigation within the FSA where appropriate (see Section 21) noting the specific stakeholders of relevance will be detailed within the Navigation Management Plan (see Section 21.3.1.1).
Noted that fishing vessels will likely seek to transit through and fish within the wind farm sites.	Considered within the Impact Assessment (see Section 21).

28. It is noted that CoS provided feedback on the Hazard Log rankings, stating that in their view "*for the realistic worst-case scenario some risk scorings are too low, in particular for Frequency and People*". This feedback is stated here for the purpose of ensuring CoS input is captured within the NRA process, noting that the final rankings are shown in Annex A are based on the overarching Hazard Workshop findings and input/feedback from all parties. This Hazard Log is then considered against other sources both qualitative and quantitative within the overarching FSA process.

5 Data Sources

5.1 Vessel Traffic Data

29. The NRA considers a total of 28 days of AIS, radar, and visual observation data in line with MGN 654 (MCA, 2021) requirements. This data comprises two 14 day surveys undertaken in 2020 and 2021, with periods chosen to account for seasonal variation.

30. Additionally, 12 months of AIS data has been assessed to ensure long term assessment of seasonal variation, low use routes and adverse weather routeing are captured.

31. The 12 months of AIS data is assessed in full within Annex B, and utilised within the NRA where appropriate. Full details of the approach to marine traffic data collection are provided in Section 7. It is noted that the approach to marine traffic data collection has been agreed with the MCA, Trinity House RYA, CA and CoS as per Table 4.2.

5.2 Summary of Data Sources

32. The data sources considered within the NRA for the purposes of establishing the baseline environment for the SEP and DEP are summarised in Table 5.1.

Table 5.1 Data Source Summary

NRA Element	Data Source	Data Purpose
Vessel Traffic	12 months of AIS data covering the entirety of 2019	To establish the marine traffic baseline
	14 days of AIS, radar, and visual observation data collected during July /August 2020	
	14 days of AIS, radar, and visual observation data collected during Jan / Feb 2021	
Maritime incidents	Maritime Accident Investigation Branch (MAIB) marine accidents database (2000 to 2019)	To define the baseline incident rates within the study area (See section 5.3) relative to the SEP and DEP
	Royal National Lifeboat Institution (RNLI) incident data (2008 to 2017)	
	Department for Transport (DfT) UK civilian SAR helicopter taskings (2016 to 2019) – current available data period.	
Marine Aggregate Dredging Features	Marine aggregate dredging areas (licenced and active)	To assess marine aggregate dredging transit patterns within the study area (See section 5.3) relative to the SEP and DEP
	Transit routes (BMAPA, published 2009, downloaded 2020)	

NRA Element	Data Source	Data Purpose
Recreational vessel traffic and facilities	RYA Coastal Atlas (RYA, 2018)	To establish the baseline in terms of recreational traffic, features, and facilities
Other Navigational Features	United Kingdom Hydrographic Office (UKHO) Admiralty Charts (UKHO, 2020) Admiralty Sailing Directions NP54 North Sea West (2016)	To establish the baseline in terms of navigational features
Weather Data	DEP & SEP, UK Metocean Summary, Doc Ref: MAD, CDEZ 11.10.2019, Metocean ME2019–144 (Equinor, 2019)	Data used to estimate wind direction and sea state probabilities
	Admiralty Sailing Directions NP54 North Sea West (2016)	Used to estimate probability of poor visibility
	UKHO Admiralty Charts (UKHO, 2020)	Used to estimate peak tidal flows

5.3 Study Areas

33. Figure 5.1 presents the shipping and navigation Study Area, which is defined as a 10nm buffer of the wind farm sites. This radius ensures relevant passing traffic is captured, while still remaining site specific to the area. It is noted that where appropriate within this NRA, analysis has been separated into individual 10nm buffers of the individual wind farm sites. These regions are shown in Figure 5.2 for reference.

34. Analysis of data for the offshore export cables has been undertaken within a 2nm buffer of the inner boundary of the offshore cable corridor (see Section 9.5), as shown in Figure 5.1.

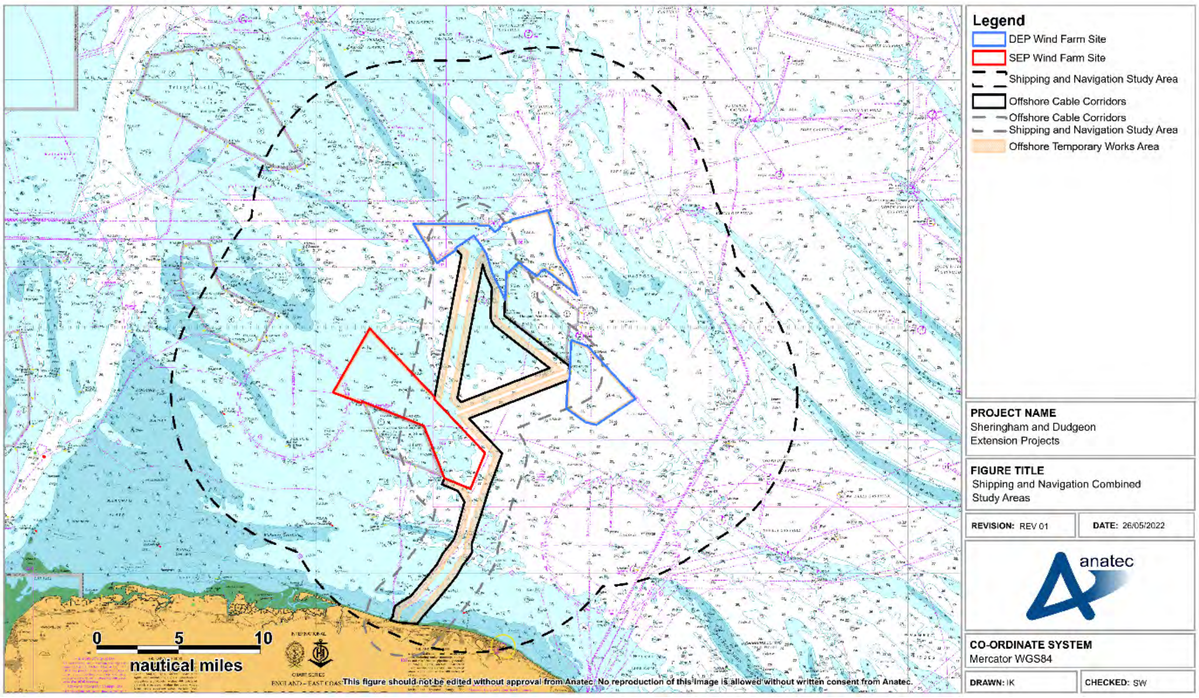

Figure 5.1 Shipping and Navigation Study Area

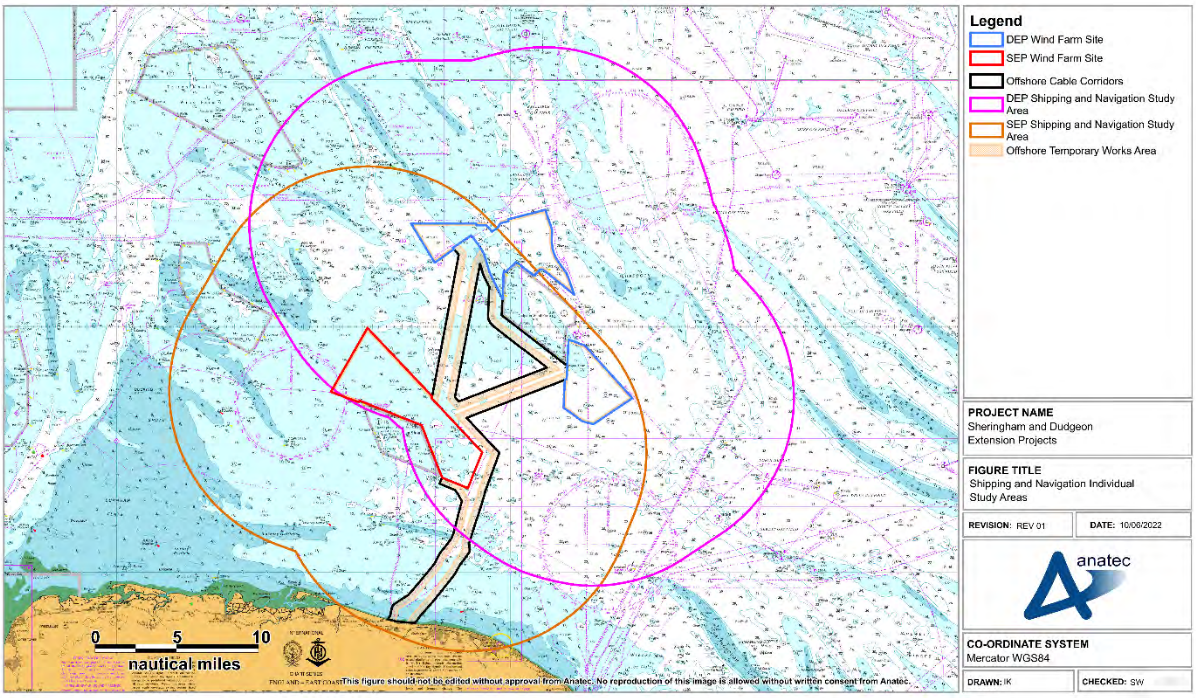

Figure 5.2 Individual SEP and DEP Shipping and Navigation Study Areas

5.4 Data Limitations

35. It should be considered that to date, radar and visual observation data has only been collected for a 14 day summer survey period for the shipping and navigation study

area. This means non AIS traffic is likely to be underrepresented within the 14 day winter data set, and within the 28 days of data assessed for the offshore export cable corridor.

36. Limitations associated with AIS carriage are discussed further in Section 7.

37. It is noted that the approach to marine traffic data has been agreed with the MCA, Trinity House, RYA, CA, and the CoS as per Section 4.2.

6 Lessons Learnt

38. There is considered to be notable benefit for Equinor to assess and consider the lessons learnt within the offshore industry, including those lessons learnt for other projects. On this basis the NRA includes general consideration for lessons learnt and expert opinion from previous OWF developments, and other sea users, capitalising upon the UK's position as a leading generator of offshore wind power.

39. Data sources for lessons learnt include the following:

- Sharing the Wind – Recreational Boating in the Offshore Wind Strategic Areas (RYA & CA, 2004);
- Results of the Electromagnetic Investigations (MCA & QinetiQ, 2004);
- Offshore Wind and Marine Energy Health and Safety Guidelines (RenewableUK, 2014);
- OWF Helicopter SAR Trials Undertaken at the North Hoyle Wind Farm (MCA, 2005);
- Interference to Radar Imagery from OWFs (Port of London Authority (PLA), 2005); and
- Strategic Assessment of Impacts on Navigation of Shipping and Related Effects on Other Marine Activities Arising from the Development of OWFs in the UK REZ (Anatec & TCE, 2012).

7 Vessel Traffic Survey Methodology

40. In agreement with the MCA and Trinity House and as per Section 5.1, the overarching NRA process for the SEP and DEP considers three primary marine traffic data sets:

- 14 days of AIS, Radar, and visual observation data collected during July and August of 2020;
- 14 days of AIS, Radar and visual observation data collected during January and February of 2021; and
- 12 months of AIS data collected over the entirety of 2019.

41. This section summarises the methodology of the dedicated surveys and 2019 AIS data collection processes.

7.1 Summer 2020 and Winter 2021 Survey Methodology

42. Both the summer 2020 and winter 2021 marine traffic surveys of the SEP and DEP were carried out by the guard vessel *Karima*. An image of the vessel, and relevant key vessel characteristics are provided in Figure 7.1 and Table 7.1, respectively.

43. The summer survey commenced on the 24th July 2020 at 01:00 and concluded on the 7th August 2020 at 01:00, thus providing 14 days of full coverage. The winter survey commenced on the 26th of January 2021 at 09:30 and concluded on the 13th of February 2021 at 19:00, with the survey vessel taking shelter between the 5th and 9th of February 2021 due to adverse weather conditions. However, 14 days of full coverage is available when active periods are combined.

Figure 7.1 Karima Survey Vessel

Table 7.1 Key Vessel Characteristics

Parameter	Specification
Name	*Karima*
MMSI	232006310
IMO Number	7427403
Callsign	MPKV5
Length Overall (LOA)	26 metres (m)
Flag State	UK

44. A number of tracks recorded during the survey periods were classified as temporary (non-routine), such as the tracks of the survey vessel and tracks of vessels associated with guard duties, survey work, or construction of the Triton Knoll wind farm. O&G support vessels operating at permanent installations were retained in the analysis, as were wind farm support vessels operating at the operational Dudgeon, Sheringham Shoal and Race Bank wind farms.

45. Both surveys included collection of AIS, Radar, and visual observation data. The visual observation data included details / identifiers of any vessels recorded via Radar that could also be identified visually. The relevant logs are presented in Annex D.

7.2 2019 AIS Data

46. The year of 2019 data was collected from a combination of coastal and offshore receivers to ensure coverage was as comprehensive as possible. The analysis of a year of data allowed seasonal variations to be captured, and considered throughout the NRA where appropriate.

47. The data is assessed in full within Annex B.

7.3 AIS Carriage

48. The carriage of AIS is required on board all vessels of greater than 300 Gross Tonnage (GT) engaged on international voyages, cargo vessels of more than 500GT not engaged on international voyages, passenger vessels irrespective of size built on or after 1st July 2002, and fishing vessels over 15m LOA.

49. Therefore, larger vessels were recorded on AIS, while smaller vessels without AIS installed (i.e., fishing vessels under 15m LOA and recreational craft) were recorded, on the Automatic Radar Plotting Aid (ARPA) Radar on board the *Karima*, with visual observation data collected where possible. It is noted that a proportion of smaller vessels also carry AIS voluntarily.

7.4 Commercial Vessel Dataset

50. The commercial vessel dataset primarily consists of the AIS tracks collected from commercial vessels within the AIS periods studied. The AIS data has been validated against Anatec's ShipRoutes database (Anatec, 2021), and consultation input has also been considered where relevant.

7.5 Recreational Vessel Dataset

51. The RYA and CA represent the interests of recreational users including yachting and motor cruising. In 2005 the RYA, supported by Trinity House and the CA, compiled, and presented a comprehensive set of charts which defined the cruising routes, general sailing and race areas used by recreational craft around the UK coast. This information has been subsequently updated and is published as the UK Coastal Atlas of Recreational Boating 2.0 (RYA, 2018). Geographical Information System (GIS) shapefiles from this publication, including a recreational AIS density grid in proximity to the east Yorkshire coast, have been used in this NRA.

52. The RYA has also developed a detailed position statement (RYA, 2019) based upon analysed data for common recreational craft which has been used to inform the NRA.

53. In addition, recreational vessel data was extracted from the vessel tracks recorded during the vessel traffic surveys, and consultation input has been considered where relevant.

7.6 Fishing Vessel Dataset

54. Fishing vessel data was extracted from the vessel tracks recorded during the vessel traffic surveys, and consultation input has been considered where relevant. It is noted that additional information and assessment is provided in Chapter 12 Commercial Fisheries.

8 Other Offshore Users

55. This section summarises approach to third party commercial activities and users other than vessels in transit (which are covered in Section 7.4). This includes O&G, marine aggregate dredging and other offshore wind farms. It is noted that further consideration of “Other Users” is made in Chapter 16 Petroleum Industry and Other Marine Users.

8.1 Oil and Gas Installations

56. Offshore O&G installation data was assessed using charted information and additional research to confirm infrastructure status and any decommissioning plans. For the purposes of the NRA, fixed platforms and wellheads which may impact a surface vessel’s transit are considered. A desktop study was undertaken using the gathered data to identify any possible cumulative effects with offshore O&G developments.

8.2 Marine Aggregate Dredging

57. Licenced and active marine aggregate dredging areas data was supplied by The Crown Estate (TCE) and transit routes of marine aggregate dredgers was supplied by BMAPA. Tracks recorded from marine aggregate dredgers within the marine traffic data collected (see Section 14) were also considered. A desktop study was undertaken using these data to identify commercial aggregate dredging activity in proximity to the wind farm sites.

8.3 Offshore Wind Farms

58. The locations of other offshore wind farms were supplied by TCE (TCE, 2020), and were charted boundaries have also been considered. Tracks recorded from wind farm related vessels within the marine traffic data collected (see Section 14) were utilised to assess associated vessel movements.

8.4 Other Navigational Features

59. Other navigational features including MOD Practice and Exercise Areas (PEXA), submarine cables and pipelines, AtoNs, anchorage areas, wrecks and ports have been considered based upon charted information and the Admiralty Sailing Directions for the area.

9 Maximum Design Scenario

60. This NRA considers the Project Design Envelope which is outlined in full in Chapter 4 Project Description. On this basis, this section outlines the maximum extent of SEP and DEP under which impacts to shipping and navigation users are assessed under the FSA.

9.1 Development Boundaries

61. An overview of SEP and DEP is given in Figure 9.1 and Figure 9.2, respectively. Following this, Table 9.1 gives the coordinates of key corner positions of both sites. The DEP wind farm site is located approximately 14nm from shore and covers an area of approximately 62 square nautical miles (nm^2) (114.75 square kilometres (km^2)). The SEP wind farm site is located approximately 8.5nm from shore and covers an area of approximately $52nm^2$ ($97.0km^2$).

62. It is noted that both the SEP and DEP wind farm sites includes area designated as the Offshore Temporary Works Area to accommodate temporary construction operations (e.g., anchor spreads). No permanent infrastructure will be located in the Offshore Temporary Works Area (see Figure 5.1).

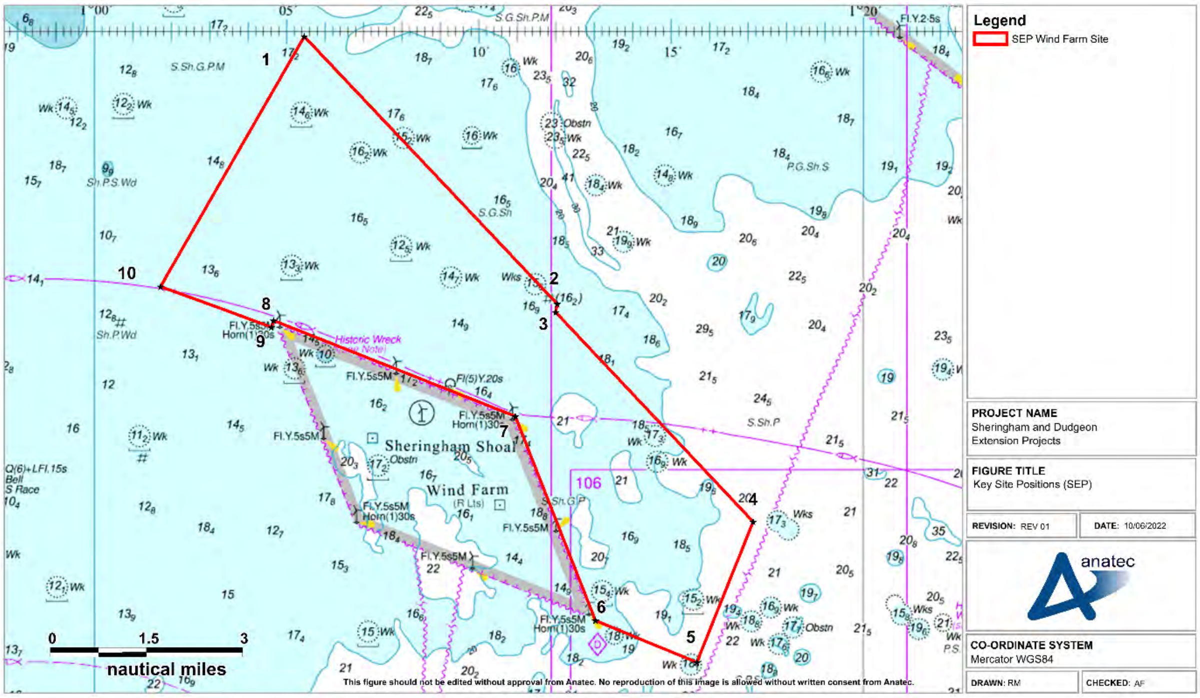

Figure 9.1 Key Site Positions (SEP)

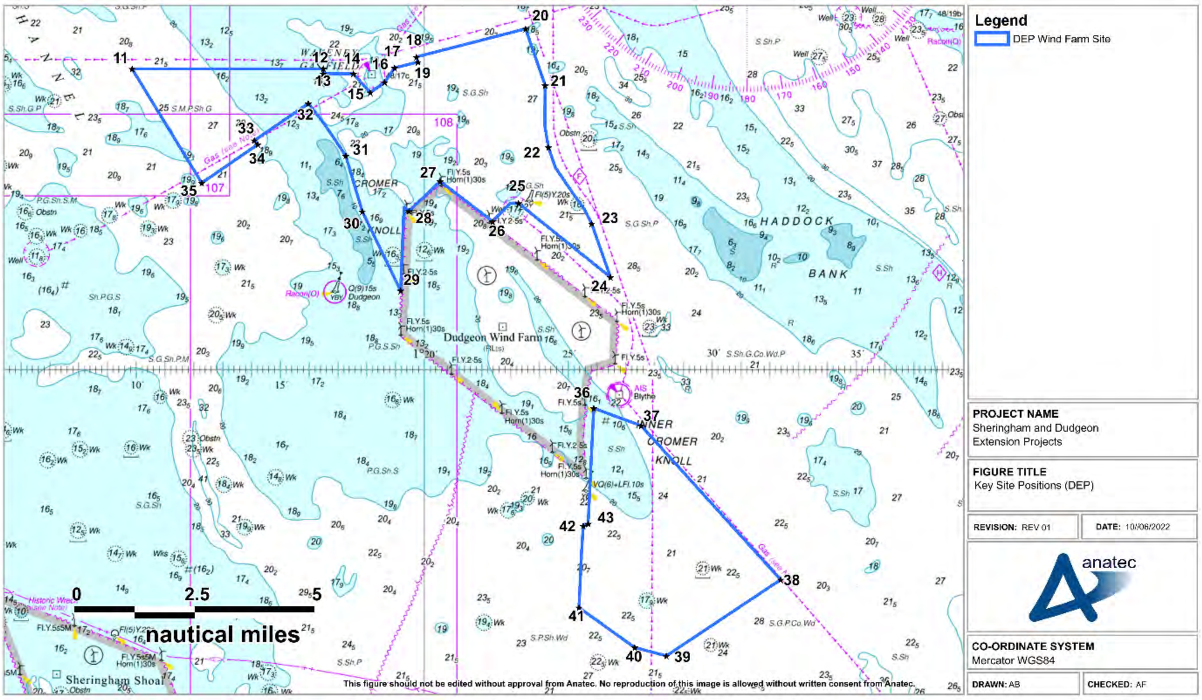

Figure 9.2 Key Site Positions (DEP)

Table 9.1 Key Site Positions

Point	Latitude (WGS84) (Degree Decimal Minutes (DDMM.mm))	Longitude (WGS84) (DDDMM.mm)
SEP		
53° 14.92 N	001° 05.46 E	53° 14.92 N
53° 10.74 N	001° 12.03 E	53° 10.74 N
53° 10.61 N	001° 11.99 E	53° 10.61 N
53° 7.33 N	001° 17.13 E	53° 07.33 N
53° 5.13 N	001° 15.67 E	53° 05.13 N
53° 5.78 N	001° 13.03 E	53° 05.78 N
53° 8.98 N	001° 10.95 E	53° 08.98 N
53° 10.48 N	001° 04.67 E	53° 10.48 N
53° 10.38 N	001° 04.60 E	53° 10.38 N
53° 11.01 N	001° 01.73 E	53° 11.01 N
DEP (North)		
11	53° 21.26 N	001° 09.86 E
12	53° 21.27 N	001° 16.50 E

Point	Latitude (WGS84) (Degree Decimal Minutes (DDMM.mm))	Longitude (WGS84) (DDDMM.mm)
13	53° 21.16 N	001° 16.50 E
14	53° 21.16 N	001° 17.54 E
15	53° 20.77 N	001° 18.12 E
16	53° 20.98 N	001° 18.63 E
17	53° 21.28 N	001° 18.97 E
18	53° 21.41 N	001° 19.78 E
19	53° 21.51 N	001° 19.73 E
20	53° 22.09 N	001° 23.52 E
21	53° 20.92 N	001° 24.2 E
22	53° 19.63 N	001° 24.31 E
23	53° 18.05 N	001° 25.82 E
24	53° 16.93 N	001° 26.47 E
25	53° 18.47 N	001° 23.28 E
26	53° 18.09 N	001° 22.38 E
27	53° 18.92 N	001° 20.56 E
28	53° 18.31 N	001° 19.48 E
29	53° 16.65 N	001° 19.19 E
30	53° 18.30 N	001° 17.85 E
31	53° 19.46 N	001° 17.28 E
32	53° 20.54 N	001° 15.98 E
33	53° 19.78 N	001° 14.11 E
34	53° 19.69 N	001° 14.23 E
35	53° 18.89 N	001° 12.28 E
DEP (South)		
36	53° 14.20 N	001° 25.89 E
37	53° 13.84 N	001° 27.54 E
38	53° 10.63 N	001° 32.38 E
39	53° 09.04 N	001° 28.41 E
40	53° 09.21 N	001° 27.31 E

Point	Latitude (WGS84) (Degree Decimal Minutes (DDMM.mm))	Longitude (WGS84) (DDDMM.mm)
41	53° 10.04 N	001° 25.37 E
42	53° 11.75 N	001° 25.52 E
43	53° 11.79 N	001° 25.69 E

9.2 Structure Layout

63. The final layouts for the SEP and DEP will be agreed with the MCA and Trinity House post consent as per the relevant Development Consent Order conditions. Final layouts are not able to be defined at this stage, and therefore indicative layouts deemed as being worst-case from a shipping and navigation perspective have been utilised within the NRA for the purposes of input into the collision and allision modelling.

64. The layouts are considered worst-case from those options under consideration on the basis that they exceed the maximum number of structures that could be built under the Project Design Envelope, and include wind turbines within every area under consideration. The envelope approach is necessary to ensure that a safe and viable layout can be constructed, noting that account will need to be made of relevant MCA requirements under SAR Annex 5 (MCA, 2021) and any existing constraints (e.g., water depth, ground conditions etc).

65. On this basis it should be noted that the layouts assessed within the NRA are not reflective of final layouts. This includes the positions of the Offshore Substation Platforms (OSPs), which have been placed on the periphery for the purposes of providing a worst-case for the impact assessment within this NRA.

66. The layouts are shown in Figure 9.3 relative to the existing Sheringham Shoal and Dudgeon structures. Following this, structure numbers within the layouts are presented in Table 9.2.

67. It is noted that the final layouts agreed with the MCA and Trinity House will comply with the Layout Commitments (see Section 20.2).

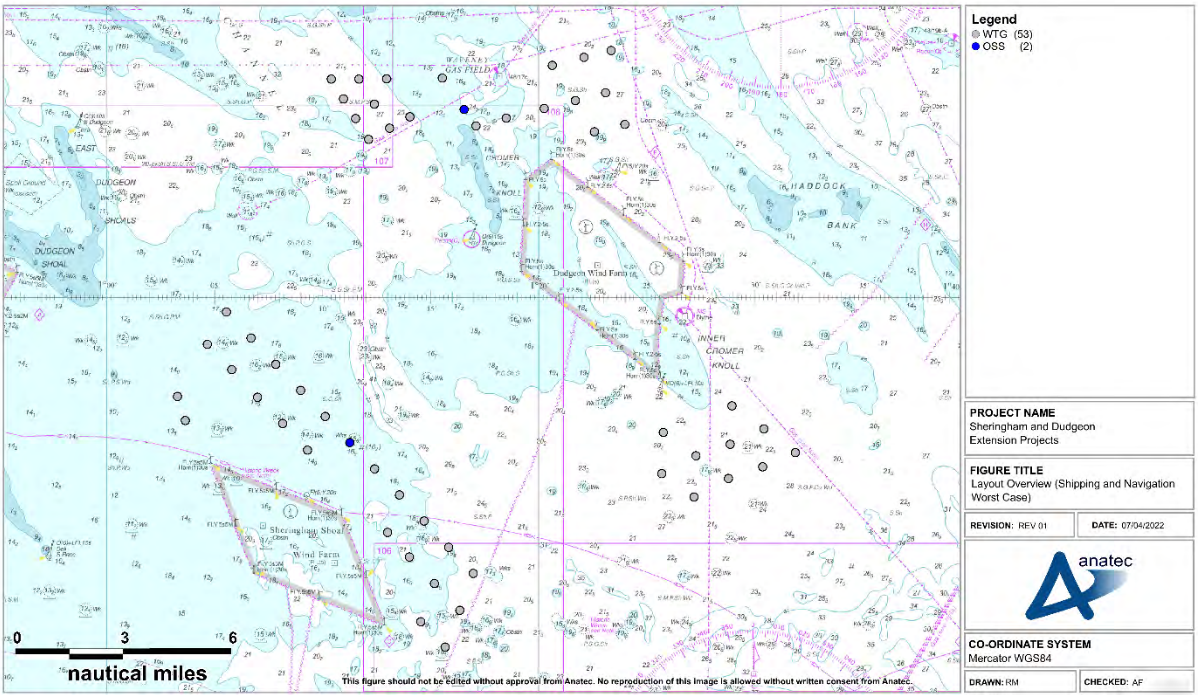

Figure 9.3 Layout Overview (Shipping and Navigation Worst-Case)

Table 9.2 Layout Structure Numbers Summary

Project	Max Wind Turbine Numbers	Max OSP Numbers
SEP	23	1
DEP	30	1

9.3 Wind Turbine Parameters

68. Jacket foundations have been considered as the Maximum Design Scenario (MDS) for shipping and navigation as these foundations provide the maximum structure dimensions at the sea surface of those under consideration. It is noted that the dimensions assumed are for the smallest wind turbine model, given that the maximum number of structures is the worst-case from a shipping and navigation perspective as per Section 9.2. The MDS wind turbine measurements assuming the use of jacket foundation design for the layout are provided in Table 9.3.

Table 9.3 MDS for Wind Turbines (assumes max number of smallest wind turbine)

Parameter	Specification for Layout
Foundation Type	Jacket
Dimensions at sea surface (dependent upon water depth, geology, and wind turbine type)	28x28m

Parameter	Specification for Layout
Maximum blade tip height (above Lowest Astronomical Tide (LAT))	330m
Minimum blade tip height (above LAT)	265m
Maximum rotor blade diameter	300m
Minimum Blade Clearance (above Highest Astronomical Tide (HAT))	30m

9.4 OSP Parameters

69. Relevant parameters of the OSPs within the wind farm sites are detailed in Table 9.4.

Table 9.4 MDS for OSP

Parameter	Specification for Layout
Dimensions of Topside	70x40m

9.5 Cables

70. In the SEP only and SEP and DEP in tandem scenarios, the offshore export cables route runs for a total of 19-22nm (35-40 kilometres (km)) from the south eastern boundary of the SEP wind farm site to the landfall at Weybourne. Up to two export cables of up to 300 millimetres (mm) diameter will be installed, with a total length of up to 43nm (80km). Export cables will also link the wind farm sites. In the DEP only scenario, the offshore export cables route runs for 31-33nm (57-62km).

71. All offshore export cables will be laid within the inner boundary of the offshore export cable corridor, noting that the Offshore Cable Corridors include the Offshore Temporary Works Area to accommodate temporary works (e.g., anchor spreads). No subsea cables are to be installed in the Temporary Works Area. The Offshore Cable Corridors are shown in Figure 9.4.

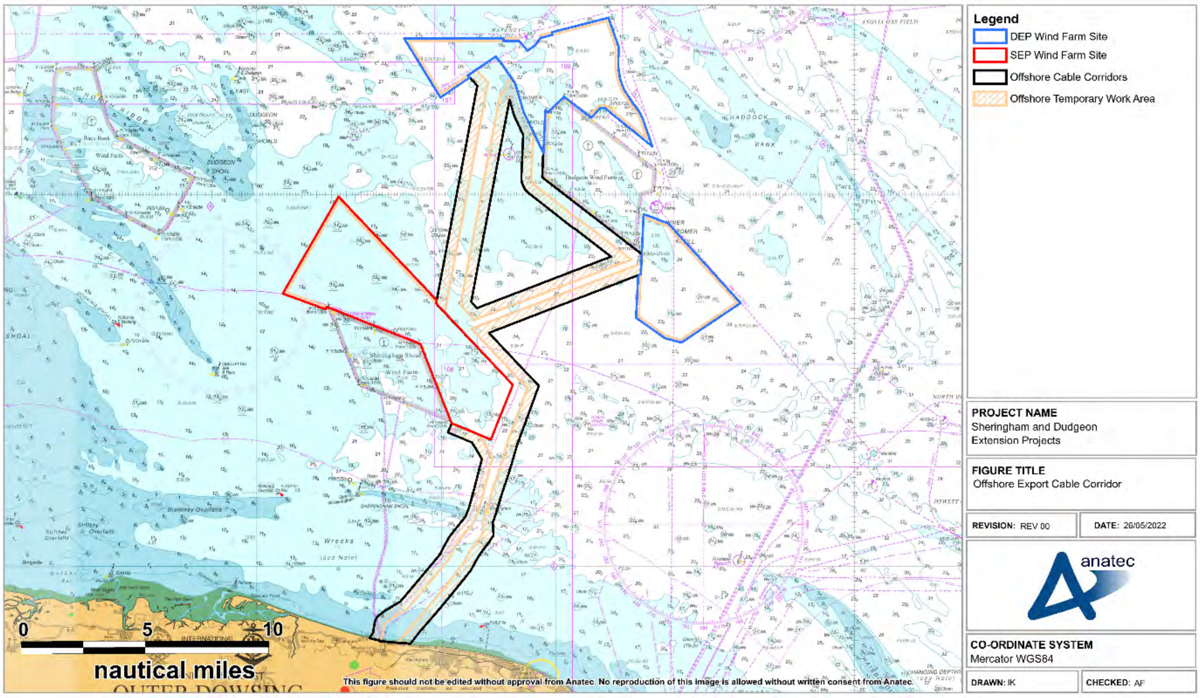

Figure 9.4 Offshore Export Cable Corridor

72. The array cables will connect individual wind turbines to OSPs. Final length of array cables will be required with the total length determined by considerations such as the final array layout and voltage capacity.

73. Target burial depths will depend on the area, and are summarised as follows:

- Marine Conservation Zone (MCZ): 0-0.3m;
- Areas of sandwaves: up to 20m; and
- All other areas: 0.5-1.0m.

74. Where target depths cannot be met, external protection may be used. It is noted that all surface laid cable section will be protected. All cable protection will be determined via the Cable Burial Risk Assessment (see Section 20).

9.6 Project Schedule

75. Two construction scenarios are under consideration. In the first, SEP and DEP will be constructed in tandem (i.e., both will begin and end construction simultaneously) this is anticipated to occur over three to four years. In the second scenario, the projects shall be built sequentially, one project will begin construction first with construction anticipated to take three to four years, with the second beginning construction two to four years later with construction anticipated to occur over three years, meaning the total construction phase would last between five to seven years.

76. Table 9.5 presents the indicative offshore construction timeline for the in tandem construction timeline, while Table 9.6 and Table 9.7 present the sequential timeline

options for a two year and four year gap between the projects, respectively. Note that it is not yet determined which project will begin various construction activities first, therefore the projects are represented by "project one" and "project two" such that these can be either DEP or SEP, respectively.

Table 9.5 In Tandem Construction Timeline

Construction Activity	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Onshore substation site preparation																
Onshore substation construction																
Landfall HDD																
Landfall cable pull																
Onshore cable ducting and installation (incl. reinstatement)																
Offshore substation installation																
Offshore substation commissioning																
WT foundation installation																
Offshore cable installation																
WT installation																

Table 9.6 Sequential Construction Timeline (Two Year Gap between Projects)

Project	Construction Activity	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project One	Onshore substation site preparation																								
	Onshore substation construction																								
	Landfall HDD																								
	Landfall cable pull																								
	Onshore cable ducting and installation (incl. reinstatement)																								
	Offshore substation installation																								
	Offshore substation commissioning																								
	WT foundation installation																								
	Offshore cable installation																								
	WT installation																								
Project Two	Onshore substation site preparation																								

Project	Construction Activity	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Onshore substation construction																								
	Landfall HDD																								
	Landfall cable pull																								
	Onshore cable ducting and installation (incl. reinstatement)																								
	Offshore substation installation																								
	Offshore substation commissioning																								
	WT foundation installation																								
	Offshore cable installation																								
	WT installation																								

Table 9.7 Sequential Construction Timeline (Four Year Gap between Projects)

Project	Construction Activity	Year 1				Year 2				Year 3				Year 4				Year 5				Year6				Year 7				Year 8			
		Q1	Q2	Q3	Q4	Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project One	Onshore substation site preparation																																
	Onshore substation construction																																
	Landfall HDD																																
	Landfall cable pull																																
	Onshore cable ducting and installation (incl. reinstatement)																																
	Offshore substation installation																																
	Offshore substation commissioning																																
	WT foundation installation																																
	Offshore cable installation																																
	WT installation																																
Project Two	Onshore substation site preparation																																

Project	Construction Activity	Year 1				Year 2				Year 3				Year 4				Year 5				Year6				Year 7				Year 8			
		Q1	Q2	Q3	Q4	Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	Onshore substation construction																																
	Landfall HDD																																
	Landfall cable pull																																
	Onshore cable ducting and installation (incl. reinstatement)																																
	Offshore substation installation																																
	Offshore substation commissioning																																
	WT foundation installation																																
	Offshore cable installation																																
	WT installation																																

9.7 Project Vessels

77. It is anticipated that the base port utilised for the construction phase of the SEP and DEP will be Great Yarmouth.

78. In terms of project vessels during the operational phase, the existing Sheringham and Dudgeon projects utilise a Service Operations Vessel (SOV) and Crew Transfer Vessel (CTV). It is anticipated that the SEP and DEP could utilise up to two additional support vessels (either a CTV, daughter crafts on board the SOV, or both).

10 Existing Environment

79. A plot of the navigational features in proximity to the wind farm sites and the offshore export cable corridor is presented in Figure 10.1. Each of the features shown are discussed in the following subsections and has been identified using the relevant UKHO Admiralty Sailing Directions (UKHO, 2016) and UKHO Admiralty Charts (UKHO, 2020).

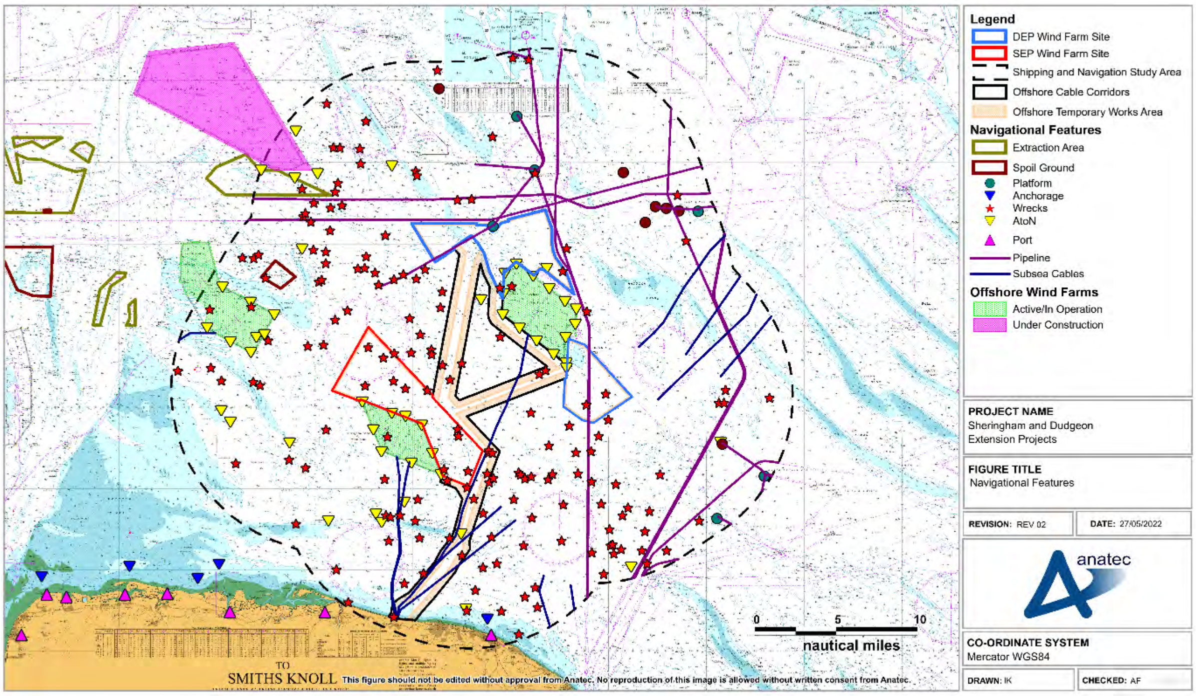

Figure 10.1 Navigational Features

10.1 Other Offshore Wind Farm Developments

80. There are a four operational or constructing OWFs located within the shipping and navigational study area as shown in Figure 10.1. Table 10.1 summarises the status and distance from the wind farm sites for the other wind farms located within the shipping and navigation study area.

Table 10.1 Wind Farms within the Shipping and Navigation Study Area

Name	Status	Minimum Distance from SEP and DEP wind farms (nm)
Dudgeon	Operational	Adjacent (0)
Sheringham Shoal	Operational	Adjacent (0)
Race Bank	Operational	5.4

Name	Status	Minimum Distance from SEP and DEP wind farms (nm)
Triton Knoll	Operational[7]	7.2

81. A full list of wind farm projects considered on a cumulative basis is given in Section 17.

10.2 Oil and Gas Features

82. A total of six gas platforms are located within the shipping and navigation study area, specifically within the northern and eastern extents. A number of pipelines also link these platforms with other wells, platforms, and landfall locations. The surface assets and subsea pipelines are shown in Figure 10.2. Following this, Table 10.2 presents relevant details of the platforms.

83. Planned O&G developments in the vicinity of SEP and DEP (and associated impacts) are covered within Chapter 16 Petroleum Industry and Other Users.

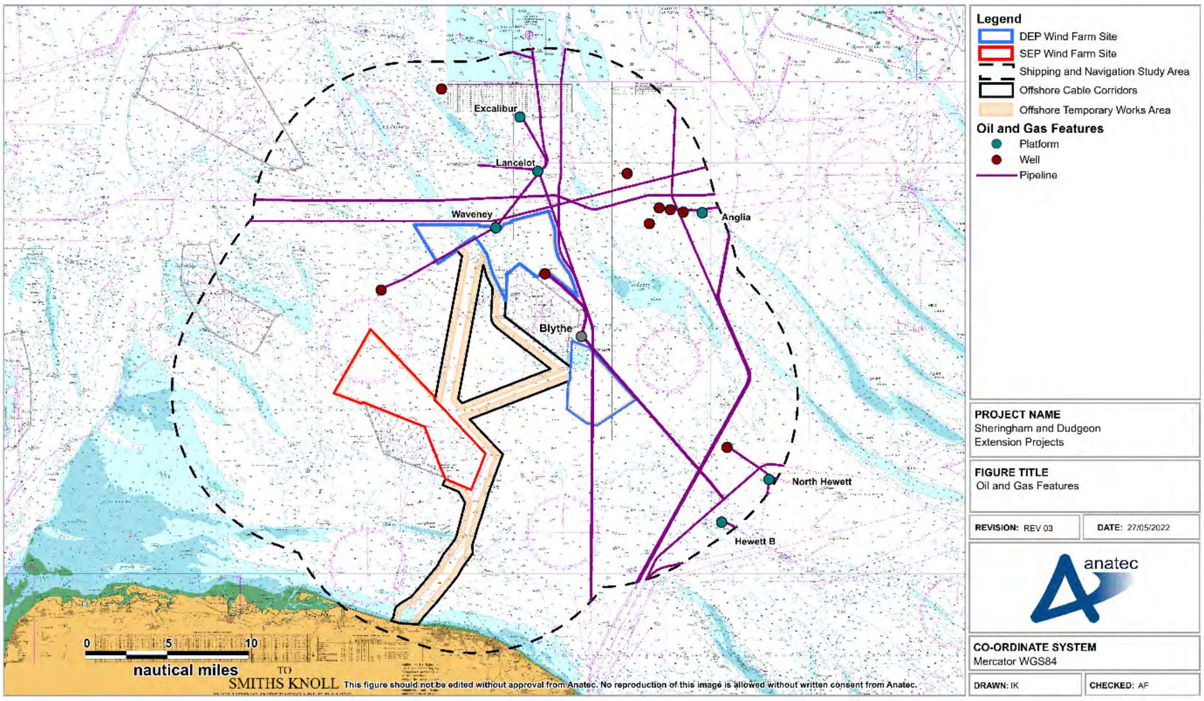

Figure 10.2 Oil and Gas Features

[7] Construction buoys removed week of 14th March 2022.

Table 10.2 Gas Platforms within Shipping and Navigation Study Area

Platform	Minimum Distance from Wind Farm Sites (nm)	Status
Waveney	0.3	Operational
Blythe	0.6	Operational
Excalibur EA	6.1	Operational
Lancelot A	2.7	Operational
Anglia	9.0	Decommissioning ongoing
48/29B (Hewett B)	9.2	Decommissioning ongoing
48/29C (North Hewett)	9.6	Decommissioning ongoing

10.3 Aids to Navigation

84. The AtoN located within the shipping and navigation study area are shown in Figure 10.1. These include those associated with the operational wind farms in the shipping and navigation study area (i.e., the peripheral turbine lighting), and it should be considered that this also captures the temporary cardinal buoys marking the constructing Triton Knoll project.

85. Other AtoNs include those that mark the shallow banks present within the shipping and navigation study area.

10.4 Submarine Cables

86. A total of 12 submarine cables are present within the shipping and navigation study area, as shown in Figure 10.1. Of particular note are the export cables from the existing Dudgeon and Sheringham sites, which make landfall at the Weybourne landfall option for SEP and DEP.

87. A small portion of the Race Bank export cable is laid within the shipping and navigation study area, however this does not come closer than 14nm to the offshore export cable corridor.

88. The other charted cables within the shipping and navigation study area are all disused.

10.5 Marine Aggregate Dredging

89. There are two marine aggregate dredging areas present within the northern section of the shipping and navigation study area, as shown in Figure 10.1. Relevant details are provided in Table 10.3.

90. There is also a spoil ground within the north west of the shipping and navigation study area.

Table 10.3 Marine Aggregate Dredging Areas

Area	Status	Min Distance from Wind Farm Sites (nm)
Outer Dowsing 515/1	Aggregate Production	5.5
Outer Dowsing 515/2	Aggregate Production	4.4

91. Additional details on marine aggregate dredging transits are provided in Sections 14 and 15.4, which show the relevant marine traffic data recorded, and the BMAPA transit routes (BMAPA, 2020).

10.6 Wrecks

92. A total of 172 charted wrecks are located within the shipping and navigation study area, with nine of these located within the SEP wind farm site and three within the DEP wind farm site.

10.7 International Maritime Organization Routeing Measures

93. There are no IMO routeing measures in proximity to the wind farm sites or the offshore export cable corridor. The nearest are those associated with the Humber (the Rosse Reach and Sea Reach Traffic Separation Scheme (TSS) lanes), which are located approximately 30nm north west of the wind farm sites.

10.8 Ports

94. Nearby ports are presented in Figure 10.3. The closest port to the wind farm sites is Blakeney Harbour, located approximately 11nm to the south west.

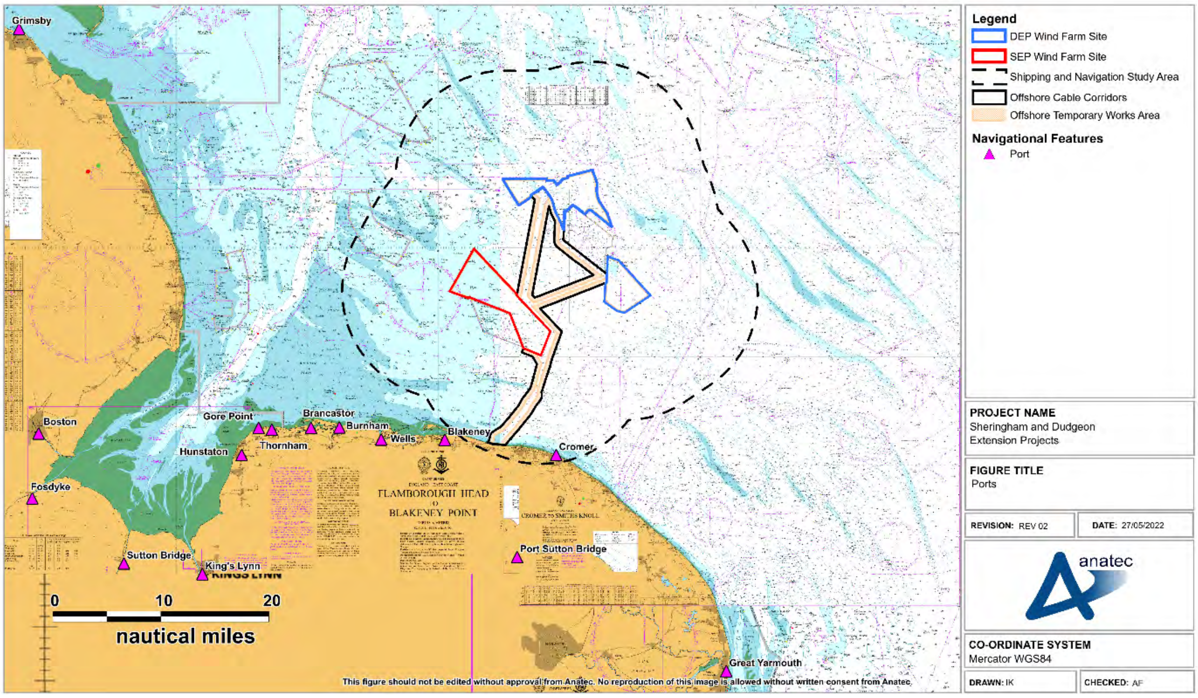

Figure 10.3 Ports

95. The number of vessel arrivals to the busiest ports in the vicinity of SEP and DEP is presented in Figure 10.4. These statistics exclude some vessel movements which occur within port or harbour limits, however, are still considered to give indication of the relative traffic levels and trends.

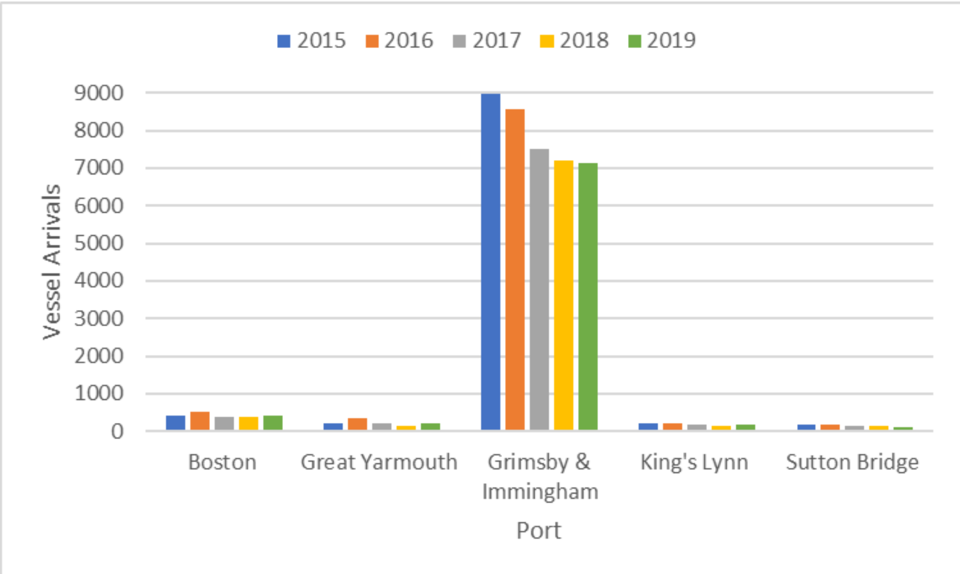

Figure 10.4 Vessel Arrivals to Ports in Proximity to Wind Farm Sites (DfT, 2019)

10.9 Anchorages

96. One charted anchorage is located within the southern extent of the shipping and navigation study area near Cromer. There are also a number of charted anchorages located to the south west of the shipping and navigation study area, the closest of which is positioned approximately 12.8nm from the wind farm sites.

97. Anchoring activity observed within the marine traffic survey data is presented in Section 14.1.3.9 for the wind farm sites and Section 14.2.2.9 for the offshore export cable corridor.

10.10 Marine Environmental High Risk Areas

98. Marine Environmental High Risk Areas (MEHRA) are areas along the UK coast designed to "*inform [ships'] Masters of areas where there is a real prospect of a problem arising. This prime purpose stands alone and regardless of any consequential defensive measures*" (Lord Donaldson, 1994).

99. There are no MEHRAs in proximity to the wind farm sites or offshore export cable corridor. The nearest is located approximately 40nm to the west of the DEP wind farm site.

10.11 Military Practice and Exercise Areas

100. There are no PEXA located in proximity to the wind farm sites or offshore export cable corridor. The nearest is located approximately 25nm to the west of the SEP wind farm site. It is noted that any military vessel activity is captured within the marine traffic survey data assessment (see Section 14).

11 Meteorological Ocean Data

101. This section presents meteorological and oceanographic statistics of relevance in the vicinity of the wind farm sites. It is noted that the data presented within this section has been used as input to the collision and allision risk modelling (see Section 19).

11.1 Wind

102. Wind data was provided by Equinor within DEP & SEP, UK Metocean Summary, Doc Ref: MAD, CDEZ 11.10.2019, Metocean ME2019–144 (Equinor, 2019).

103. The probabilities are shown in Figure 11.1. As can be seen, the predominant wind direction is from the south west.

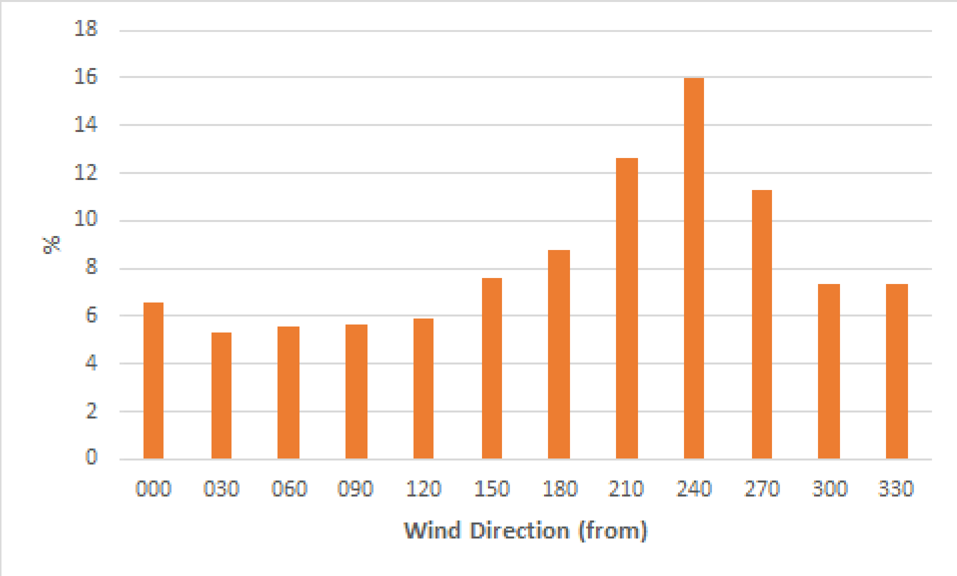

Figure 11.1 Wind Direction Probabilities

11.2 Wave

104. Sea state probabilities have been estimated based upon Significant Wave Height data provided by Equinor within the DEP & SEP, UK Metocean Summary, Doc Ref: MAD, CDEZ 11.10.2019, Metocean ME2019–144 (Equinor, 2019).

105. The probabilities are presented in Table 11.1.

Table 11.1 Sea State Probabilities

Sea State	Proportion (%)
Calm (<1m)	41.2

Sea State	Proportion (%)
Moderate (1–5m)	58.6
Severe (>5m)	0.2

11.3 Visibility

106. It is assumed that the proportion of poor visibility (defined as the proportion of a year where the visibility can be expected to be less than 1km) is 3%. This is based upon information available within UHKO Admiralty Sailing Directions North Sea (West) Pilot NP54 (UKHO, 2016) for the region.

11.4 Tide

107. Tidal data to be used as input to the collision and allision modelling is based upon information available from UKHO Admiralty charts 106, and 105.

108. Table 11.2 presents the peak flood and ebb direction and speed values for tidal diamond “G” on UKHO Admiralty Chart 108 (0.3nm south from the SEP wind farm site). Table 11.3 presents the same values for tidal diamond “A” on UKHO Admiralty Chart 105 (0.4nm from the northern section of DEP). For each location, the most local tidal diamond will be used in the collision and allision modelling.

Table 11.2 Details for tidal diamond “G” on UKHO Admiralty Chart 108

Hours		Directions of Streams (°)	Rates at Spring Tide (knots (kt))	Rate at Neap Tide (kt)
Before high water	6	300	1.9	1.0
	5	296	2.4	1.2
	4	289	2.4	1.2
	3	281	1.6	0.8
	2	248	0.4	0.2
	1	131	0.7	0.4
High water		120	1.6	0.8
After high water	1	115	2.1	1.1
	2	111	2.1	1.1
	3	109	1.6	0.8
	4	087	0.6	0.3

Hours		Directions of Streams (°)	Rates at Spring Tide (knots (kt))	Rate at Neap Tide (kt)
	5	326	0.6	0.3
	6	301	1.6	0.8

Table 11.3 Details for tidal diamond "A" on UKHO Admiralty Chart 105

Hours		Directions of Streams (°)	Rates at Spring Tide (kt)	Rate at Neap Tide (kt)
Before high water	6	331	1.4	0.7
	5	331	1.7	0.9
	4	325	1.6	0.8
	3	313	0.9	0.4
	2	209	0.3	0.1
	1	160	0.7	0.4
High water		143	1.3	0.6
After high water	1	142	1.6	0.8
	2	140	1.2	0.6
	3	137	0.8	0.4
	4	143	0.2	0.1
	5	325	0.6	0.3
	6	329	1.2	0.6

12 Emergency Response Overview

109. This section summarises the existing SAR resources of relevance to SEP and DEP.

12.1 Search and Rescue Helicopters

110. Since April 2015, the Bristow Group have provided helicopter SAR operations in the UK and is contracted to do so until March 2026. The SAR helicopter service is operated out of 10 base locations around the UK, with the closest located at Humberside, approximately 57nm north west of the DEP wind farm site (see Figure 12.1). This base is the most likely (93% of incidents) to respond to any incident requiring SAR helicopter services, based upon the SAR helicopter data for the region (See Section 13.3).

12.2 Royal National Lifeboat Institute

111. The RNLI is organised into six divisions, with the relevant region for the SEP and DEP being *"East"*. Based out of more than 230 stations around the UK, there are around 350 lifeboats across the RNLI fleet, including both All-Weather Lifeboats (ALBs) and Inshore Lifeboats (ILBs). Figure 12.1 presents the locations of RNLI stations in proximity to the wind farm sites and Table 12.1 summarises the types of lifeboat operated by the RNLI out of these stations.

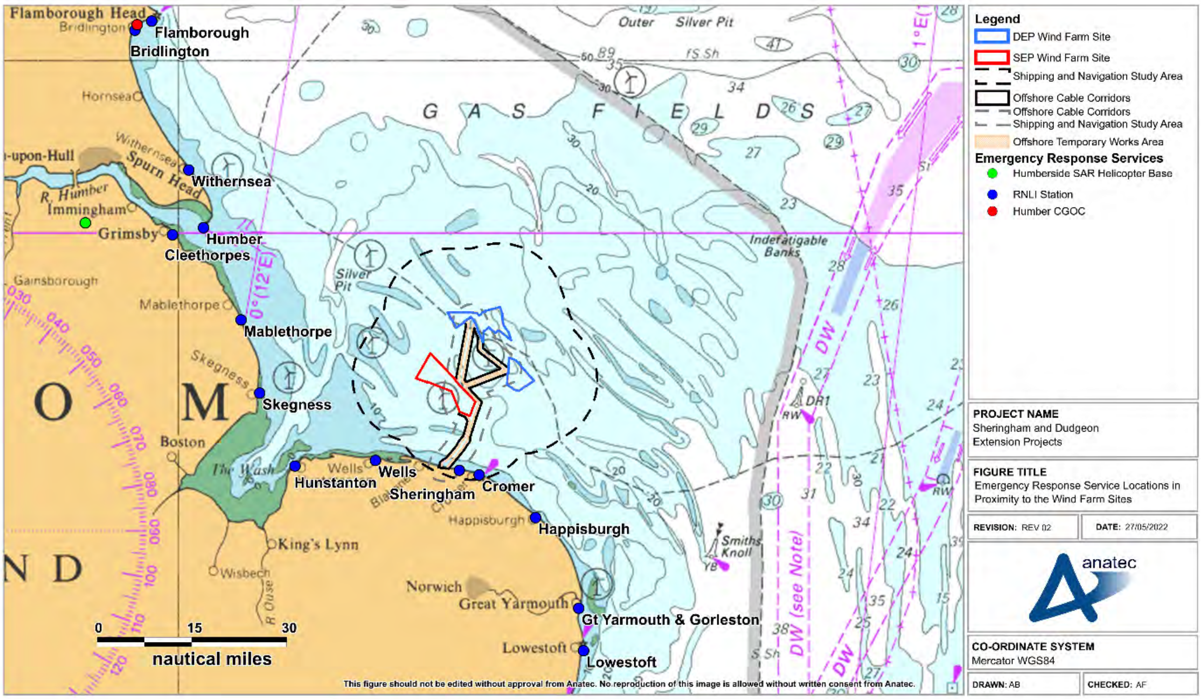

Figure 12.1 Emergency Response Service Locations in Proximity to the Wind Farm Sites

Table 12.1 Types of Lifeboat Held at RNLI Stations in Proximity to the Wind Farm Sites

Station	Lifeboat(s)	ALB Class	ILB Class	Minimum Distance to Wind Farm Sites (nm)
Sheringham	ILB	-	B Class	9
Cromer	ALB & ILB	Tamar	D Class	9
Wells	ALB & ILB	Mersey	D Class	15
Happisburgh	ILB x2	-	B Class & D Class	19
Hunstanton	ILB	-	B Class	24
Skegness	ALB & ILB	Shannon	D Class	25
Mablethorpe	ILB x2		B Class & D Class	30
Great Yarmouth & Gorleston	ALB & ILB	Trent	B Class	35
Humber	ALB	Severn	-	40
Lowestoft	ALB	Shannon	-	41
Cleethorpes	ILB	-	D Class	44
Withernsea	ILB	-	D Class	46
Southwold	ILB	-	B Class	48

112. RNLI lifeboats are available on a 24-hour basis throughout the year. Given that the RNLI have a 100nm operational limit, a RNLI lifeboat could respond to an incident within the wind farm sites. This is reflected within the RNLI incident data for the region (see Section 13.2).

12.3 Her Majesty's Coastguard Station

113. Her Majesty's Coastguard (HMCG), a division of the MCA, is responsible for requesting and tasking SAR resources made available to other authorities and for coordinating the subsequent SAR operations (unless they fall within military jurisdiction).

114. The HMCG coordinates SAR operations through a network of 11 Maritime Coastguard Co-ordination Centres (MRCC), including a Joint Rescue Co-ordination Centre (JRCC) based in Hampshire. A corps of over 3,500 volunteer Coastguard Rescue Officers (CRO) around the UK from 352 local Coastguard Rescue Teams (CRT) are involved in coastal rescue, searches, and surveillance.

115. 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, and therefore covers an area encompassing the wind farm sites.

116. Each region is divided into six districts with its own MRCC, which coordinates the SAR response for maritime and coastal emergencies within its district boundaries (East of England includes an additional station, London Coastguard, for coordinating SAR on the River Thames). The closest MRCC to the wind farm sites is the Humber MRCC in Bridlington, in East Yorkshire, located approximately 70nm north west of the closest point to SEP and DEP.

12.4 Self Help Resources

117. Companies operating offshore typically have resources of vessels, helicopters, and other equipment available for normal operations that can assist with emergencies offshore. Moreover, all vessels under IMO obligations set out in the International Convention for the Safety of Life at Sea (SOLAS) (IMO, 1974) as amended, are required to render assistance to any person or vessel in distress if safely able to do so.

13 Maritime Incidents

118. This section reviews historic maritime incident data to assess baseline incident rates within the vicinity of the SEP and DEP wind farm sites. Recorded / reports incidents associated with constructing or operational wind farm projects are presented and discussed.

119. This maritime incident assessment is for the purpose of determining whether the sea area in and around the SEP and DEP wind farm sites is currently low or high risk in terms of maritime accidents, and whether OWFs in general pose a high risk to vessels.

120. Data from the following sources has been analysed:

- MAIB;
- RNLI; and
- DfT.

121. It should be considered that the same incident may be recorded by multiple sources.

13.1 Marine Accident Investigation Branch Incident Data

122. All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12nm), a UK port or carrying passengers to a UK port are required to report accidents to the MAIB. Data arising from these reports are assessed within this section, covering the ten year period between 2010 and 2019.

123. At UK CoS request (see Sections 4.2 and 4.4) an additional ten years of MAIB incident data covering 2000-2009 has also been considered to bring the total up to 20 years. It should be considered that the 2000-2009 data precedes key features of the area (notably the operational wind farms), and therefore the most recent ten years available has remained the focus of the analysis.

13.1.1 Wind Farm Sites

13.1.1.1 2010-2019

124. The incidents recorded within the MAIB data between 2010 and 2019 occurring within the shipping and navigation study area are presented in Figure 13.1, colour coded by incident type. Following this, Figure 13.2 shows the same data colour coded by the type of vessel(s) involved in the incident.

125. A total of 27 incidents were recorded by the MAIB within the shipping and navigation study area between 2010 and 2019, which corresponds to an average of approximately three incidents per year. Of these, two occurred within the SEP wind farm site. None were recorded within the DEP wind farm site.

126. The most common incident types recorded were “accident to person” (24%) and “machinery failure” (21%). Of pertinence to the vessel-to-vessel collision modelling (see Section 19) is that one collision was recorded over the ten years studied. This incident occurred in the area between the SEP and DEP wind farm sites on the 2nd June 2012, and involved a passenger vessel colliding with a small commercial workboat.

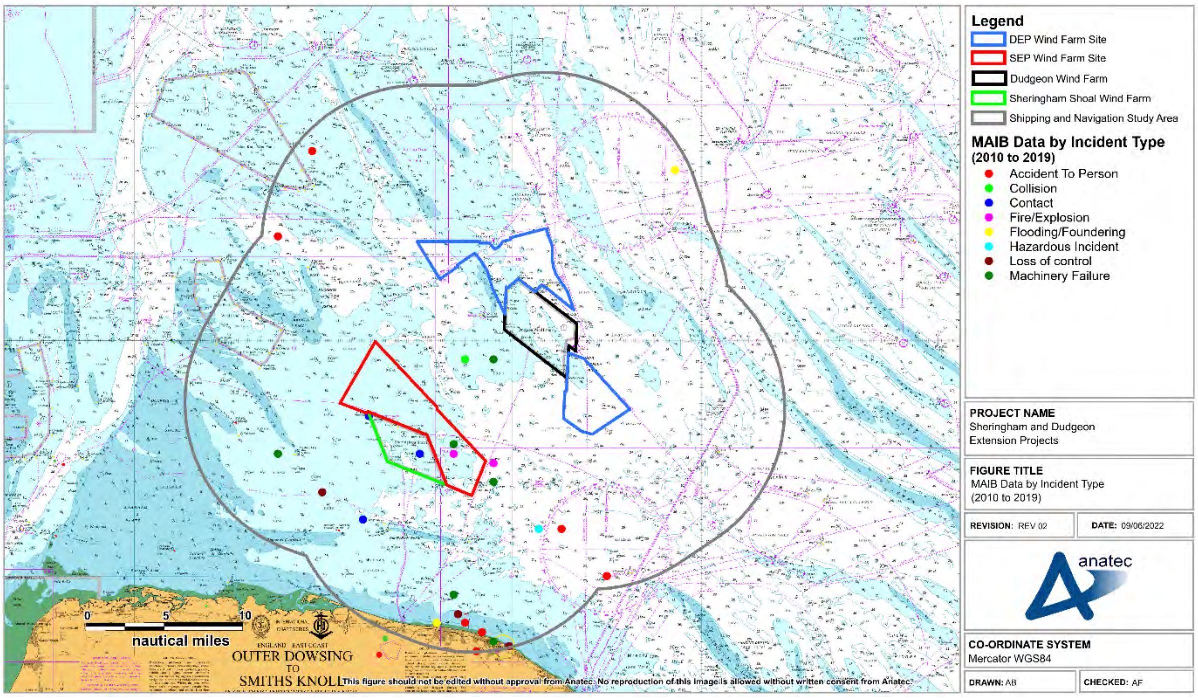

Figure 13.1 MAIB Data by Incident Type (2010 to 2019)

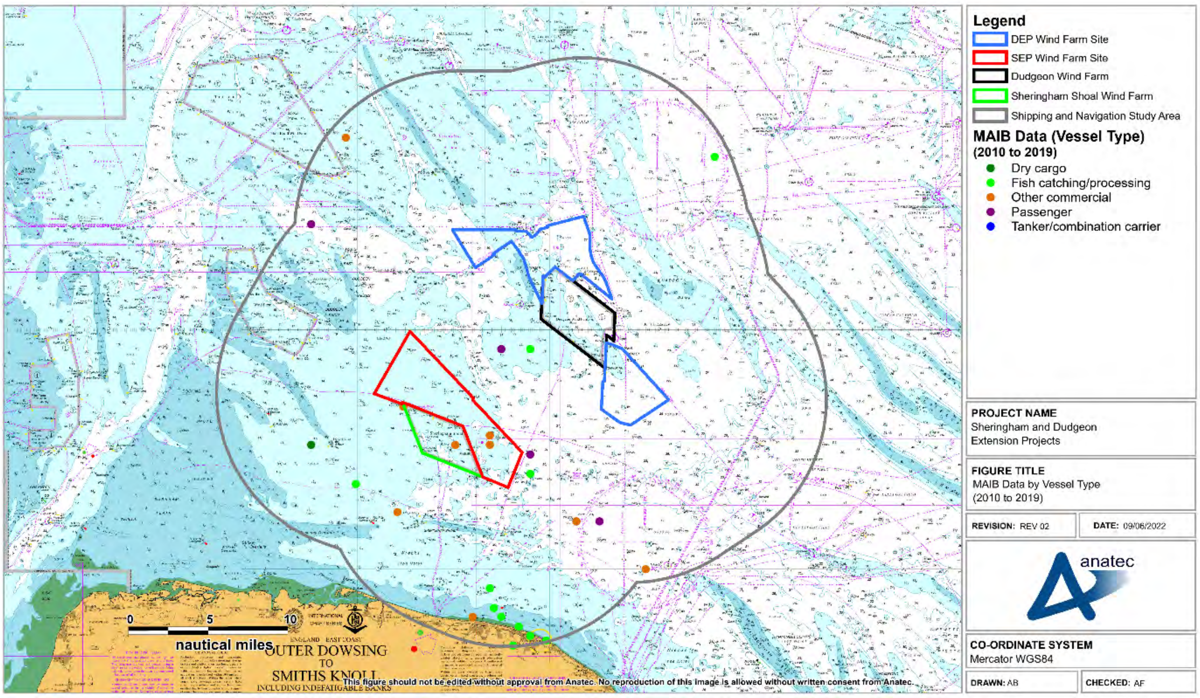

Figure 13.2 MAIB Data by Vessel Type (2010 to 2019)

13.1.1.2 2000-2009

127. In addition to the ten most recent years of MAIB data, an additional ten years was also analysed, from 2000-2009.

128. A total of 53 incidents were recorded by the MAIB within the shipping and navigation study area between 2000 and 2009, which corresponds to an average of approximately five incidents per year. Of these, one occurred within the SEP wind farm site. None were recorded within the DEP wind farm site.

129. The most common incident types recorded were “machinery failure” (54%) and “accident to person” (17%).

130. These findings broadly align with the assessment of the 2010 to 2019 data.

13.1.2 Offshore Cable Corridor

13.1.2.1 2010-2019

131. The incidents recorded within the MAIB data between 2010 and 2019 occurring within the offshore export cable corridor shipping and navigation study area are presented in Figure 13.3 and Figure 13.4, colour coded by incident type and casualty type, respectively. A total of 10 unique incidents were recorded within the offshore export cable corridor shipping and navigation study area, which corresponds to an average of approximately one incident per year. Three of these incidents occurred within the

offshore export cable route itself. One incident involved a collision between two vessels, and so a total of eleven vessels were involved in incidents over the 10-year period.

132. The most common incident type in the offshore export cable corridor was machinery failure (40%). The most common casualty type in the offshore export cable corridor were other commercial vessels (46%) and fish catching/processing vessels (36%).

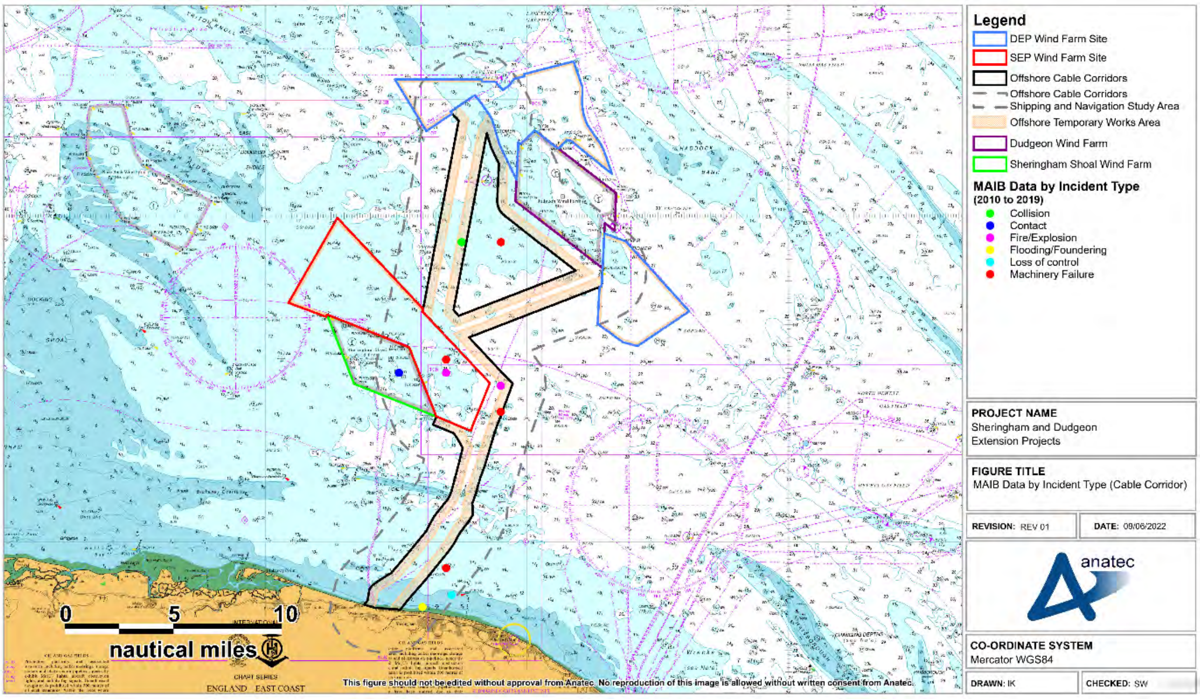

Figure 13.3 MAIB Data by Incident Type within Cable Corridor Shipping and Navigation Study Area (2010 to 2019)

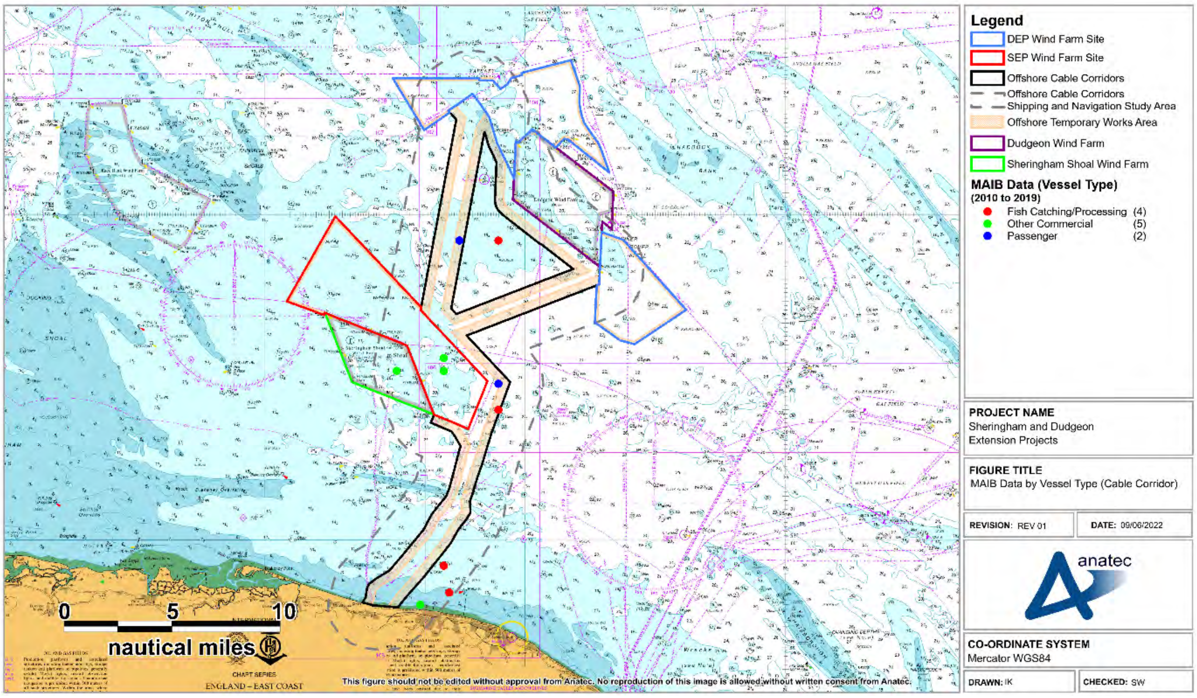

Figure 13.4 MAIB Data by Vessel Type within Cable Corridor Shipping and Navigation Study Area (2010 to 2019)

13.1.2.2 2000-2009

133. In addition to the ten most recent years of MAIB data, an additional ten years was also analysed, from 2000-2009.

134. A total of 12 unique incidents involving 14 vessels were recorded within the offshore export cable corridor shipping and navigation study area. Four of these incidents occurred within the offshore export cable route itself.

135. The most common incident types in the offshore export cable corridor were machinery failure (33%), accident to person (25%), and hazardous incident (25%). The most common casualty type in the offshore export cable corridor were fish catching/processing (36%), dry cargo (21%), and passenger vessel (21%).

136. These findings broadly align with the assessment of the 2010 to 2019 data.

13.2 Royal National Lifeboat Institute Data

137. Data on incidents to which an RNLI lifeboat responded to over the 10-year period between 2010 and 2019 are presented within this section (excluding hoaxes or false alarms).

13.2.1 Wind Farm Sites

138. Incidents within the RNLI data recorded within the shipping and navigation study area between 2010 and 2019 are presented in Figure 13.5 colour coded by incident type. Following this, Figure 13.6 shows the same data colour coded by casualty type.

139. A total of 153 incidents were responded to by the RNLI within the shipping and navigation study area between 2010 and 2019, with a total of 160 lifeboats mobilised (i.e., certain incidents were responded to by multiple lifeboats). This corresponds to an average of 15 incidents per year, however it is noted that the majority of these were coastal. Two incidents were recorded within the SEP wind farm site, and no incidents were recorded within the DEP wind farm site.

140. Similarly to the MAIB data, the most common incident types recorded were "machinery failure" (35%), and "person in danger" (29%).

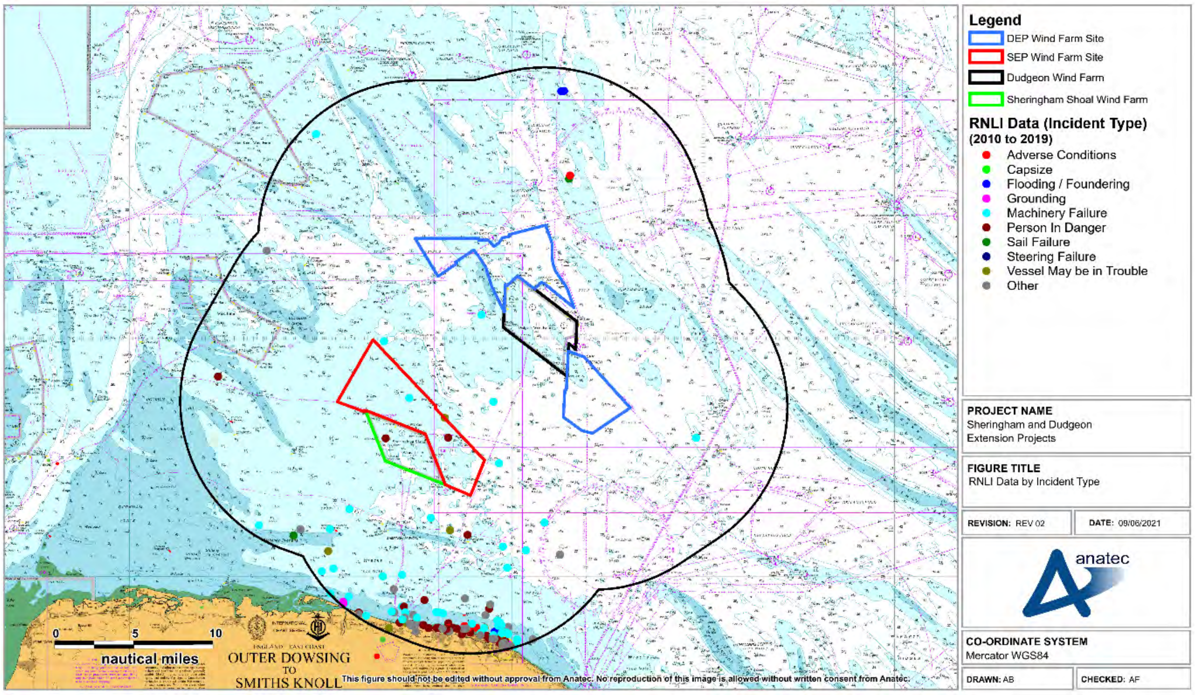

Figure 13.5 RNLI Data by Incident Type (2010 to 2019)

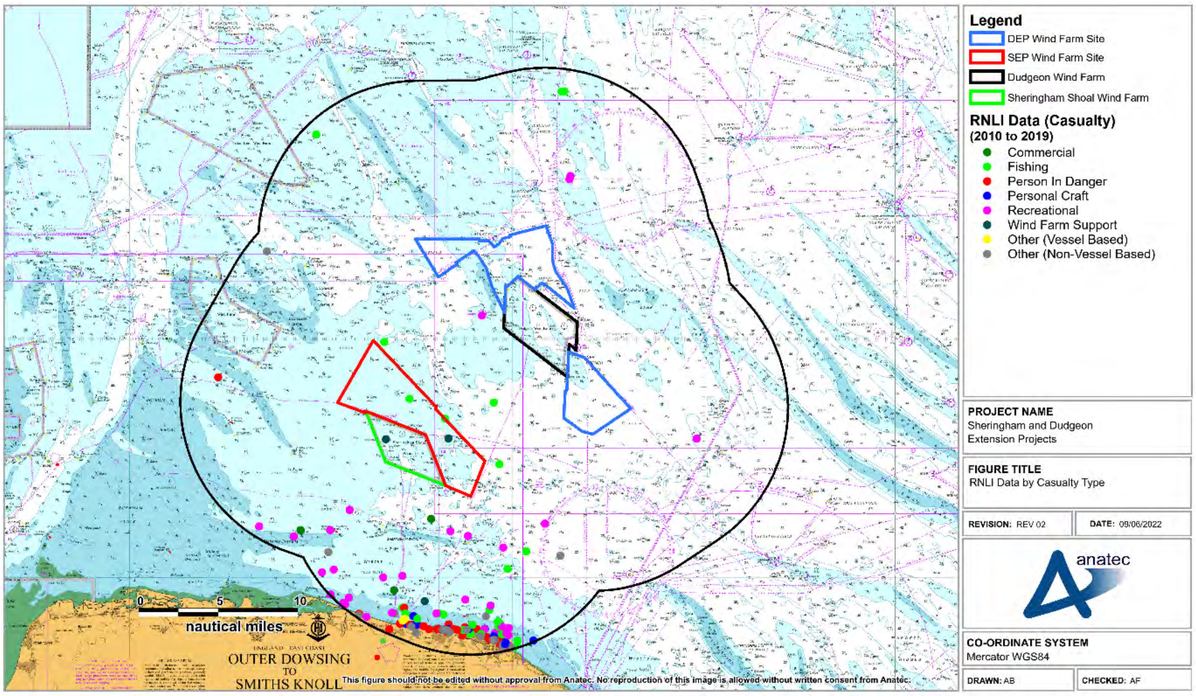

Figure 13.6 RNLI Incident Data by Casualty (2010 to 2019)

13.2.2 Offshore Cable Corridor

141. Incidents within the RNLI data recorded within the offshore export cable corridor shipping and navigation study area between 2010 and 2019 are presented in Figure 13.7 and Figure 13.8 colour coded by incident type and casualty type, respectively.

142. A total of 49 incidents with were recorded by the RNLI within the offshore export cable corridor shipping and navigation study area between 2010 and 2019, with 54 lifeboats deployed to provide assistance. This corresponds to an average of approximately five incidents per year, with the majority of the RNLI incidents occurring within coastal regions. A total of 11 incidents occurred within the offshore export cable corridor itself with the majority of these occurring near the landfall option at Weybourne.

143. The main RNLI incident types within the offshore export cable corridor shipping and navigation study area were person in danger (35%) and machinery failure (31%). The main RNLI casualty types within the offshore export cable corridor shipping and navigation study area were person in danger (33%), recreational craft (17%), and fishing vessels (17%).

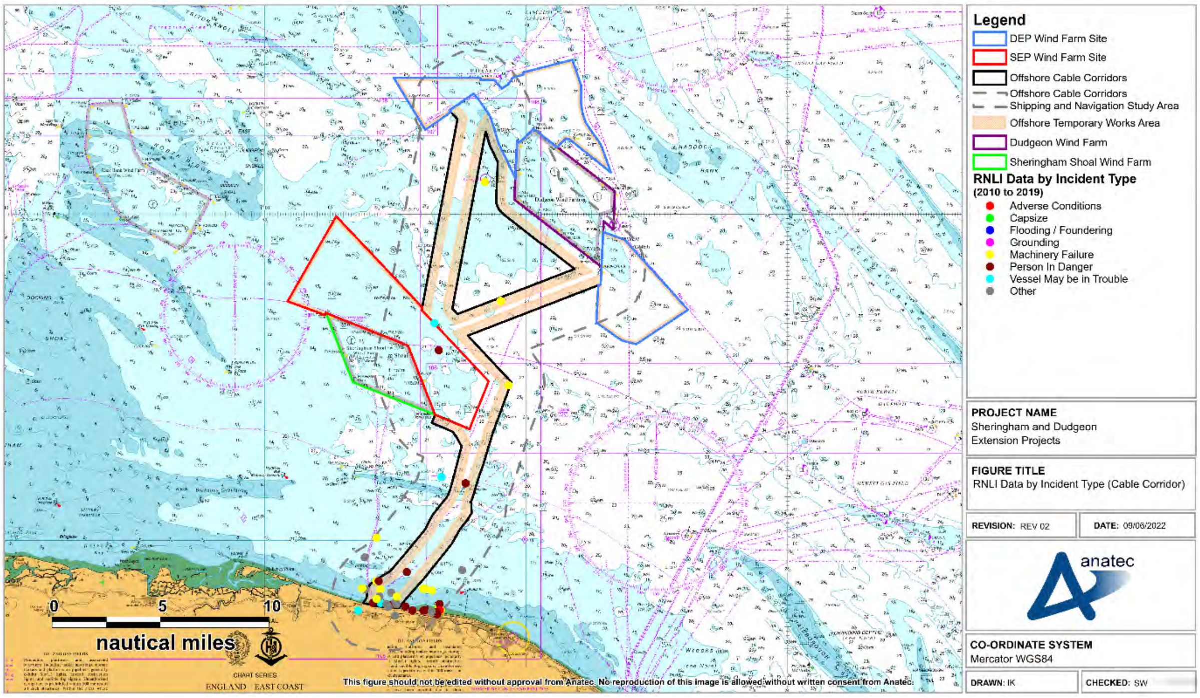

Figure 13.7 RNLI Data by Incident Type within the Offshore Export Cable Corridor Shipping and Navigation Study Area

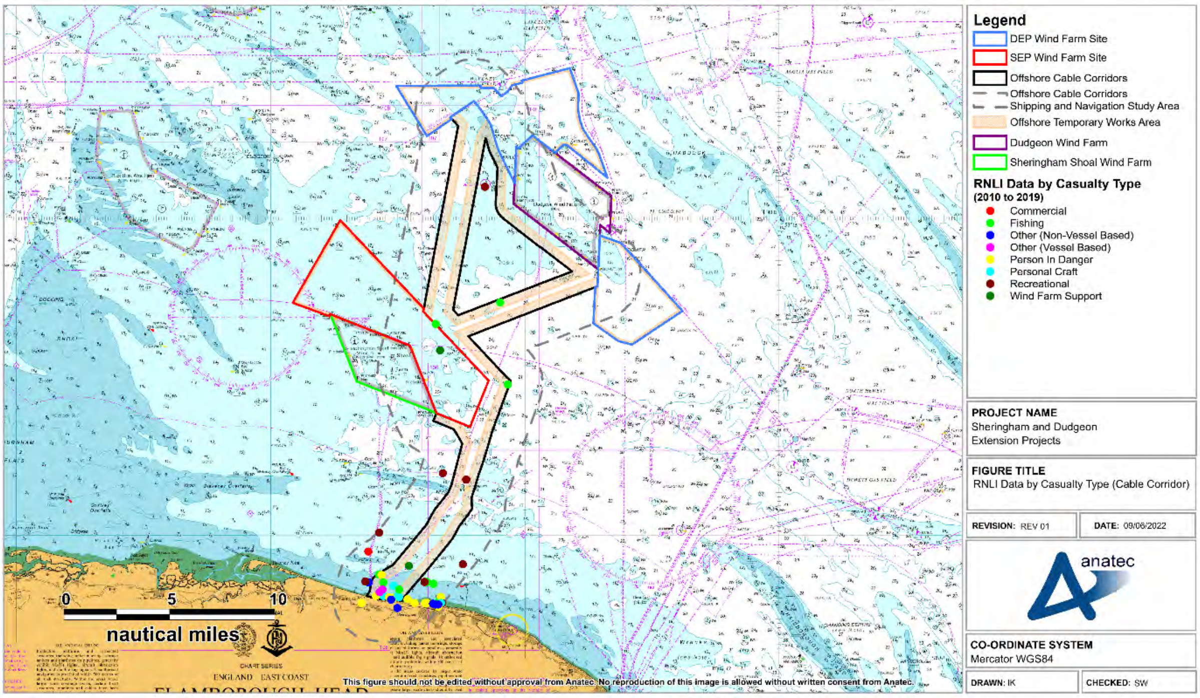

Figure 13.8 RNLI Data by Casualty Type within the Offshore Export Cable Corridor Shipping and Navigation Study Area

13.3 Department for Transport Search and Rescue Helicopter Data

13.3.1 Wind Farm Sites

144. A total of 18 SAR helicopter taskings were undertaken for incidents within the shipping and navigation study area, corresponding to an average of six taskings per year. The majority of these taskings were Rescue / Recovery (66%). No SAR helicopter taskings were undertaken within the wind farm sites. Figure 13.9 presents the SAR helicopter taskings undertaken within the shipping and navigation study area and the offshore export cable corridor shipping and navigation study area.

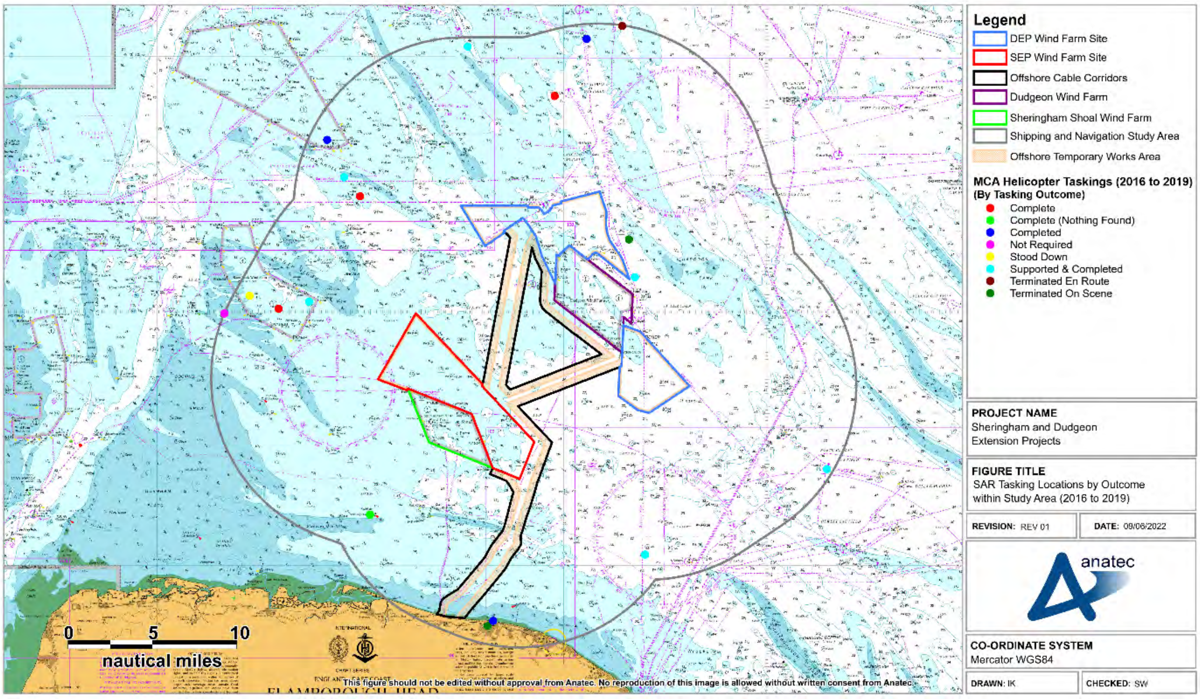

Figure 13.9 SAR Tasking Locations by Outcome with Study Area (2016 to 2019)

13.3.2 Offshore Export Cable Corridor

145. A total of two SAR helicopter taskings were undertaken for incidents within the offshore export cable corridor shipping and navigation study area, corresponding to an average of one taskings every two to three years. One of the three taskings involved was rescue/recovery, with the other being support. No SAR helicopter taskings were undertaken within the offshore export cable corridor itself.

13.4 Historical Offshore Wind Farm Incidents

146. At the time of writing[8] there are 41 fully commissioned and operational OWFs in the UK, ranging from the North Hoyle OWF (fully commissioned in 2003) to Moray East

[8] June 2022

(fully commissioned in 2022). These developments consist of approximately 18,400 fully operational wind turbine years.

147. MAIB incident data has been used to collate a list of historical collision and allision incidents involving UK OWF developments, which is summarised in Table 13.1. Other sources have also been used to produce this list including the UK Confidential Human Factors Incident Reporting Programme (CHIRP) for Aviation and Maritime, International Marine Contractors Association (IMCA) and basic web searches.

148. There have also been a number of collision and allision incidents involving non-UK OWF developments, including an allision incident involving an offshore service and supply vessel which experienced a loss of control whilst undertaking an emergency control system test shortly after casting off from a wind turbine in a German OWF (Federal Bureau of Maritime Casualty Investigation (BSU), 2019).

149. The worst consequences reported for vessels involved in a collision or allision incident involving a UK OWF development has been minor flooding, with no life-threatening injuries to persons reported.

150. As of June 2022, there have been no collisions as a result of the presence of an OWF in the UK. The only reported collision incident in relation to a UK OWF involved a project vessel hitting a third-party vessel whilst in harbour.

151. As of June 2022 there have been 12[9] reported cases of an allision between a vessel and a wind turbine (under construction, operational or disused) in the UK, with all but one involving a support vessel for the development and the errant vessel in each case under power rather than drifting. Therefore, there has been an average of 1,848 years per wind turbine allision incident in the UK, noting that this is a conservative calculation given that only operational wind turbine hours have been included (whereas allision incidents counted include non-operational wind turbines). Table 13.1 presents these nine WT allision incidents, any other allision incidents, and collision incidents involving UK OWF developments.

[9] Reported to an accident investigation branch or an anonymous reporting service. Unconfirmed incidents have not been considered noting that to date only one further alleged incident has been rumoured but there is no evidence to confirm.

Table 13.1 Summary of historical collision and allision incidents involving UK OWF developments

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage based on Incident Reports	Harm to Persons	Source
Project	Allision – project vessel with wind turbine	7th August 2005	A vessel involved with the installation of wind turbines underestimated the effect of the current and allided with the base of a wind turbine whilst manoeuvring alongside it. Minor damage was sustained to a gangway on the vessel, the wind turbine tower, and a wind turbine blade.	Minor damage to gangway on the vessel	None	MAIB
Project	Allision – project vessel with wind turbine	29th September 2006	When approaching a wind turbine, an offshore services vessel was struck by the tip of a wind turbine blade which was rotating rather than secured in a fixed position.	None	None	MAIB
Project	Allision – project vessel with disused pile	8th February 2010	The Skipper on-board a work boat slipped their hand on the throttle controls whilst in proximity to a disused pile. There was insufficient time to correct the error and the vessel struck the pile. A passenger moving around the interior of the vessel was thrown off his feet. Although not known at the time, the passenger was later diagnosed with back injuries. No serious damage was caused to the vessel.	Minor	Injury	MAIB
Project	Collision – third party vessel with project vessel	23rd April 2011	A third-party catamaran was hit by a project guard vessel within a harbour.	Moderate	None	MAIB

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage based on Incident Reports	Harm to Persons	Source
Project	Allision – project vessel with wind turbine	18th November 2011	The Officer of the Watch (OOW) on-board a cable-laying vessel fell asleep and woke to find the vessel inside a wind farm. He attempted to manoeuvre the vessel out of the wind farm on autopilot, but the settings did not allow a quick turn and the vessel struck the foundations of a partially completed wind turbine. The vessel suffered two hull breaches.	Major	None	MAIB
Project	Collision – project vessel with service vessel	2nd June 2012	A CTV became lodged under the boat landing equipment of a flotel. Nine persons were safely evacuated and transferred to a nearby vessel before being brought back into port.	Moderate	None	UK CHIRP
Project	Allision – project vessel with wind turbine	20th October 2012	The OOW misjudged the distance from a wind turbine monopile and made contact with the vessel's stern resulting in minor damage.	Minor	None	MAIB
Project	Allision – project vessel with buoy	21st November 2012	A wind farm passenger transfer catamaran struck a buoy at high speed whilst supporting operation for an OWF. The vessel was abandoned by the crew of 12 with the vessel having been holed, causing extensive flooding. There were however no injuries. It was found that the Master had unknowingly altered the vessel's course and had not been formally assessed to determine his suitability for the role.	Major	None	MAIB

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage based on Incident Reports	Harm to Persons	Source
Project	Allision – project vessel with wind turbine	21st November 2012	A work boat allided with the unlit transition piece of a wind turbine at moderate speed. The impact caused all five persons on-board to be forced out of their seats. The vessel was able to proceed to port unassisted with no water ingress incurred, although there was some structural damage. It was found that the vessel's Master had relied too heavily on visual cues and there had been insufficient training with navigation equipment. The wind turbine transition piece had been reported as unlit although the defect reporting system had failed to promulgate a navigation warning.	Moderate	None	MAIB
Project	Allision – project vessel with wind turbine	1st July 2013	After disembarking passengers at an offshore substation a service vessel's jets were disengaged, but the vessel jet drive suffered a failure which resulted in an allision with a wind turbine foundation. The vessel suffered some damage whereas the wind turbine foundation was not damaged.	Minor	None	IMCA Safety Flash
Project	Allision – project vessel with wind turbine	14th August 2014	A standby safety vessel allided with a wind turbine pile and consequently leaked marine gas oil and a surface sheen trailed from the vessel. Under its own power the vessel moved away from environmentally sensitive areas until the leak was stopped.	Minor with pollution	None	UK CHIRP

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage based on Incident Reports	Harm to Persons	Source
Third party	Allision – fishing vessel with wind turbine	26th May 2016	A crew member on-board a fishing vessel left the autopilot on, resulting in an allision with a wind turbine. A lifeboat attended the incident.	Moderate	Injury	Web search (RNLI, 2016)
Project	Allision - project vessel with wind turbine jacket	14th February 2019	A survey vessel undertaking a survey at an offshore wind farm ran too close to a wind farm jacket whilst the autopilot was engaged. Before the autopilot could be disengaged the vessel's rubbing strake made light contact with the jacket.	Minor	None	MAIB
Project	Allision – project vessel with wind turbine	16th January 2020	A project vessel servicing wind turbines allided with a wind turbine whilst transiting back to port resulting in a member of the crew coming into contact with the railings. The vessel proceeded unaided back to port where the man was subsequently taken to hospital to obtain doctors' advice.	None	Injury	Web search (Vessel Tracker, 2020)
Project	Allision – project vessel with wind turbine	27th January 2020	When picking up crew from a turbine, auto dynamic positioning was deployed by the OOW on a project vessel. However, the OOW (who was alone on the bridge) left the dynamic positioning desk to deal with other duties without having confirmed that the vessel was indeed in full auto DP. In reality the vessel was still in DP surge mode and, with help from the current, drifted towards a wind turbine and made contact six minutes later at a speed of 1.1 knots. The allision resulted in minor damage to the WT and vessel and no personal injuries.	Minor	None	Marine Safety Forum

14 Vessel Traffic Surveys

14.1 Wind Farm Sites

152. This section presents the results of analysis of 28 days of marine traffic survey data, comprising the 14 days of the summer 2020 vessel traffic survey and the 14 days of the winter 2021 vessel traffic survey (see Section 7.1).

153. A number of tracks recorded during the survey periods were classified as temporary (non-routine), such as tracks of the survey vessel, tracks performing guard duties, and vessels associated with the construction of Triton Knoll (see Section 14.1.3.5). These have therefore been excluded from the analysis. O&G support vessels operating at permanent installations were retained in the analysis. Wind farm support vessels at operational wind farms within the shipping and navigation study area (Dudgeon, Sheringham Shoal, and Race Bank (see Section 14.1.3.5)) have been retained.

14.1.1 Overview

154. A plot of the vessel tracks recorded during the 28-day survey period in July/August 2020 (summer) and January/February 2021 (winter) within the shipping and navigation study area, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 14.1. Following this, Figure 14.2 presents a density map for the 28-day survey period.

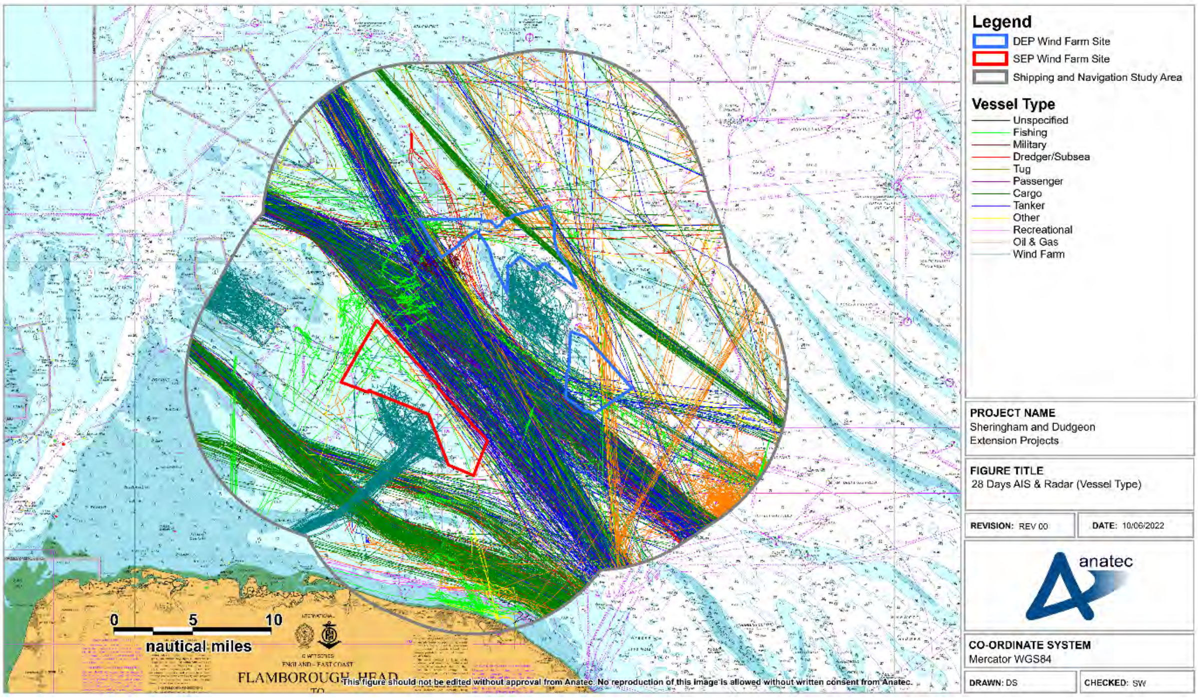

Figure 14.1 28 Days Marine Traffic Data (Vessel Type)

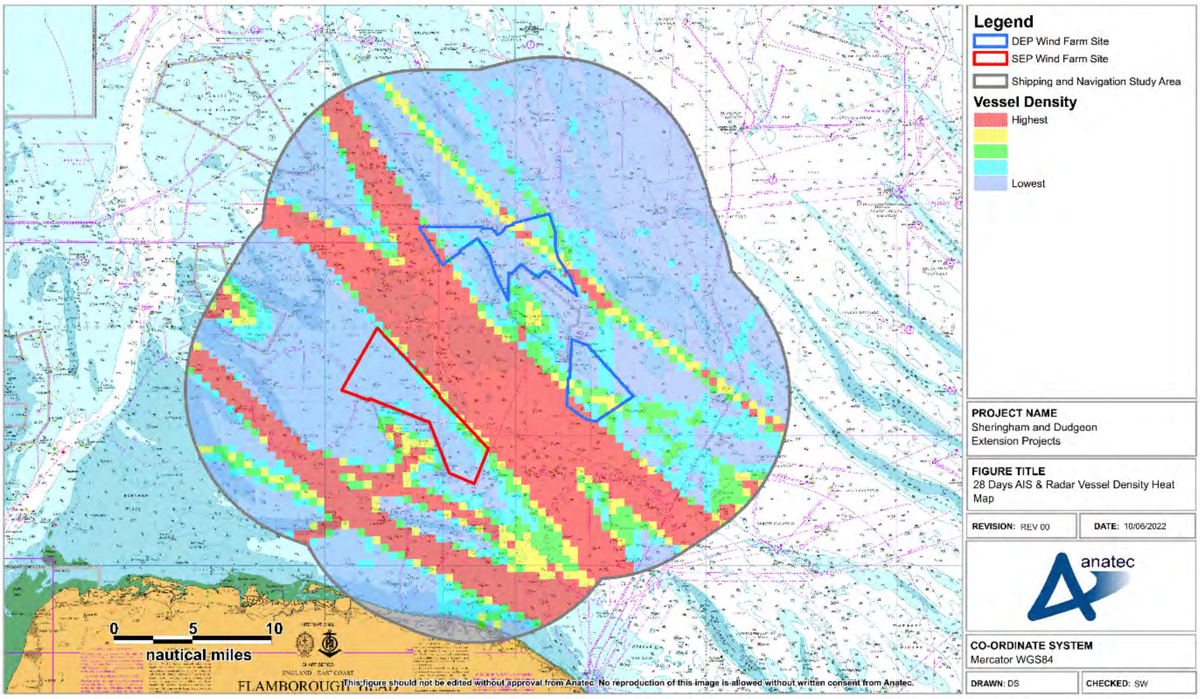

Figure 14.2 Vessel Traffic Density Heat Map

14.1.2 Vessel Counts

155. Over the 28 days of survey data, an average of 82 unique vessels per day were recorded within the shipping and navigation study area. There was not observed to be significant seasonal variation in terms of vessel numbers between the summer and winter survey periods, with an average of 82 per day recorded during summer compared to 81 in winter.

156. Additional analysis by survey is provided in Sections 14.1.2.1 and 14.1.2.2. It should be considered when viewing these sections that the first and last day of the summer survey period are partial days. Similarly, for the winter 2021 survey period, the 26th of January, the 5th - 9th of February, and the 13th of February are partial days (noting the survey vessel sought shelter between the 5th and 9th February).

14.1.2.1 Summer

157. Figure 14.3 and Figure 14.4 illustrate the daily number of unique vessels recorded within the shipping and navigation study area and the wind farm sites during the summer survey period. Throughout the summer survey period approximately 15% of unique vessel tracks recorded within the shipping and navigation study area intersected the DEP wind farm site while 3% of unique vessel tracks intersected the SEP wind farm site.

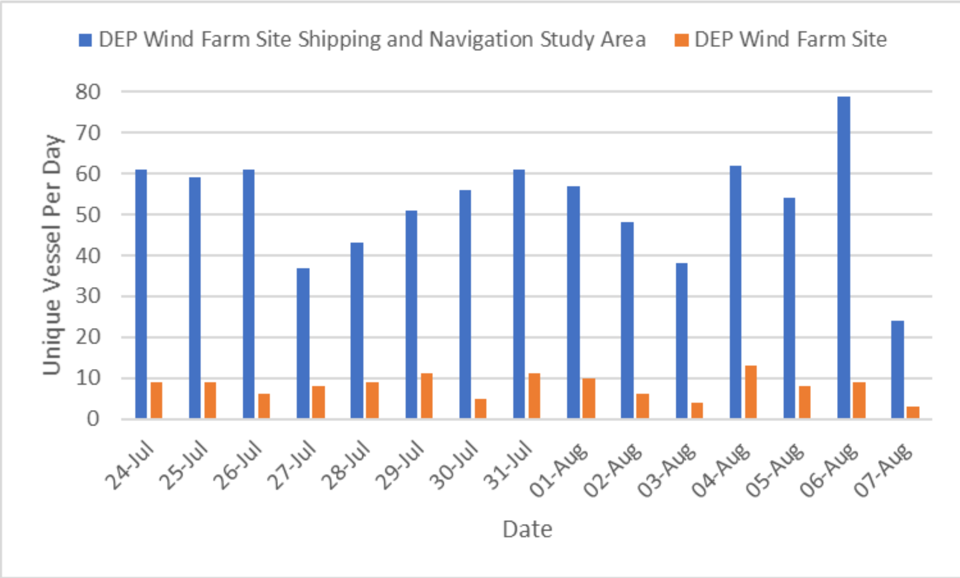

Figure 14.3 Daily Counts – DEP (Summer)

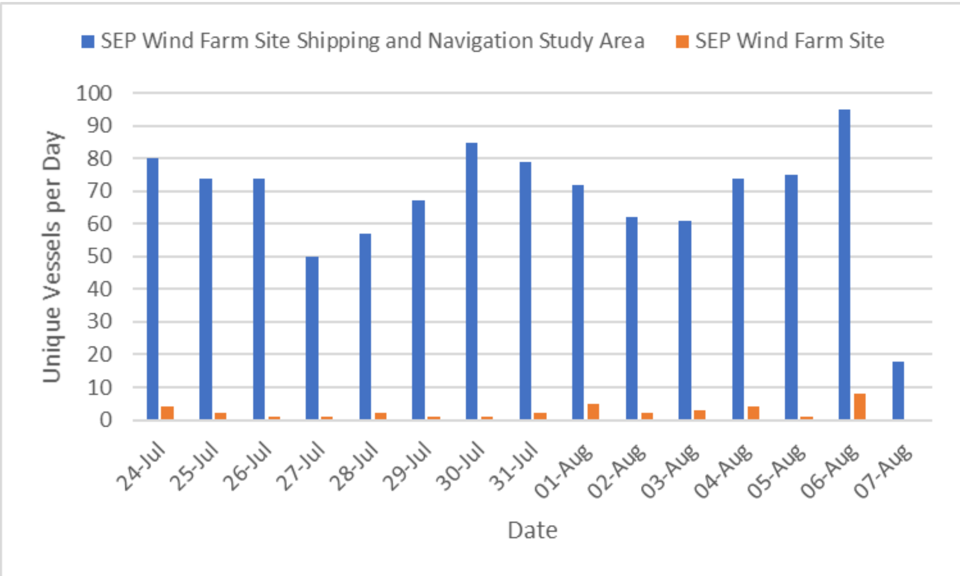

Figure 14.4 Daily Counts – SEP (Summer)

158. For the 14 days analysed in the summer survey period, there were an average of 82 unique vessels per day recorded within the shipping and navigation study area. In terms of intersecting traffic, the DEP wind farm had an average of eight unique vessels per day while the SEP wind farm had an average of three unique vessels per day.

159. The busiest full day recorded within the DEP shipping and navigation study area during the summer study period was the 6th August, when 79 unique vessels were recorded. The busiest full day for the summer survey period recorded within the DEP wind farm site was the 4th August, when 13 unique vessels were recorded.

160. The busiest full day recorded within the SEP shipping and navigation study area during the summer study period was the 6th August, when 95 unique vessels were recorded. The busiest full day recorded during the summer survey period within the SEP wind farm site was also the 6th August where eight unique vessels were recorded.

161. The quietest full day recorded within the DEP shipping and navigation study area during the summer study period was the 27th July when 37 unique vessels were recorded. The quietest full day recorded within the DEP wind farm site was the 3rd August, where four unique vessels were recorded.

162. The quietest full day recorded within the SEP shipping and navigation study area during the summer study period was the 27th July when 50 unique vessels were recorded. In terms of quietest days for the SEP wind farm site, a single transit was noted on multiple days.

14.1.2.2 Winter

163. Figure 14.5 and Figure 14.6 illustrate the daily number of unique vessels recorded within the shipping and navigation study area and the wind farm sites during the winter survey period. It is noted that, for the winter 2021 survey period, the 26th of January, 5th of February, 9th of February and 13th of February are partial days. Throughout the winter survey period approximately 9% of unique vessel tracks recorded within the shipping and navigation study area intersected the DEP wind farm site while 3% of unique vessel tracks intersected the SEP wind farm site.

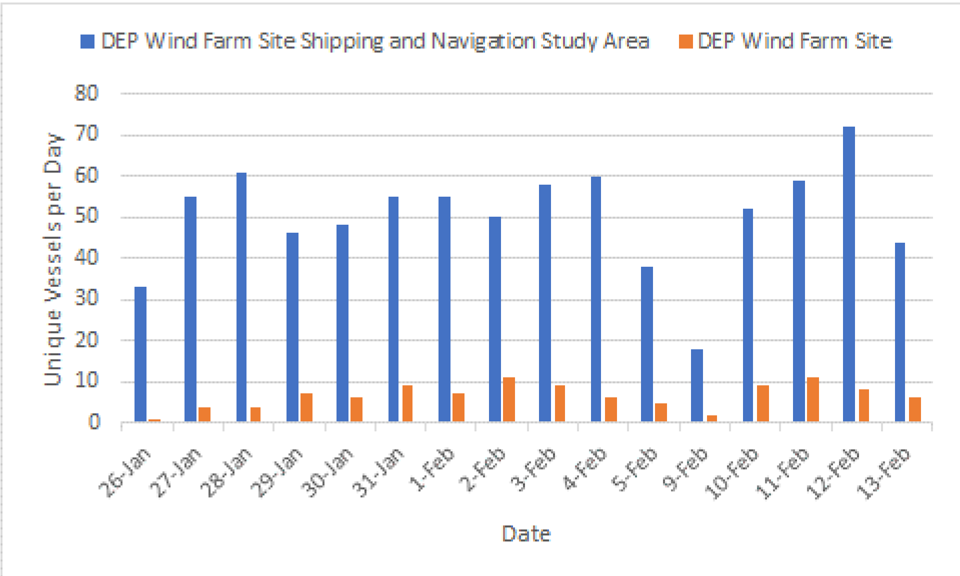

Figure 14.5 Daily Counts – DEP (Winter 2019)

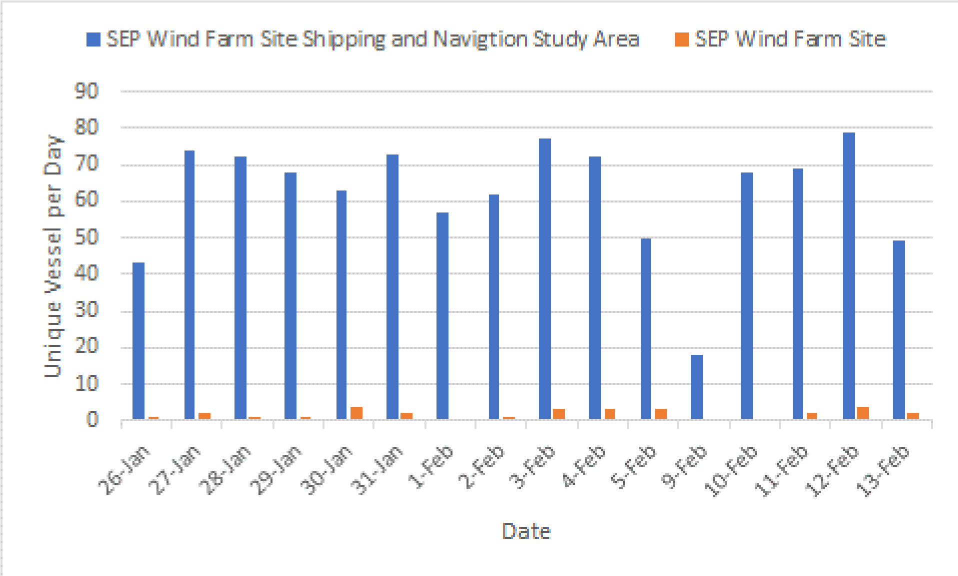

Figure 14.6 Daily Counts – SEP (Winter 2019)

164. For the 14 days analysed in the winter survey period, there were an average of 81 unique vessels per day recorded within the shipping and navigation study area. In terms of intersecting traffic, the DEP wind farm site had an average of eight unique vessel per day while the SEP wind farm site had an average of two unique vessel per day.

165. The busiest full day recorded during the winter survey period within the DEP shipping and navigation study area was the 12th of February, when 72 unique vessels were recorded. Within the DEP wind farm site, the highest count of 11 unique vessels were recorded on the 2nd and 11th of February.

166. The busiest full day recorded during the winter survey period within the SEP shipping and navigation study area was also the 12th of February, when 79 unique vessels were recorded. The busiest full days recorded within the SEP wind farm site were the 30th of January and 12th of February where four unique vessels were recorded on each day.

167. The quietest full day recorded within the DEP shipping and navigation study area was the 29th of January when 46 unique vessels were recorded. The quietest full days recorded within the DEP wind farm site were the 27th and 28th of January, where 4 unique vessels were recorded each day.

168. The quietest full day recorded within the SEP shipping and navigation study area was the 1st of February when 57 unique vessels were recorded. The quietest full day recorded within the SEP wind farm site was also the 1st of February, when no vessels were recorded.

14.1.3 Vessel Type

169. The percentage distribution of the main vessel types recorded passing within the shipping and navigation study area during the summer and winter study periods are presented in Figure 14.7, and Figure 14.8, respectively. It is noted that vessel types recorded in smaller numbers have been included within the 'other' vessel type category for the purposes of this type analysis.

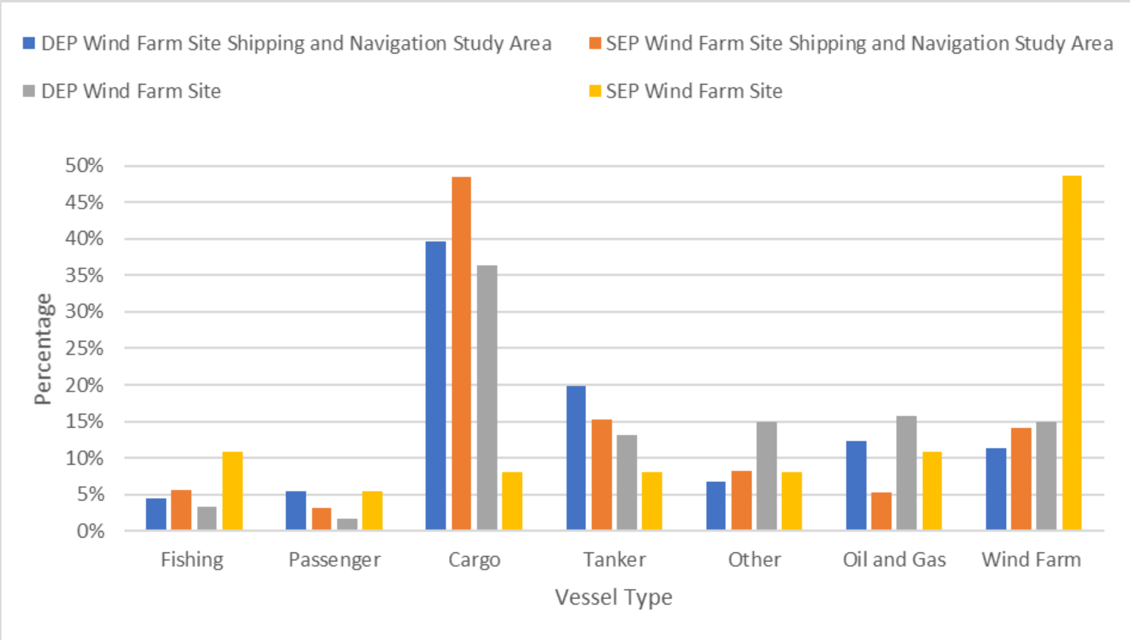

Figure 14.7 Vessel Type Distribution (Summer 2020)

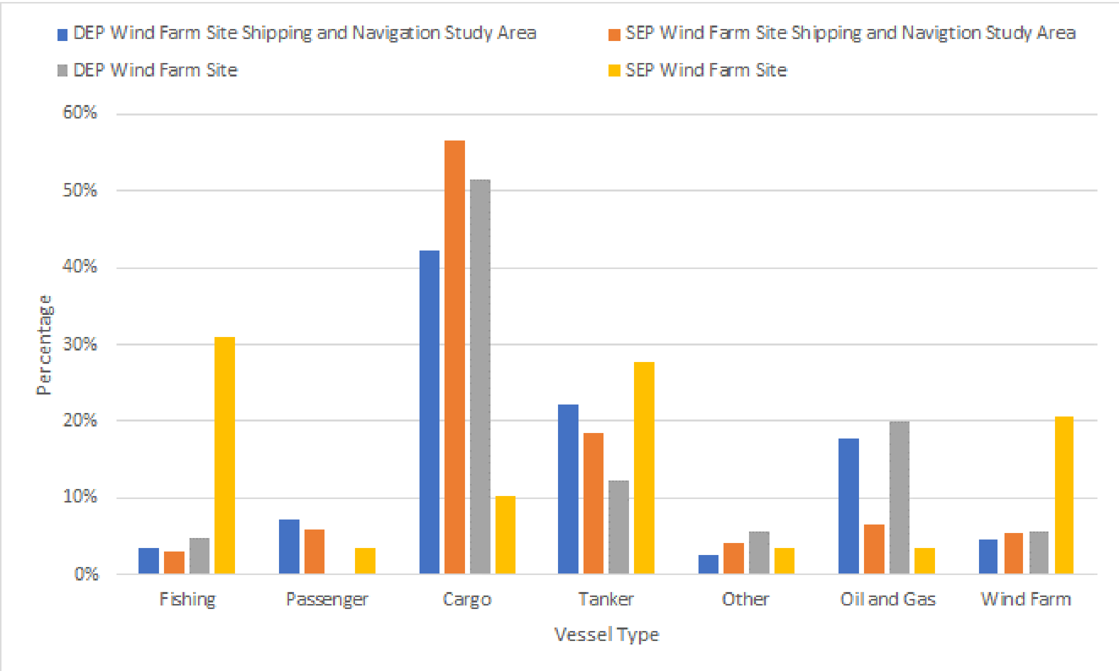

Figure 14.8 Vessel Type Distribution (Winter 2021)

170. Throughout the summer period in the DEP shipping and navigation study area, the main vessel types were cargo vessels (40%), tankers (20%), O&G vessels (12%), and wind farm support vessels (12%). Throughout the winter survey period in the DEP shipping and navigation study area the main vessel types recorded were also cargo vessels (42%), tankers (22%), and O&G vessels (18%).

171. Throughout the summer period in the SEP shipping and navigation study area, the main vessel types were cargo vessels (48%), tankers (15%), and wind farm vessels (14%). Throughout the winter survey study period in the SEP shipping and navigation study area the main vessel types were also cargo vessels (57%), tankers (18%), and wind farm vessels (6%). Passenger vessels and oil and gas vessels also comprised 6% of vessels in the SEP shipping and navigation study area during the winter survey period.

172. It is noted that wind farm support vessels accounted for a large proportion of vessels within the SEP wind farm site. This was due to operational traffic associated with the existing Sheringham project.

173. It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo.

14.1.3.1 Cargo Vessels

174. Figure 14.9 presents a plot of cargo vessels, including commercial ferries, recorded within the shipping and navigation study area during the 28-day survey period.

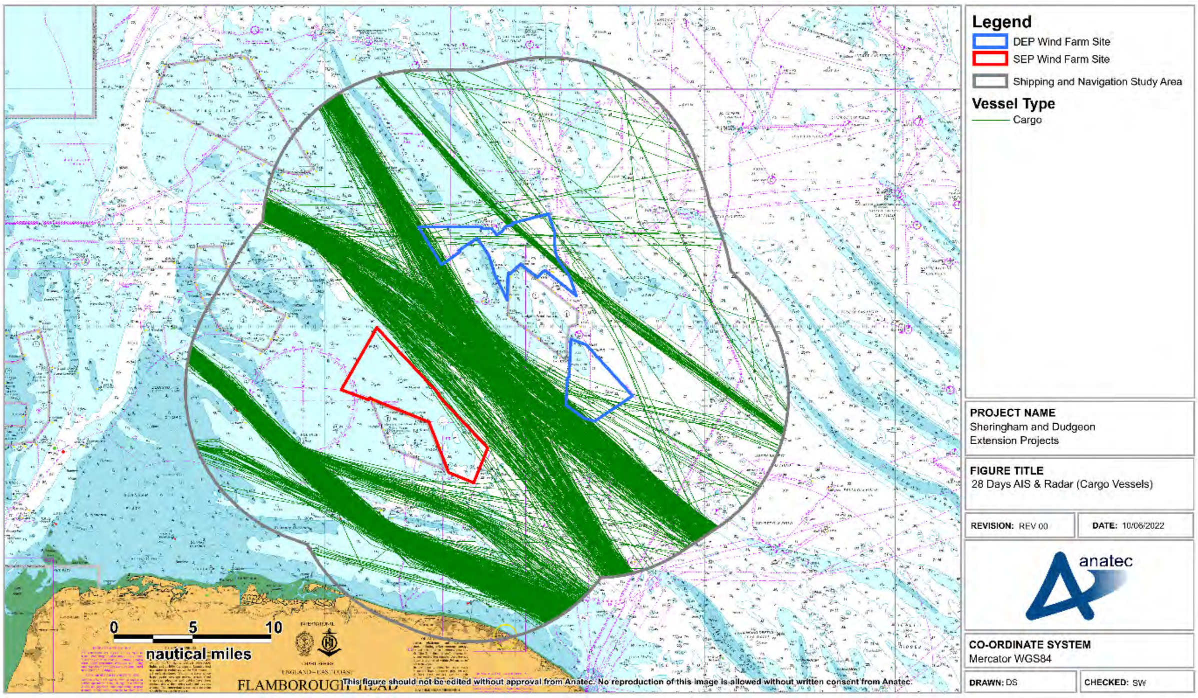

Figure 14.9 Cargo Vessels within the Shipping and Navigation Study Area

175. An average of 41 cargo vessels per day were recorded within the shipping and navigation study area over the 28-day period. A total of 23 per day were recorded within the DEP shipping and navigation study area, and 38 per day within the SEP shipping and navigation study area.

176. The regular cargo vessels operating within the shipping and navigation study area included Roll On Roll Off (Ro Ro) vessels operated by Cobelfret Ferries, DFDS Seaways, P&O Ferries and Stena Line. Main destinations included Humber-based ports such as Immingham (UK) and Hull (UK), and European ports such as Rotterdam (Netherlands) and Zeebrugge (Belgium). It is noted that DFDS, P&O and Stena all responded to the regular operator outreach as per Section 4.3, and attended the Hazard Workshop (Section 4.5).

177. Smaller cargo vessels typically passed using inshore routes, south of Sheringham Shoal, while the larger tankers transited further offshore between the SEP and DEP boundaries.

14.1.3.2 Tankers

178. Figure 14.10 presents a plot of tankers recorded within the shipping and navigation study area during the survey period.

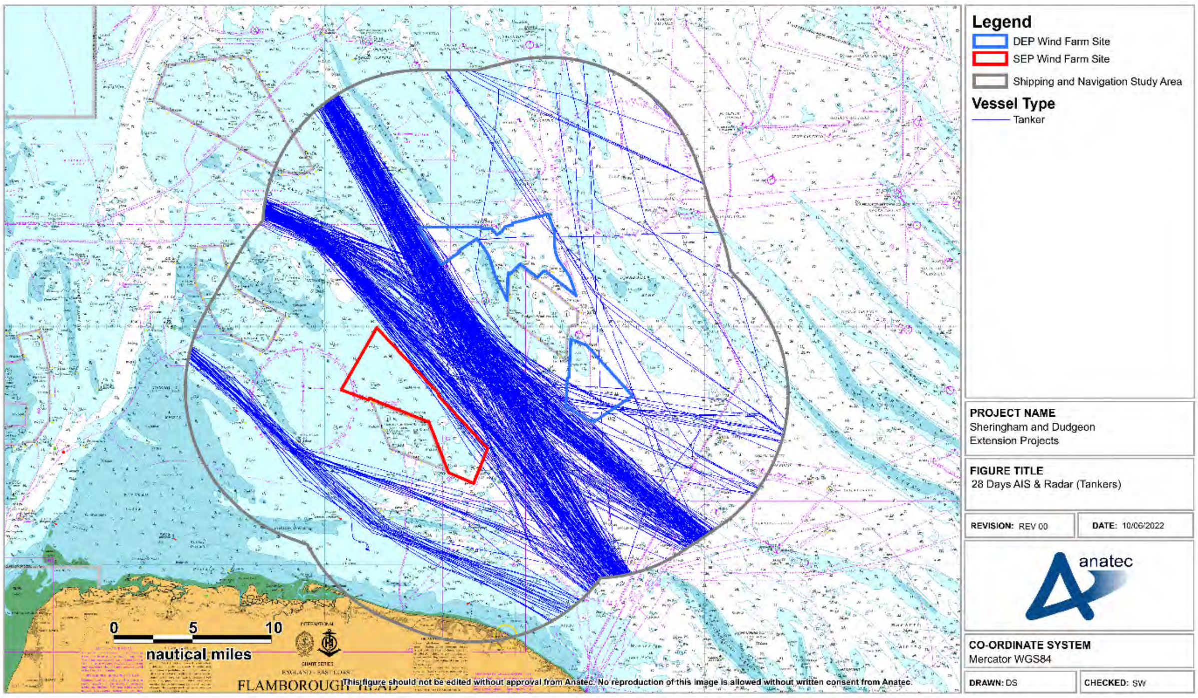

Figure 14.10 Tankers within the Shipping and Navigation Study Area

179. An average of 13 tankers per day were recorded within the shipping and navigation study area over the 28-day period. A total of 12 per day were recorded within the DEP shipping and navigation study area, and 12 per day within the SEP shipping and navigation study area.

180. The main destinations recorded for tankers within the shipping and navigation study area were the Humber and mainland Europe. As seen with cargo vessels, the smaller tankers typically passed using inshore routes, south of Sheringham Shoal, while the larger tankers transited further offshore between the wind farm sites.

14.1.3.3 Passenger

181. Figure 14.11 presents a plot of passenger vessel activity recorded within the shipping and navigation study area during the survey period, colour-coded by operator.

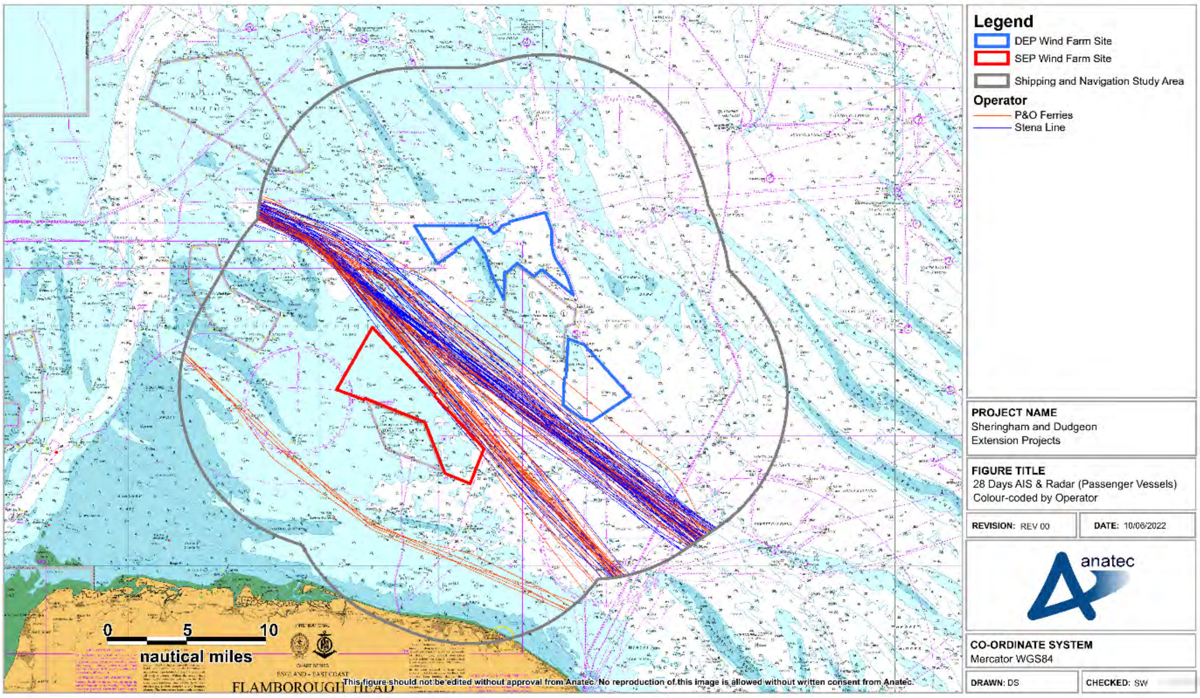

Figure 14.11 Passenger Vessel Activity within the Shipping and Navigation Study Area Colour-coded by Operator

182. An average of between three and four passenger vessels per day were recorded within the shipping and navigation study area over the 28-day period. A total of between three and four per day were recorded within the DEP shipping and navigation study area, and three per day within the SEP shipping and navigation study area.

183. The operators were P&O and Stena Lines, however it is noted that DFDS also utilise the area for adverse weather routeing (see Section 15.3).

184. It is noted that DFDS, P&O and Stena all responded to the regular operator outreach as per Section 4.3, and attended the Hazard Workshop (Section 4.5).

185. Long term assessment of passenger vessels is provided within Annex B (Section B.4.4), noting that the relevant long term data precedes the COVID 19 pandemic.

14.1.3.4 Oil and Gas Support Traffic

186. Figure 14.12 presents a plot of O&G activity recorded within the shipping and navigation study area during the survey period.

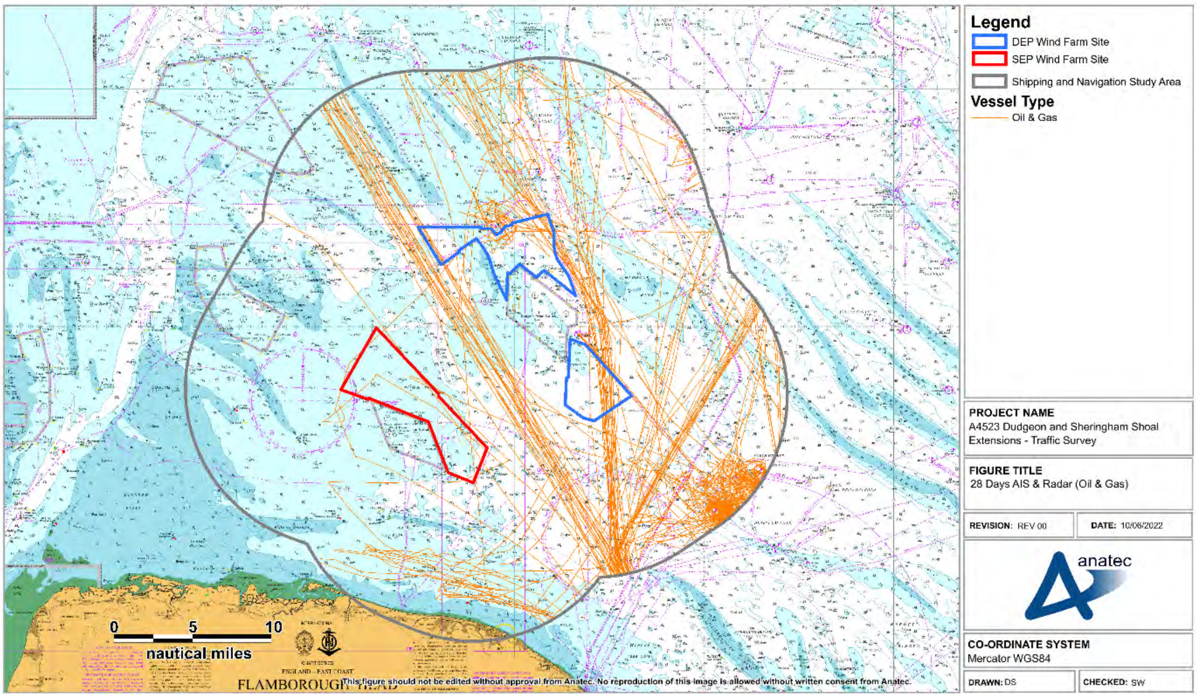

Figure 14.12 Oil & Gas Activity within the Shipping and Navigation Study Area

187. An average of nine O&G vessels per day were recorded within the shipping and navigation study area over the 28-day period. Nine per day were recorded within the DEP shipping and navigation study area, and four per day within the SEP shipping and navigation study area.

188. O&G traffic was generally passing in close proximity to (or intersecting) the DEP wind farm site. O&G traffic recorded during the survey period was typically heading for Waveney, West Sole or Pickerill gas fields.

189. It is noted that Boston Putford and Sentinel Marine responded to the regular operator outreach as per Section 4.3. Perenco and IOG were also present at the Hazard Workshop (see Section 4.5).

14.1.3.5 Wind Farm Support

190. Figure 14.13 presents a plot of wind farm support vessels recorded within the shipping and navigation study area throughout the survey period.

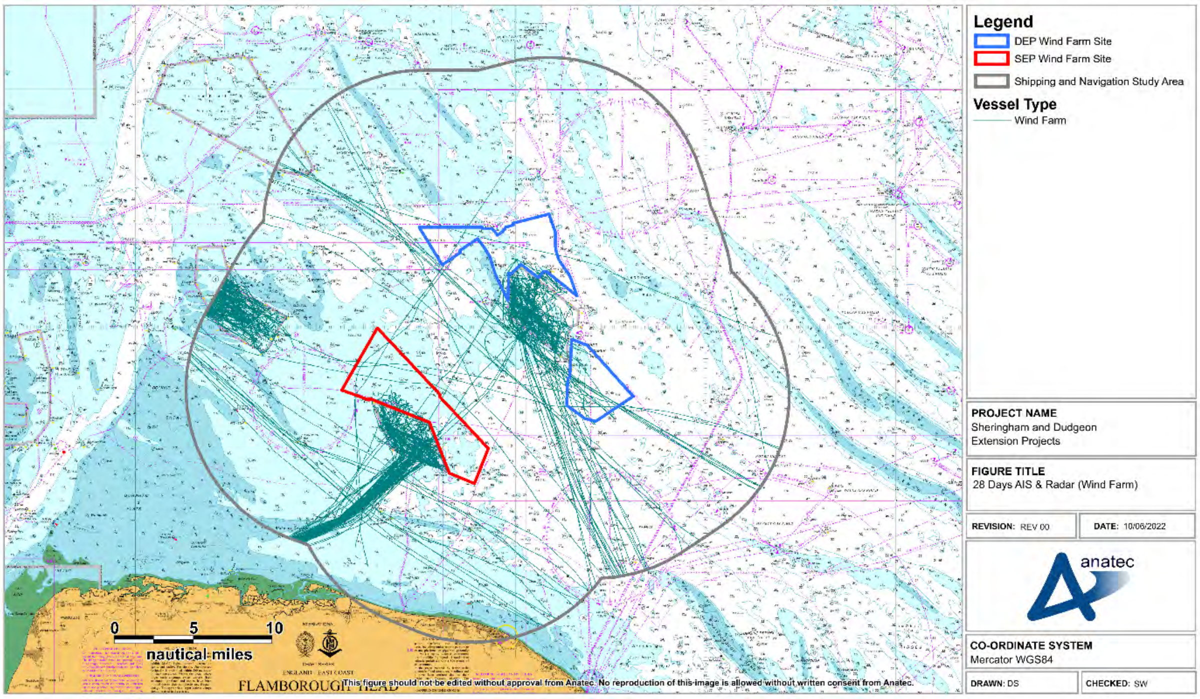

Figure 14.13 Wind Farm Activity within the Shipping and Navigation Study Area

191. An average of seven wind farm vessels per day were recorded within the shipping and navigation study area over the 28-day period. Five per day were recorded within the DEP shipping and navigation study area, and seven per day within the SEP shipping and navigation study area.

192. Wind farm support vessels were typically operating at the Dudgeon, Sheringham Shoal, and Race Bank wind farms.

14.1.3.6 Marine Aggregate Dredging

193. Figure 14.14 presents a plot of marine aggregate dredger vessels recorded within the shipping and navigation study area throughout the 28-day study period. Additionally, BMAPA transit routes are presented in Figure 14.15.

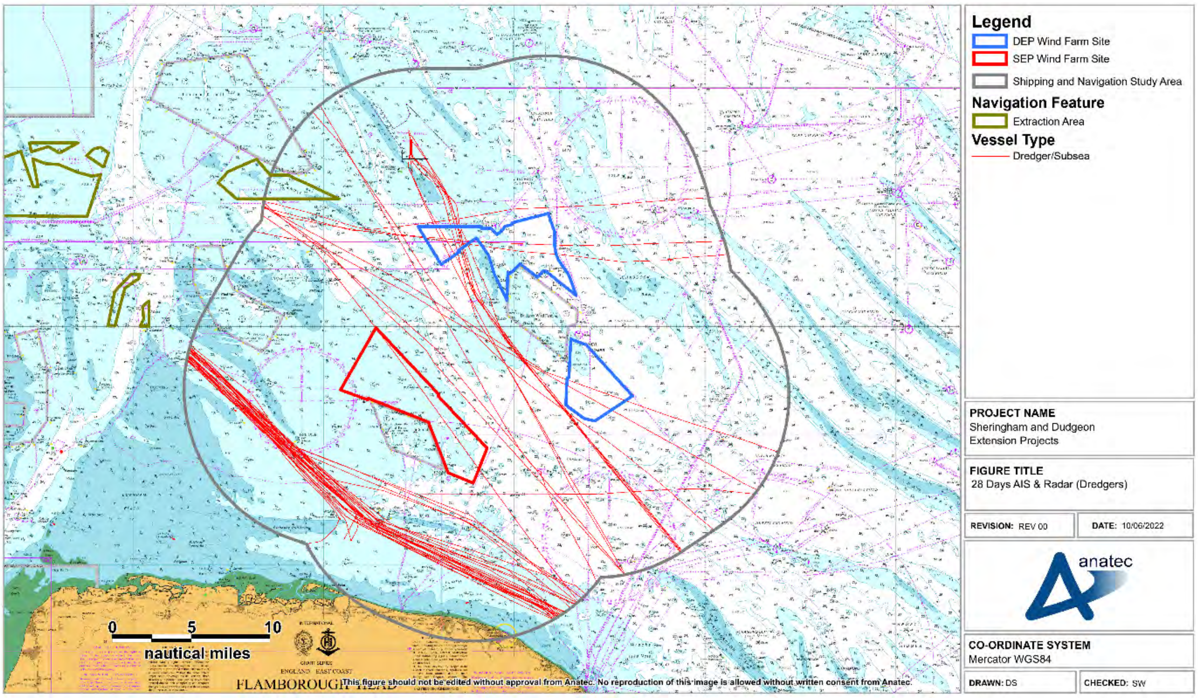

Figure 14.14 Marine Aggregate Dredger Activity within the Shipping and Navigation Study Area

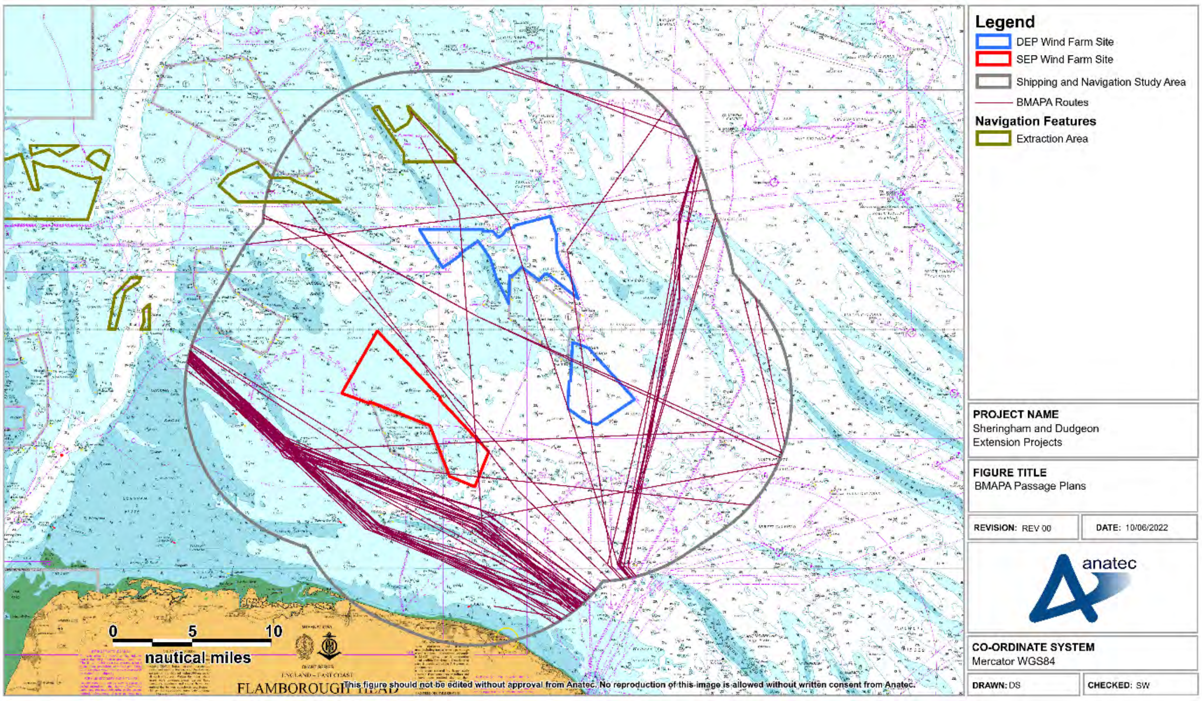

Figure 14.15 BMAPA Routeing within the Shipping and Navigation Study Area

194. An average of two marine aggregate dredgers per day were recorded within the shipping and navigation study area over the 28-day period. Approximately one per day

was recorded within the DEP shipping and navigation study area, and two per day within the SEP shipping and navigation study area.

195. Marine aggregate dredgers were typically recorded in transit to various marine aggregate dredging areas to the south west of the SEP wind farm site. Other marine aggregate dredgers were noted intersecting the northern extent of the DEP wind farm site.

196. The majority of marine aggregate dredgers within the shipping and navigation study area were observed to pass south of the SEP wind farm site, and aligned with the corresponding BMAPA route.

14.1.3.7 Fishing Vessel Activity

197. Figure 14.16 presents a plot of fishing vessels recorded within the shipping and navigation study area during the study period.

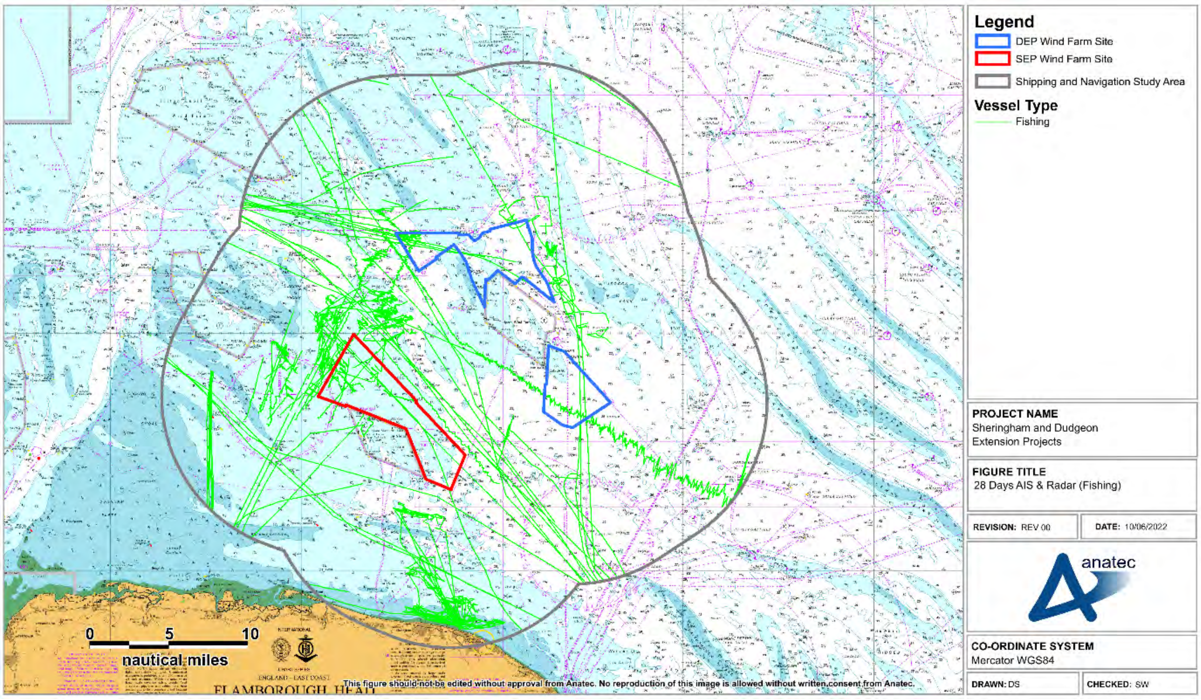

Figure 14.16 28 Days AIS & Radar (Fishing Vessels)

198. An average of three fishing vessels per day were recorded within the shipping and navigation study area over the 28-day period. Approximately two per day were recorded within the DEP shipping and navigation study area, and approximately three per day within the SEP shipping and navigation study area.

199. Fishing vessels were recorded on passage through the shipping and navigation study area as well as actively engaged in fishing, typically to the north of the SEP wind farm site and inshore, off Cromer.

200. It is noted that the carriage of AIS is not required on fishing vessels under 15m LOA, and therefore it is expected that fishing vessel activity in the shipping and navigation study area may be underrepresented. However, the majority of fishing vessels were recorded on AIS, during the summer survey period, within the shipping and navigation study area were under 15m in length (70%), indicating they were broadcasting voluntarily.

14.1.3.8 Recreational Vessel Activity

201. Figure 14.17 presents a plot of recreational vessels recorded within the shipping and navigation study area during the study period throughout the 28-day survey period.

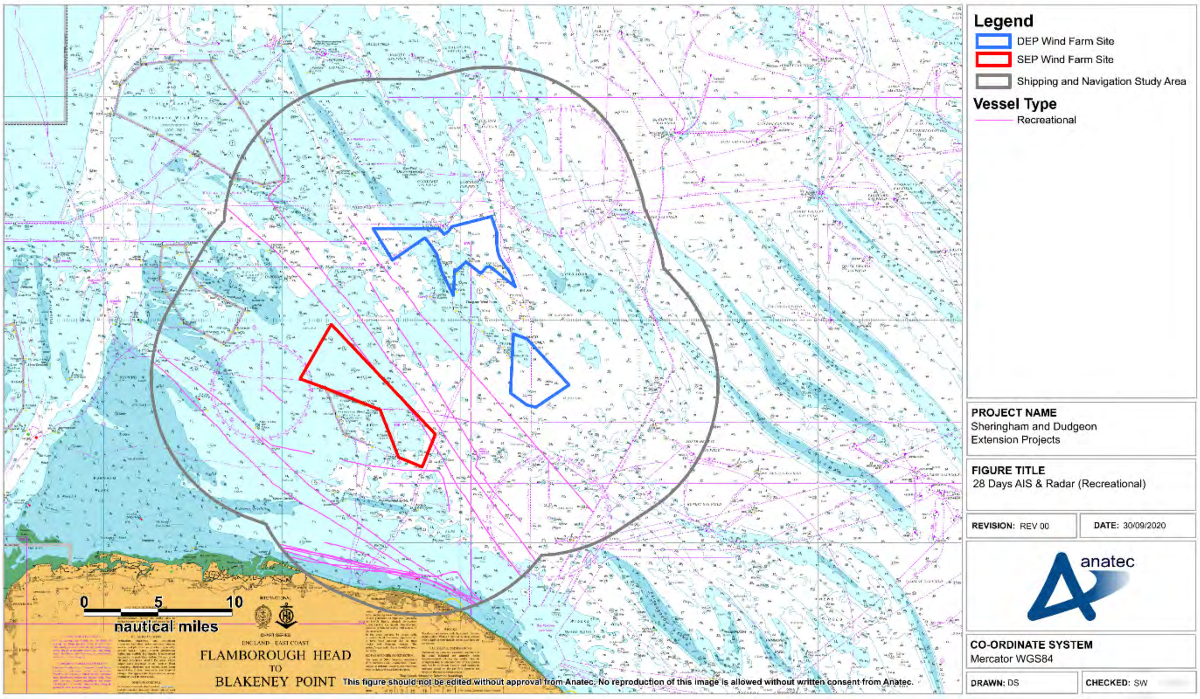

Figure 14.17 28 Days AIS & Radar (Recreational)

202. An average less than one recreational vessel per day was recorded within the shipping and navigation study area over the 28-day period with all of these being detected during the summer period. The majority of recreational vessels were observed within the SEP shipping and navigation study area, as most vessels transited close to the coastline.

203. The RYA coastal atlas is presented in Figure 14.18 and Figure 14.19. The former shows recreational vessel density, whilst the latter shows identified general boating areas.

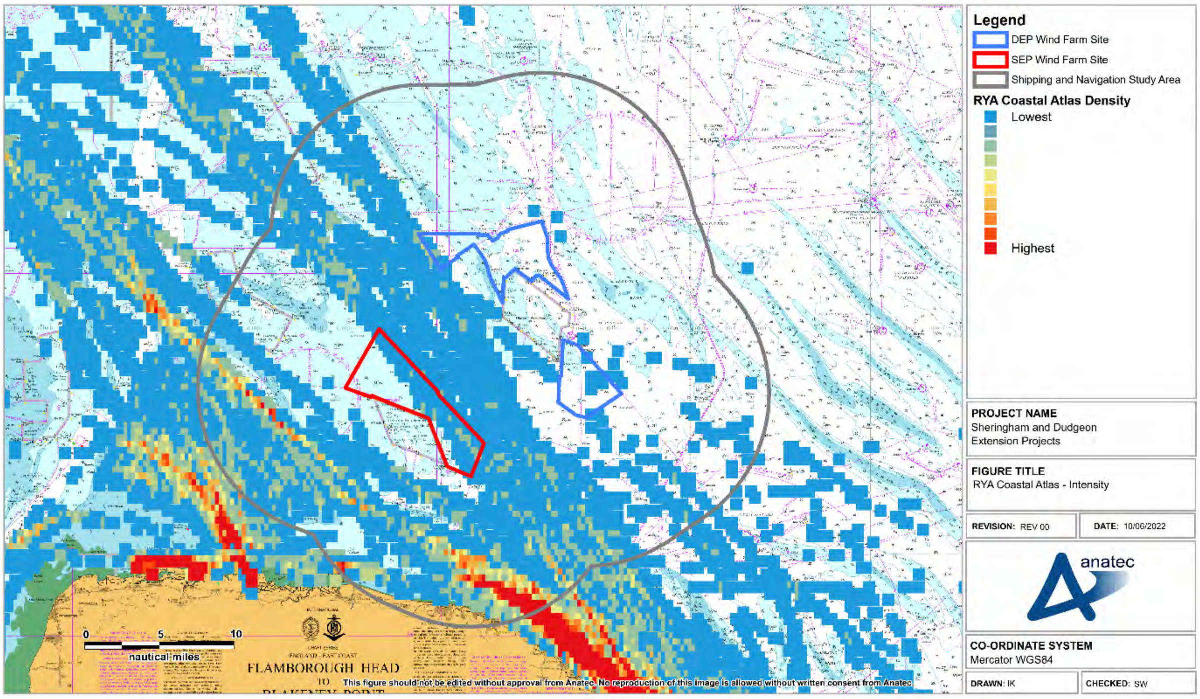

Figure 14.18 RYA Coastal Atlas – Vessel Density

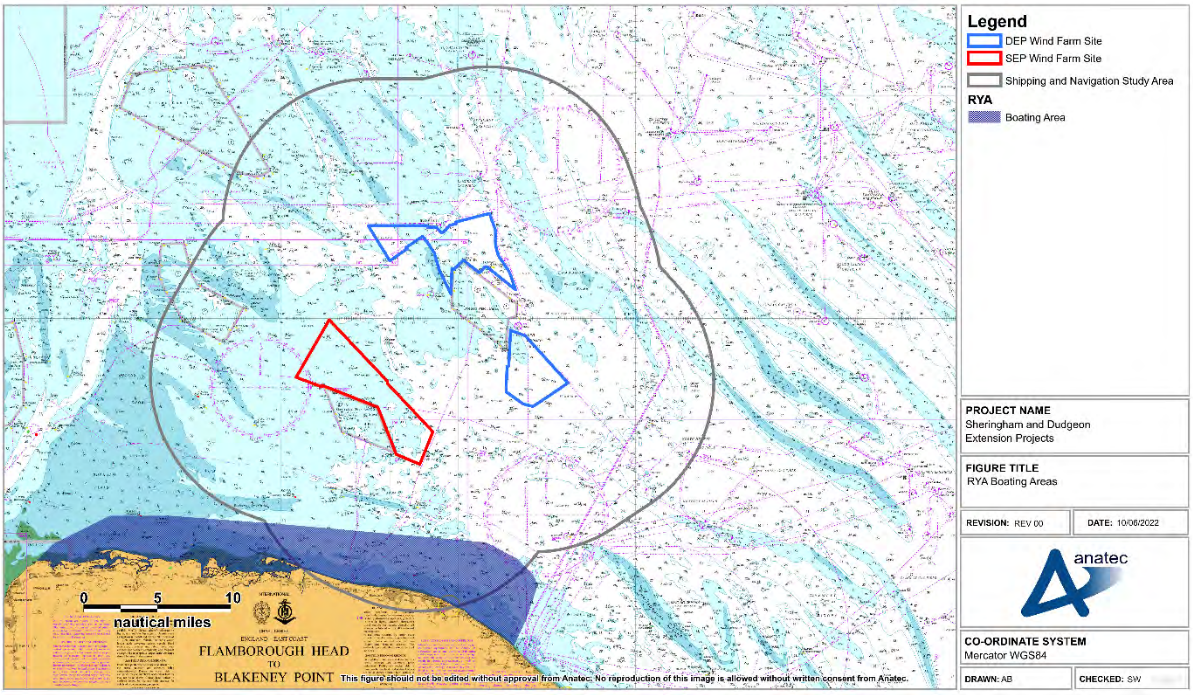

Figure 14.19 RYA Boating Areas – Boating Areas

14.1.3.9 Anchored Vessels

204. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

205. For this reason, those vessels which travelled at a speed of less than one kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, 46 cases of anchored vessels were identified within the shipping and navigation study area, with 91% of vessels broadcasting an AIS navigational status of "at anchor". Figure 14.18 presents a plot of anchored vessels recorded within the shipping and navigation study area throughout the survey periods.

206. Approximately between one and two unique vessels per day were recorded at anchor within the shipping and navigation study area. The majority of these were observed to be related to O&G (48%). However, cargo vessels, tankers, wind farm support (near Race Bank) and marine aggregate dredgers were also recorded.

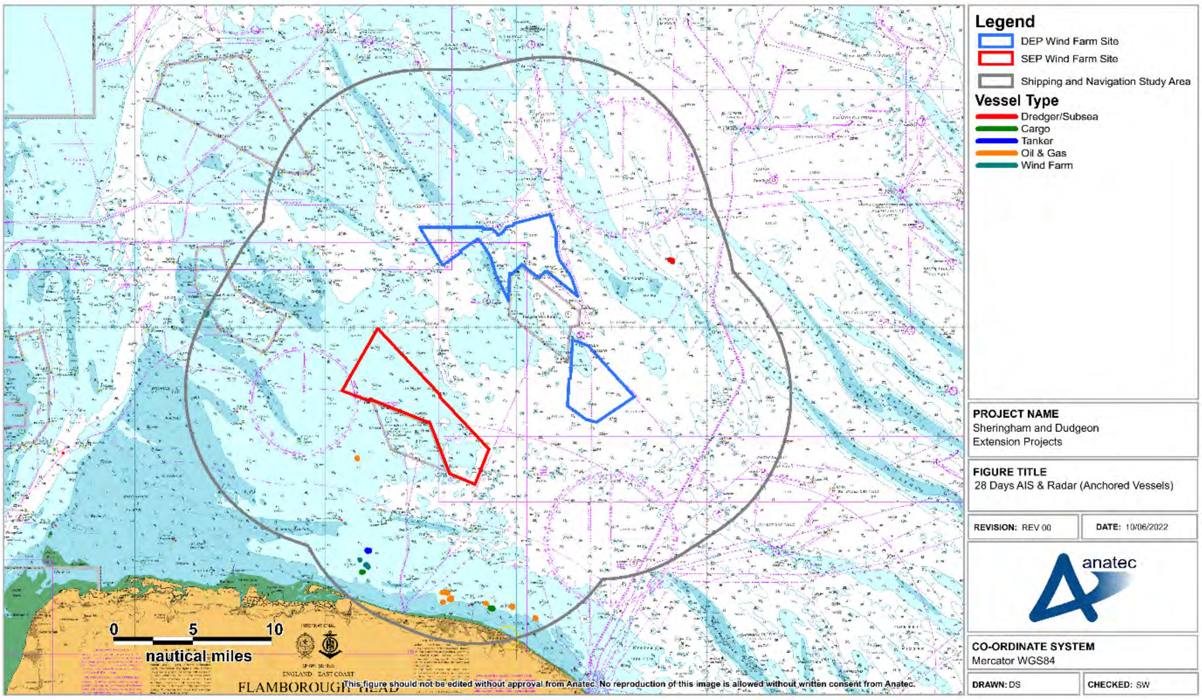

Figure 14.20 28 Days AIS & Radar (Anchored Vessels)

14.2 Offshore Export Cable Corridor

207. A plot of the vessel tracks recorded during the two 14-day survey periods in July/August 2020 (summer) and January/February 2021 (winter), colour-coded by vessel type is presented in Figure 14.21.

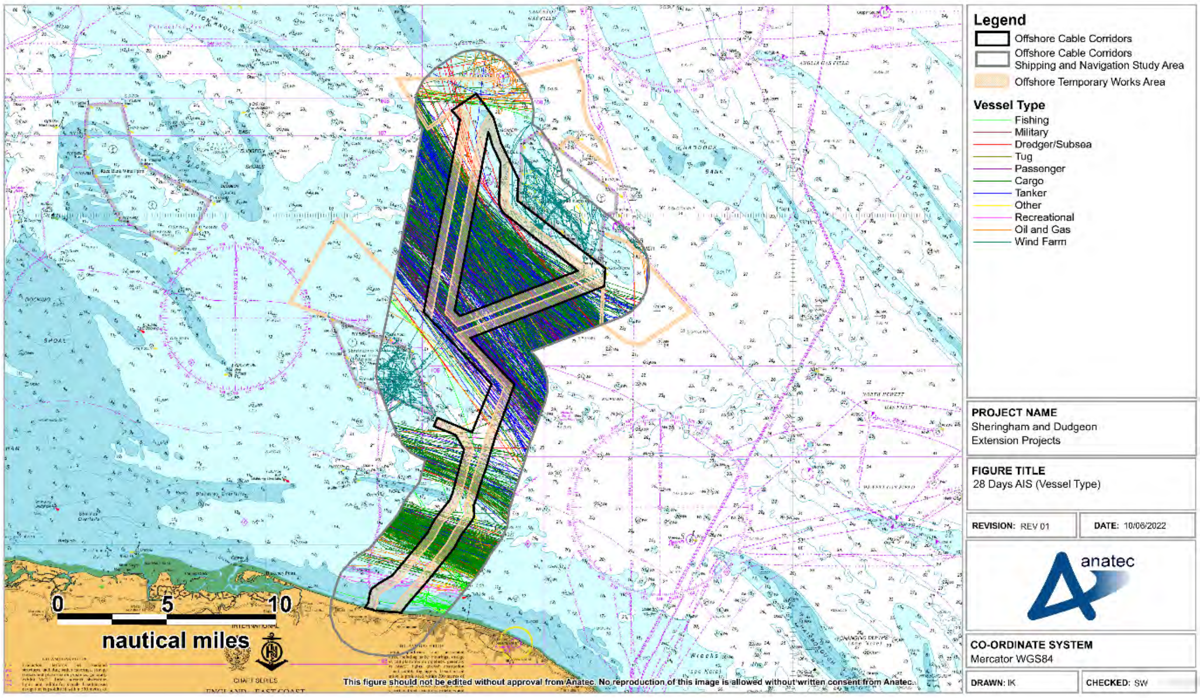

Figure 14.21 Vessel Traffic Survey Data by Vessel Type within the Offshore Export Cable Corridor

14.2.1 Vessel Count

208. For the 14 days analysed in the summer survey period, there were an average of 58 unique vessels per day recorded within the offshore export cable corridor shipping and navigation study area. In terms of vessels intersecting the offshore export cable corridor itself, there was an average of 51 unique vessels per day.

209. For the 14 days analysed in the winter survey period, there were an average of 66 unique vessels per day recorded within the offshore export cable corridor shipping and navigation study area. In terms of vessels intersecting the offshore export cable corridor itself, there was an average of 60 unique vessels per day. The increase over the summer data was observed to be largely due to increased commercial traffic, and therefore may be related to adverse weather routeing.

210. Figure 14.22 and Figure 14.23 illustrate the daily number of unique vessels recorded within the offshore export cable corridor shipping and navigation study area and the offshore export cable corridor itself during the summer and winter survey periods, respectively. It should be considered when viewing this analysis that the first and last day of the summer survey period are partial days. Similarly, for the winter 2021 survey period, the 26th of January, the 5th - 9th of February, and the 13th of February are partial days (noting the survey vessel sought shelter between the 5th and 9th February).

211. Throughout the summer survey period approximately 88% of unique vessel tracks recorded within the offshore export cable corridor shipping and navigation study area

intersected the offshore export cable corridor itself. During the winter period approximately 91% of unique vessel tracks recorded within the offshore export cable corridor shipping and navigation study area intersected the offshore export cable corridor itself.

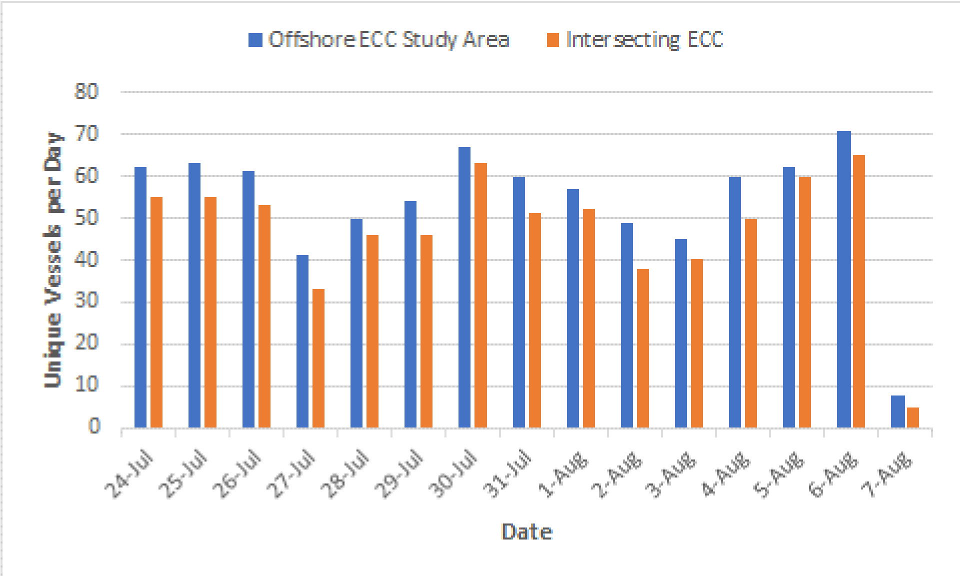

Figure 14.22 Daily Counts – Offshore Export Cable Corridor and Study Area (Summer 2020)

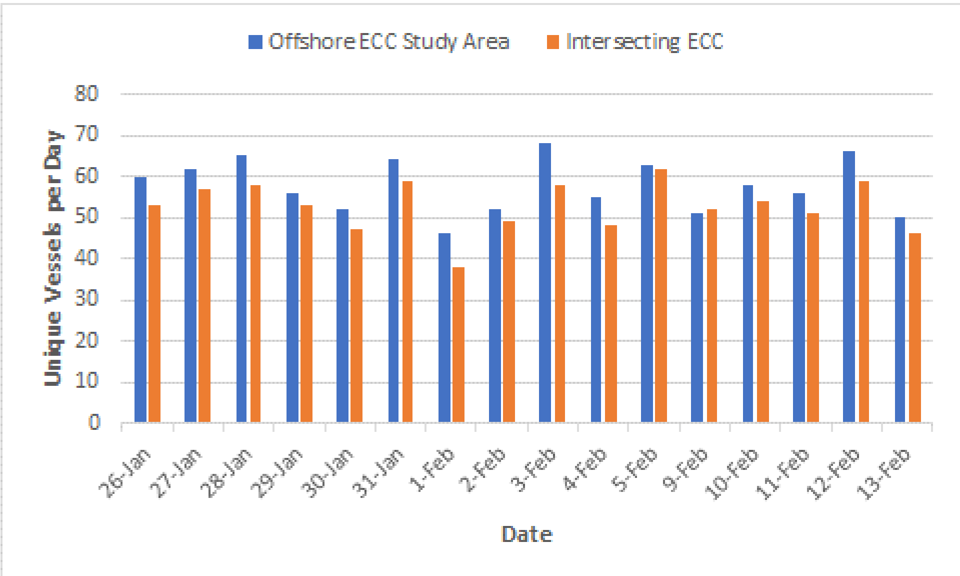

Figure 14.23 Daily Counts Offshore Export Cable Corridor and Study Area (Winter 2021)

212. The busiest full day recorded during the summer survey period within the offshore export cable corridor shipping and navigation study area was the 6th of August, when 71 unique vessels were recorded. In terms of intersecting the offshore export cable corridor itself, the busiest full day recorded during the summer survey period was also the 6th of August when 65 unique vessels were recorded.

213. The quietest full day recorded during the summer survey period within the offshore export cable corridor shipping and navigation study area was the 27th of July when 41 unique vessels were recorded. In terms of intersecting the offshore export cable corridor itself, the quietest day recorded during the summer survey period was also the 27th of July, when 33 unique vessels were recorded.

214. The busiest day recorded during the winter survey period within the offshore export cable corridor shipping and navigation study area was the 3rd of February, when 68 unique vessels were recorded. In terms of intersecting the offshore export cable corridor itself, the busiest day recorded during the winter survey period was the 5th of February, when 62 unique vessels were recorded.

215. The quietest full day recorded during the winter survey period within the offshore export cable corridor shipping and navigation study area was the 1st of February when 46 unique vessels were recorded. In terms of intersecting the offshore export cable corridor itself, the quietest day recorded during the winter survey period was also the 1st of February, when 38 unique vessels were recorded.

14.2.2 Vessel Type

216. The percentage distribution of the main vessel types recorded passing within the offshore export cable corridor shipping and navigation study area during the summer and winter survey periods is presented in Figure 14.24. It is noted that minor vessel types have been included within the 'other' vessel type category.

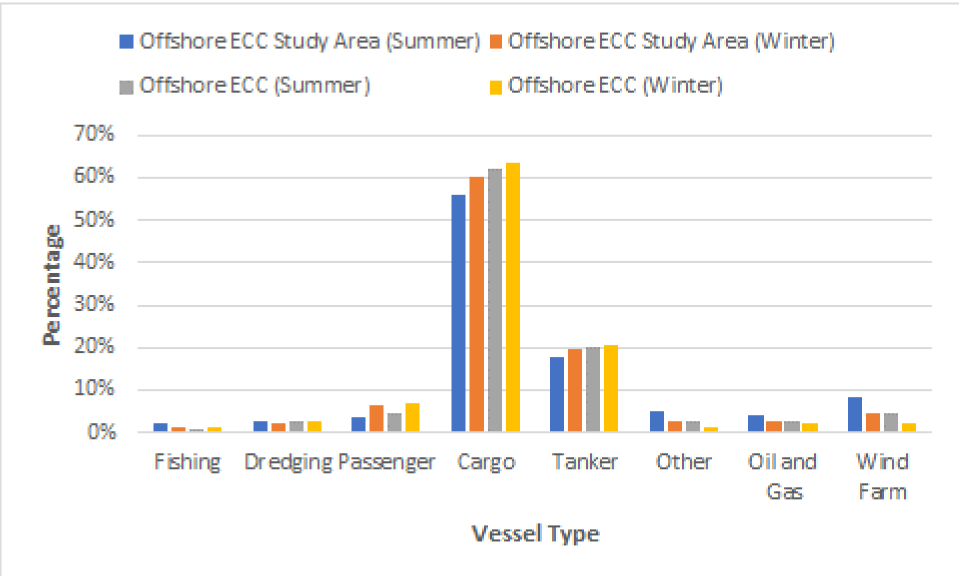

Figure 14.24 Vessel Type Distribution – Offshore Export Cable Corridor

217. Throughout the summer period, the main vessel types recorded within the offshore export cable corridor shipping and navigation study area were cargo vessels (56%) and tankers (18%). Throughout the winter survey, the main vessel types recorded within the offshore export cable corridor shipping and navigation study area were also cargo

vessels (62%) and tankers (20%). It should be noted that the cargo vessel category includes commercial ferries which generally broadcast their vessel types on AIS as cargo.

14.2.2.1 Cargo Vessels

218. Figure 14.25 presents a plot of cargo vessels, including commercial ferries, recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

219. Throughout the summer survey period an average of 32 unique cargo vessels per day were recorded within the offshore export cable corridor shipping and navigation study area. During the winter survey period an average of 40 unique cargo vessels per day were recorded within the offshore export cable corridor shipping and navigation study area. This increase during the winter period may be due to cargo vessels in the area choosing coastal routes during periods of adverse weather.

220. The regular cargo vessels operating within the offshore export cable corridor shipping and navigation study area included Roll On Roll Off vessels operated by Cobelfret Ferries, DFDS Seaways, P&O Ferries and Stena Line. Main destinations included Humber-based ports such as Immingham (UK) and Hull (UK), and European ports such as Rotterdam (Netherlands) and Zeebrugge (Belgium). It is noted that DFDS, P&O and Stena all responded to the regular operator outreach as per Section 4.3, and attended the Hazard Workshop (Section 4.5).

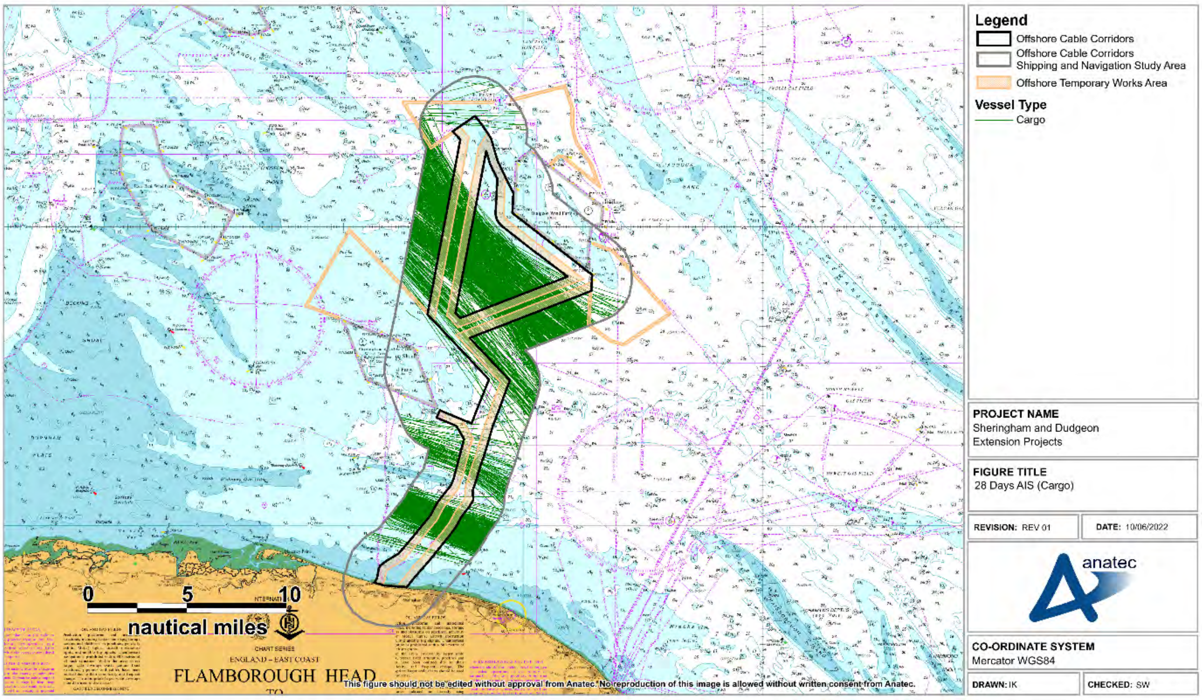

Figure 14.25 Cargo Vessels within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.2 Tankers

221. Figure 14.26 presents a plot of tankers recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

222. Throughout the summer survey period an average of 10 unique tankers per day were recorded within the offshore export cable corridor shipping and navigation study area. Throughout the winter survey period an average of 13 unique tankers per day were recorded within the offshore export cable corridor shipping and navigation study area. The main destinations recorded for tankers within the offshore export cable corridor shipping and navigation study area were the Humber and mainland Europe. Smaller tankers typically passed using inshore routes while larger tankers transited further offshore.

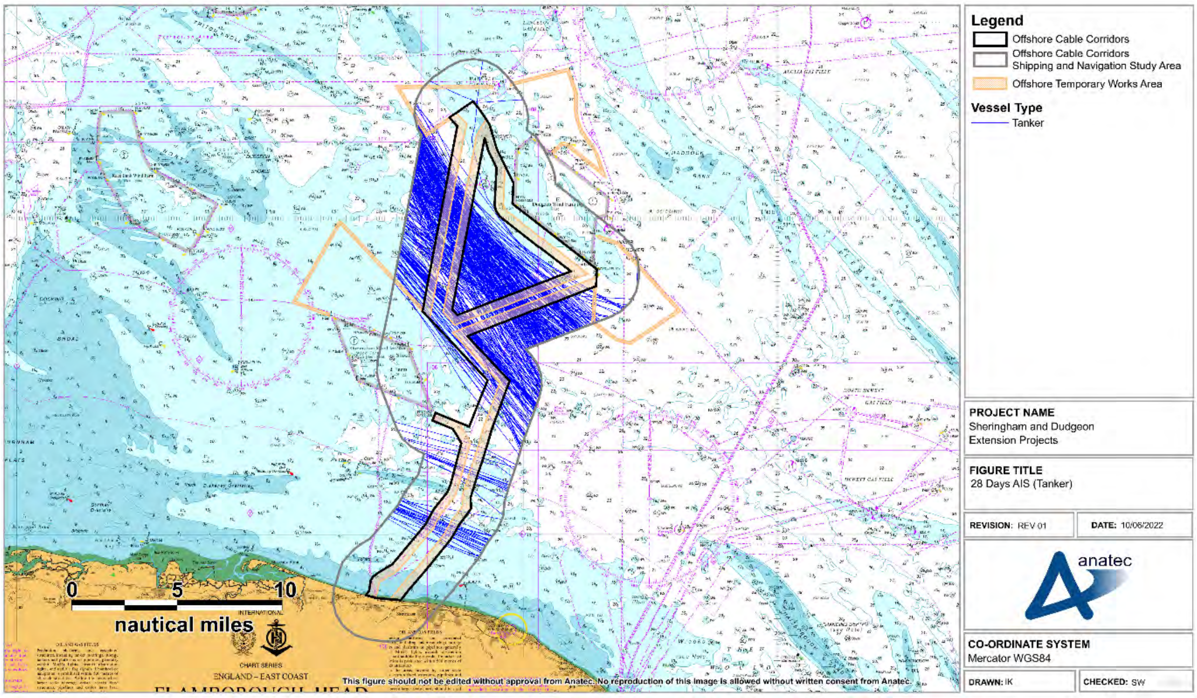

Figure 14.26 Tankers within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.3 Passenger

223. Figure 14.27 presents a plot of passenger vessel activity recorded within the offshore export cable corridor shipping and navigation study area during the survey period, colour-coded by operator.

224. Throughout the summer survey period an average of two unique passenger vessels per day were recorded within the offshore export cable corridor shipping and navigation study area. Throughout the winter survey period an average of four to five unique passenger vessels per day were recorded within the offshore export cable corridor shipping and navigation study area.

225. It is noted that DFDS, P&O and Stena all responded to the regular operator outreach as per Section 4.3, and attended the Hazard Workshop (Section 4.5).

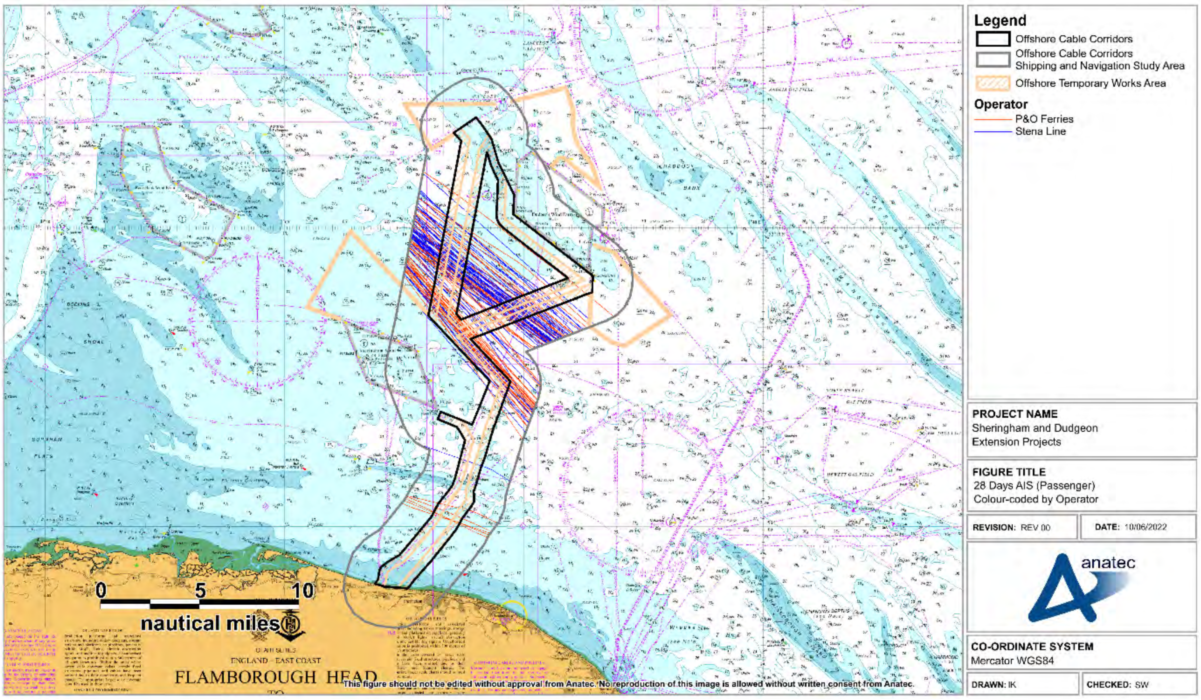

Figure 14.27 Passenger Vessel Activity within the Offshore Export Cable Corridor Shipping and Navigation Study Area Colour-coded by Operator

14.2.2.4 Oil and Gas Support Traffic

226. Figure 14.28 presents a plot of O&G support vessel activity recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

227. Throughout the summer survey period, an average of two to three unique O&G support vessels per day passed within the offshore export cable corridor shipping and navigation study area. During the winter survey period, an average of two unique O&G support vessels per day passed within the offshore export cable corridor shipping and navigation study area. O&G traffic was generally in transit within the northern half of the offshore export cable corridor shipping and navigation study area while tracks in the southern half were typically operating at the Hewett field.

228. It is noted that Boston Putford and Sentinel Marine responded to the regular operator outreach as per Section 4.3. Perenco and IOG were also present at the Hazard Workshop (see Section 4.5).

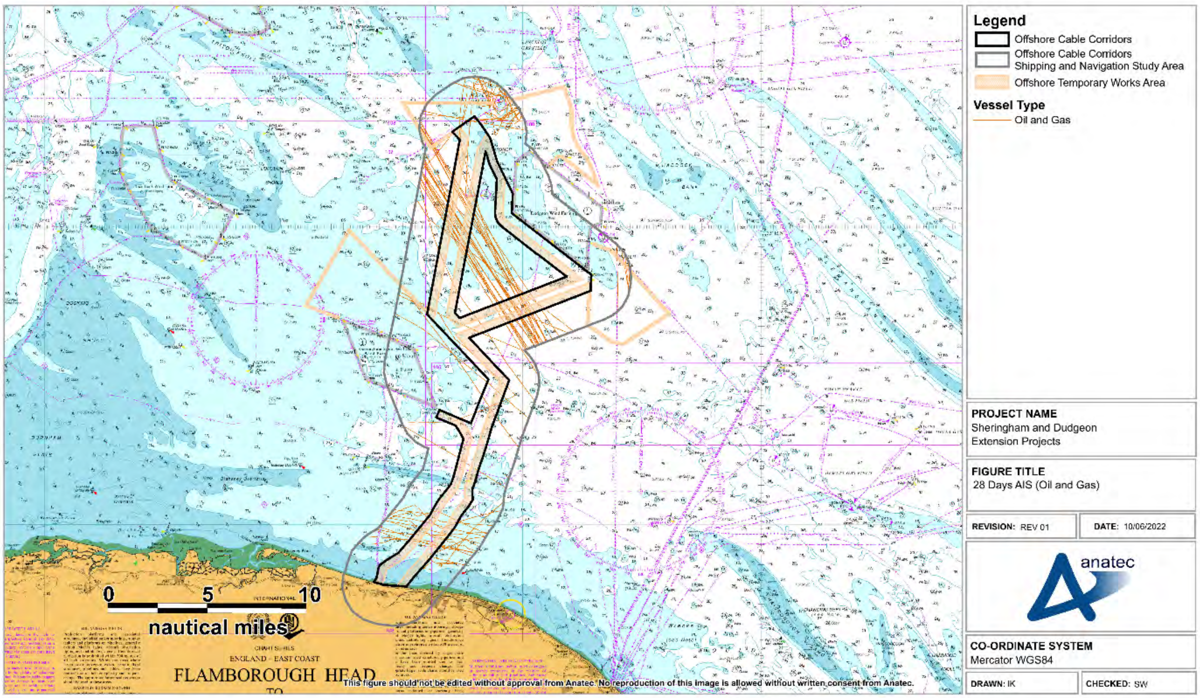

Figure 14.28 Oil and Gas Support Traffic within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.5 Wind Farm Support Traffic

229. Figure 14.29 presents a plot of wind farm support vessel activity recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

230. Throughout the summer survey period, an average of five unique wind farm support vessels per day were recorded within the offshore export cable corridor shipping and navigation study area. During the winter survey period, an average of three unique wind farm support vessels were recorded per day within the offshore export cable corridor shipping and navigation study area. Wind farm support vessels were typically operating at the existing Dudgeon and Sheringham Shoal wind farms, transiting traffic was noted crossing the southern offshore export cable corridor heading for Race Bank wind farm.

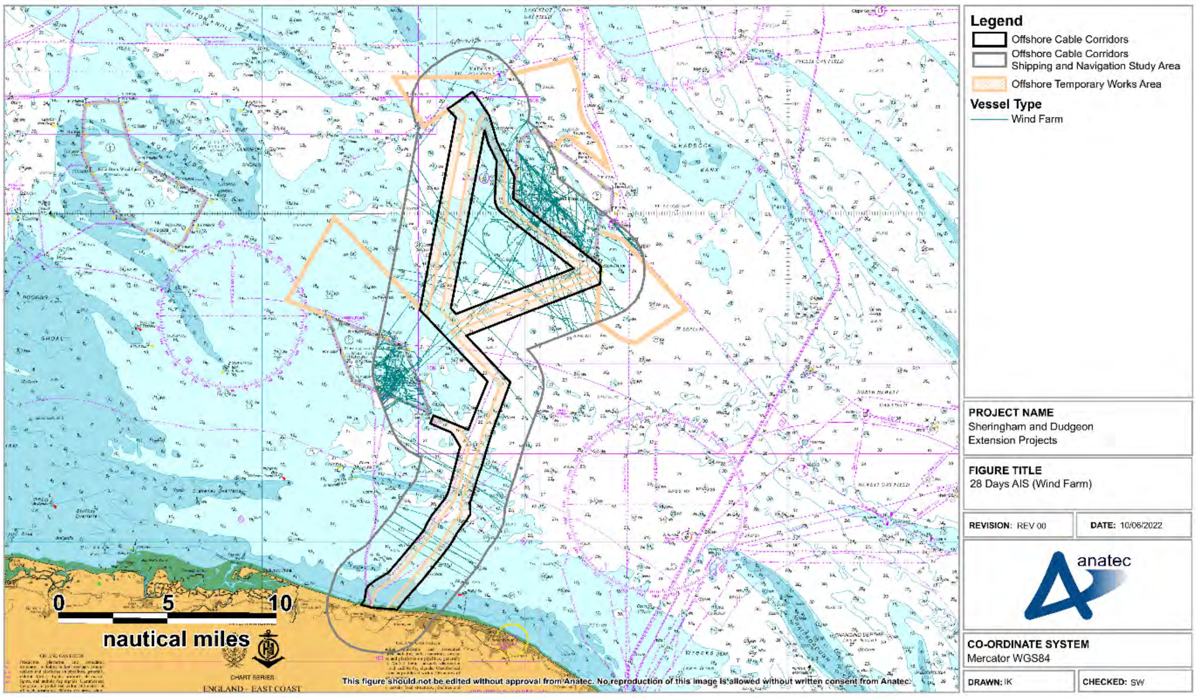

Figure 14.29 Wind Farm Support Traffic within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.6 Marine Aggregate Dredging

231. Figure 14.30 presents a plot of marine aggregate dredging activity recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

232. Throughout the summer survey period, an average of one to two unique marine aggregate dredgers were recorded per day within the offshore export cable corridor shipping and navigation study area. During the winter survey period, an average of one to two unique marine aggregate dredgers were recorded per day within the offshore export cable corridor shipping and navigation study area. Marine aggregate dredgers were typically recorded in transit to various marine aggregate dredging areas, crossing all offshore export cable corridors.

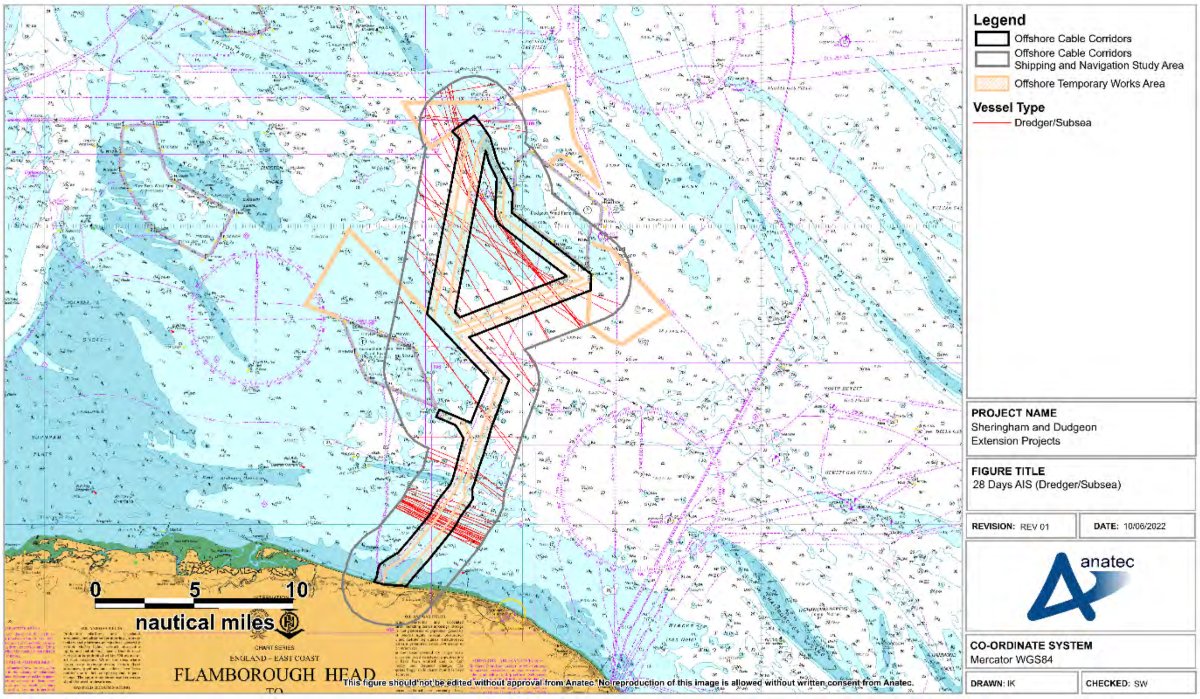

Figure 14.30 Dredging Activity within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.7 Fishing Vessel Activity

233. Figure 14.31 presents a plot of fishing vessel activity recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period.

234. Throughout the summer survey period an average of one unique fishing vessel per day was recorded within the offshore export cable corridor shipping and navigation study area. Throughout the winter survey period an average of one unique fishing vessel per day was recorded within the offshore export cable corridor shipping and navigation study area. Fishing vessels were recorded on passage through the offshore export cable corridor shipping and navigation study area, typically in a northwest-southeast direction. Vessels were also actively engaged in fishing inshore, off Cromer.

235. It is noted that the carriage of AIS is not required on fishing vessels under 15m LOA, and therefore it is expected that fishing vessel activity in the shipping and navigation study area may be underrepresented. However, 71% of fishing vessels recorded on AIS within the offshore export cable corridor shipping and navigation study area were under 15m in length, indicating they were broadcasting voluntarily.

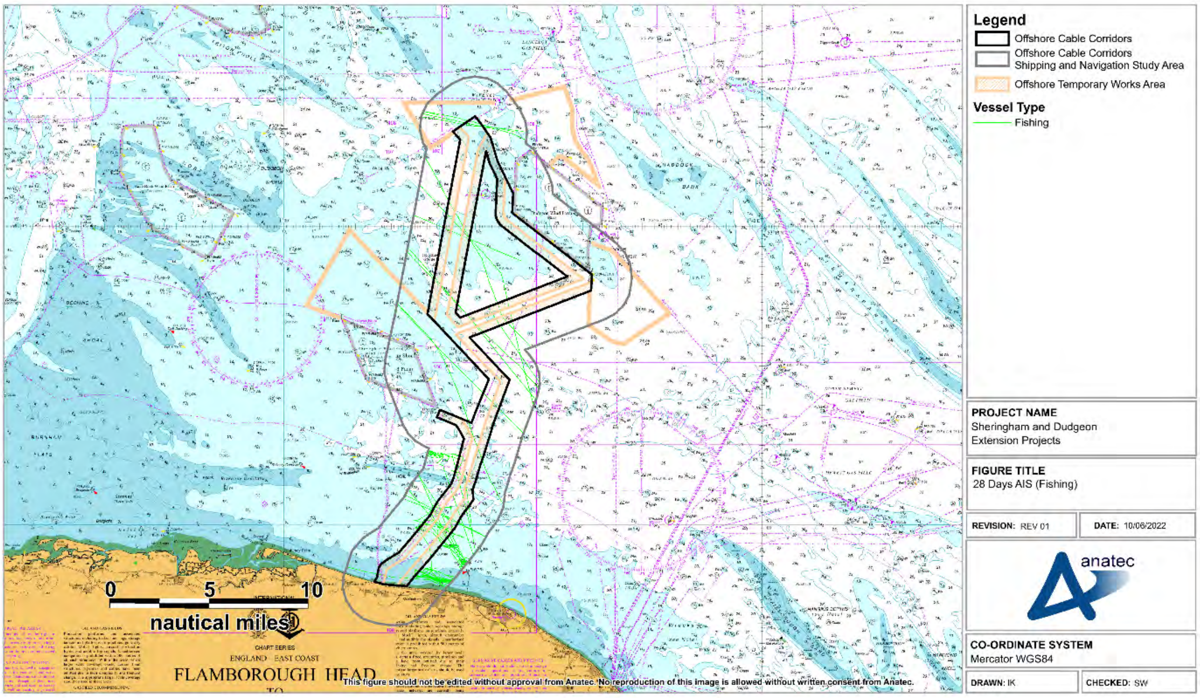

Figure 14.31 Fishing Vessel Activity within the Offshore Export Cable Corridor Shipping and Navigation Study Area

14.2.2.8 Recreational Vessel Activity

236. Figure 14.32 presents a plot of recreational vessel activity recorded within the offshore export cable corridor shipping and navigation study area during the 28-day survey period. Additionally, the RYA coastal atlas is presented in Figure 14.33.

237. Throughout the summer survey period an average of one unique recreational vessel per day was recorded within the offshore export cable corridor shipping and navigation study area. During the winter survey period no recreational vessels were recorded. Recreational vessels were predominantly seen transiting inshore. However, some were recorded transiting in a northwest-southeast direction further offshore.

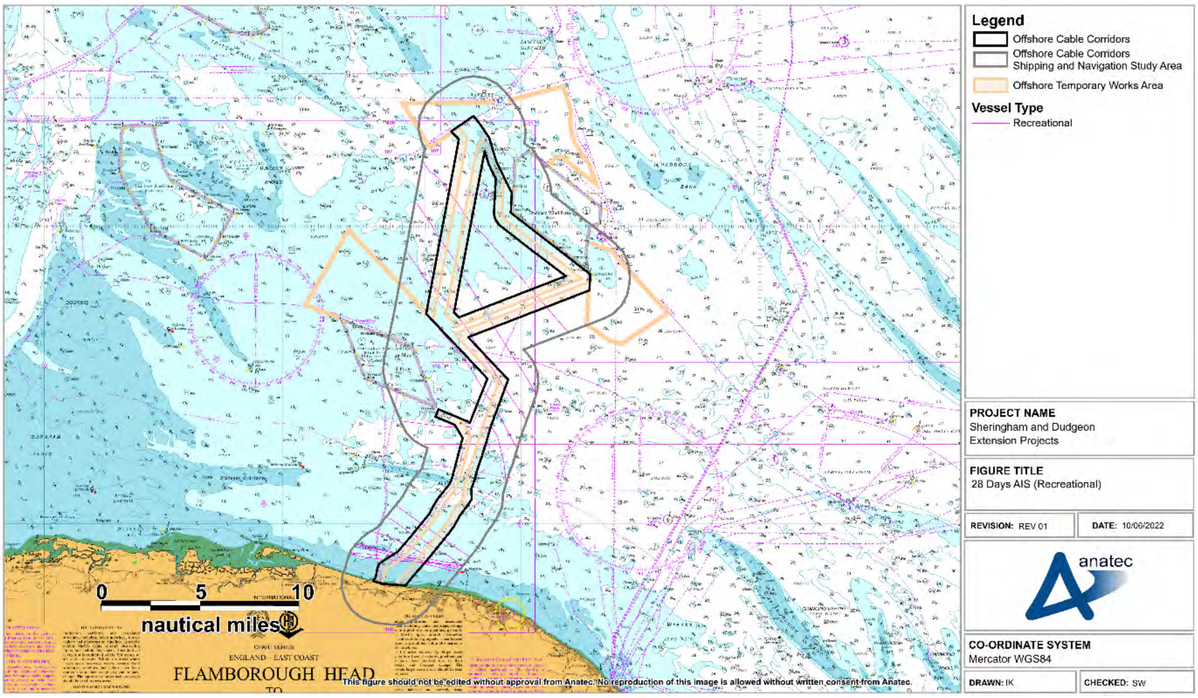

Figure 14.32 Recreational Vessel Activity within the Offshore Export Cable Corridor Shipping and Navigation Study Area

238. The RYA coastal atlas is presented in Figure 14.33 and Figure 14.34. The former shows recreational vessel density, whilst the latter shows identified general boating areas.

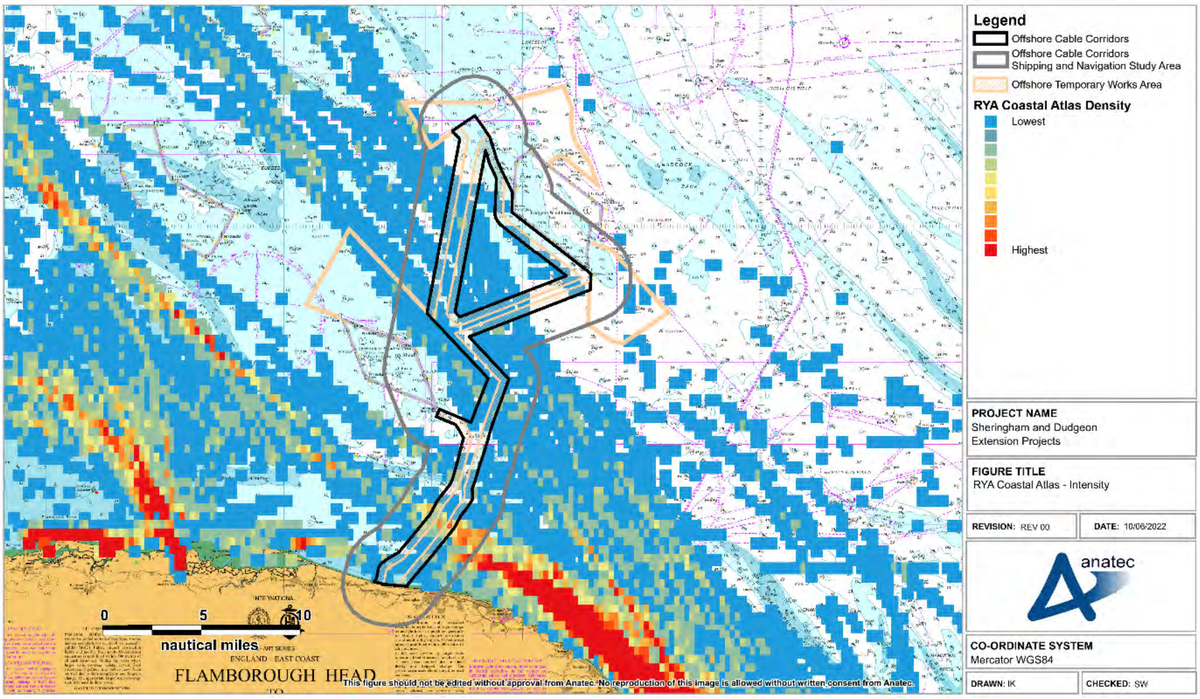

Figure 14.33 RYA Coastal Atlas – Offshore Export Cable Corridor

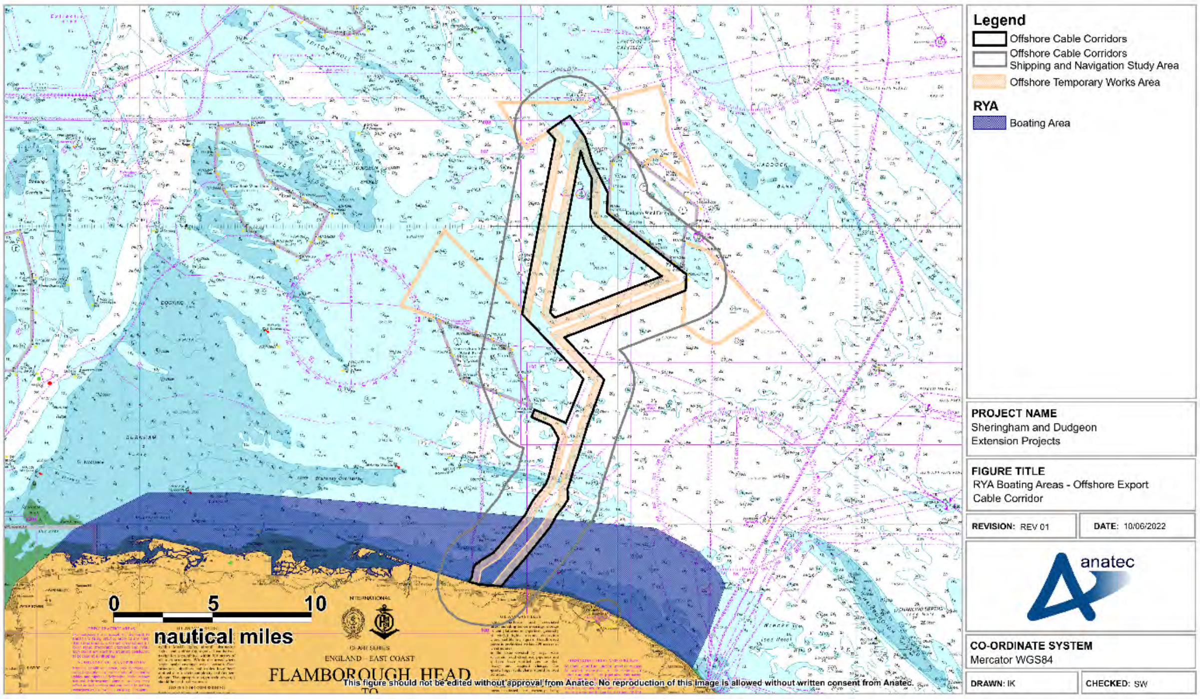

Figure 14.34 RYA Boating Areas – Offshore Export Cable Corridor

239. It is noted that based on the RYA Coastal Atlas, a general boating area intersects the Weybourne landfall option, indicating the potential for non AIS activity.

14.2.2.9 Anchored Vessels

240. Anchored vessels can be identified based upon the AIS navigational status which is programmed on the AIS transmitter on board a vessel. However, information is manually entered into the AIS, and therefore it is common for vessels not to update their navigational status if only at anchor for a short period of time.

241. For this reason, those vessels which travelled at a speed of less than one kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. After applying these criteria, 10 cases of anchored vessels were identified within the offshore export cable corridor shipping and navigation study area, with 10% of vessels broadcasting an AIS navigational status of “at anchor”. Figure 14.35 and Figure 14.36 present plots of anchored vessels recorded within the shipping and navigation study area throughout the survey periods.

242. An average of approximately one unique vessel every three days was determined to be at anchor during the survey period within the offshore export cable corridor shipping and navigation study area. It is noted that one O&G vessel was recorded in the Offshore Cable Corridors close to the coast. All anchored vessels recorded were oil and gas support vessels.

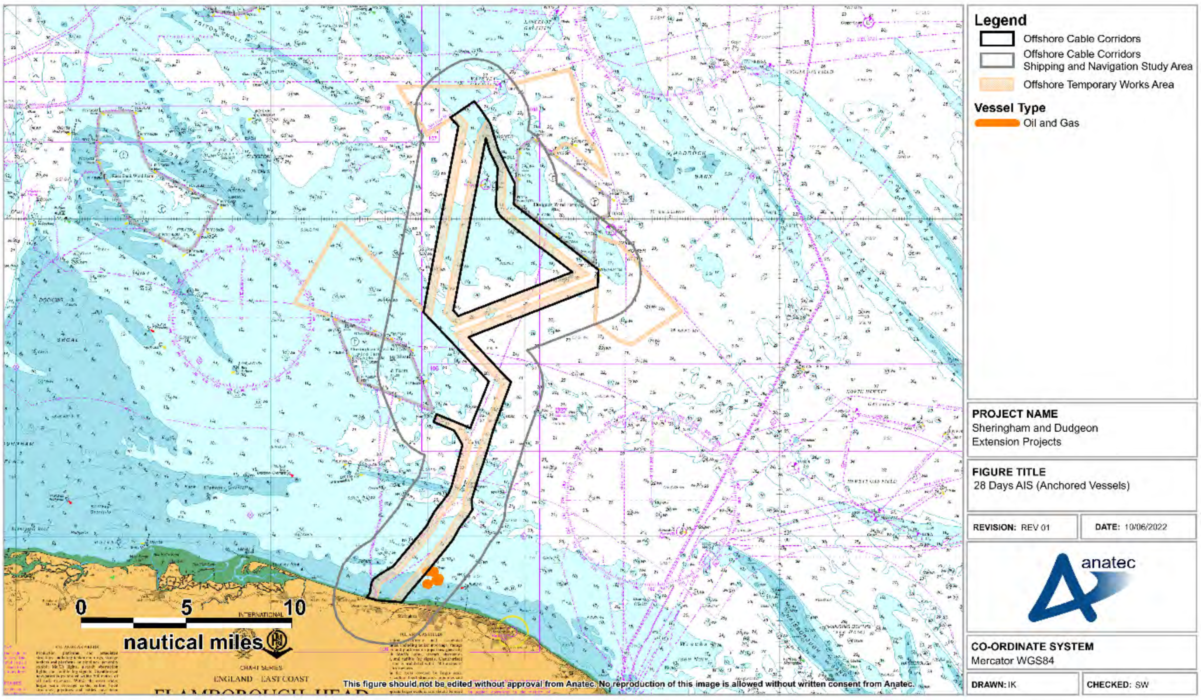

Figure 14.35 Anchored Vessels within the Offshore Export Cable Corridor Shipping and Navigation Study Area

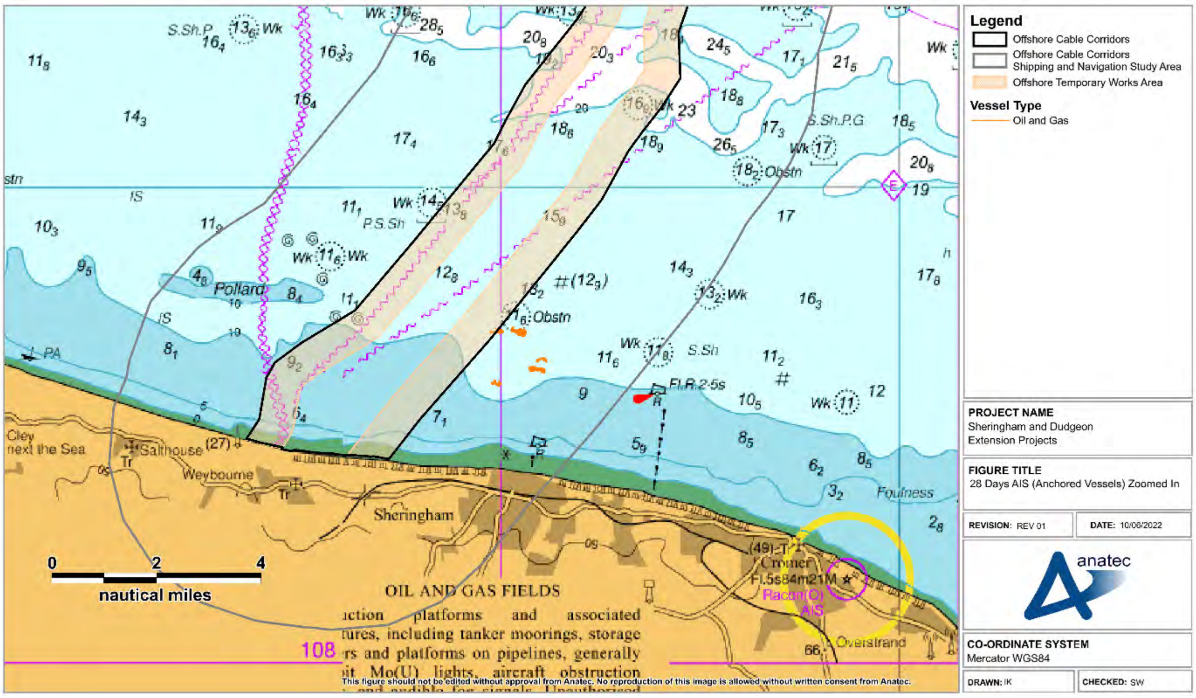

Figure 14.36 Anchored Vessels within the Offshore Export Cable Corridor Shipping and Navigation Study Area (Zoomed in)

15 Pre-Wind Farm Routeing

15.1 Definition of a Main Route

243. Main routes have been identified using the principles set out in MGN 654 (MCA, 2021). Vessel traffic data are assessed and vessels transiting at similar headings and locations are identified as a main route. To help identify main routes, vessel traffic data can also be interrogated to show vessels (by name and/or operator) that frequently transit those routes identifying 'regular runner/operator routes'. The route width is then calculated using the 90th percentile rule from the median line of the potential shipping route as shown in Figure 15.1.

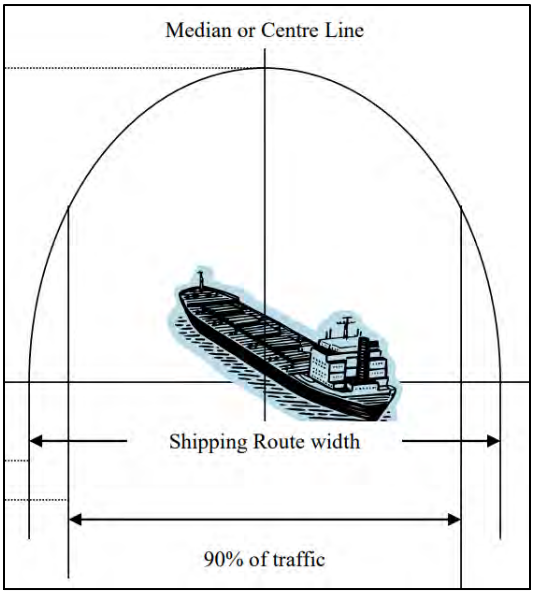

Figure 15.1 Illustration of main route calculation (MCA, 2016)

15.2 Pre Wind Farm Main Routes

244. A total of 14 main routes were identified from the 12 months of AIS data studied. These routes and corresponding 90th percentiles are shown relative to the wind farm sites in Figure 15.2. Following this, relevant details of each route are given in Table 15.1. This includes terminus ports, however it should be considered that these are based on the most common destinations transmitted via AIS by vessels on those routes and therefore it should not be assumed that a transit through the shipping and navigation study area on a given route will be to one of the destinations listed.

245. To ensure all routes are captured (including low use routes), the 12 months of AIS data has been utilised to characterise routeing, as opposed to the vessel survey data which covers a specific period and therefore may omit certain activity. It is noted that the 12 months of data precedes the construction of Triton Knoll, and the associated deviations were not reflected within the data. Given that Triton Knoll is considered

baseline, the Mean Route Positions of the any affected Main Routes have accounted for the construction buoyage.

246. For the purposes of this NRA, only routes with at least 182 vessels per year (i.e., a vessel every other day) have been presented as a Main Route within this section. However, low use routes have still been identified and included within the allision and collision modelling (see Section 19).

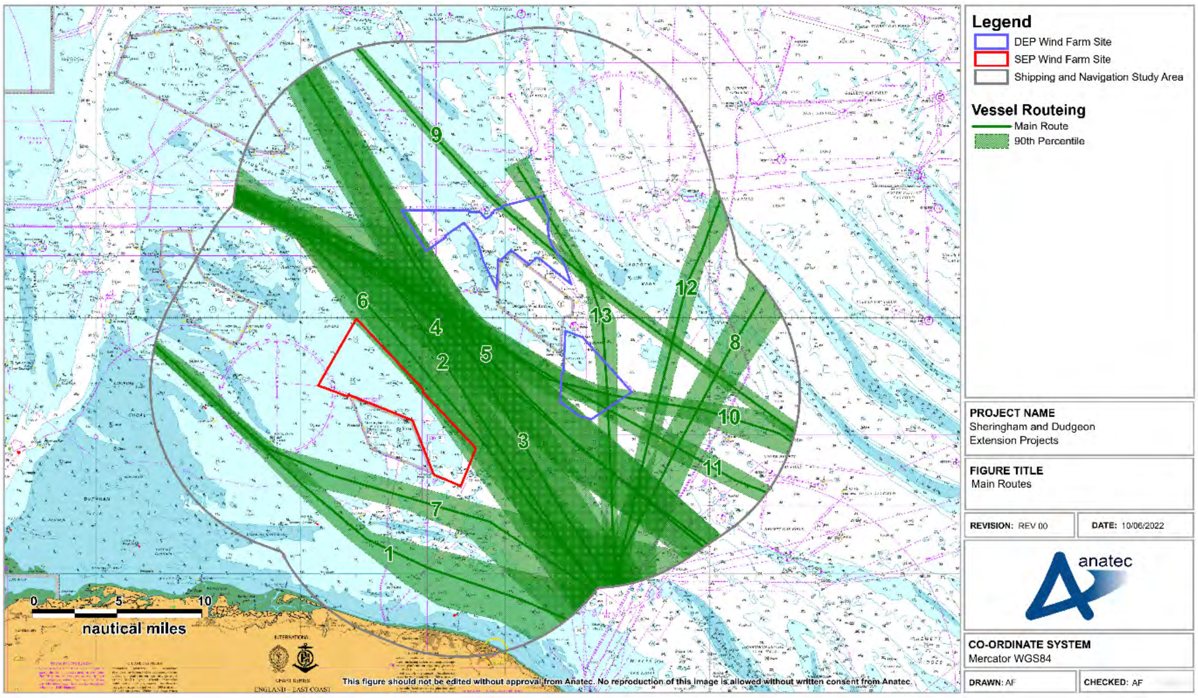

Figure 15.2 Main Routes – Pre Wind Farm

Table 15.1 Main Route Details

Route	Terminus Ports	Vessels per Day
1	Humber (UK) / Rotterdam (Netherlands)	20
2	Humber (UK) / Rotterdam (Netherlands)	13
3	Tees (UK) / Zeebrugge (Belgium)	12
4	Humber (UK) / Rotterdam (Netherlands)	12
5	Tees (UK) / Rotterdam (Netherlands)	4
6a	Hull (UK) / Zeebrugge (Belgium)	2[10]
6b	Hull (UK) / Rotterdam (Netherlands)	2[10]

[10] Note this is a P&O route, vessel numbers presented are based on timetables, as these exceeded actual vessel numbers within the traffic data. Excludes chartered vessels, which are captured under separate routes.

Route	Terminus Ports	Vessels per Day
7	Humber (UK) / Rotterdam (Netherlands)	3
8	Great Yarmouth (UK) / Lincolnshire Offshore Gas Gathering System (LOGGS) (UK waters)	2
9	Tees (UK) / Rotterdam (Netherlands)	1
10	Humber (UK) / Rotterdam (Netherlands)	< 1
11	Humber (UK) / Rotterdam (Netherlands)	< 1
12	Great Yarmouth (UK) / Clipper (UK waters)	< 1
13	Great Yarmouth (UK) / Lancelot (UK waters)	< 1

15.3 Adverse Weather Routeing

247. This section assesses the adverse weather routeing within the shipping and navigation study area.

248. Adverse weather includes wind, wave, and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's standard route and/or speed of navigation. Adverse weather routes are assessed to be significant course adjustments to mitigate vessel motion in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various types of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or discomfort and danger to persons on board. The sensitivity of a vessel to these phenomena will depend upon various factors, including stability parameters, hull geometry, vessel type, vessel size, and speed.

249. The marine traffic data has been studied based upon consultation input to identify any adverse weather routes utilised within the shipping and navigation study area. It is noted that this adverse weather routes assessment is based upon the 12 months of AIS (see Annex B) as opposed to the short-term vessel survey data to ensure adverse periods are captured. DFDS stated during consultation that vessels associated with their Newcastle / Amsterdam route may utilise the "Beach Route" during periods of adverse weather, and that this route passes within the shipping and navigation study area. However, DFDS also stated they did not view the SEP and DEP as likely to adversely affect this route.

250. This input aligns with the findings of the marine traffic assessment, in that the vessels associated with the Newcastle / Amsterdam route (the *King Seaways* and the *Princess Seaways*) were both recorded in the shipping and navigation study area during January, February, March, October, and December of 2019. The relevant AIS tracks

are shown in Figure 15.3, and as is demonstrated by this figure, the vessels can choose transit between the wind farm sites during adverse conditions.

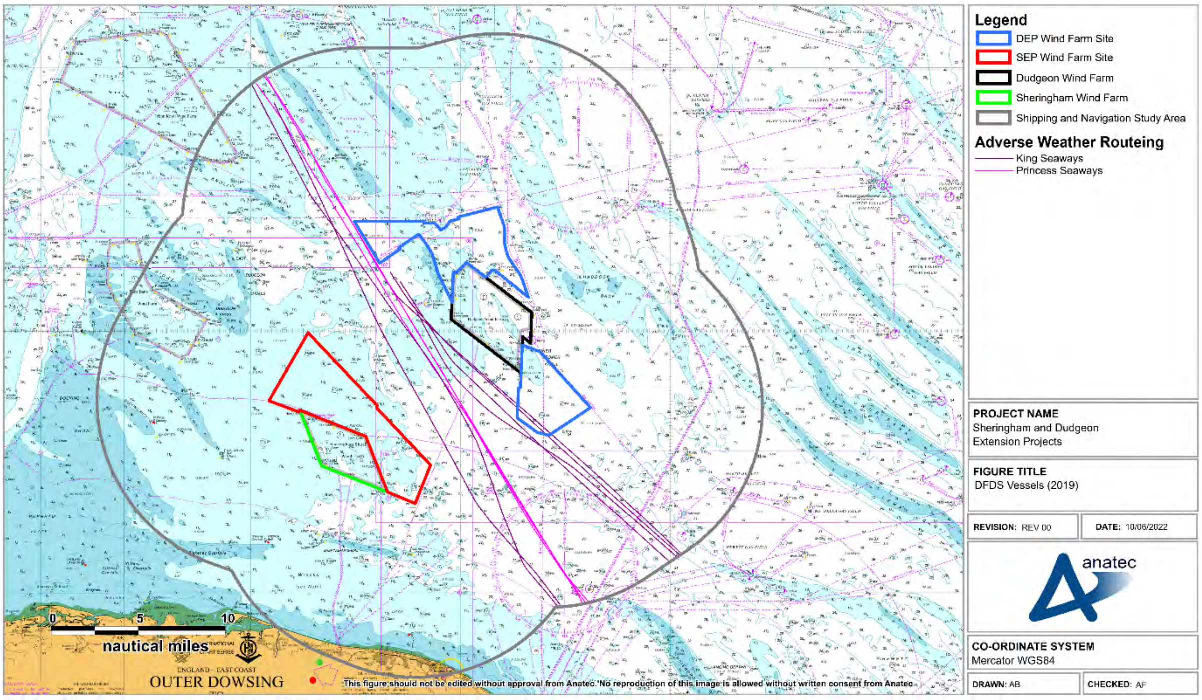

Figure 15.3 Adverse Weather Routeing - DFDS

15.4 Marine Aggregate Dredgers Transits

251. As per Section 14.1.3.6, there is marine aggregate dredging presence within the shipping and navigation study area. Figure 15.4 shows the BMAPA transit routes within the shipping and navigation study area and the tracks recorded from marine aggregate dredgers during the year of 2019 data that intersected a one nm buffer of the wind farm sites. For reference the extraction areas within the vicinity are included.

252. On average, a marine aggregate dredger was recorded within one nm of the wind farm sites every other day. A total of six BMAPA routes intersected the wind farm sites, however the majority of routes within the shipping and navigation study area were observed to pass to the south.

253. Routeing to the Outer Dowsing aggregate production areas within the shipping and navigation study area was observed within both the AIS data and the BMAPA transit routes. This includes vessels intersecting the wind farm sites. Likely post wind farm activity of these vessels is discussed in Section 18.6.3.

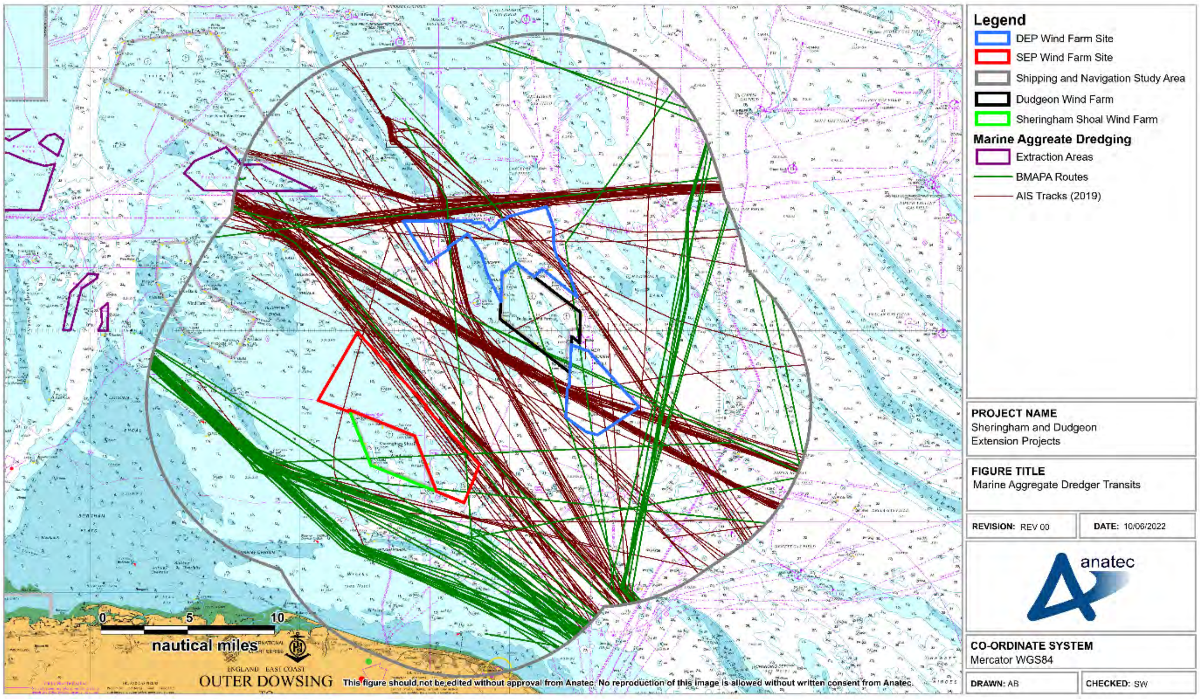

Figure 15.4 Marine Aggregate Dredger Transits

16 Navigation, Communication and Position Fixing Equipment

16.1 Very High Frequency Communications (Including Digital Sensitive Calling)

254. In 2004, trials were undertaken at the North Hoyle OWF, located off the coast of North Wales. As part of these trials, tests were undertaken to evaluate the operational use of typical small vessel VHF transceivers (including DSC) when operated close to wind turbines.

255. The wind turbines had no noticeable effect on voice communications within the wind farm or ashore. It was noted that if small craft vessel to vessel and vessel to shore communications were not affected significantly by the presence of wind turbines, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

256. During this trial, a number of telephone calls were made from ashore, within the wind farm, and on its seawards side. No effects were recorded using any system provider (MCA and QinetiQ, 2004).

257. Furthermore, as part of SAR trials carried out at the North Hoyle OWF in 2005, radio checks were undertaken between the Sea King helicopter and both Holyhead and Liverpool coastguards. The aircraft was positioned to the seaward side of the wind farm and communications were reported as very clear, with no apparent degradation of performance. Communications with the service vessel located within the wind farm were also fully satisfactory throughout the trial (MCA, 2005).

258. In addition to the North Hoyle trials, a desk-based study was undertaken for the Horns Rev 3 OWF in Denmark in 2014 and it was concluded that there were not expected to be any conflicts between point-to-point radio communications networks and no interference upon VHF communications (Energinet.dk, 2014).

259. Following consideration of these reports, and noting that since the trials detailed above there have been no significant issues with regards to VHF observed or reported, the SEP and DEP are anticipated to have no significant impact upon VHF communications.

16.2 Very High Frequency Direction Finding

260. During the North Hoyle OWF trials in 2004, the VHF Direction Finding (DF) equipment carried in the trial boats did not function correctly when very close to wind turbines (within approximately 50m). This is deemed to be a relatively small-scale impact due to the limited use of VHF direction finding equipment and will not impact operational or SAR activities (MCA and QinetiQ, 2004).

261. Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King[11] radio homer system utilises the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading. With the aircraft and the target vessel within the wind farm, at a range of approximately 1nm, the homer system operated as expected with no apparent degradation.

262. Since the trials detailed above, no significant issues with regards to VHF DF have been observed or reported, and therefore the SEP and DEP are anticipated to have no significant impact upon VHF DF equipment.

16.3 Automatic Identification System

263. No significant issues with interference to AIS transmission from operational OWFs has been observed or reported to date. Such interference was also not evident in the trials carried out at the North Hoyle OWF (MCA and QinetiQ, 2004).

264. In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e. blocking line of sight) of the AIS. However, given no issues have been reported to date at operational developments or during trials, no significant impact is anticipated due to the SEP and DEP.

16.4 Navigational Telex Systems

265. The Navigational Telex (NAVTEX) system is used for the automatic broadcast of localised Maritime Safety Information (MSI) and either prints it out in hard copy or displays it on a screen, depending upon the model.

266. There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518kHz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings and navigation warnings such as obstructions or buoys off station. Depending on the user's location, other information options may be available such as ice warnings for high latitude sailing.

267. The 490kHz national NAVTEX service may be transmitted in the local language. In the UK full use is made of this secondary frequency including useful information for smaller craft, such as the inshore waters forecast and actual weather observations from weather stations around the coast.

268. Although no specific trials have been undertaken, no significant effect on NAVTEX has been reported to date at operational developments, and therefore no significant impact is anticipated due to the SEP and DEP.

[11] Sea King helicopters are no longer used for SAR within UK waters.

16.5 Global Positioning Systems

269. Global Positioning System (GPS) is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle OWF and it was stated that "*no problems with basic GPS reception or positional accuracy were reported during the trials*".

270. The additional tests showed that "even with a very close proximity of a wind turbine to the GPS antenna, there were always enough satellites elsewhere in the sky to cover for any that might be shadowed by the wind turbine tower" (MCA and QinetiQ, 2004).

271. Therefore, there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the SEP and DEP, noting that there have been no reported issues relating to GPS within or in proximity to any operational OWFs to date.

16.6 Electromagnetic Interference

272. A compass, magnetic compass or mariner's compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the north end) free to align itself with the Earth's magnetic field. A compass can be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

273. Like any magnetic device, compasses are affected by nearby ferrous materials as well as by strong local electromagnetic forces, such as magnetic fields emitted from power cables. As the compass still serves as an essential means of navigation in the event of power loss or as a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited. The important factors with respect to cables that affect the resultant deviation are:

- Water depth;
- Burial depth;
- Current (alternating or direct) running through the cables;
- Spacing or separation of the two cables in a pair (balanced monopole and bipolar designs); and/or
- Cable route alignment relative to the Earth's magnetic field.

274. The offshore export cables and array cables are expected to be Alternating Current (AC). Studies indicate that, unlike Direct Current (DC) AC does not emit an Electromagnetic Field (EMF) significant enough to impact marine magnetic compasses (Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), 2008).

275. No problems with respect to magnetic compasses have been reported to date in any of the trials carried out (inclusive of SAR helicopters) nor at any operational OWFs. However, small vessels with simple magnetic steering and hand bearing compasses

should be wary of using these close to wind turbines as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004).

16.7 Marine Radar

276. This section summarises trials and studies undertaken in relation to Radar effects from OWFs in the UK. It is important to note that since the time of the trials and studies discussed, offshore wind turbine technology has advanced significantly, most notably in terms of the size of wind turbines available to be installed and utilised. The use of these larger wind turbines allows for a greater minimum spacing than was achievable at the time of the studies being undertaken, which is beneficial in terms of Radar interference effects (and surface navigation in general) as detailed below.

16.7.1 Trials

277. During the early years in offshore renewables within the UK, maritime regulators undertook a number of trials (both shore-based and vessel-based) into the effects of wind turbines on the use and effectiveness of marine Radar.

278. In 2004 trials undertaken at the North Hoyle OWF (MCA, 2004) identified areas of concern regarding the potential impact on marine and shore-based Radar systems due to the large vertical extents of the wind turbines (based on the technology at that time). This resulted in Radar responses strong enough to produce interfering side lobes and reflected echoes (often referred to as false targets or ghosts).

279. Side lobe patterns are produced by small amounts of energy from the transmitted pulses that are radiated outside of the narrow main beam. The effects of side lobes are most noticeable within targets at short range (below 1.5nm) and with large objects. Side lobe echoes form either an arc on the Radar screen similar to range rings, or a series of echoes forming a broken arc, as illustrated in Figure 16.1.

280. Multiple reflected echoes are returned from a real target by reflection from some object in the Radar beam. Indirect echoes or “ghost” images have the appearance of true echoes but are usually intermittent or poorly defined; such echoes appear at a false bearing and false range, as illustrated in Figure 16.2.

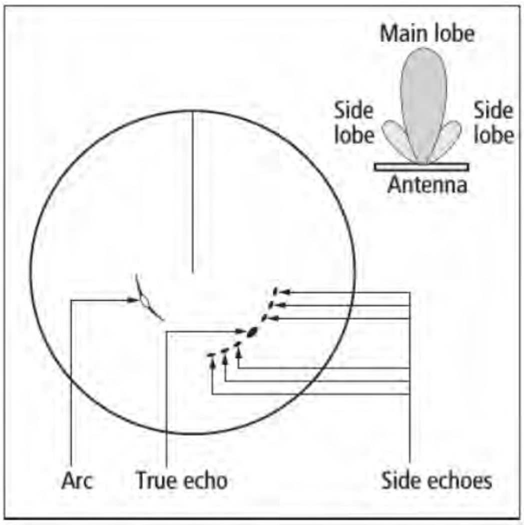

Figure 16.1 Illustration of side lobes on Radar screen

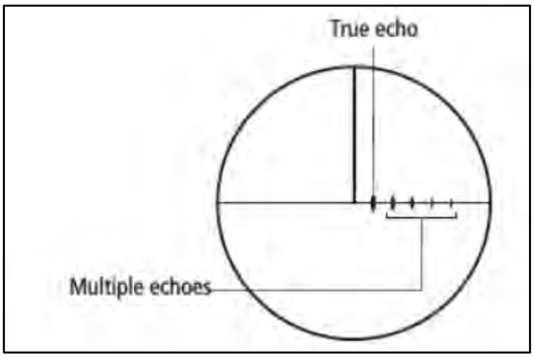

Figure 16.2 Illustration of multiple reflected echoes on Radar screen

281. Based upon the results of the North Hoyle trials, the MCA produced a Shipping Route Template designed to give guidance to mariners on the distances which should be established between shipping routes and OWFs. The latest version of the Shipping Template is included within MGN 654 (MCA, 2021).

282. A second set of trials conducted at Kentish Flats OWF in 2006 on behalf of the British Wind Energy Association (BWEA) – now called RenewableUK (BWEA, 2007) – also found that Radar antennas which are sited unfavourably with respect to components of the vessel's structure can exacerbate effects such as side lobes and reflected echoes. Careful adjustment of Radar controls suppressed these spurious Radar returns but mariners were warned that there is a consequent risk of losing targets with a small Radar cross section, which may include buoys or small craft, particularly yachts or Glass Reinforced Plastic (GRP) constructed craft; therefore due care should be taken in making such adjustments.

283. Theoretical modelling of the effects of the development of the proposed Atlantic Array OWF, which was to be located off the south coast of Wales in the UK, on marine Radar systems was undertaken by the Atlantic Array project (Atlantic Array, 2012) and

considered a wider spacing of turbines than that considered within the early trials. The main outcomes of the modelling were the following:

- Multiple and indirect echoes were detected under all modelled parameters;
- The main effects noticed were stretching of targets in azimuth (horizontal) and appearance of ghost targets;
- There was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the wind turbines and safe navigation;
- Even in the worst-case with Radar operator settings artificially set to be poor, there is significant clear space around each wind turbine that does not contain any multipath or side lobe ambiguities to ensure safe navigation and allow differentiation between false and real (both static and moving) targets;
- Overall, it was concluded that the amount of shadowing observed was very little (noting that the model considered lattice-type foundations which are sufficiently sparse to allow Radar energy to pass through);
- The lower the density of wind turbines the easier it is to interpret the Radar returns and fewer multipath ambiguities are present;
- In dense, target rich environments S-Band Radar scanners suffer more severely from multipath effects in comparison to X-Band Radar scanners;
- It is important for passing vessels to keep a reasonable separation distance between the wind turbines in order to minimise the effect of multipath and other ambiguities;
- The Atlantic Array study undertaken in 2012 noted that the potential for Radar interference was mainly a problem during periods of reduced visibility when mariners may not be able to visually confirm the presence of other vessels in proximity (i.e. those without AIS installed which are usually fishing and recreational craft). It is noted that this situation would arise with or without wind turbines in place; and
- There is potential for the performance of a vessel's ARPA to be affected when tracking targets in or near the array. Although greater vigilance is required, during the Kentish Flats trials it was shown that false targets were quickly identified as such by the mariners and then by the equipment itself.

284. In summary, experience in UK waters has shown that mariners have become increasingly aware of any Radar effects as more OWFs become operational. Based on this experience, the mariner can interpret the effects correctly, noting that effects are the same as those experienced by mariners in other environments such as in close proximity to other vessels or structures. Effects can be effectively mitigated by "careful adjustment of Radar controls".

285. The MCA has also produced guidance to mariners operating in proximity to OREIs in the UK which highlights Radar issues amongst others to be taken into account when planning and undertaking voyages in proximity to OREIs (MCA, 2008). The interference buffers presented in Table 16.1 are primarily based on information provided in MGN 654 (MCA, 2021), but also consider MGN 371 (MCA, 2008a), MGN 543 (MCA, 2016), and MGN 372 (MCA, 2008).

Table 16.1 Distances at which impacts on marine Radar occur

Distance at Which Radar Effect Occurs (nm)	Identified Effects on Radar - *Target size of the wind turbine echo increases close to the wind turbine with a consequent degradation on both X and S-Band Radars as noted below*.

0.5	▪ Under MGN 654 impacts on Radar use within 0.5nm are "very high" risk and are deemed intolerable.
	▪ Detail included in MGN 371 (now archived) noted that:
	    ▪ X-band Radar interference is intolerable <0.25nm.
	    ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45nm.

0.5 to <1nm	▪ Under MGN 654 impacts on Radar are "high" risk but can be Tolerable if ALARP.
1 to <1.5nm	▪ Under MGN 654 impacts on Radar between 1nm to <1.5 nm are "medium" risk but can be Tolerable if ALARP ▪ Detail included in MGN 371 (now archived) noted S-band Radar interference was present at < 1.5nm. ▪ Echoes develop at approximately 1.5nm, with progressive deterioration in the Radar display as the range closes. Where a main vessel routes passes within this range considerable interference may be expected along a line of wind turbines. ▪ Noting that the wind turbines produced strong Radar echoes giving early warning of their presence.

286. As noted in Table 16.1, the onset range from the wind turbines of false returns is approximately 1.5nm, with progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the Convention on International Regulations for Preventing Collisions at Sea (COLREGs) *Rule 6 Safe Speed* are particularly applicable and must be observed with due regard to the prevailing circumstances. In restricted visibility, *Rule 19 Conduct of Vessels in Restricted Visibility* applies and compliance with *Rule 6* becomes especially relevant. In such conditions mariners are required, under *Rule 5 Look-out* to take into account information from other sources which may include sound signals and VHF information, for example from a Vessel Traffic Service (VTS) or AIS (MCA, 2016).

16.7.2 Experience from Operational Developments

287. The evidence from mariners operating in proximity to existing OWFs is that they quickly learn to adapt to any effects. Figure 16.3 presents the example of the Galloper and Greater Gabbard OWFs, which are located in proximity to IMO routeing measures. Despite this proximity to heavily trafficked TSS lanes, there have been no reported incidents or issues raised by mariners who operate within the vicinity. The interference buffers presented in Figure 16.3 are as per Table 16.1.

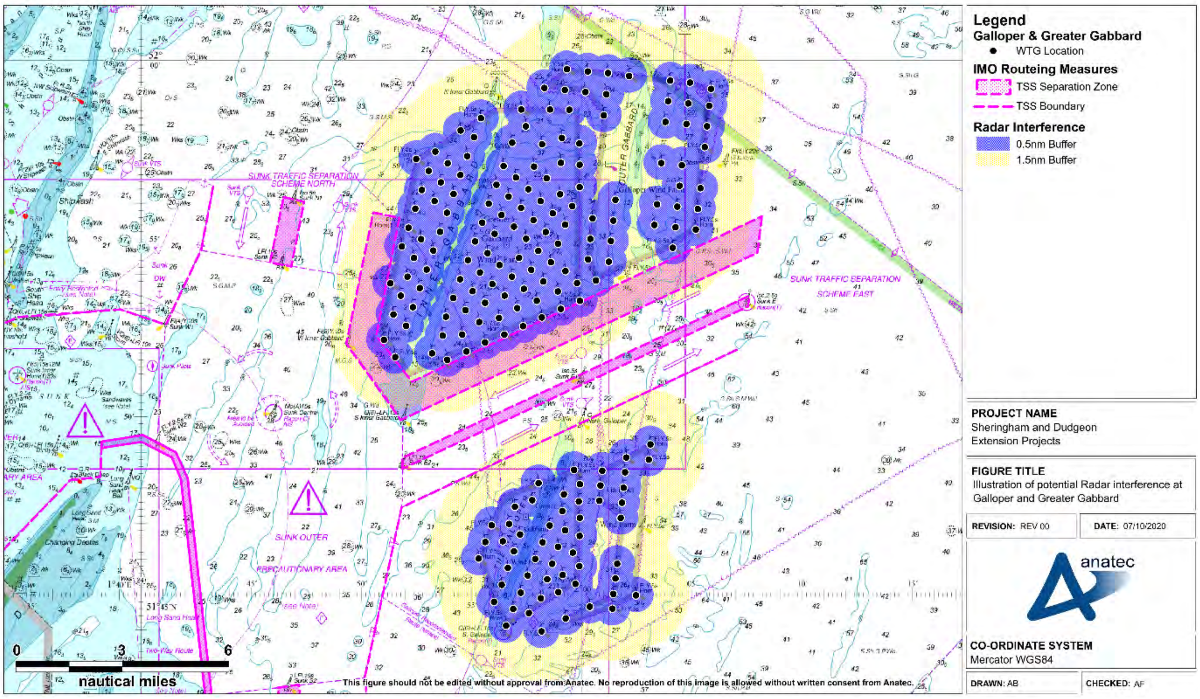

Figure 16.3 Galloper and Greater Gabbard

288. As indicated by Figure 16.3, vessels utilising these TSS lanes will experience some Radar interference based on the available guidance. Both developments are operational, and each of the lanes is used by a minimum of five vessels per day on average. However, to date, there have been no incidents recorded (including any related to Radar use) or concerns raised by the users.

289. AIS information can also be used to verify the targets of larger vessels (generally vessels over 15m LOA – the minimum threshold for fishing vessel AIS carriage requirements). It is noted only approximately 4% of the vessel traffic recorded within the shipping and navigation study area was under 15m LOA. For any smaller vessels, particularly fishing vessels, and recreational vessels, AIS Class B devices are becoming increasingly popular and allow the position of these small craft to be verified when in proximity to an OWF.

16.7.3 Increased Target Return

290. Beam width is the angular width, horizontal or vertical, of the path taken by the Radar pulse. Horizontal beam width ranges from 0.75° to 5°, and vertical beam width from 20° to 25°. How well an object reflects energy back towards the Radar depends upon its size, shape, and aspect angle.

291. Larger wind turbines (either in height or width) will return greater target sizes and/or stronger false targets. However, there is a limit to which the vertical beam width would be affected (20° to 25°) dependent upon the distance from the target. Therefore, increased wind turbine height in the array will not create any effects in

addition to those already identified from existing operational wind farms (i.e., interfering side lobes, multiple and reflected echoes).

292. Again, when taking into consideration the potential options available to marine users (e.g., reducing gain to remove false returns) and feedback from operational experience, this shows that the effects of increased returns can be managed effectively.

16.7.4 Fixed Radar Antenna Use in Proximity to Operational Wind Farm

293. It is noted that there are multiple operational wind farms including Galloper that successfully operate fixed Radar antenna from locations on the periphery of the array. These antennas are able to provide accurate and useful information to onshore coordination centres.

16.7.5 Applications to the SEP and DEP

294. Upon development of the SEP and DEP, based on the post wind farm routeing assessment (see section 18.5) some commercial vessels may pass within 1.5nm of the wind farm infrastructure and therefore may be subject to a minor level of Radar interference. Trials, modelling and experience from existing developments note that any impact can be mitigated by adjustment of Radar controls.

295. Figure 16.4 presents an illustration of potential Radar interference due to the SEP and DEP relative to the post wind farm routeing illustrated in Section 18.6.2. The wind turbines within the existing sites are included for reference.

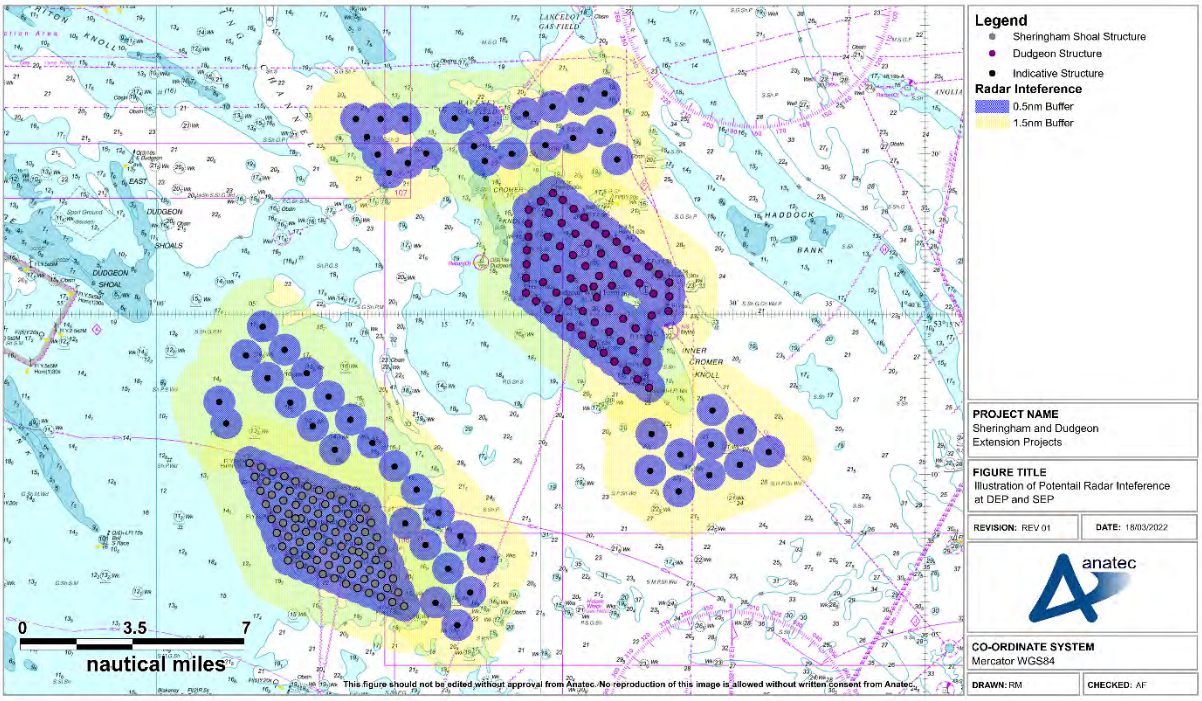

Figure 16.4 Potential Radar Interference

296. Vessels passing within the array will be subject to a greater level of interference with impacts becoming more substantial in close proximity to wind turbines. This will require additional mitigation by any vessels including consideration of the navigational conditions (i.e., visibility) when passage planning and compliance with the COLREGs will be essential. Again, looking at existing experience within UK OWFs, vessels do navigate safely within arrays including those with spacing significantly less than that of the minimum spacing of the SEP and DEP.

297. Overall, the impact on marine Radar is expected to be low and no further impact upon navigational safety is anticipated outside the parameters which can be mitigated by operational controls.

16.8 Sound Navigation Ranging Systems

298. No evidence has been found to date with regard to existing OWFs to suggest that Sound Navigation Ranging (SONAR) systems produce any kind of SONAR interference which is detrimental to the fishing industry, or to military systems. No impact is therefore anticipated in relation to the SEP and DEP.

16.9 Noise

16.9.1 Surface Noise

299. The sound level from wind turbines at a distance of 350m has been predicted to be in the range of 35 decibels (dB) and 45dB (A) (Scottish Government, 2002). Furthermore, modelling undertaken during the consenting process for the Atlantic Array OWF showed that the highest predicted level due to operational wind turbine noise (for a 125m tall eight Megawatt (MW) wind turbine) is around 60dB (Atlantic Array, 2012).

300. A vessel’s whistle for a vessel of 75m length should generate in the order of 138dB and be audible at a range of 1.5nm (IMO, 1972/77); hence this should be heard above the background noise of the wind turbines. Similarly, foghorns will also be audible over the background noise of the wind turbines.

301. There are therefore no indications that the sound level of the SEP and DEP will have a significant influence on marine safety.

16.9.2 Underwater Noise

302. In 2005, the underwater noise produced by wind turbines of 110m height and with 2MW capacity was measured at the Horns Rev OWF in Denmark. The maximum noise levels recorded underwater at a distance of 100m from the wind turbines was 122dB or one micropascal (µPa) (Institut für technische und angewandte Physik (ITAP), 2006).

303. During the operation and maintenance phase of the SEP and DEP, the subsea noise levels generated by wind turbines will likely be greater than that produced at Horns

Rev given the larger wind turbine size, but nevertheless is not anticipated to have any significant impact as they are designed to work in pre-existing noisy environments.

16.10 Existing Aids to Navigation

304. There are numerous existing AtoN within the shipping and navigation study area, including those marking the perimeters of the other OWFs located within the shipping and navigation study area (See section 10.3). After the construction of the SEP and DEP, changes may be required to the AtoN marking the perimeter of the existing Dudgeon and Sheringham Shoal sites. Any changes required as a result would be discussed and agreed with Trinity House.

305. One AtoN is also located within the offshore export cable corridor. These may be required to be temporarily moved whilst construction work occurs, however should any such change be required, it would be discussed with Trinity House to agree any appropriate mitigation.

306. The other AtoN within the shipping and navigation study area mark a number of hazards, notably numerous shallow banks. It is not expected that the SEP and DEP will impact any of these buoys.

16.11 Summary

307. Table 16.2 summarises the impacts of the SEP and DEP on communication (including consideration of any cumulative impacts associated with tier 1-3 projects as per Table 17.1) and position fixing equipment based on the assessment undertaken within this section.

Table 16.2 Assessment Summary

Topic		Sensitivity	Screen In/Out (Isolation)	Screen In/Out (Cumulative)
Type	Specific			
Communication	VHF	No anticipated impacts.	Screened out	Screened out
	VHF DF	No notable degradation and therefore no anticipated impacts.	Screened out	Screened out
	AIS	No anticipated impacts.	Screened out	Screened out
	NAVTEX	No anticipated impacts.	Screened out	Screened out
	GPS	No anticipated impacts.	Screened out	Screened out
Electromagnetic fields	Subsea cables	No anticipated impacts.	Screened out	Screened out
	WTs	No anticipated impacts.	Screened out	Screened out
Marine Radar	Use of marine Radar	Vessels have sufficient sea room to distance themselves from the array in line with the "*Shipping Route Template*" to mitigate any effects.	Screened out	Screened out

Topic		Sensitivity	Screen In/Out (Isolation)	Screen In/Out (Cumulative)
Type	**Specific**			
SONAR	SONAR Systems	No anticipated impacts.	Screened out	Screened out
Noise	WT generated noise	No anticipated impacts.	Screened out	Screened out
	Sound Navigation Ranging System	No anticipated impacts.	Screened out	Screened out

17 Cumulative and Transboundary Overview

308. Potential cumulative effects have been considered for activities in combination and cumulatively with the SEP and DEP. This section provides an overview of the developments and projects that have been screened into the cumulative impact assessment based on the criteria provided in Section 3.3. Given the unique nature of shipping and navigation receptors, a bespoke tiering system has been applied to ensure relevant projects / developments are captured and assessed appropriately (see Section 3.3).

309. A summary of the tier characterisation of the screened in projects / developments is given in Table 17.1. The project statuses shown are correct as of the time of writing[12].

Table 17.1 Project Tier Summary

Tier	Project	Type	Project Status	Distance from wind farm sites (nm)	Data Confidence	Tier Rationale
1	Sustainable Seaweed Ltd	Seaweed Farm	Application Submitted	0.8	Low	▪ Within 100nm ▪ Effect on cumulative routeing
1	Norfolk Vanguard OWF	OWF	Consented	31.5	High	▪ Wind farm within 50nm ▪ Effect on cumulative routeing
1	Norfolk Boreas OWF	OWF	Consented	44.7	High	▪ Wind farm within 50nm ▪ Effect on cumulative routeing
2	East Anglia THREE	OWF	Consented	51.1	High	▪ Wind farm within 100nm ▪ Effect on cumulative routeing
2	East Anglia ONE North	OWF	Consented	53.0	Medium	▪ Wind farm within 100nm ▪ Effect on cumulative routeing

[12] 13/06/2022

Tier	Project	Type	Project Status	Distance from wind farm sites (nm)	Data Confidence	Tier Rationale
2	East Anglia TWO	OWF	Consented	56.7	Medium	▪ Wind farm within 100nm ▪ Effect on cumulative routeing
3	Hornsea Project Two OWF	OWF	Under Construction	28.3	High	▪ Wind farm within 50nm ▪ Effect on cumulative routeing
3	Hornsea Project Four	OWF	Under Examination	28.5	Medium	▪ Pre application ▪ Wind farm within 50nm
3	Hornsea Project Three OWF	OWF	Consented	44.6	High	▪ Wind farm within 50nm
3	North Falls	OWF	Scoped	68.6	Low	▪ Low data confidence ▪ Wind farm within 100nm
3	Five Estuaries	OWF	Scoped	72.7	Low	▪ Low data confidence ▪ Wind farm within 100nm
3	Dogger Bank A	OWF	Consented	80.5	High	▪ Wind farm within 100nm
3	Dogger Bank B	OWF	Consented	90.3	High	▪ Wind farm within 100nm
3	Sofia	OWF	Consented	93.6	High	▪ Wind farm within 100nm
3	Norfolk Seaweed Ltd	Seaweed Farm	Application Submitted	6.5	High	▪ Within 100nm ▪ Unlikely to impact upon a main route identified as passing within the study area

17.1 Offshore Wind Farms

310. In addition to SEP and DEP, there are a number of OWF developments within the North Sea, both within UK and non-UK waters. OWFs screened into Tiers 1, 2, and 3 are

shown in Figure 17.1. It is noted that operational developments are considered baseline.

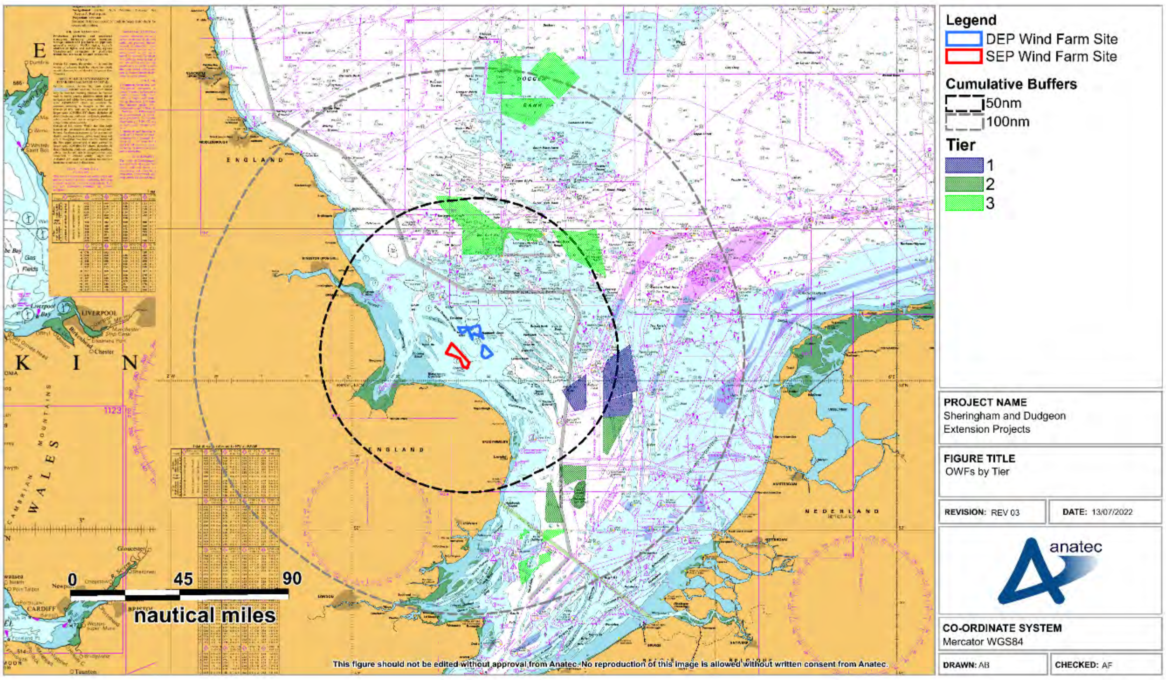

Figure 17.1 OWFs by Tier

17.2 Oil and Gas Infrastructure

311. O&G surface assets have been considered as part of the baseline impact assessment (see Section 10.2).

17.3 Seaweed Farm

312. As per Table 17.1, the Norfolk seaweed farm and Sustainable seaweed farm are proposed off the Norfolk coast, noting that the Sustainable Seaweed project is in close proximity to the SEP wind farm site.

313. The locations of the proposed sites are shown in Figure 17.2.

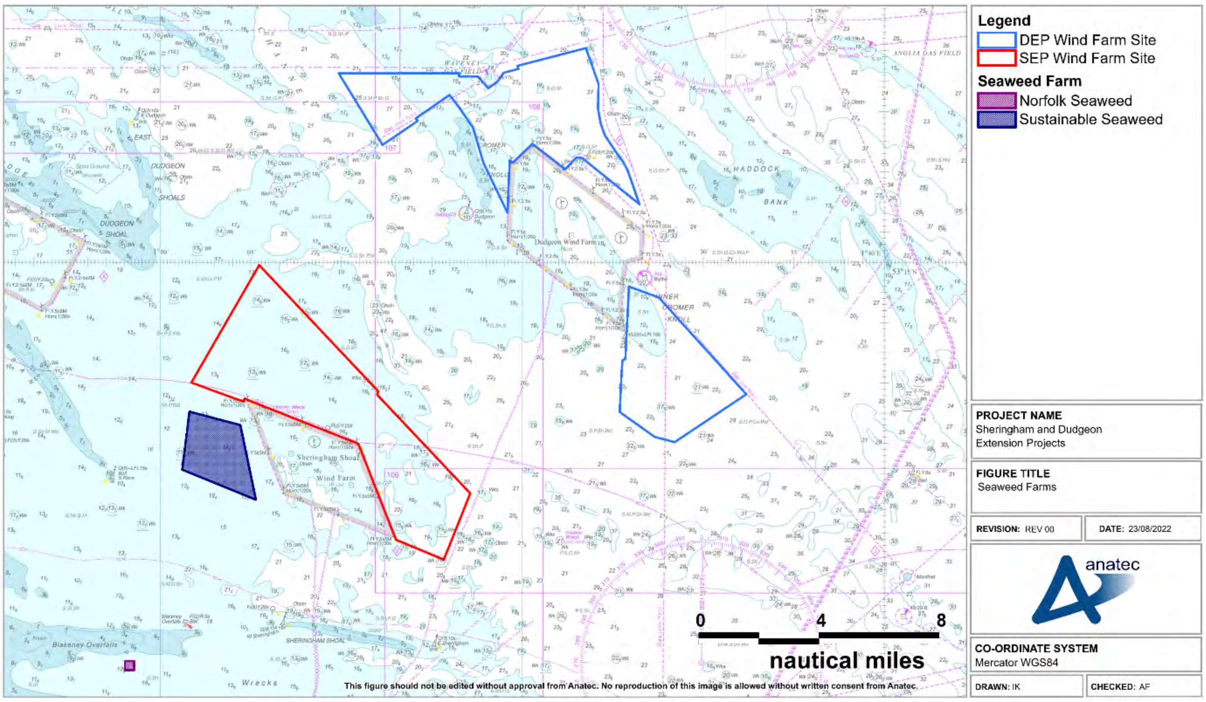

Figure 17.2 Seaweed Farm relative to Wind Farm Sites

18 Future Case Vessel Traffic

314. This section presents the predicted future case level of activity within and in proximity to SEP and DEP, and the anticipated shift in the mean positions of the main commercial routes post wind farm identified from the marine traffic data studied (see Section 14).

18.1 Increases in Commercial Traffic

315. Given future commercial traffic trends are dependent on various factors, and are hence difficult to predict, the NRA has assumed potential increases of 10 and 20% within the commercial traffic allision and collision modelling. The consideration of a range of conservative values is considered as covering potential increases over the course of the project's operational lifespan.

18.2 Increase in Commercial Fishing Vessel Activity

316. An indicative 10% increase in commercial fishing vessel transits is considered in the impact assessment included as part of this NRA to demonstrate potential impacts (in line with other renewables impact assessments). This value is used due to there being limited reliable information on future activity levels upon which any firm assumption could be made. It is noted that additional information on commercial fishing trends are contained within Chapter 12 Commercial Fisheries.

18.3 Increase in Recreational Activity

317. There are no known major developments which will increase the activity of recreational vessels within the southern North Sea. As with commercial fishing activity, given the lack of reliable information relating to future trends, a 10% increase is considered conservative, and has therefore been applied.

18.4 Available Searoom

318. MGN 654 requires that where turbines are present on both sides of a sea area, the required width requirement should be proportional to the length of area bordered on both sides by wind turbines, based on a 20-degree course deviation.

319. In the case of the wind farm sites, the length of the area bordered on "both sides" by wind turbines is of length 11.2nm, meaning that the required minimum width is 4.1nm. As shown in Figure 18.1, width of the area is in excess of this at 5.6nm, and hence the area is considered compliant.

320. These calculations have been applied based upon the interpretation implied by the wording of MGN 654, whereby the area must be bordered on "both sides" by wind turbines.

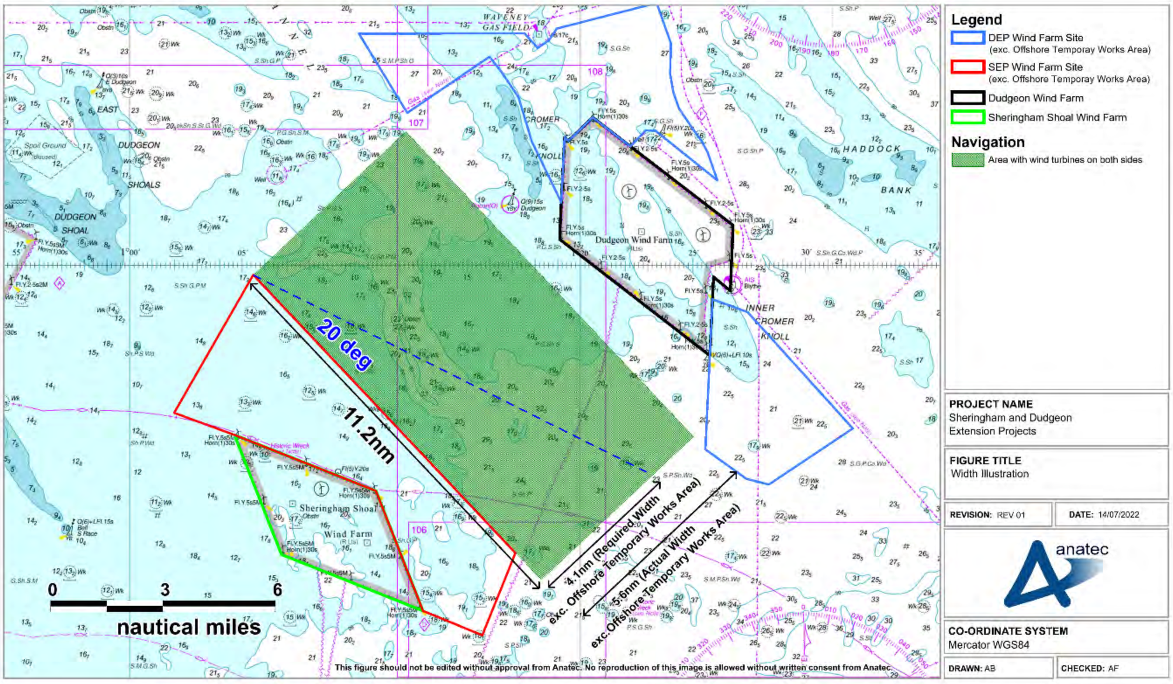

Figure 18.1 Width Illustration (widths do not account for Offshore Temporary Works Area)

321. It must be considered that while the available searoom is compliant with the MGN 654 width requirements, it still represents a notable reduction in width than is currently available between the existing sites. As shown in Figure 18.2, assuming the same bearing as utilised within the calculations illustrated in Figure 18.1, the equivalent pre wind farm width is 8.2nm, compared to 5.6nm post wind farm.

322. It should also be considered that while the MGN 654 (MCA, 2021) calculations do provide good indication as to appropriate widths for a rectangular "corridor", the shape of the area between the existing Dudgeon and Sheringham sites means that simple application of these calculations does not capture additional areas of sea room outside of the corridors shown in Figure 18.2 that would also be lost. In particular, the CoS raised within their Section 42 response (see Section 4.4) and post PEIR consultation (see Section 4.2) that the 5.6nm width estimated by the MGN 654 corridor calculations are based on the "pinch point" between the wind farm sites, and that measurements taken from other points exceed the 5.6nm value. The relevant distances quoted by the CoS are summarised as follows:

- 9.5nm between the north west corner of the existing Sheringham Shoal site and the Dudgeon Cardinal Buoy; and
- 10.1nm between the south east corner of the existing Sheringham Shoal site and south east corner of the existing Dudgeon site.

323. The CoS also noted that including the East Dudgeon Shoal as the western extent of the "corridor" between the sites would extend the length to approximately 20nm.

324. It is important to note that the "additional" areas lost that sit outside of the existing "corridor" shown in Figure 18.2 are not heavily transited and are largely avoided by established routeing. This is due to numerous existing routeing constraints located in the area including the shallow banks.

325. It should be considered that the distance that commercial vessels pass wind farms would be at the discretion of the individual vessels, and it noted that relevant guidance indicates a range of appropriate distances dependent on various factors (e.g., the CoS raised during consultation that the Witherby Guide recommends 2nm) however, experience shows that commercial vessels are frequently and comfortably passing within 1nm of operational wind farms, and that effects on Radar at these distances are manageable (see Section 16.7) in line with MGN 654 (MCA, 2021) and MGN 372 (MCA, 2008).

326. Despite precedent for wind farms being constructed within 1nm of routeing measures, as per Section 13.4 there have no reported allisions to date between routed commercial vessels (i.e., cargo, tanker, passenger) and UK wind farms. This has been considered within the deviation assessment (see Section 18.6.2) and within the FSA where appropriate (see Section 21).

327. It is noted that the CoS also raised a more general concern associated with loss of searoom on a cumulative basis. This is considered and assessed within Section 21.2.

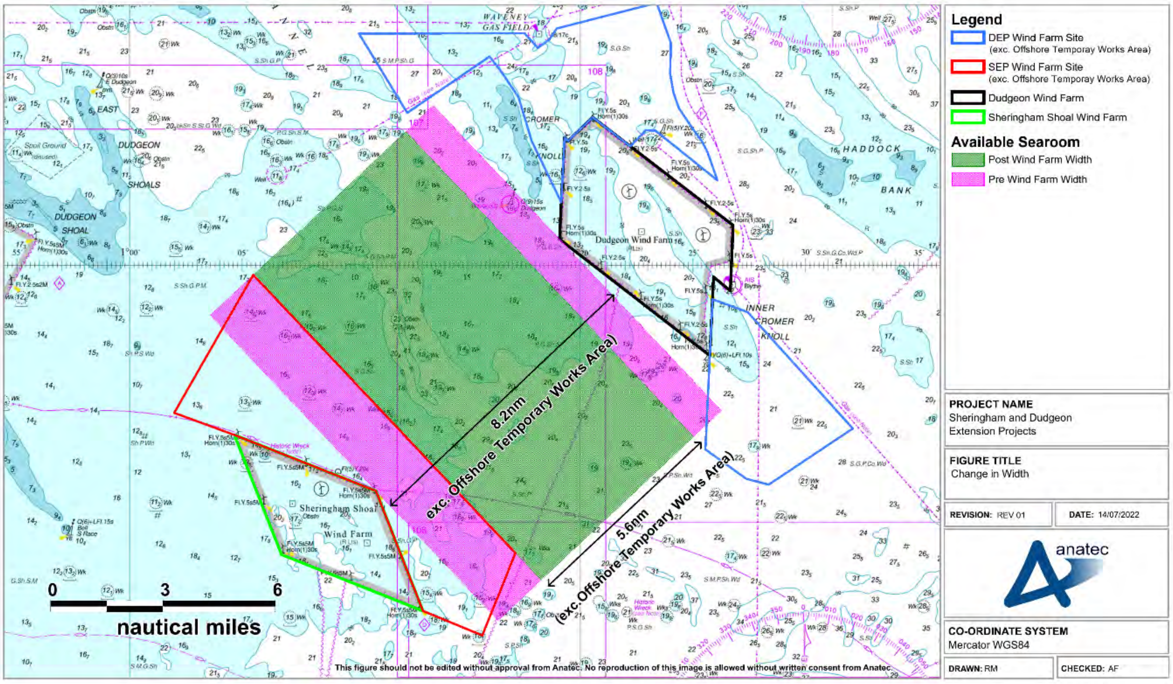

Figure 18.2 Reduction in Available Searoom (widths do not account for Offshore Temporary Works Area)

328. The overarching reduction in searoom was raised as a concern during consultation (see Section 4) by regular operators, however these concerns were largely in relation to impacts on journey distance and time as opposed to navigational safety. The RYA, CA and CoS also raised the change in searoom as being of concern given the potential for an increase in vessel encounters which could raise collision rates, and it was noted that the deviations assessed within Section 18.5 must be viewed within this context (i.e., even with a minor deviation in terms of change in transit distance, vessels could still be displaced into reduced searoom and hence increased collision risk).

329. Assessment of collision risk is assessed within Section 21.1.3.

18.5 Third Party Deviations associated with Project Vessels

330. Concern was raised by certain regular operators during consultation (see Section 4.2) around a need to deviate to avoid project vessels (as opposed to the structures within the wind farm sites), noting that this concern was reiterated in the Hazard Workshop (see Section 4.5). It is noted that these concerns were not safety related, but were instead linked to cumulative impacts over time on transit distances and times.

331. General operator consensus was that the implementation and promulgation of project vessel procedures would mitigate this concern therefore a Navigation Management Plan will be developed post consent to mitigate impacts associated with crew transfer vessels (including daughter craft) during the construction and operations phase of the project.

332. The Navigation Management Plan has been considered as recommended additional mitigation where appropriate within the Formal Safety Assessment (see Section 21).

18.6 Commercial Traffic Routeing (Projects in Isolation)

18.6.1 Methodology

333. It is not possible to consider all potential alternative routeing options for commercial traffic and therefore worst-case alternatives have been considered based upon existing routeing relative to the proposed SEP and DEP. Assumptions for re-routeing include:

- All alternative routes maintain a minimum mean distance of one nm[13] from offshore installations and existing wind turbine boundaries in line with the MGN 654 Shipping Route Template (MCA, 2021). This distance is considered for shipping and navigation from a safety perspective as explained below; and
- All mean routes take into account sandbanks and known routeing preferences.

[13] For the purposes of re-routeing the Temporary Offshore Works Area has not been included given its is to accommodate temporary works only.

334. MGN 654 provides guidance to offshore renewable energy developers on both the NRA process and design elements associated with the development of an OWF. Annex 2 of MGN 654 defines a methodology for assessing passing distances between OWF boundaries but states that it is "not a prescriptive tool but needs intelligent application".

335. To date, internal and external studies undertaken by Anatec on behalf of the UK Government and individual clients show that vessels do pass consistently and safely within one nm of established OWFs (including between different wind farms) and these distances vary depending upon the sea room available as well as the prevailing conditions. This evidence also demonstrates that the Mariner defines their own safe passing distance based upon the conditions and nature of the traffic at the time, but they are shown to frequently pass one nm off established developments. Evidence also demonstrates that commercial vessels do not transit through wind farm arrays.

336. It should be considered that the deviations defined within this NRA are worst-case from a wind turbine exposure perspective, and in reality, vessels may choose to pass further from the structures.

337. Potential deviations have been assessed for the following scenarios:

- DEP in isolation;
- SEP in isolation; and
- SEP and DEP together.

18.6.2 Main Route Deviations

338. Taking into account the assumptions detailed within Section 18.6.1, the predicted deviations of the main routes identified are presented as follows:

- Figure 18.4 shows the deviations assuming DEP in isolation;
- Figure 18.5 shows the deviations assuming SEP in isolation; and
- Figure 18.6 shows the deviations assuming SEP and DEP together.

339. A summary of the deviations including approximate increases in journey distances for the affected routes are given in Table 18.1. Of the 14 main routes identified, a total of four were predicted to require deviation for DEP in isolation, two for SEP in isolation, and six as a result of the SEP and DEP combined. It is noted that these deviations must be considered against the available searoom post wind farm – while no deviations are considered significant in terms of change in journey distance, the effected vessels are being displaced into smaller navigable space than is currently available (see Section 18.4), and this will lead to increased encounters and potentially collision risk, as assessed within Section 21.1.3.

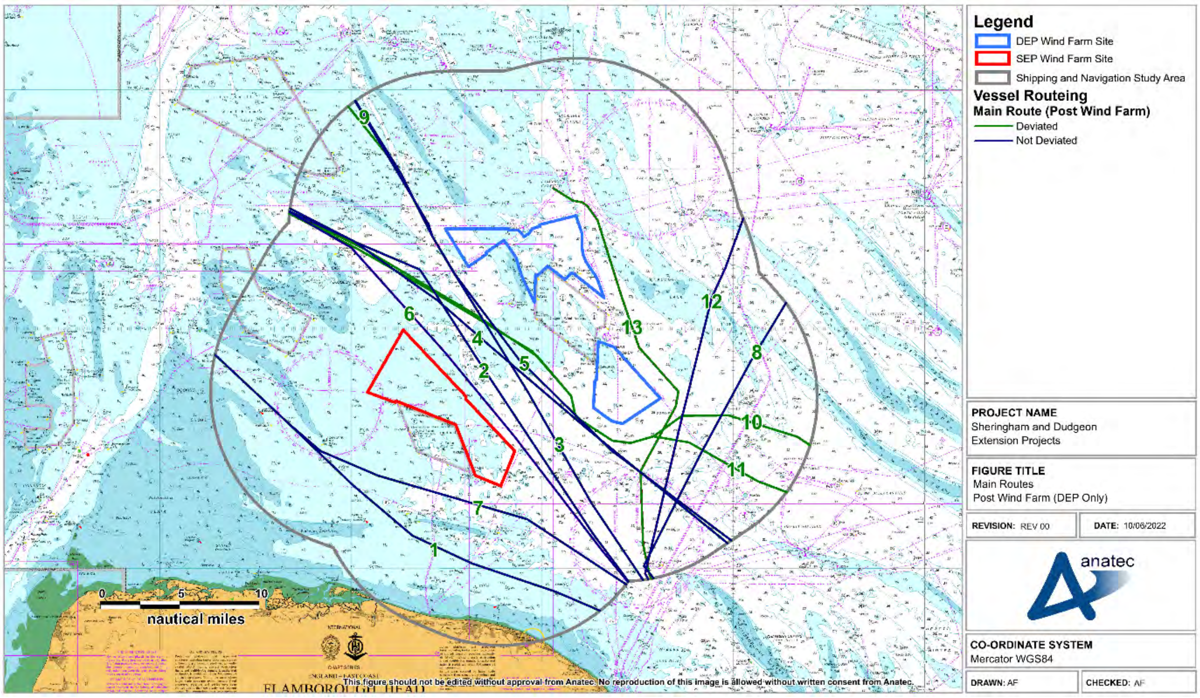

Figure 18.3 Post Wind Farm Routeing (DEP only)

Figure 18.4 Post Wind Farm Routeing (SEP only)

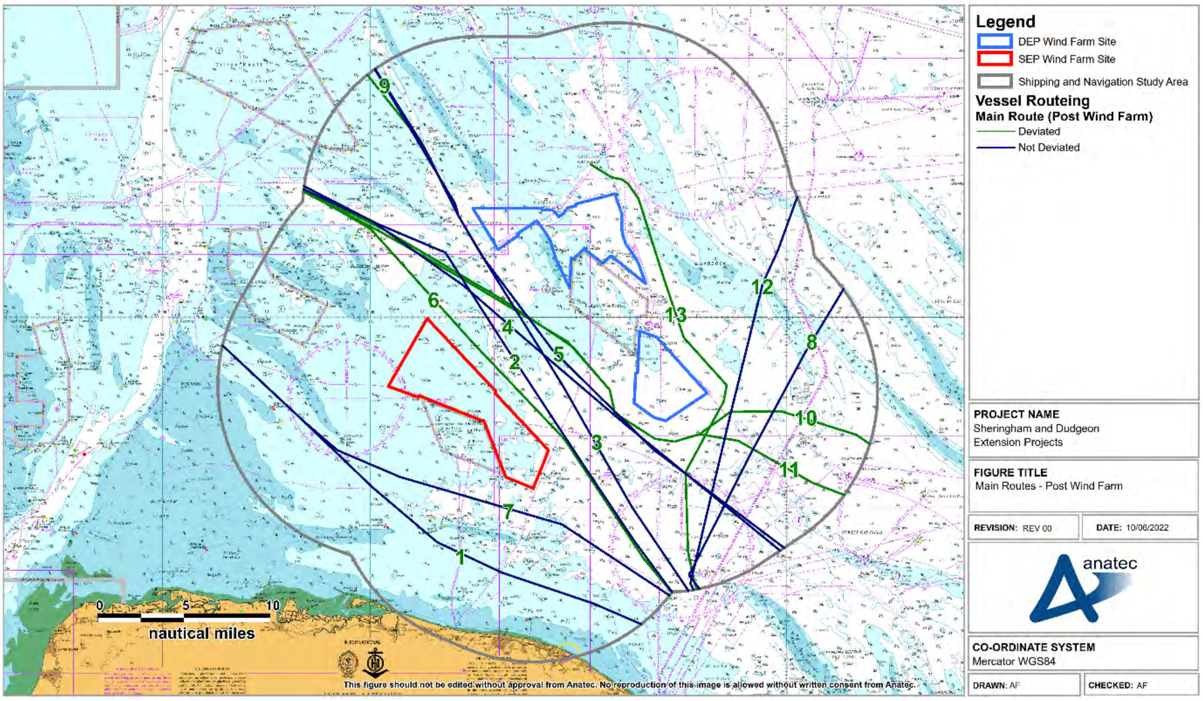

Figure 18.5 Post Wind Farm Routeing (SEP and DEP together)

Table 18.1 Post Wind Farm Journey Distance Increases

Main Route	Pre Wind Farm Distance (nm)	DEP Only			SEP Only			SEP and DEP Together		
		Post Wind Farm Distance (nm)	Change (nm)	Change (%)	Post Wind Farm Distance (nm)	Change (nm)	Change (%)	Post Wind Farm Distance (nm)	Change (nm)	Change (%)
1	172.9	172.9	0.0	0.0%	172.9	0.0	0.0%	172.9	0.0	0.0%
2	174.6	174.6	0.0	0.0%	174.6	0.0	0.0%	174.6	0.0	0.0%
3	259.9	259.9	0.0	0.0%	259.9	0.0	0.0%	259.9	0.0	0.0%
4	172.9	172.9	0.0	0.0%	172.9	0.0	0.0%	172.9	0.0	0.0%
5	248.7	248.8	0.0	0.0%	248.7	0.0	0.0%	248.8	0.0	0.0%
6a	183.5	183.5	0.0	0.0%	183.6	0.1	0.1%	183.6	0.1	0.1%
6b	173.8	173.8	0.0	0.0%	173.9	0.1	0.1%	173.9	0.1	0.1%
7	173.0	173.0	0.0	0.0%	173.0	0.0	0.0%	173.0	0.0	0.0%
8	58.3	58.3	0.0	0.0%	58.3	0.0	0.0%	58.3	0.0	0.0%
9	247.2	248.2	0.9	0.4%	247.2	0.0	0.0%	248.2	0.9	0.4%
10	175.2	177.6	2.4	1.4%	175.2	0.0	0.0%	177.6	2.4	1.4%
11	174.7	176.1	1.3	0.8%	174.7	0.0	0.0%	176.1	1.3	0.8%

Main Route	Pre Wind Farm Distance (nm)	DEP Only			SEP Only			SEP and DEP Together		
		Post Wind Farm Distance (nm)	Change (nm)	Change (%)	Post Wind Farm Distance (nm)	Change (nm)	Change (%)	Post Wind Farm Distance (nm)	Change (nm)	Change (%)
12	56.5	56.5	0.0	0.0%	56.5	0.0	0.0%	56.5	0.0	0.0%
13	53.1	55.2	2.1	4.0%	53.1	0.0	0.0%	55.2	2.1	4.0%

340. The maximum deviation observed, with regards to change in distance, was to Route 10 in the event that either DEP was built in isolation, or both projects are constructed, with an increase of 2.4nm overall, corresponding to a percentage increase of 1.4%. The maximum deviation observed with regards to percentage increase was to Route 13 (4%).

18.6.3 Marine Aggregate Dredging Routeing

341. As per Section 15.4, baseline transits to the Outer Dowsing aggregate production areas intersect the wind farm sites. Such transits were low in number, and as such have not been assessed quantitatively in of themselves within Section 18.6.2, unless the corresponding vessels were utilising a main route.

342. For reference, the tracks from marine aggregate dredgers recorded as intersecting the wind farm sites are shown relative to the Outer Dowsing aggregate production areas in Figure 18.7.

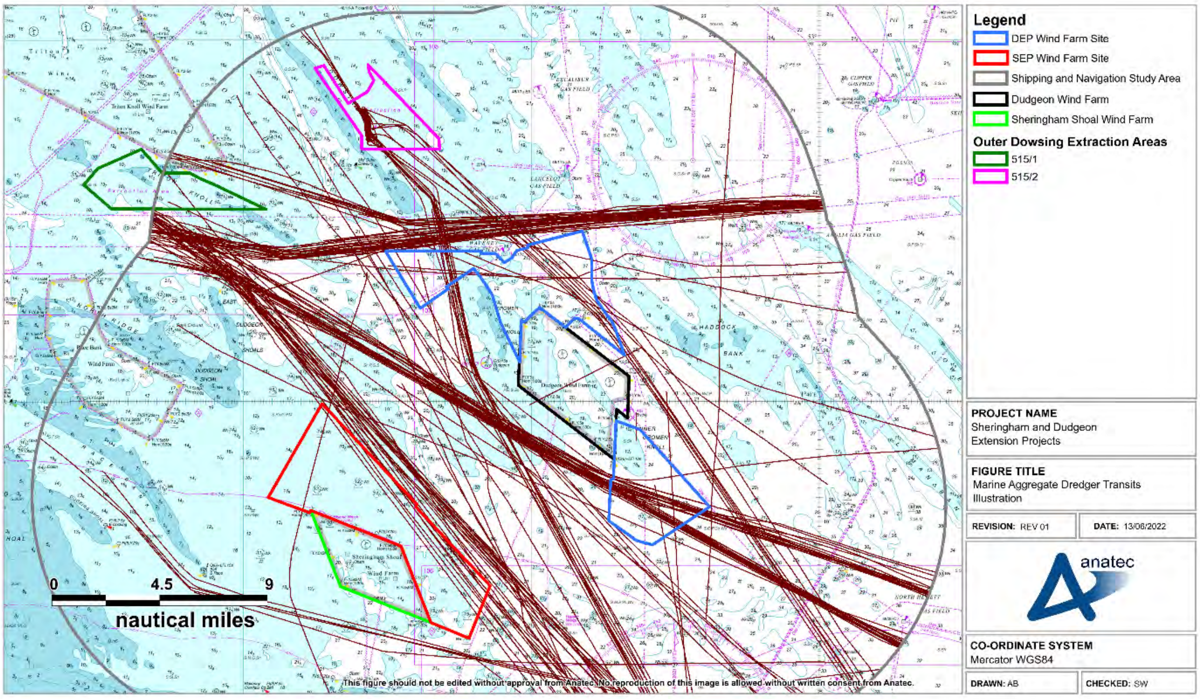

Figure 18.6 Marine Aggregate Dredging Transits Illustration

343. There are considered to be alternate routeing options to both Outer Dowsing aggregate production areas as follows:

- Vessels accessing area 515/1 that intersect the DEP wind farm site can make a minor deviation to the south; and
- Vessels accessing area 515/2 that intersect the DEP wind farm site can either pass east, or deviate further west, and pass north avoiding the Outer Dowsing shallows.

344. Regardless of the presence of alternate routeing options, marine aggregate dredgers would be free to transit through the wind farm sites, and minimum spacing of 990m is considered sufficient to facilitate this.

18.7 Commercial Traffic Routeing (Cumulative)

345. The same methodology outlined for the main route deviations for the SEP and DEP in isolation (see Section 18.6.1) has been considered within the cumulative routeing assessment. These assumptions for re-routeing have been applied to all screened in developments and projects (see Section 17).

346. Based upon the screened in developments, the results of the cumulative re-routeing assessment assuming the worst-case of both the SEP and DEP being built are given in Table 18.2.

347. For reference, the deviations associated with the corresponding in isolation case are included.

Table 18.2 Cumulative Deviation Summary

Route	Pre Wind Farm Distance (nm)	Post Wind Farm Distance (nm) – In Isolation	Post Wind Farm Distance (nm) – Cumulative	Change from Pre Wind Farm Case (nm)	Change from Pre Wind Farm Case (%)
1	172.9	172.9	172.9	0.0	0.0%
2	174.6	174.6	174.6	0.0	0.0%
3	259.9	259.9	259.9	0.0	0.0%
4	172.9	172.9	173.0	0.1	0.0%
5	248.7	248.8	248.8	0.1	0.0%
6a	183.5	183.6	183.6	0.1	0.1%
6b	173.8	173.9	173.9	0.1	0.1%
7	173.0	173.0	173.0	0.0	0.0%
8	58.3	58.3	58.3	0.0	0.0%
9	247.2	248.2	248.2	1.0	0.4%
10	175.2	177.6	178.6	3.4	1.9%
11	174.7	176.1	177.1	2.4	1.4%
12	56.5	56.5	56.5	0.0	0.0%
13	53.1	55.2	55.2	2.1	4.0%

19 Collision and Allision Risk Modelling

19.1 Overview

348. To inform the NRA, a quantitative assessment of the major hazards associated with allision and collision arising from the SEP and DEP has been undertaken. The following subsections outline the inputs and methodology used for the collision and allision risk modelling.

19.1.1 Allision and Collision Scenarios under Consideration

349. For each element of the quantitative assessment both a pre and post wind farm scenario with base and future case vessel traffic levels have been considered. As a result, six distinct scenarios have been modelled:

- Pre wind farm with base case vessel traffic levels;
- Pre wind farm with future case vessel traffic levels (10% scenario);
- Pre wind farm with future case vessel traffic levels (20% scenario);
- Post wind farm with base case vessel traffic levels;
- Post wind farm with future case vessel traffic levels (10% scenario); and
- Post wind farm with future case vessel traffic levels (20% scenario).

19.1.2 Project Scenarios

350. Noting the potential for only one, or both of the SEP and DEP to be built, the following scenarios have been modelled:

- DEP in isolation;
- SEP in isolation; and
- SEP and DEP together.

19.1.3 Hazards under Consideration

351. Hazards considered in the quantitative allision and collision assessment are as follows:

- Increased vessel to vessel collision risk;
- Increased powered vessel to structure allision risk;
- Increased drifting vessel to structure allision risk; and
- Increased fishing vessel to structure allision risk.

352. The pre wind farm collision assessment has used the vessel traffic survey data (see Section 15) in combination with the outputs of consultation (see Section 4) and other baseline data sources (such as Anatec's ShipRoutes database (Anatec, 2021)). Conservative assumptions have then been made with regard to route deviations and future shipping growth as discussed in Section 18.

19.2 Results

19.2.1 Pre-Wind Farm

19.2.1.1 Vessel to Vessel Encounters

353. An assessment of current vessel to vessel encounters in proximity to the wind farm sites has been undertaken by replaying at high speed the data collected as part of the summer 2020 and winter 2021 vessel traffic surveys (see Section 14).

354. The model defines an encounter as two vessels passing within 1nm of each another within the same minute. This helps to identify areas where existing shipping congestion is highest, and therefore where offshore developments (e.g., an OWF) could potentially increase this congestion (i.e., potentially increase the risk of encounters and collisions). It is noted that no account has been given as to whether the encounters are head on or stern to head; just whether the associated vessels were in close proximity.

355. It is noted that any identified encounters which were observed to be between vessels that were part of the same planned operation have been excluded from the analysis. This includes:

- Encounters between wind farm or O&G vessels associated with the same project / development; or
- Towing operations.

356. On this basis, a total of 1,762 genuine encounters were recorded within the shipping and navigation study area over the two surveys, corresponding to an average of approximately 63 per day. Encounter numbers per day are shown in Figure 19.1 and Figure 19.2 for the summer and winter periods respectively.

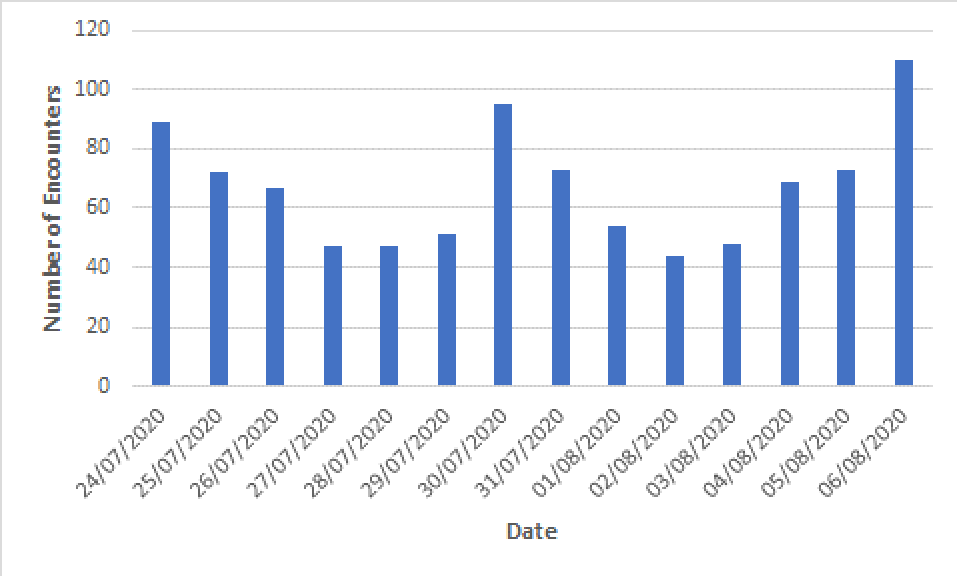

Figure 19.1 Number of Encounters per Day – Summer 2020 Survey

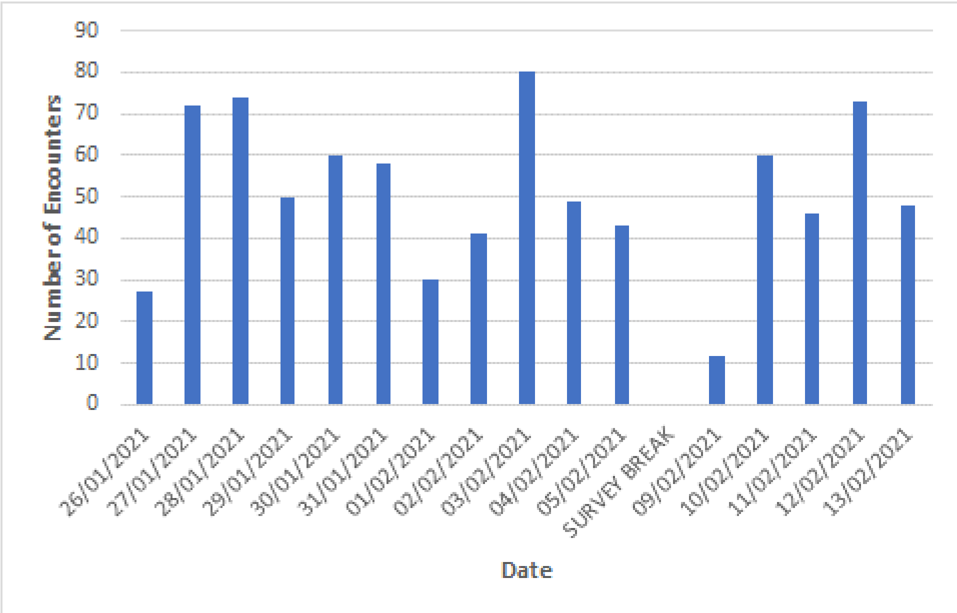

Figure 19.2 Number of Encounters per Day – Winter 2021 Survey

357. The identified encounters are shown in Figure 19.3, colour coded by vessel type. Following this, an encounters heat map within a 0.5 x 0.5nm resolution grid is shown in Figure 19.4 to illustrate where encounter densities are highest.

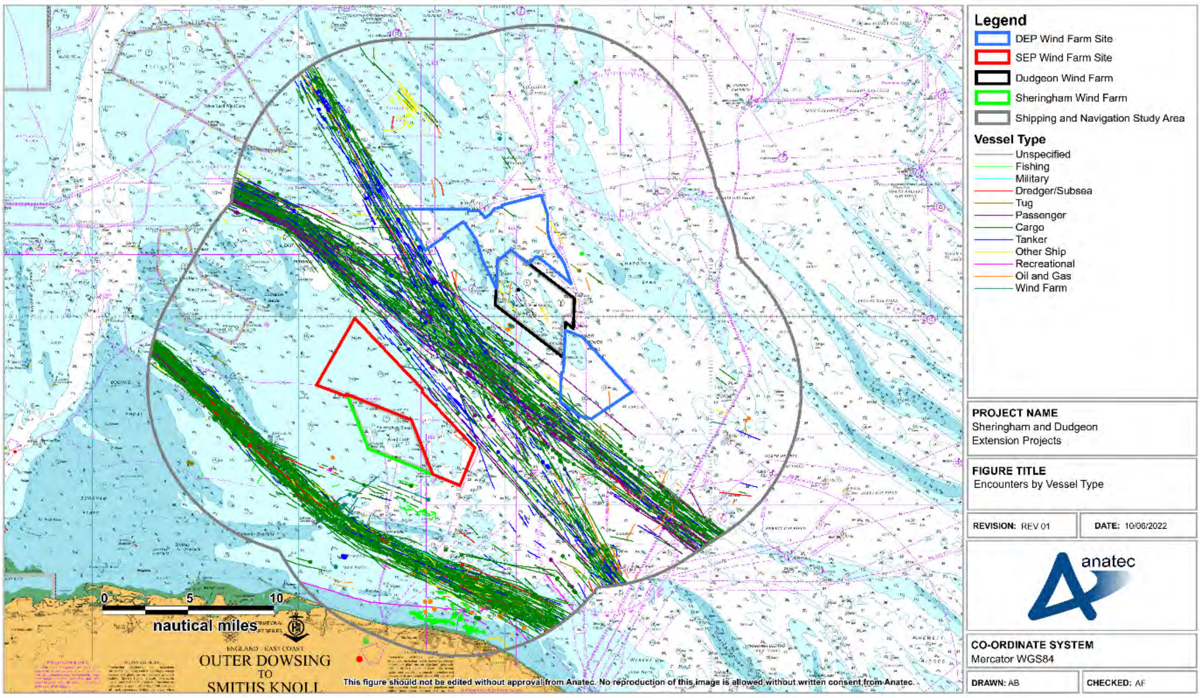

Figure 19.3 Encounters by Vessel Type

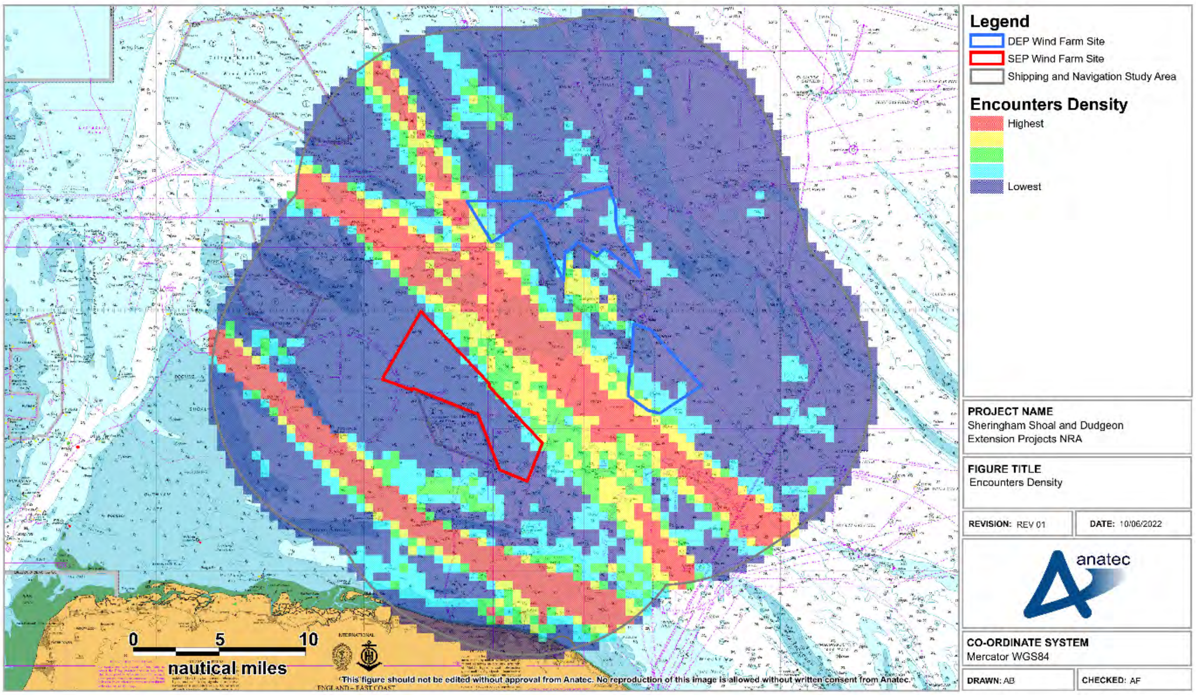

Figure 19.4 Encounter Density

358. The highest areas of encounter density were within the area between the wind farm sites, and to the south of the SEP wind farm site. This is reflective of the large volumes of traffic within the area utilising similar passage, including between the existing sites.

359. Likely effects on encounter rates are discussed in Section 21.1.3, noting that the available searoom will decrease within an area of already high encounters as a result of the SEP and DEP (see Section 18.4).

19.2.1.2 Vessel to Vessel Collisions

360. Using the pre wind farm vessel routeing (see Section 15.2) as input, Anatec's COLLRISK model has been run to estimate the vessel to vessel collision risk in the vicinity of the wind farm sites. It is noted that low use routes not presented as a "main route" have still been included within this modelling.

361. The results of the pre wind farm collision assessment are presented graphically in Figure 19.5, which shows a collision risk heat map presented in a 0.5x0.5nm resolution grid.

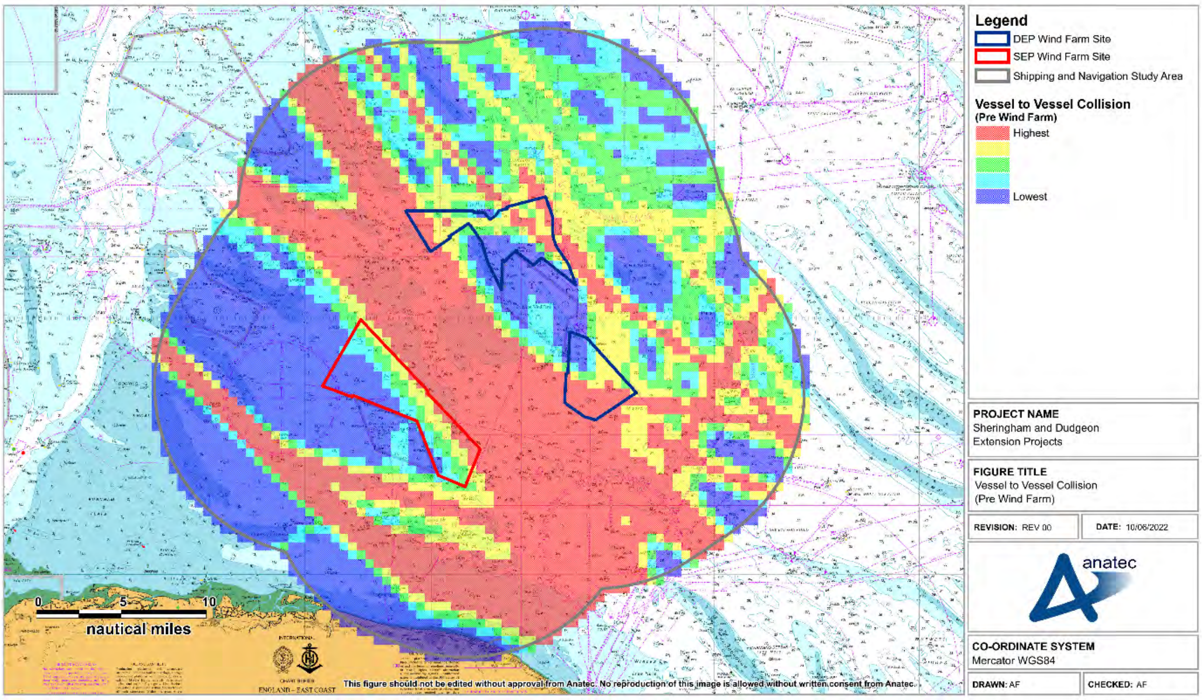

Figure 19.5 Vessel to Vessel Collision (Pre Wind Farm)

362. Assuming base case traffic levels, it was estimated that a vessel would be involved in a collision within the shipping and navigation study area once per 9.6 years. It is noted that, broadly speaking, this aligns with the findings of the baseline incident section (see Section 13), in that the MAIB data showed one collision occurred over the ten year period between 2008 and 2017.

363. The highest risk areas were associated with the busy routes passing between the existing Dudgeon and Sheringham sites, and the busy Humber / Rotterdam route passing to the south.

364. Future case results assuming increases of 10% and 20% in traffic volumes are presented in Table 19.1.

Table 19.1 Vessel to Vessel Collision Summary (Pre Wind Farm)

Traffic Scenario	Frequency	Return Period (Years)
0% Increase	1.04×10^{-1}	9.6
10% Increase	1.26×10^{-1}	7.9
20% Increase	1.50×10^{-1}	6.7

19.2.2 Post Wind Farm

19.2.2.1 Vessel to Vessel Collisions

365. Using the predicted post wind farm routeing as input (see Section 18.4), Anatec's COLLRISK model was run to estimate the vessel to vessel collision risk post wind farm within the shipping and navigation study area.

366. The worst-case from a collision perspective is that both the SEP and DEP are constructed, and the results of this scenario assuming base case traffic levels are shown graphically in Figure 19.6, which shows a collision risk heat map within a 0.5×0.5nm grid. Results for the scenarios where the SEP and DEP are built in isolation are given in Table 19.2.

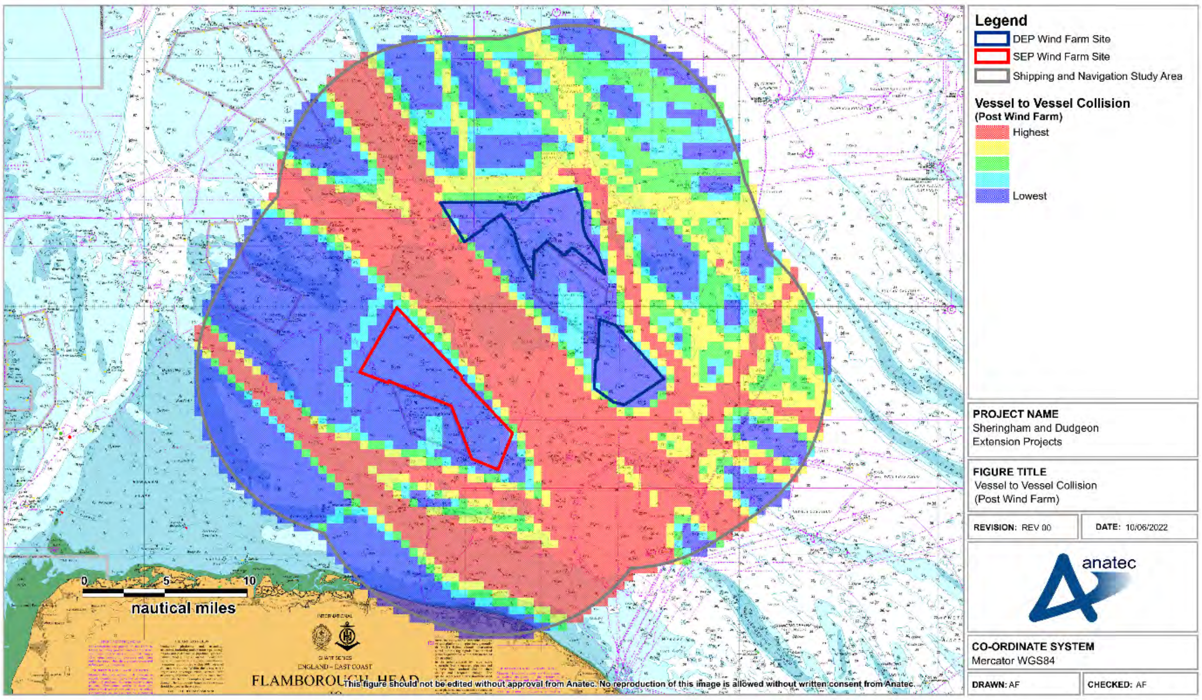

Figure 19.6 Vessel to Vessel Collision – Post Wind Farm (SEP and DEP Together)

367. Assuming both SEP and DEP are built, it was estimated that a vessel would be involved in a collision once every 8.5 years for the base case, which represents a 13% increase over the pre wind farm base case. It is observed that the area of high risk between the wind farm sites has been "concentrated" noting the reduced searoom available (see Section 18.4).

368. Future case results assuming increases of 10% and 20% are given in Table 19.2.

Table 19.2 Vessel to Vessel Collision Summary (Post Wind Farm)

Scenario	Pre Wind Farm			Post Wind Farm		
	0%	10%	20%	0%	10%	20%
DEP Only	1.04×10^{-1} (1 per 10 years)	1.26×10^{-1} (1 per 8 years)	1.50×10^{-1} (1 per 7 years)	1.17×10^{-1} (1 per 9 years)	1.42×10^{-1} (1 per 7 years)	1.68×10^{-1} (1 per 6 years)
SEP Only	1.04×10^{-1} (1 per 10 years)	1.26×10^{-1} (1 per 8 years))	1.50×10^{-1} (1 per 7 years))	1.17×10^{-1} (1 per 9 years)	1.29×10^{-1} (1 per 8 years)	1.53×10^{-1} (1 per 7 years)
SEP and DEP	1.04×10^{-1} (1 per 10 years)	1.26×10^{-1} (1 per 8 years)	1.50×10^{-1} (1 per 7 years)	1.18×10^{-1} (1 per 8 years)	1.43×10^{-1} (1 per 7 years)	1.70×10^{-1} (1 per 6 years)

369. The change in collision risk pre and post wind farm is shown graphically in Figure 19.7, via a heat map within a 0.5x0.5nm resolution grid. This analysis assumes base case traffic levels, and that both SEP and DEP are built.

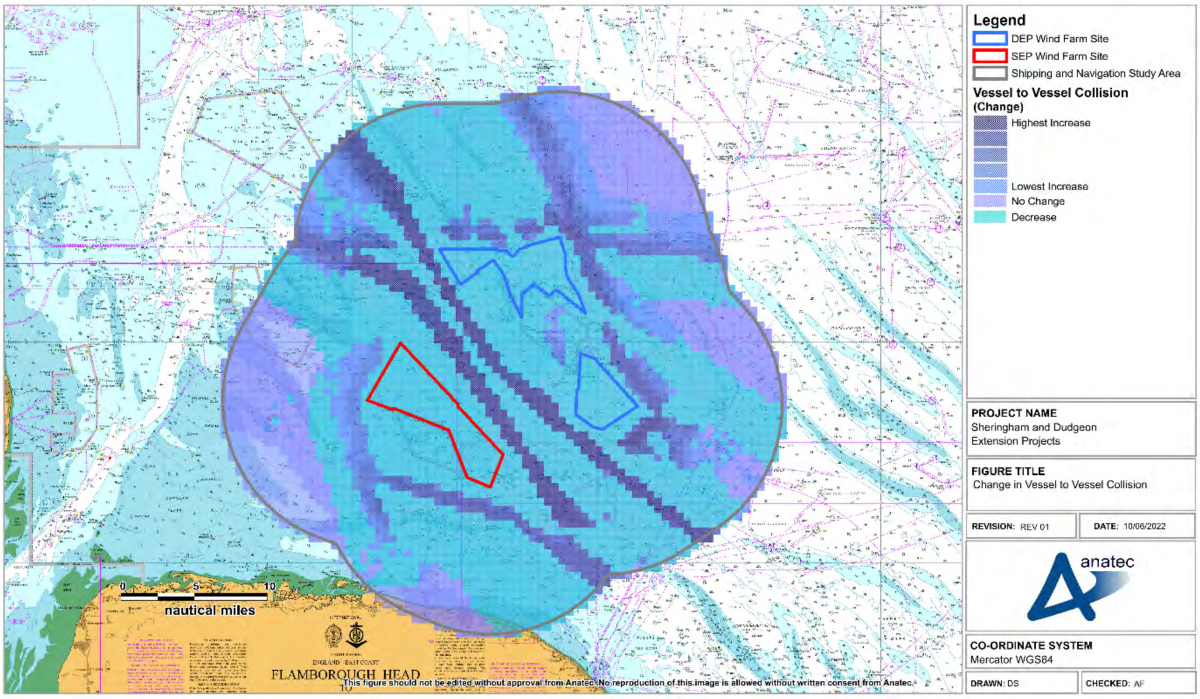

Figure 19.7 Vessel to Vessel Collision (Change)

370. The greatest increases in collision risk were observed to be associated with the routes that passed between the wind farm sites, which is reflective of a reduced width within which vessels will be able to transit post wind farm (see Section 18.4).

19.2.2.2 Powered Vessel to Structure Allision

371. Based upon the vessel routeing identified in the region, the anticipated change in routeing due to the wind farm sites, the mitigations in place, and levels of allision incidents to date associated with UK OWFs, the frequency of an errant vessel under power deviating from its route to the extent that it comes into proximity with a structure within the wind farm sites is considered low.

372. From consultation with the shipping industry and observations at other constructing or operational UK wind farms, it is also assumed that commercial vessels would be highly unlikely to navigate between wind farm structures due to the restricted sea room and will instead be directed by the aids to navigation located in the region. During the construction and decommissioning phases this will primarily consist of the buoyed construction area whilst during the operation and maintenance phase this will primarily consist of the lighting and marking of the wind farm structures themselves (noting that final lighting and marking will be directed by and agreed with Trinity House).

373. Using the predicted post wind farm routeing as the primary input, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the wind farm structures within the wind farm sites whilst under power.

374. Both the SEP and DEP being built represents the worst-case from an allision perspective. A plot of the annual powered allision frequency per structure assuming this scenario at base case traffic levels is presented in Figure 19.8. Results for the SEP and DEP in isolation scenarios are included within Table 19.3.

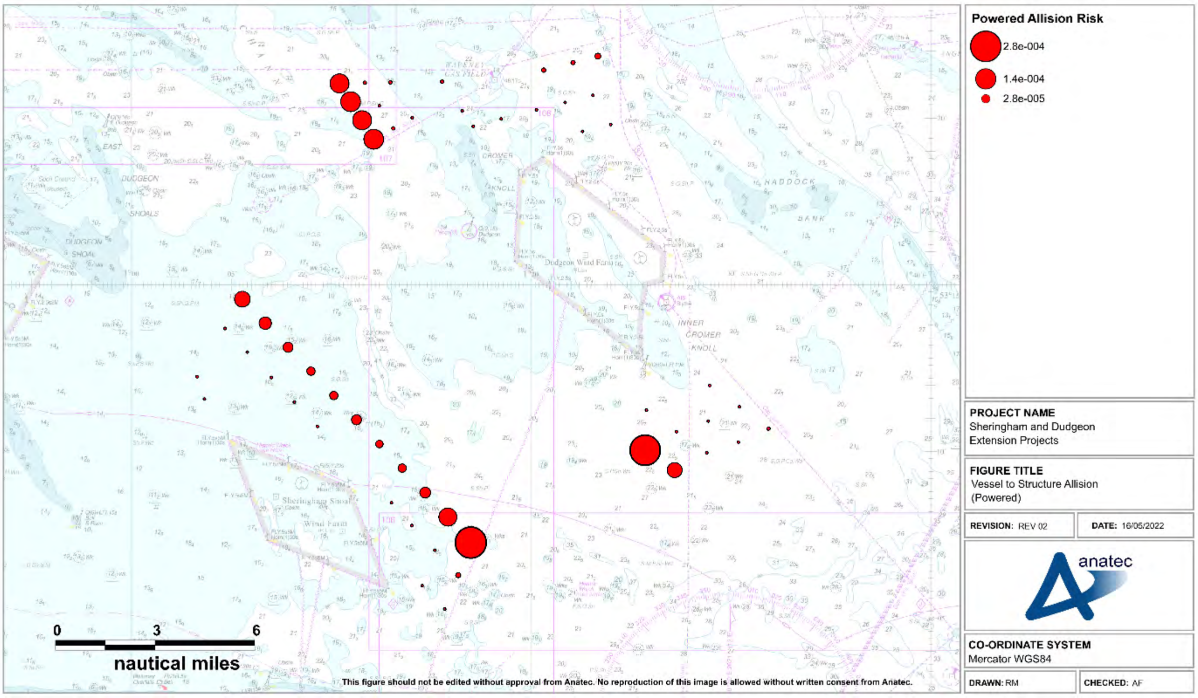

Figure 19.8 Vessel to Structure Allision (Powered)

375. An allision under power was estimated as occurring once per 618 years at base case traffic levels. The structures at most risk were those on the northern periphery of the SEP wind farm site and the southern peripheries of the DEP wind farm site. This is reflective of the traffic levels passing between the two extensions.

376. A full summary of the powered allision results are given in Table 19.3, including future case traffic scenarios.

Table 19.3 Vessel to Structure Allision (Powered)

Scenario	Post Wind Farm Scenario		
	0%	10%	20%
DEP Only	9.06×10^{-4} (1 per 1,104 years)	9.97×10^{-4} (1 per 1,003 years)	1.09×10^{-3} (1 per 920 years)
SEP Only	7.42×10^{-4} (1 per 1,347 years)	8.17×10^{-4} (1 per 1,225 years)	8.91×10^{-4} (1 per 1,123 years)
SEP and DEP	1.62×10^{-3} (1 per 618 years)	1.78×10^{-3} (1 per 562 years)	1.94×10^{-3} (1 per 515 years)

19.2.2.3 Drifting Vessel to Structure Allision

377. Using the post wind farm routeing as the primary input, Anatec's COLLRISK model was run to estimate the likelihood of a drifting commercial vessel alliding with one of the

wind farm structures within the wind farm sites. The model is based on the premise that propulsion on a vessel must fail before drifting will occur. The model takes account of the type and size of the vessel, the number of engines and the average time required to repair but does not consider navigational error caused by human actions.

378. The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the wind farm sites (up to 10nm from the site boundaries, i.e., the shipping and navigation study area). These have been estimated based upon the revised post wind farm routeing. The exposure is divided by vessel type and size to ensure these factors, which based upon analysis of historical incident data have been shown to influence incident rates, are taken into account within the modelling.

379. Using this information, the overall rate of mechanical failure within proximity to the SEP and DEP wind farm sites was estimated. The probability of a vessel drifting towards a wind farm structure and the drift speed are dependent upon the prevailing wind, wave, and tidal conditions at the time of the accident. Therefore, three drift scenarios were modelled, each using the Metocean data provided in Section 11:

- Wind;
- Peak spring flood tide; and
- Peak spring ebb tide.

380. The probability of vessel recovery from drift is estimated based upon the speed of drift and hence the time available before reaching the wind farm structure. Vessels which do not recover within this time are assumed to allide.

381. After modelling the drift scenarios, it was established that the flood tide dominated scenario produced the worst-case results for the worst-case scenario from a shipping and navigation perspective, i.e., build out of both SEP and DEP. On this basis, a plot of the annual drifting allision frequency per structure for the base case is presented in Figure 19.9, assuming the scenario where both the SEP and DEP are built.

382. Results for the scenarios where the SEP and DEP are built in isolation are shown in Table 19.4.

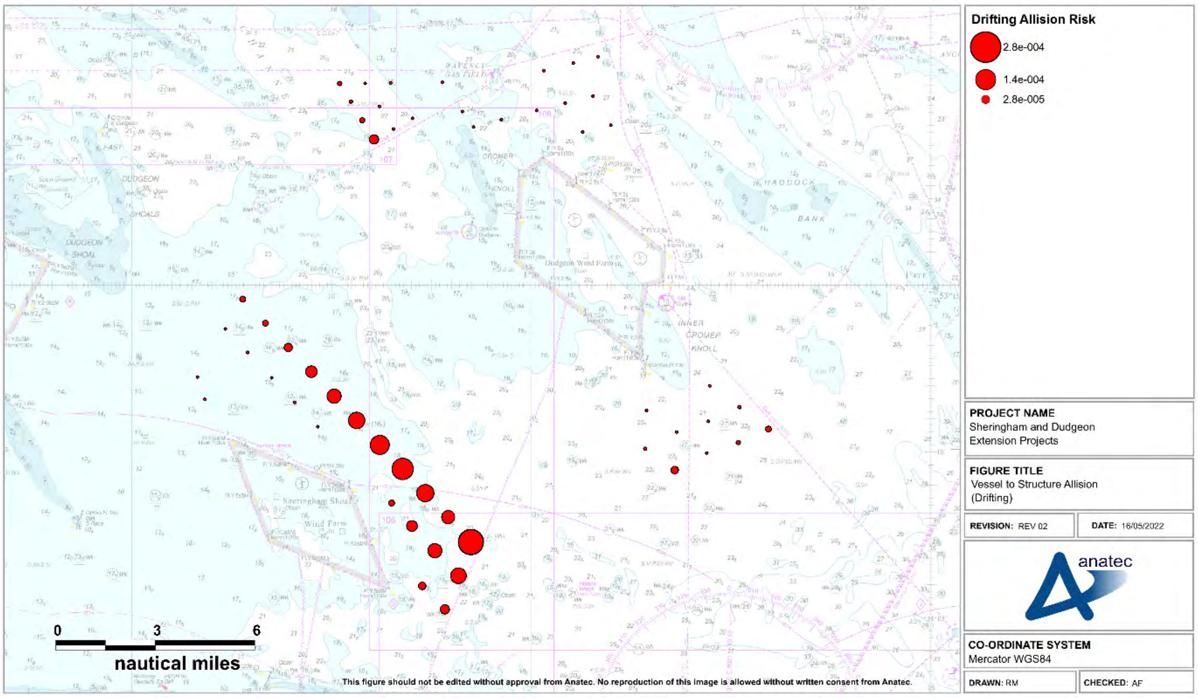

Figure 19.9 Vessel to Structure Allision (Drifting)

383. Assuming base traffic levels, should both the SEP and DEP be constructed, it was estimated that a vessel would allide with a structure within the wind farm sites once per 898 years. The majority of this risk was observed to be associated with the structures on the northern periphery of the SEP wind farm site, which is reflective of the busy traffic levels in the vicinity relative to dominant flood tidal direction.

384. A full summary of the drifting allision results are given in Table 19.4, including future case traffic scenarios.

Table 19.4 Vessel to Structure Allision (Drifting)

Scenario	Post Wind Farm Scenario		
	0%	10%	20%
DEP Only	7.48×10^{-4} (1 per 1,336 years)	8.23×10^{-3} (1 per 1,215 years)	8.98×10^{-3} (1 per 1,113 years)
SEP Only	1.05×10^{-3} (1 per 950 years)	1.16×10^{-3} (1 per 864 years)	1.26×10^{-3} (1 per 792 years)
SEP and DEP	1.11×10^{-3} (1 per 898 years)	1.23×10^{-3} (1 per 816 years)	1.34×10^{-3} (1 per 748 years)

19.2.2.4 Fishing Vessel to Structure Allision

385. The 28 days of marine traffic survey data (see Section 14) was used as input to the fishing allision function of Anatec's COLLRISK modelling software suite to assess the potential fishing vessel to structure allision risk following the installation of the Project.

386. A fishing vessel allision is classified separately from other allisions since, unlike in the case of the commercial traffic characterised via the main routes (see Section 15.2), fishing vessels may be either in transit or actively fishing within the area. Further, fishing vessels could be observed internally within the wind farm sites in addition to externally (noting that experience shows that commercial vessels will generally avoid wind farm structures). The COLLRISK fishing allision model uses fishing vessel numbers, sizes (length and beam), wind farm layout, and structure dimensions as input. The likelihood of a major allision incident has been calibrated against historical maritime incident data and historical AIS vessel traffic data within operational offshore arrays in the UK. Both AIS and non AIS vessels (i.e., those recorded via Radar) have been included as input.

387. Noting uncertainty around potential fishing vessel behaviour post wind farm, it should be considered that the model conservatively assumes no changes to baseline activity in terms of proximity to structures (i.e., vessels are not altering their navigational patterns based on the presence of structures in line with good seamanship). This is considered a very conservative approach given experience shows that while commercial fishing vessels do continue to transit operational arrays, activity immediately around the structures is very likely to reduce.

388. The results of the fishing allision assessment are shown geographically in Figure 19.10. It should be considered when viewing the figure that specific risk ranges have been utilised to ensure clarity, and as such the plot is not directly comparable to the allision results shown in Sections 19.2.2.2 and 19.2.2.3.

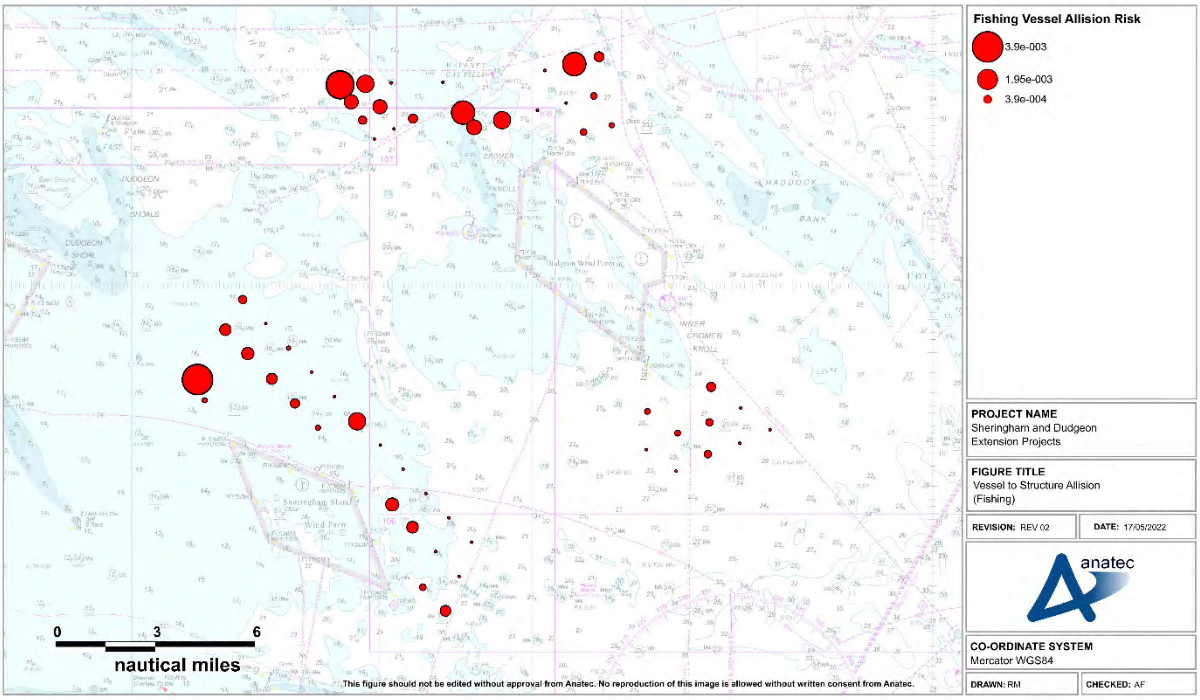

Figure 19.10 Vessel to Structure Allision (Fishing)

389. Assuming base traffic levels, should both the SEP and DEP be constructed, it was estimated that a vessel would allide with a structure within the wind farm sites once per 37 years. The majority of this risk was observed to be associated with the structures within the SEP wind farm site, which is reflective of the active fishing occurring in close proximity to the western periphery of this site (see Section 14.1.3.7).

390. The model is calibrated against known allision incidents within UK wind farms (see Section 13.4). Most likely consequences will be a low impact / minor contact with no significant damage, no injuries to persons, and no pollution (in line with incident statistics to date as per Section 13.4).

391. A full summary of the fishing allision results are given in Table 19.5, including future case traffic scenarios.

Table 19.5 Vessel to Structure Allision (Fishing)

Scenario	Post Wind Farm Scenario		
	0%	10%	20%
DEP Only	1.67×10^{-2} (1 per 60 years)	1.84×10^{-2} (1 per 55 years)	2.00×10^{-2} (1 per 50 years)
SEP Only	1.05×10^{-2} (1 per 96 years)	1.15×10^{-2} (1 per 87 years)	1.26×10^{-2} (1 per 80 years)
SEP and DEP	2.72×10^{-2} (1 per 37 years)	2.99×10^{-2} (1 per 34 years)	3.26×10^{-2} (1 per 31 years)

19.2.3 Risk Results Summary

392. Table 19.6 presents a summary of the collision and allision modelling assuming both the SEP and DEP are constructed, which is the worst-case from a collision / allision perspective. This includes "change" columns which show the change in frequency of a collision / allision incident between the pre and post wind farm scenarios, and a "total" row which shows the combined allision and collision frequency for each scenario.

Table 19.6 Summary of Annual Collision and Allision Risk

Allision / Collision Scenario	Base Case (0%)			Future Case (10%)			Future Case (20%)		
	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	0.104 (1 in 10 years)	0.118 (1 in 8 years)	$1.39x10^{-2}$ (1 in 72 years)	0.126 (1 in 8 years)	0.143 (1 in 7 years)	$1.68x10^{-2}$ (1 in 60 years)	0.150 (1 in 7 years)	0.170 (1 in 6 years)	$1.99x10^{-2}$ (1 in 50 years)
Powered vessel to structure allision	N/A	$1.62x10^{-3}$ (1 in 618 years)	$1.62x10^{-3}$ (1 in 618 years)	N/A	$1.78x10^{-3}$ (1 in 562 years)	$1.78x10^{-3}$ (1 in 562 years)	N/A	$1.94x10^{-3}$ (1 in 515 years)	$1.94x10^{-3}$ (1 in 515 years)
Drifting vessel to structure allision	N/A	$1.11x10^{-3}$ (1 in 898 years)	$1.11x10^{-3}$ (1 in 898 years)	N/A	$1.23x10^{-3}$ (1 in 816 years)	$1.23x10^{-3}$ (1 in 816 years)	N/A	$1.34x10^{-3}$ (1 in 748 years)	$1.34x10^{-3}$ (1 in 748 years)
Fishing vessel to structure allision	N/A	$2.72x10^{-2}$ (1 in 37 years)	$2.72x10^{-2}$ (1 in 37 years)	N/A	$2.99x10^{-2}$ (1 in 34 years)	$2.99x10^{-2}$ (1 in 34 years)	N/A	$3.26x10^{-2}$ (1 in 31 years)	$3.26x10^{-2}$ (1 in 31 years)
Total	**0.104 (1 in 10 years)**	**0.148 (1 in 7 years)**	**0.0438 (1 in 23 years)**	**0.126 (1 in 8 years)**	**0.176 (1 in 6 years)**	**0.0497 (1 in 20 years)**	**0.150 (1 in 7 years)**	**0.206 (1 in 5 years)**	**0.0558 (1 in 18 years)**

393. Overall, the collision and allision frequency was estimated to be approximately 0.148 (one incident in seven years) for the base case. The overall allision and collision frequency was estimated to be 0.176 (one incident in six years) and 0.206 (one incident in five years) for the 10% and 20% future cases, respectively.

19.2.4 Consequences

394. The most likely consequences for the majority of hazards associated with shipping and navigation are anticipated to be minor in nature, e.g. glancing blow or minor bump. However, the worst-case consequences may be severe, including incidents with Potential Loss of Life (PLL).

395. For larger commercial vessels, a powered allision incident would be more likely to result in the collapse of a structure within the wind farm sites than any material damage to the vessel itself. For such larger vessels, the breach of a fuel tank is

considered unlikely given the robustness of the vessel and in the case of vessels carrying cargoes which may be deemed to be hazardous (e.g., tankers or gas carriers) the additional safety features associated with these vessels would further mitigate the risk of pollution (e.g., double hulls). Similarly, in a drifting allision incident the structures within the wind farm sites would likely absorb the majority of the impact energy, particularly given the likely low speed of the errant vessel and the allision energy deflected by the movement of the vessel.

396. For smaller vessels, such as fishing vessels and recreational vessels, the worst-case consequences would be the risk of vessel damage leading to foundering of the vessel and potential for persons in the water and PLL.

397. A quantitative assessment of the potential consequences of a collision or allision incident is provided in Annex C. This assessment applies the modelling results presented in this section to historical data regarding collision and allision incidents and oil pollution. The following paragraphs summarise the output of the assessment.

398. The overall annual increase in PLL estimated due to the impact of SEP and DEP on passing vessels for the base case is approximately 2.43×10^{-4}, corresponding to one additional fatality in approximately 4,100 years. In terms of individual risk to people, the incremental increase estimated due to the impact of SEP and DEP for the base case is 5.96×10^{-6}.

399. Based upon the collision and allision frequencies and historical oil spill data, the overall increase in oil spilled due to SEP and DEP is estimated to be 1.14 tonnes of oil per year for the base case. From research undertaken as part of the Identification of Marine Environmental High Risk Areas (MEHRAs) in the UK (DfT, 2001) the average annual tonnes of oil spilled in the waters around the British Isles due to marine incidents in the 10-year period from 1989 to 1998 was 16,111. Therefore, the overall increase in pollution estimated for SEP and DEP represents a very low increase compared to the current average annual tonnes of oil spilled and hence can be considered minimal in comparison to the annual average.

400. On this basis, the incremental increase in risk to both people and the environment caused by SEP and DEP is estimated to be very low.

20 Mitigation

401. The draft FSA undertaken within Section 21 assumes certain embedded mitigation measures will be in place. These are summarised in Table 20.1.

Table 20.1 Embedded Mitigation Summary

Mitigation	Description	How Mitigation is Secured
Lighting and marking	Lighting and marking in consultation and agreement with Trinity House, MCA, and the CAA, and considering IALA G1162/O-139 (IALA, 2021).	Via Development Consent Order (DCO)/deemed Marine Licence (dML) Condition.
Safety Zones	Application for safety zones during construction and periods of major maintenance (see Section 20.1).	Application for safety zones to be made post consent under 'The Electricity (Offshore Generating Stations) (Safety Zones) (Applications Procedures and Control of Access) Regulations 2007 (SI No 2007/1948)'.
COLREGS and SOLAS	Compliance by all project vessels with COLREGS (IMO, 1972) and SOLAS (1974)	International maritime law and flag state regulations.
Layout Approval	Layout will be discussed and agreed with the MCA and Trinity House. It is noted that the final layout will comply with the layout commitments (see Section 20.2).	Via DCO/dML Condition.
MGN 654	Project will comply with all aspects of MGN 654 including its annexes.	Via DCO/dML Condition.
Marine Coordination	On shore base from where the project including associated vessel movements will be coordinated and managed.	Existing function already in place for the Dudgeon and Sheringham offshore wind farms. There will be close cooperation and coordination between the parent sites and SEP and DEP.
ERCoP	ERCoP in the required format and structure (MCA, 2019). The ERCOP (hub) will require cooperation with other developments and be updated / agreed on a live basis in liaison with the MCA	Via DCO/dML Condition.

Mitigation	Description	How Mitigation is Secured
Promulgation of information	Advance warning and accurate location details of construction, maintenance and decommissioning operations, associated Safety Zones and advisory passing distances will be given via Notices to Mariners and Kingfisher Bulletins.	Via DCO/dML Conditions.
Guard Vessels where Appropriate	Use of guard vessels where identified as necessary via risk assessment, as required under MGN 654.	Via DCO/dML Condition.
Cable Monitoring	Periodic monitoring of cable burial / protection to ensure it remains effective	Via DCO/dML Condition.
Display on Nautical Charts	Display of project infrastructure on appropriately scaled nautical charts, including cables.	Via DCO/dML Condition.
Cable Burial Risk Assessment	Assessment of required cable protection measures.	*Via DCO/dML Condition.*

20.1 Safety Zones

402. Equinor intend to submit an application to Department of Business, Energy, and Industrial Strategy (BEIS) post consent for safety zones during the construction and operational phases, with a separate application submitted for the decommissioning phase at a later date. It is expected that the following safety zones will be applied for:

- 500m around any structure where construction is ongoing, as denoted by the presence of a construction vessel;
- 50m around any structure where active construction is not ongoing prior to full commissioning of the wind farm; and
- 500m around any structure where major maintenance is ongoing during the operational phase, where major maintenance is as defined within the Electricity Regulations (2007).

20.2 Layout Commitments

403. Equinor have developed a set of Layout Commitments to which the final layout will comply, which are shown in Table 20.2. It is noted that these have been discussed and agreed with the MCA and Trinity House, and that the final layout will be required to be approved by MCA and Trinity House.

Table 20.2 Layout Commitments

Commitment	Description
1	The project will undertake a thorough appraisal of the potential for two consistent lines of orientation. Should two consistent lines not be possible, as a minimum the position of surface structures shall be arranged in straight lines with at least one consistent line of orientation with the exact locations to be determined with consideration of micro siting allowances agreed in consultation with the MCA (see Commitment 4). The spacing between these straight lines shall comply with MGN 654 (i.e., SAR lanes will be at least 500m in width tip to tip).
2	Where practically possible, the position of surface structures shall be aligned with existing lines of orientation of the nearest operational wind farm. Otherwise, the position of surface structures will be arranged as stated in commitment 1 with the modification that a minimum spacing of 1 nautical mile tip to tip will be maintained between the turbines of the nearest operational wind farm and the turbines of SEP and DEP.
3	The position of all structures along the perimeter will be arranged such to aid visual navigation and avoid outliers as far as is practicable within the shape of the Red Line Boundaries. They will be arranged in straight lines along the perimeter where practically possible.
4	Tolerance of ±150 metres (inclusive of a 50m micrositing value in any direction) may be used in agreement with the MCA and will avoid placement of structures which impact on minimum SAR Access Lanes widths (i.e., any tolerance / micrositing applied will not reduce SAR lanes below 500m minimum in width) or result in dangerously protruding structures.

20.3 Construction and Post Construction Monitoring

404. The DCO/DML will require the developer to undertake periodic traffic monitoring.

20.4 Aids to Navigation Management Plan

405. The DCO/dML will require “An Aids to Navigation Management Plan to be agreed in writing by the MMO following appropriate consultation with Trinity House specifying how the undertaker will ensure compliance with conditions relating to ‘Aids to Navigation’ from the commencement of construction of the authorised project to the completion of decommissioning”.

20.5 Post-construction plans and documents

406. A swath bathymetric survey to IHO Order 1a of the area within the Offshore Order Limits extending to an appropriate buffer around the site, will be undertaken. The survey shall include all proposed cable routes. The survey will fulfil the requirements of MGN 654 and its supporting ‘Hydrographic Guidelines for Offshore Renewable Energy Developers’, which includes the requirement for the full density data and reports to be delivered to the MCA and the UKHO for the update of nautical charts and publications. This will be submitted as soon as possible, and no later than three

months prior to construction. The Order Limit shapefiles will be submitted to the MCA. The Report of Survey will also be sent to the MMO.

407. Equinor will also a conduct a swath bathymetric survey to IHO Order 1a of the installed export cable route and provide the data and survey report(s) to the MCA and UKHO. The MMO will be notified once this has been done, with a copy of the Report of Survey also sent to the MMO.

408. Post decommissioning, the undertaker will conduct a swath bathymetric survey to IHO Order 1a of the cable route and the installed generating assets area and provide the data and survey report(s) to the MCA and UKHO.

409. This will fulfil the requirements of MGN654 and its supporting 'Hydrographic Guidelines for Offshore Renewable Energy Developers', which includes the requirement for the full density data and reports to be delivered to the MCA and the UKHO for the update of nautical charts and publications.

410. Post construction monitoring will include vessel traffic monitoring by AIS for a duration of three consecutive years following the completion of construction unless otherwise agreed in writing by the MMO. An appropriate report will be submitted to the MMO, Trinity House and the MCA at the end of each year of the three year period.

21 Formal Safety Assessment

411. This section provides high level impact assessment for the purposes of informing Chapter 13 Shipping and Navigation, which will consider impacts by phase and receptor in more detail. The NRA impact assessment follows the IMO FSA approach (IMO, 2018) as detailed in Section 3.

412. It is noted that where an impact is assessed as being of greater than broadly acceptable significance, it has been made clear within the text the significance of each individual scenario (i.e., DEP in isolation, SEP in isolation, and SEP and DEP together). Where in impact has been assessed as broadly acceptable, it follows that this is the case for each scenario.

21.1 SEP and DEP Together

21.1.1 Displacement / Deviation

413. **The presence of the structures within the wind farm sites or project vessels in the area could lead to deviation / displacement of third party vessels.**

414. During the construction phase, it is considered likely that buoyage will be utilised to mark the wind farm sites as buoyed construction areas, indicating to passing third party traffic the areas within which construction is ongoing. There will be no restriction on entry into any buoyed construction area, assuming any active safety zones were avoided. However, experience at other projects indicates that areas of active construction will generally be avoided, and therefore it is likely that the ongoing construction works will displace existing traffic from within the wind farm sites (noting that this aligns with feedback received at the hazard workshop – see Section 4.5).

415. Similarly, during the operational phase, there would be restrictions on entry into the wind farm sites, assuming active safety zones around major maintenance work were avoided.

416. Based upon the post wind farm routeing, it was predicted that six of the 14 main commercial routes identified would deviate as a result of the SEP and DEP, with a maximum proportional increase of 4% in journey distance. There are pre-established routeing options available within the area, and these are defined primarily by the shallow banks present within the vicinity.

417. During consultation (see Sections 4.2 and 4.5), regular operators of the area also raised concern over long term impacts associated with deviations to avoid project vessels in the area. As discussed in Section 18.5, these concerns were not safety related and were instead related to impacts on transit times and distances. The operator feedback was that the implementation of project vessel procedures (Navigation Management Plan, see Section 21.3.1.1) would mitigate this impact.

418. In terms of marine aggregate dredging, alternate routeing exists for any affected transits, and it is noted that marine aggregate dredgers would be free to transit through the wind farm sites if they chose to as part of their passage plans (see Section 18.6.3). It is noted that routeing to local gas platforms will be affected as raised during consultation (see Section 4.3), and Boston Putford indicated they would not transit through the structures.

419. For internal transit, minimum spacing of 990m is considered as being sufficient to facilitate vessels types that have been observed to pass through operational arrays (e.g., fishing and recreation). Regardless, these vessels were not recorded in large numbers within the marine traffic data studied within the wind farm sites. It is noted that displacement of active commercial fishing is assessed within Chapter 12 Commercial Fisheries.

420. As required under the DCO, promulgation via all the usual means (e.g., NtM, Kingfisher Bulletin) will be undertaken to ensure third party vessels are aware of the SEP and DEP. This will facilitate advanced passing planning to ensure any deviations are minimised.

421. When considering the likely navigation safety consequence (negligible i.e. no risk to life or pollution) associated with displacement / deviation and the frequency (frequent- vessels will be deviated every day) displacement impacts are assessed as being tolerable. Relevant embedded mitigations are considered to be:

- Promulgation of information; and
- Display on nautical charts.

422. The impact is therefore considered to be **tolerable.** Assuming the implementation of the Navigation Management Plan the frequency of displacement is lowered and the impacts are then assessed as being **tolerable with additional mitigation** and ALARP. This is determined to be the case for DEP in isolation, SEP in isolation, and SEP and DEP together.

21.1.2 Adverse Weather Routeing

423. **The presence of the structures within the wind farm sites could affect adverse weather routes in the shipping and navigation study area.**

424. Adverse weather includes wind, wave, and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's normal route and/or speed of navigation. Adverse weather routes are defined as significant course adjustments to mitigate vessel movement in adverse weather conditions. When transiting in adverse weather conditions, a vessel is likely to encounter various kinds of weather and tidal phenomena, which may lead to severe roll motions, potentially causing damage to cargo, equipment and/or danger to persons on board. The sensitivity of a vessel to these phenomena will depend on the actual stability parameters, hull geometry, vessel type, vessel size and speed.

425. The presence of offshore structures within or near to any adverse weather routes may prevent the route from being utilised during adverse conditions. Mitigations for vessels include adjusting their heading to position themselves 45° to the wind, altering or delaying sailing times, reducing speed and/or potentially cancelling journeys. However, there is considered to be sufficient sea room between the SEP and DEP wind farm sites to accommodate safe transit including in adverse conditions.

426. DFDS raised during consultation that their "Beach Route" (a known DFDS adverse weather route) passed within the shipping and navigation study area, however they stated that they do not anticipate any negative effects on the route arising from the SEP and DEP. Similarly, P&O as the other key commercial ferry operator in the area stated they had no concerns associated with navigational safety. This aligned with the output of the Hazard Workshop (see Section 4.5).

427. The DFDS Beach Route was reflected within the marine traffic data studied. In line with the DFDS consultation, no adverse effect on this route is anticipated, noting that, as above, there is considered to be sufficient sea room between the SEP and DEP wind farm sites to accommodate safe transit during adverse conditions (see Section 15.3).

428. Lighting and marking will be defined in consultation with Trinity House as required under the DCO, and this will include consideration of requirements during periods of poor visibility (e.g., sound signals). Under COLREGS (IMO, 1972), vessels are also required to take appropriate measures with regards to determining a safe speed, taking into account various factors including the state of visibility, the state of the wind, sea, and current as well as the proximity of navigational hazards.

429. When considering the likely navigation safety consequence (minor i.e. potential for slight injuries or pollution) associated with displacement /deviation during the low frequency of adverse weather (reasonably probable - vessels will be deviated frequently through the year but not every day) displacement impacts during adverse weather are assessed as being **tolerable** with embedded mitigations in place and ALARP. This is determined to be the case for DEP in isolation, SEP in isolation, and SEP and DEP together. Embedded mitigations are considered to be:

- Promulgation of information; and
- Display on nautical charts.

430. When considered with the additional mitigation of a Navigation Management Plan and therefore reducing the frequency of any displacement and deviation the impact is considered to be **Broadly Acceptable** and ALARP.

21.1.3 Increased Vessel to Vessel Collision

21.1.3.1 Third Party to Third Party

431. **Changes in routeing as a result of the wind farm sites could lead to increased vessel to vessel collisions.**

432. It was predicted that six of the 14 main routes identified will deviate as a result of the SEP and DEP. This could lead to increases in vessel densities within the area, which could lead to an increase in vessel to vessel encounters and hence collision rates.

433. Based upon the pre wind farm modelling, baseline collision rates (i.e., pre wind farm) within the vicinity are high, with a vessel estimated as being involved in a collision once per 9.6 years. This broadly aligns with the baseline incident data studied, with the MAIB data showing that one collision occurred within the shipping and navigation study area over the ten-year period between 2008 and 2017. This high collision rate is due to the defined routeing occurring in the area as a result of the shallow banks, with high volumes of vessels utilising similar passage.

434. Assuming both SEP and DEP are built (which is considered to be the worst-case from a collision perspective), it was estimated that a vessel would be involved in a collision once every 8.5 years, which represents an increase of approximately 13% over the pre wind farm case. This increase is primarily due to the squeeze of traffic into reduced sea room between the wind farm sites.

435. Concern was raised during consultation from both the CA and the RYA over increases in encounters between recreational and commercial vessels within the area between the wind farm sites. It is a noted that there will be no restrictions on passage through the wind farm sites, and such transit could therefore be utilised by smaller vessels (hence avoiding larger vessels), noting that the minimum spacing of 990m is considered sufficient for safe internal navigation. Regardless, recreational vessels may still choose to transit between the wind farm sites.

436. Feedback from regular operators was that concerns associated with the SEP and DEP were primarily commercial based as opposed to navigational safety. In particular, P&O noted during consultation (see Section 4.2) that their vessels navigate in areas that are more restricted than would be the case here without issues (in terms of navigational safety).

437. It should be considered that the CoS did raise concerns over the reduced searoom in relation to the potential for increased encounters and collision risk, and recommended that site design consider existing shipping in this regard. The final layout will be agreed with the MCA and Trinity House, and these discussions will include consideration of navigational safety.

438. When considering the likely navigation safety consequence (serious i.e., potential for fatalities) associated with collision risk against potential of such a collision (remote for a significant collision), the impact is assessed as being **tolerable**. Relevant embedded mitigation is considered as being:

- Promulgation of information; and
- Display on nautical charts.

439. When considered with the additional mitigation of a Navigation Management Plan and therefore reducing the frequency of any displacement and deviation the impact is considered to be **tolerable with additional mitigation** and ALARP.

21.1.3.2 Third Party to Project Vessel

440. **Increases in wind farm vessel activity associated with the SEP and DEP could lead to increased collision rates in the area.**

441. The construction, operation, and decommissioning of the SEP and DEP will necessitate the use of various project vessels, which will increase traffic volumes within the area, which may lead to an increase in collision risk.

442. Project traffic movements will be managed via marine coordination, and relevant information in relation to the SEP and DEP would be promulgated to stakeholders to ensure third party traffic is aware of areas and periods where there may be increased wind farm traffic. The Navigational Management Plan (see Section 21.3.1.1) will also be in place to manage certain vessels transiting between the wind farm sites.

443. During consultation (see Sections 4.2 and 4.5), regular operators of the area raised concern over long term impacts associated with deviations to avoid project vessels in the area. As discussed in Section 18.5, these concerns were not safety related and were instead related to impacts on transit times and distances, however the Navigation Management Plan is considered to be of benefit to collision risk associated with project vessels. It is noted in this regard that the RYA noted during the hazard workshop (see Section 4.5) concern over the potential for interactions between recreational vessels and project vessels particularly in nearshore areas including port approaches. The RYA also recommended project details and any project vessel movements should be promulgated on a targeted basis to specific recreational clubs and organisations that may be impacted, the Navigation Management Plan (see Section 21.3.1.1) will include a list of stakeholders.

444. It should also be considered that, as identified within the baseline assessment, there is operational traffic transiting to the existing Dudgeon and Sheringham sites, and as such vessels will be familiar with wind farm traffic in the area, noting that similar transit routes to the wind farm sites by project vessels are likely.

445. When considering the likely navigation safety consequence (major i.e., potential for fatalities) associated with collision risk against potential of such a collision the impact is assessed as being **tolerable**. Relevant embedded mitigation is considered as being:

- COLREGS (IMO, 1972) and SOLAS (1974);and
- Marine Coordination.

446. Assuming the implementation of the Navigation Management Plan the impact is assessed as being **tolerable with additional mitigation**, and ALARP. This is determined to be the case for DEP in isolation, SEP in isolation, and SEP and DEP together.

21.1.4 Increased Vessel to Structure Allision

447. **The structures within the wind farm sites will create allision risk in the shipping and navigation study area to third party passing traffic.**

448. Based on the allision modelling undertaken as part of the NRA process, it was estimated that an allision under power with a structure within the wind farm sites would occur once per 618 years, with a drifting allision occurring once per 898 years.

449. Noting that experience and consultation show that commercial vessels will avoid the wind farm sites, it is likely that internal transits will be from smaller vessels (e.g., fishing and recreation). This aligns with input received at the Hazard Workshop. Minimum spacing of 990m is considered as being sufficient to accommodate safe transit, allowing such vessels to maintain safe distances from structures (and hence minimising allision risk) when internal to the array.

450. A quantitative assessment of allision risk to fishing vessels estimated an allision between a fishing vessel and a structure within the wind farm sites would occur once per 37 years. It is noted that this conservatively assumes no change in baseline activity and makes no account of potential consequences (i.e., minor "bumps" are included). Most likely consequences are low impact / minor contact with no significant damage, no injuries to persons, and no pollution (in line with incident statistics to date as per Section 13.4).

451. Equinor have developed a set of Layout Commitments, which include commitment to ensuring straight line edges without dangerously protruding or isolated structures. Further, as required under the DCO the layout will be agreed with the MCA and Trinity House.

452. Additionally, as per the DCO, Lighting and marking will be agreed with Trinity House, and will be displayed on nautical charts to ensure the structures are visible to passing traffic.

453. It should be considered that during the construction phase when structures are only partially complete or not yet commissioned, operational lighting and marking may not yet be active, however other forms of mitigation will be utilised (e.g., construction lighting / marking, guard vessels).

454. When considering the likely navigation safety consequence (serious i.e., potential for fatalities) associated with allision risk against likely frequency of such an allision (remote), the impact is assessed as being **tolerable** with embedded mitigation, and ALARP. This is determined to be the case for DEP in isolation, SEP in isolation, and SEP and DEP together. Relevant embedded mitigation is considered as being:

- Lighting and marking;
- Safety zones;
- Layout approval;

- MGN 654 (MCA, 2021);
- Promulgation of information;
- Guard vessels where appropriate; and
- Display on nautical charts.

21.1.5 Interaction with Subsea Cables

455. **The subsea cables associated with the SEP and DEP and any external protection may cause an interaction risk to vessel anchors.**

456. The SEP and DEP will utilise array cables to connect the wind farm structures, and up to two export cables. Cables will be buried where possible, with a minimum target burial depth of 0.5m (rising to up to 20m in areas of sandwaves, or between 0 and 3m in the MCZ in the case of the export cables). External protection may also be used where target burial depths cannot be met, noting that this will be confirmed via the Cable Burial Risk Assessment.

457. Scenarios that could lead to cable interaction include:

- Vessel dragging anchor over subsea cable following anchor failure;
- Vessel anchoring in an emergency over cable (e.g., to avoid drifting into a structure, of into an area of busy traffic);
- Vessel dropping anchor inadvertently (e.g., mechanical failure); or
- Negligent anchoring (e.g., use of out of date charts, neglecting to raise anchor when departing anchorage).

458. Based on the survey vessel data, anchoring activity does occur within the vicinity of the offshore export cable corridor, specifically near the Weybourne landfall. The majority of this activity (75%) was associated with O&G activity, with the remainder comprising cargo vessels. Consideration to baseline anchoring activity will be included within the Cable Burial Risk Assessment.

459. When considering the likely navigation safety consequence (moderate) associated with cable interaction risk against likely frequency (extremely unlikely), the impact is assessed as being **broadly acceptable** with embedded mitigation, and ALARP. Relevant embedded mitigation is considered as being:

- Promulgation of information;
- Guard vessels where appropriate;
- Cable Protection Monitoring;
- Display on nautical charts; and
- Cable Burial Risk Assessment.

21.1.6 Changes in Under Keel Clearance

460. **Any changes in under keel clearance as a result of the SEP and DEP could lead to risk to passing vessels of under keel interaction.**

461. The use of external protection for the cables may be necessary if target burial depths cannot be met. This could lead to reductions in under keel clearance for passing vessels, and potential grounding / interaction risk. The RYA raised the landfall areas as being of particular concern, noting the potential for higher levels of non AIS traffic. It should be considered that the RYA Coastal Atlas shows the Weybourne landfall is within a "general boating area" indicating potential for non-AIS traffic.

462. It is noted that the need for and location of any external cable protection will be determined via the Cable Burial Risk Assessment.

463. As required under the DCO, Equinor will consult with the MCA and Trinity House in any instances where water depths are reduced by more than 5% as a result of cable protection to determine whether additional mitigation is necessary to ensure the safety of passing vessels.

464. Similarly, sediment / scour transport will also need to be considered to ensure any changes in water depth do not adversely affect passing traffic. Any changes in depths which may impact upon navigational safety associated with scour / sediment will be discussed with the MCA and Trinity House to determine any required mitigation.

465. When considering the likely navigation safety consequence (moderate) associated with under keel risk against likely frequency of such an incident (extremely unlikely), the impact is assessed as being **broadly acceptable** and ALARP. Relevant embedded mitigation is considered as being:

- MGN 654 (MCA, 2021);
- Promulgation of information;
- Guard vessels where appropriate;
- Cable Protection Monitoring;
- Display on nautical charts; and
- Cable Burial Risk Assessment.

21.1.7 Impacts on Emergency Response Resources

466. **An increase in incident rates may arise as a result of the SEP and DEP, leading to an effect on emergency response resources.**

467. The construction of the SEP and DEP will lead to an increased level of vessels and personnel in the area, and as such there may be an increase in the number of incidents requiring emergency response. Vessel / personnel levels are likely to be less during the operational phase, during construction, however operational / maintenance traffic will still be required

468. Baseline incident rates are considered low in the area based on the data studied, and it is noted that to date, there are only nine reported allision or collision incidents associated with OWFs in the UK. While it should be considered that this only covers

allisions and collisions, it is still not anticipated that the SEP and DEP would notably increase the observed baseline incident rates.

469. Further, it should be considered that the on-site presence associated with the SEP and DEP will form additional resource to respond to any incidents in the area in liaison with the MCA, both in terms of incidents associated with the projects (i.e., self help resources), but also incidents occurring outside of the arrays to third party vessels. As required under MGN 654, Equinor will produce and submit an ERCoP to the MCA detailing how they would cooperate and assist in the event of an incident.

470. The final layout will be agreed with the MCA and Trinity House post consent as required under the DCO, and these discussions will include SAR considerations. It is also noted that the Layout Commitments include provision for facilitating SAR access, in that so far as is practicable, all wind turbines will be arranged in straight lines in an easily understandable pattern within individual wind farm site layouts, avoiding structures which break this pattern.

471. When considering the likely navigation safety consequence (serious i.e., potential for fatalities) associated with an impact on emergency response against the likely low frequency (extremely unlikely noting low baseline incident rates), the impact is assessed as being **tolerable** with embedded mitigation and ALARP. Relevant embedded mitigation is considered as being:

- COLREGS (IMO, 1972) and SOLAS (1974);
- Layout approval
- MGN 654 (MCA, 2021);
- Marine Coordination;
- ERCoP; and
- Promulgation of information.

21.2 Cumulative

21.2.1 Displacement / Deviation

472. **The presence of the structures within the wind farm sites or project vessels in the area in combination with other cumulative projects could lead to deviation / displacement of third party vessels**.

473. A cumulative deviation assessment of the main routes identified showed that cumulative increases over pre wind farm routeing represented only minor increases in journey distances over that of the in-isolation post wind farm case**.**

474. The seaweed farm within the area (see Section 17.3) was not observed to impact upon any main routes, noting local shallow banks to the west of the SEP wind farm site mean all main routes already pass south of the proposed seaweed farm site location.

475. During consultation (see Sections 4.2 and 4.5), regular operators of the area also raised concern over long term impacts associated with deviations to avoid project vessels in the area. As discussed in Section 18.5, these concerns were not safety related and were instead related to impacts on transit times and distances. The operator feedback was that the implementation of the Navigational Management Plan (see Section 21.3.1.1) would mitigate this impact. All developers should be establishing appropriate vessel management systems (e.g., marine coordination) and it is noted that given the existing baseline projects, third party vessels in the area will be familiar with wind farm traffic in the area.

476. On this basis, noting the size of the cumulative area assessed, cumulative displacement impacts are assessed as being of negligible consequence (in terms of navigational safety) but of reasonably probable occurrence, meaning significance is **broadly acceptable** and ALARP.

21.2.2 Adverse Weather Routeing

477. **The presence of the structures within the wind farm sites could affect adverse weather routes in the area when considered in combination with other cumulative projects.**

478. As per Section 15.3 and Section 21.1.2, the SEP and DEP in isolation are not anticipated to impede adverse weather routeing on the basis that there is sufficient sea room between the wind farm sites to accommodate transit during periods of adverse weather. This sea space is unaffected when the screened in cumulative projects are incorporated.

479. On this basis, noting the size of the cumulative area assessed any cumulative impacts on adverse weather routeing are assessed as being of minor consequence and remote occurrence, meaning they are **broadly acceptable** and ALARP.

21.2.3 Increased Vessel to Vessel Collision

21.2.3.1 Third Party to Third Party

480. **Changes in routeing as a result of the wind farm sites and other cumulative projects could lead to increased vessel to vessel collisions.**

481. It is noted that the CoS raised concern during consultation over a long term cumulative impact on available searoom as wind farm development progresses in terms of effects on encounters and collision rates. No notable changes in traffic patterns or volumes were identified within the cumulative deviation assessment of the main routes identified, and as such cumulative associated changes in collision risk are also considered to align with the in isolation assessment based on the screened in developments.

482. Consequence is considered to be serious, with frequency considered to be remote, and the impact is therefore **tolerable**. This is determined to be the case (on a cumulative basis) for DEP in isolation, SEP in isolation, and SEP and DEP together noting the implementation of the additional mitigation (Navigation Management Plan) will result in a lower frequency of encounters and therefore reduce the impact to **tolerable with mitigation** and ALARP.

21.2.3.2 Third Party to Project Vessel

483. Increases in wind farm vessel activity associated with the SEP and DEP and other cumulative projects could lead to increased collision rates in the area.

484. Given Lowestoft and Great Yarmouth are likely to be utilised for base ports for future wind farm projects, there may be an increase in wind farm associated traffic on a cumulative basis as other projects being constructing. However, all developers should be establishing appropriate vessel management systems (e.g., marine coordination) and it is noted that given the existing baseline projects, third party vessels in the area will be familiar wind farm traffic in the area.

485. On this basis, cumulative collision risk associated with wind farm traffic is assessed as being of major consequence but extremely unlikely occurrence, and therefore of **broadly acceptable** significance.

21.2.4 Increased Vessel to Structure Allision

486. **The structures within the wind farm sites in combination with nearby cumulative projects will create allision risk in the area to third party passing traffic.**

487. As required, the layouts utilised within the wind farm sites will be agreed with the MCA post consent. These discussions will include consideration of existing projects in terms of alignment, primarily the existing operational Dudgeon and Sheringham sites.

488. Similarly, lighting and marking will require cumulative consideration, and requirements will be discussed and agreed with key stakeholders, including Trinity House and the MCA.

489. As for the in-isolation case, noting traffic volumes, consultation will be undertaken with the MCA and Trinity House to determine whether any additional measures (i.e., above those considered as embedded mitigation) should be put in place to manage allision risk in the area.

490. On this basis, allision risk is assessed as being of serious consequence and remote frequency, and therefore is **tolerable with embedded mitigation,** and ALARP. This is determined to be the case (on a cumulative basis) for DEP in isolation, SEP in isolation, and SEP and DEP together.

21.2.5 Interaction with Subsea Cables

491. **The subsea cables associated with the SEP and DEP in combination with cables associated with other projects may cause a cumulative interaction risk to vessel anchors.**

492. Existing cables do lie in proximity to the offshore export cable corridor, and these will be considered within the Cable Burial Risk Assessment undertaken for the SEP and DEP. The developers of any future cables in proximity would be undertaking their own similar assessments, noting that cable interaction risk is considered as being localised to the area of the cables.

493. On this basis, cumulative cable interaction risk is assessed as being of moderate consequence and extremely unlikely frequency, and therefore is **broadly acceptable.**

21.2.6 Changes in Under keel Clearance

494. Any changes in under keel clearance as a result of the SEP and DEP in combination with changes arising from other projects could lead to cumulative risk to passing vessels of under keel interaction.

495. Any changes in water depth of greater than 5% resultant of the offshore export cables will be discussed with the MCA as per MGN 654, and will account for the best understanding of baseline depths at the time. Similarly, any changes in depths which may impact upon navigational safety associated with scour / sediment will be discussed with the MCA to determine any required mitigation. Any future OWF projects will be required to have similar discussions with the MCA under MGN 654.

496. Based on the publicly available information there may be restrictions for navigational access associated with the proposed seaweed farm (see Section 17.3) in relation to under keel interaction risks. However, data confidence with regards to actual under keel restrictions which may impact on the accessibility are low. Regardless, under keel impacts arising from the SEP and DEP are considered likely to be associated with the areas in the vicinity of the landfall of the offshore export cables (as opposed to the wind farm sites where the seaweed farm is located). On this basis, any cumulative impact is expected to be limited. Equinor will continue to consult with the relevant developer, and it is assumed that the seaweed farm developer will seek to mitigate under keel risks in consultation with the MCA.

497. Associated cumulative impacts are assessed as being of moderate consequence and extremely unlikely frequency in line with the in isolation assessment, and are therefore **broadly acceptable** and ALARP.

21.2.7 Impacts on Emergency Response Resources

498. An increase in incident rates may arise as a result of the SEP and DEP in combination with other cumulative projects, leading to an effect on emergency response resources.

499. Given low baseline incident rates, and noting the additional “self help” resources that would be available at other projects, there is not considered likely to be an adverse effect on emergency response resources on a cumulative level.

500. The final layout will be agreed with the MCA post consent, and these discussions will include SAR considerations at a cumulative level.

501. Associated cumulative impacts are therefore assessed as being of serious consequence and negligible occurrence, and are therefore of **broadly acceptable** significance**.**

21.3 Impact Assessment Summary

21.3.1.1 Additional Mitigation

502. Based on the findings of the FSA and overarching NRA process, the following additional mitigations are recommended for consideration where applicable within Chapter 13: Shipping and Navigation:

- Navigation Management Plan – A navigation management plan will be developed post consent to manage crew transfer vessels (including daughter craft) during the construction and operations phase of the project. The navigation management plan will not apply to large construction and operations vessels including the Service Operations Vessel who will adhere to flag state regulations as required including COLREGS. The navigation management plan will include:
  - Application – who the plan applies to.
  - Navigation stakeholders that should be contacted with project vessel movements.
  - A summary of the commercial vessel movements within the area.
  - What considerations the applicable vessels need to have when navigating across the corridor i.e., clear intentions as the give way/stand on vessel (under COLREGS), safe speeds and restricted visibility

21.3.1.2 Impact Significance

503. The outputs of the FSA for the SEP and DEP are summarised in Table 21.1 for SEP and DEP together, and in Table 21.2 for the cumulative assessment. As detailed within the relevant FSA sections above, the ranking of any impact assessed as being tolerable or tolerable with additional mitigation was found to apply to all of the DEP in isolation, SEP in isolation, and SEP and DEP together scenarios. Where an impact was found to be broadly acceptable, it follows that this was the case for all three scenarios.

Table 21.1 Impact Assessment Summary – SEP and DEP Together

Impact	Consequence	Frequency	Significance	Additional Mitigation	Residual Significance
Displacement / Deviation	Negligible	Frequent	Tolerable	Navigation Management Plan	Tolerable with embedded and additional mitigation
Adverse Weather Routeing	Minor	Reasonably Probable	Tolerable	Navigation Management Plan	Broadly Acceptable
Increased Collision Risk	Serious	Remote	Tolerable	Navigation Management Plan	Tolerable with additional mitigation
Increased Allision Risk	Serious	Remote	Tolerable	n/a	Tolerable with embedded mitigation
Interaction with subsea cables	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Changes in Under keel Clearance	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Impacts on Emergency Response Resources	Serious	Extremely Unlikely	Tolerable	n/a	Tolerable with embedded mitigation

Table 21.2 Impact Assessment Summary – Cumulative

Impact	Consequence	Frequency	Significance	Additional Mitigation	Residual Significance
Displacement / Deviation	Negligible	Reasonably Probable	Broadly Acceptable	Navigation Management Plan	Broadly Acceptable
Adverse Weather Routeing	Minor	Remote	Broadly Acceptable	n/a	Broadly Acceptable
Increased Collision Risk	Serious	Remote	Tolerable	Navigation Management Plan	Tolerable with additional mitigation
Increased Allision Risk	Serious	Remote	Tolerable	n/a	Tolerable with embedded mitigation
Interaction with subsea cables	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Changes in Under keel Clearance	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Impacts on Emergency Response Resources	Serious	Negligible	Broadly Acceptable	n/a	Broadly Acceptable

21.4 Cost Benefit Analysis

504. The FSA Guidelines may require a process of CBA to rank the proposed mitigation (risk control) options in terms of risk benefit related to lifecycle costs. This will be considered in terms of Gross Cost of Averting a Fatality (GCAF). This is a cost effectiveness measure in terms of ratio of marginal (additional) cost of the risk control option to the reduction in risk to personnel in terms of the fatalities averted.

505. Until the layout and associated mitigations are finalised, a review of CBA does not need to be undertaken and the requirement will be discussed further with regulators if required.

22 Through Life Safety Management

506. Quality, Health, Safety and Environment documentation including a Safety Management System will be in place for the SEP and DEP and will be continually updated throughout the development process.

507. Equinor will be responsible for reviewing and updating all documentation including any risk assessments and the ERCoP as defined by MGN 654.

22.1 Decommissioning Plan

508. A decommissioning plan will be developed. With regards to impacts on shipping and navigation this will include consideration of the scenario where decommissioning and completion of removal operations, an obstruction is left on site (attributable to the SEP and DEP) which is considered to be a danger to safe navigation and which it has not proven possible to remove. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation.

23 Summary

509. Using various baseline data sources and giving consideration to the consultation undertaken, impacts relating to shipping and navigation that may arise as a result of the SEP and DEP have been identified. This has been fed into an FSA designed to inform Chapter 13 Shipping and Navigation of the PEIR.

23.1 Existing Environment

510. The existing environment has been presented in Section 10. In summary within the shipping and navigation study area there are OWFs, gas platforms and associated infrastructure, AtoNs, submarine cables, marine aggregate dredging areas, and wrecks. In addition, there are a number of ports, anchorages, and IMO routeing measures nearby to the wind farm sites.

23.2 Maritime Incidents

23.2.1 Wind Farm Site

511. From MAIB incident data analysed over a 10-year period, an average of three unique incidents per year occurred within the shipping and navigation study area. Two incidents occurred within the SEP wind farm site, with none occurring within the DEP wind farm site

512. From RNLI incident data analysed over a 10-year period, 160 RNLI lifeboat launches were reported within the shipping and navigation study area responding to 153 incidents, corresponding to an average of 15 incidents per year. The majority of the incidents occurred within coastal regions. Two incidents were recorded within the SEP wind farm site itself, with none occurring within the DEP wind farm site.

23.2.2 Offshore Export Cable Corridor

513. An average of one unique incident was reported to the MAIB per year within the offshore export cable corridor shipping and navigation study area, three in total of which occurred within the offshore export cable corridor itself.

514. An average of five unique incidents were reported to the RNLI per year occurred within the offshore export cable corridor shipping and navigation study area, with 11 incidents in total within the offshore export cable corridor itself. The majority of these occurred near the landfall at Weymouth.

23.3 Marine Traffic

23.3.1 Wind Farm Sites

515. From vessel traffic survey data recorded by AIS, radar and visual observations over 14 full days in July/August 2020 (summer), there was an average of 82 unique vessels per

day recorded within the shipping and navigation study area, with eight and three unique vessels recorded per day in the DEP wind farm site and SEP wind farm site, respectively. Cargo vessels, tankers, and O&G vessels were the main vessel types recorded within the shipping and navigation study area throughout the summer survey study period. Recreational vessels were also observed during the summer survey period within the shipping and navigation study area with the majority of these observed within coastal regions.

516. From vessel traffic survey data recorded by AIS, radar and visual observations over 14 full days in January/February 2021 (winter), there was an average of 81 unique vessels per day recorded within the shipping and navigation study area, with eight and two unique vessels recorded per day in DEP wind farm site and SEP wind farm site, respectively. Cargo vessels, tankers, and O&G vessels were the main vessel types recorded within the shipping and navigation study area throughout the winter survey study period. No recreational vessels were observed during the winter study period within the shipping and navigation study area.

517. Fishing vessels were observed during the study periods both in transit and actively engaged in fishing.

23.3.2 Offshore Export Cable Corridor

518. From vessel traffic survey data recorded on AIS over 14 full days in July/August 2020 (summer), there was an average of 58 unique vessels per day recorded within the offshore export cable corridor shipping and navigation study area and 51 unique vessels per day within the offshore export cable corridor itself. Cargo vessels and tankers were the main vessel types recorded within the offshore export cable corridor throughout the summer survey period. Recreational vessels were observed, generally inshore, during the summer survey period within the offshore export cable corridor shipping and navigation study area.

519. From vessel traffic survey data recorded on AIS over 14 full days in January/February 2021 (winter), there was an average of 66 unique vessels per day recorded within the offshore export cable corridor shipping and navigation study area and 60 unique vessels per day within the offshore export cable corridor itself. Cargo vessels and tankers were the main vessel types recorded within the offshore export cable corridor throughout the winter survey period. No recreational vessels were observed during the summer survey period within the offshore export cable corridor shipping and navigation study area.

520. Fishing vessels were observed during both study periods both in transit and actively engaged in fishing, particularly off Cromer.

23.4 Post Wind Farm Routeing

521. An indicative 10% and 20% increase in traffic associated with ports, commercial fishing vessel transits, and recreational vessel transits were considered for the future case scenario.

522. Deviations would be required for six out of the 14 main routes[14] identified within the shipping and navigation study area assuming both the SEP and DEP are constructed.

23.5 Collision and Allision Modelling

523. Collision and allision modelling was undertaken for SEP in isolation, DEP in isolation, and SEP and DEP in combination.

524. An assessment of current vessel to vessel encounters in proximity to the wind farm sites was undertaken by replaying at high speed the data collected as part of the summer vessel traffic survey, noting that a similar assessment will be undertaken with data from the second (winter) survey for the post PEIR NRA. There was an average of 67 encounters per day during the summer survey period within the shipping and navigation study area.

525. The annual vessel to vessel collision risk within the shipping and navigation study area following installation of the wind farm for the base case traffic levels was estimated to be 0.118, corresponding to a collision return period of approximately one in eight years. This represents a 13% increase in collision frequency over the pre wind farm result.

526. The annual powered vessel to structure allision risk for the base case traffic levels, following installation of the wind farm sites, was estimated to be $1.62\text{x}10^{-3}$, corresponding to a powered allision return period of approximately 618 years.

527. The annual drifting vessel to structure allision risk for the base case traffic levels, following the installation of the wind farm sites, was estimated to be $1.11\text{x}10^{-3}$, corresponding to a drifting allision return period of approximately 898 years.

528. The annual fishing vessel allision risk was estimated at $2.72 \text{ x } 10^{-2}$, which corresponds to one allision per 37 years. It should be considered that this conservatively assumes no change in baseline fishing patterns post wind farm and also makes no account of consequences (i.e., minor “bumps” are included).

23.6 Conclusion

529. The key output of the NRA is the findings of the FSA, which has considered the risk assessment findings, consultation, and baseline environment. The FSA is summarised

[14] Note 6a and 6b counted as distinct routes.

in Table 23.1. All impacts on SEP and DEP together and on a cumulative basis were assessed at being of most **tolerable with additional mitigation** and ALARP.

530. It is noted that the ranking of any impact assessed as being tolerable or tolerable with additional mitigation was found to apply to all of the DEP in isolation, SEP in isolation, and SEP and DEP together scenarios. Where an impact was found to be broadly acceptable, it follows that this was the case for all three scenarios.

531. The output of the FSA will be considered in Chapter 13 Shipping and Navigation.

Table 23.1 FSA Summary – In Isolation

Impact	Consequence	Frequency	Significance	Additional Mitigation	Residual Significance
Displacement / Deviation	Negligible	Frequent	Tolerable	Navigation Management Plan	Tolerable with additional mitigation
Adverse Weather Routeing	Minor	Reasonably Probable	Tolerable	Navigation Management Plan	Broadly Acceptable
Increased Collision Risk	Serious	Remote	Tolerable	Navigation Management Plan	Tolerable with additional mitigation
Increased Allision Risk	Serious	Remote	Tolerable	n/a	Tolerable with embedded mitigation
Interaction with subsea cables	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Changes in Under keel Clearance	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Impacts on Emergency Response Resources	Serious	Extremely Unlikely	Tolerable	n/a	Tolerable with embedded mitigation

Table 23.2 FSA Summary – Cumulative

Impact	Consequence	Frequency	Significance	Additional Mitigation	Residual Significance
Displacement / Deviation	Negligible	Reasonably Probable	Broadly Acceptable	Navigation Management Plan	Broadly Acceptable
Adverse Weather Routeing	Minor	Remote	Broadly Acceptable	n/a	Broadly Acceptable
Increased Collision Risk	Serious	Remote	Tolerable	Navigation Management Plan	Tolerable with additional mitigation
Increased Allision Risk	Serious	Remote	Tolerable	n/a	Tolerable with embedded mitigation
Interaction with subsea cables	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Changes in Under keel Clearance	Moderate	Extremely Unlikely	Broadly Acceptable	n/a	Broadly Acceptable
Impacts on Emergency Response Resources	Serious	Negligible	Broadly Acceptable	n/a	Broadly Acceptable

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Annex A MGN 654 Checklist

532. This Annex provides a completed MCA MGN 654 (MCA, 2021) checklist. This checklist demonstrates that the NRA is compliant with the MCA requirements for OREIs.

533. A template checklist is provided by the MCA (2021a), which has been used as the basis of this document. The template provides tables containing the requirements of MGN 654, and the requirements of the MCA Methodology for Assessing Navigational Safety and Emergency Response Risks of OREIs. These are provided in Table A.1 and Table A.2, respectively.

534. It should be noted that in certain cases the points raised will be specifically addressed post consent – any such cases have been made clear in the text within the completed checklist.

Table A.1. MGN 654 Checklist

MGN Reference	Yes/No	Comments
Planning Stage – Prior to Consent		
Site and Installation Co-ordinates: Developers are responsible for ensuring that formally agreed co-ordinates and subsequent variations of site perimeters and individual OREI structures are made available, on request, to interested parties at relevant project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided with latitude and longitude coordinates in WGS84 (ETRS89) datum.	✓	Will be provided by Equinor.
Traffic Survey – includes:		
All vessel types	✓	**Section 14: Vessel Traffic Surveys** Includes AIS, radar and visual observation data to ensure all vessel types captured.
At least 28 days duration, within either 12 or 24 months prior to submission of the Environmental Impact Assessment Report	✓	**Section 14: Vessel Traffic Surveys** A total of 28 days of data has been collected within the required timeframe from ES submission.
Multiple data sources	✓	**Section 5: Data Sources** Additional data sources have been used to supplement the vessel traffic data.

Seasonal variations	✓	**Section 14: Vessel Traffic Surveys** A summer and winter survey have both been undertaken. **Annex B: Long Term AIS Data Assessment** Long term data spanning entirety of 2019 has been used to provide additional assessment of seasonal variation.
MCA consultation	✓	**Section 4: Consultation** Shows MCA consultation to date including how input has been addressed within the NRA.
General Lighthouse Authority consultation	✓	**Section 4: Consultation** Shows Trinity House consultation to date including how input has been addressed within the NRA.
Chamber of Shipping and shipping company consultation	✓	**Section 4: Consultation** Shows CoS consultation to date including how input has been addressed within the NRA.
Recreational and fishing vessel organisations consultation	✓	**Section 4: Consultation** Summarised consultation to date including engagement with relevant stakeholders including RYA and CA. Both recreational and fishing representatives were present at the hazard workshop.
Port and navigation authorities consultation, as appropriate	✓	**Section 4: Consultation** Key port authority represented at the hazard workshop.
Assessment of the cumulative and individual effects of (as appropriate):		
i. Proposed OREI site relative to areas used by any type of marine craft.	✓	**Section 14: Vessel Traffic Surveys** Vessel traffic data in proximity to the wind farm sites has been analysed **Section 21: Formal Safety Assessment** Impacts have been assessed on both an in isolation and cumulative basis
ii. Numbers, types and sizes of vessels presently using such areas	✓	**Section 14: Vessel Traffic Surveys** Vessel traffic data in proximity to the wind farm sites has been analysed and includes breakdowns of daily count and vessel type
iii. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, personal watercraft etc.	✓	**Section 10: Existing Environment** Section 10.5 identifies marine aggregate dredging areas in proximity to the wind farm sites based upon data available on UKHO admiralty charts **Section 14: Vessel Traffic Surveys** Non-transit users were identified in the vessel traffic survey data and included recreational traffic, fishing vessels, and marine aggregate dredgers
iv. Whether these areas contain transit routes used by coastal, deep-draught or international scheduled vessels on passage.	✓	**Section 15: Pre Wind Farm Routes** Main routes have been identified using the principles set out in MGN 654 in proximity to the wind farm sites.
v. Alignment and proximity of the site relative to adjacent shipping routes	✓	**Section 10: Existing Environment** Section 10.7 shows the nearest routeing measures to the wind farm sites, noting none are in close proximity.

		Section 15: Pre Wind Farm Routes Main routes have been identified using the principles set out in MGN 654 in proximity to the wind farm sites.
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas	✓	**Section 10: Existing Environment** Section 10.7 shows the nearest routeing measures to the wind farm sites, noting none are in close proximity.
vii. Proximity of the site to areas used for anchorage (charted or uncharted), safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 10: Existing Environment** Sections 10.8 and 10.9 present the ports and anchorage areas in proximity to the wind farm sites.
viii. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 10: Existing Environment** Sections 10.8 present the nearby ports relative to the wind farm sites.
ix. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 14: Vessel Traffic Surveys** Fishing vessel movements are considered in Section 14.1.3.7 for the shipping and navigation study area
x. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 10: Existing Environment** Section 10.11 discusses the nearest military areas to the wind farm sites, noting none are in close proximity
xi. Proximity of the site to existing or proposed submarine cables or pipelines, offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Area or other exploration/exploitation sites	✓	**Section 10: Existing Environment** Section 10.2 identifies O&G features in proximity to the wind farm sites, Section 10.4 covers submarine cables, Section 10.5 identifies marine aggregate dredging areas in proximity to the wind farm sites, Section 10.6 identifies charted wrecks in proximity to the wind farm sites, and Section 10.10 identifies MEHRAs in proximity to the wind farm sites
xii. Proximity of the site to existing or proposed OREI developments, in co-operation with other relevant developers, within each round of lease awards.	✓	**Section 10: Existing Environment** Section 10.1 identifies other operational or constructing OWF developments in proximity to the wind farm sites. **Section 17: Cumulative and Transboundary Overview** Section 17.1 presents relevant proposed / planned OWF developments.
xiii. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground	✓	**Section 10: Existing Environment** Section 10.5 identified foul and spoil grounds in proximity to the wind farm sites
xiv. Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✓	**Section 10: Existing Environment** Section 10.3 identifies the AtoNs in proximity to the wind farm sites
xv. Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density and nearby or consented OREI sites not yet constructed.	✓	**Section 19: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the wind farm sites, which includes consideration of the effect of likely vessel displacement on collision risk

xvi. With reference to xv. above, the number and type of incidents to vessels which have taken place in or near to the proposed site of the OREI to assess the likelihood of such events in the future and the potential impact of such a situation.	✓	**Section 13: Maritime Incidents** Historical vessel incident data published by the MAIB (see Section 13.1), RNLI (see Section 13.2), and DfT (see Section 13.3) in proximity to the wind farm sites has been considered alongside historical OWF incident data throughout the UK (see Section 13.4). **Section 19: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the wind farm sites to estimate the effect of the SEP and DEP in terms of allision and collision incident rates
xvii. Proximity of the site to areas used for recreation which depend on specific features of the area	✓	**Section 14: Vessel Traffic Surveys** Recreational traffic is considered in Section 14.1.3.8 noting this includes consideration of the RYA Coastal Atlas features (RYA, 2018).
Predicted Effect of OREI on traffic and Interactive Boundaries – where appropriate, the following should be determined:		
a. The safe distance between a shipping route and OREI boundaries.	✓	**Section 18: Future Case Vessel Traffic** Presents the methodology for post wind farm routeing and includes a minimum distance of 1 nm from offshore installations and wind turbine boundaries.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 18: Future Case Vessel Traffic** Section 18.4 considers and assesses the available sea space between the wind farm sites.
OREI Structures – the following should be determined:		
a. Whether any feature of the OREI, including auxiliary platforms outside the main generator site, mooring and anchoring systems, inter-device and export cabling could pose any type of difficulty or danger to vessels underway, performing normal operations, including fishing, anchoring and emergency response.	✓	**Section 19: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the wind farm sites. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken, impacts have been identified and assessed using the IMO FSA, including impacts involving anchoring and emergency response.
b. Clearances of fixed or floating wind turbine blades above the sea surface are *not less than 22 metres (*above MHWS for fixed). Floating turbines allow for degrees of motion.	✓	**Section 9: Maximum Design Scenario** The minimum blade tip height is included in the MDS for wind turbines.
c. Underwater devices i. changes to charted depth ii. maximum height above seabed iii. Under Keel Clearance	✓	**Section 9: Maximum Design Scenario** Inter array, interconnector, and export cable specifications are included for the MDS for cables. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed using the IMO FSA, including under keel clearance effects.
d. Whether structure block or hinder the view of other vessels or other navigational features.	✓	**Section 10: Existing Environment** Section 10.1 identifies the AtoN in proximity to the wind farm sites.

		Section 16: Navigation, Communication and Position Fixing Equipment Section 16.10 assesses impact of SEP and DEP on existing AtoNs.
The Effect of Tides, Tidal Streams and Weather: It should be determined whether:		
a. Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✓	**Section 11: Meteorological Ocean Data** Various states of tide local to the wind farm sites are provided. **Section 14: Vessel Traffic Surveys** Vessel traffic data in proximity to the wind farm sites has been analysed. **Section 19: Collision and Allision Risk Modelling** The collision and allision risk models consider tidal conditions.
b. The set and rate of the tidal stream, at any state of the tide, has a significant affect on vessels in the area of the OREI site.	✓	**Section 11: Meteorological Ocean Data** Various states of tide local to the wind farm sites are provided. **Section 19: Collision and Allision Risk Modelling** The collision and allision risk models consider tidal conditions.
c. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓	
d. The set is across the major axis of the layout at any time, and, if so, at what rate.	✓	
e. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream, including unpowered vessels and small, low speed craft.	✓	**Section 11: Meteorological Ocean Data** Various states of tide local to the wind farm sites are provided **Section 19: Collision and Allision Risk Modelling** The drifting allision model considers tidal conditions and assesses whether machinery failure could cause vessels to be set into danger
f. The structures themselves could cause changes in the set and rate of the tidal stream.	✓	**Section 11: Meteorological Ocean Data** No effects are anticipated.
g. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the area	✓	**Section 20: Mitigation** Mitigations have been included as part of the SEP and DEP, including compliance with MGN 654. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed within the FSA, including those associated with changes in water depths.
h. The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✓	**Section 11: Meteorological Ocean Data** Weather and visibility data local to the wind farm sites is provided. **Section 14: Vessel Traffic Surveys** Vessel traffic data in proximity to wind farm sites has been analysed including recreational vessels. **Section 21: Formal Safety Assessment** Adverse weather routeing is considered for both wind farm sites in isolation and cumulatively with other developments in the area.

i. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed within the FSA, including those associated with effects on recreational vessels.
j. In general, taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set such as referred to above.	✓	**Section 19: Collision and Allision Risk Modelling** Drifting allision risk model considers weather and tidal conditions and assesses whether machinery failure could cause vessels to be set in danger. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed within the FSA, including those associated with drifting allision.
Assessment of Access to and Navigation Within, or Close to, an OREI. To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:		
a. Navigation within or close to the site would be safe: i. for all vessels, or ii. for specified vessel types, operations and/or sizes. iii. in all directions or areas, or iv. in specified directions or areas. v. in specified tidal, weather or other conditions	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts on navigation of the different communications and position fixing devices used in an around OWFs are assessed. **Section 19: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the wind farm sites which includes use of post wind farm routeing and takes account of tidal and weather conditions. **Section 20: Mitigation** Mitigations have been included as part of the SEP and DEP. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed using the IMO FSA.
b. Navigation in and/or near the site should be prohibited or restricted: i. for specified vessels types, operations and/or sizes. ii. in respect of specific activities, iii. in all areas or directions, or iv. in specified areas or directions, or v. in specified tidal or weather conditions.	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts on navigation of the different communications and position fixing devices used in an around OWFs are assessed **Section 18: Future Case Vessel Traffic** Collision and allision risk modelling has been undertaken for the wind farm sites and includes the use of post wind farm routeing which assumes commercial vessel traffic avoids the wind farm sites. **Section 21: Formal Safety Assessment** Based upon the baseline data and consultation undertaken impacts have been identified and assessed within the FSA
c. Where it is not feasible for vessels to access or navigate through the site it could cause navigational, safety or routeing problems for vessels operating in the area e.g. by preventing vessels from responding to calls for assistance from persons in distress	✓	**Section 18: Future Case Vessel Traffic** Assessment of post wind farm routeing which assumes commercial vessel traffic avoids the wind farm sites has been undertaken. **Section 21: Formal Safety Assessment**

		Impacts have been assessed including in relation to emergency response.
d. Guidance on the calculation of safe distance of OREI boundaries from shipping routes has been considered	✓	**Section 18: Future Case Vessel Traffic** Presents the methodology for post wind farm routeing and includes a minimum distance of 1 nm from offshore installations and wind turbine boundaries.
Search and rescue, maritime assistance service, counter pollution and salvage incident response. The MCA, through HM Coastguard, is required to provide Search and Rescue and emergency response within the sea area occupied by all offshore renewable energy installations in UK waters. To ensure that such operations can be safely and effectively conducted, certain requirements must be met by developers and operators.		
a. An ERCoP will be developed for the construction, operation and decommissioning phases of the OREI.	✓	**Section 20: Mitigation** Equinor will comply with MGN 654, which requires the creation of an ERCoP.
b. The MCA's guidance document *Offshore Renewable Energy Installation: Requirements, Advice and Guidance for Search and Rescue and Emergency Response* for the design, equipment and operation requirements will be followed.	✓	**Section 20: Mitigation** Equinor will comply with MGN 654, which requires the fulfilment of requirements in the stated guidance document.
c. A SAR checklist will be completed to record discussions regarding the requirements, recommendations and considerations outlined in the above document (to be agreed with MCA)	✓	**Section 20: Mitigation** Equinor will comply with MGN 654, including the requirement for a SAR checklist.
Hydrography - In order to establish a baseline, confirm the safe navigable depth, monitor seabed mobility and to identify underwater hazards, detailed and accurate hydrographic surveys are included or acknowledged for the following stages and to MCA specifications:		
i. Pre-construction: The proposed generating assets area and proposed cable route	✓	**Section 20: Mitigation** Equinor will comply with MGN 654 Annex 4 Hydrography requirements (see Section 20.3).
ii. On a pre-established periodicity during the life of the development	✓	
ii. Post-construction: Cable route(s)	✓	
iii. Post-decommissioning of all or part of the development: the installed generating assets area and cable route	✓	
Communications, Radar and Positioning Systems - To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:		
a. The structures could produce radio interference such as shadowing, reflections or phase changes, and emissions with respect to any frequencies used for marine positioning, navigation and timing (PNT) or communications, including GMDSS and AIS, whether ship borne, ashore or fitted to any of the proposed structures, to:	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts on navigation of the different communications and position fixing devices used in an around OWFs are assessed.

i. Vessels operating at a safe navigational distance	✓	
ii. Vessels by the nature of their work necessarily operating at less than the safe navigational distance to the OREI, e.g. support vessels, survey vessels, SAR assets.	✓	
iii. Vessels by the nature of their work necessarily operating within the OREI.	✓	
b. The structures could produce radar reflections, blind spots, shadow areas or other adverse effects: i. Vessel to vessel; ii. Vessel to shore; iii. VTS radar to vessel; iv. Racon to/from vessel	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts on marine Radar are assessed in Section 16.7.
c. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts associated with sonar interference are assessed in Section 16.8.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts associated with noise are assessed in Section 16.9.
e. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✓	**Section 16: Navigation, Communication and Position Fixing Equipment** Potential impacts associated with electromagnetic interference are assessed in Section 16.6.
Risk mitigation measures recommended for OREI during construction, operation and decommissioning.		
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the Environmental Impact Assessment (EIA).The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement (ES). These will be consistent with international standards contained in, for example, the Safety of Life at Sea (SOLAS) Convention - Chapter V, IMO Resolution A.572 (14)3 and Resolution A.671(16)4 and **could include any or all** of the following:	✓	**Section 20: Mitigation** Details the embedded mitigation that will be applied.
i. Promulgation of information and warnings through notices to mariners and other appropriate maritime safety information (MSI) dissemination methods.	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including promulgation of information.

ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including promulgation of information and marine coordination.
iii. Safety zones of appropriate configuration, extent and application to specified vessels[15]	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including application for safety zones (see Section 20.1).
iv. Designation of the site as an area to be avoided (ATBA).	✓	It is not planned to propose any areas as an ATBA, noting that consultation is ongoing
v. Provision of AtoN as determined by the GLA	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including lighting and marking.
vi. Implementation of routeing measures within or near to the development.	✓	It is not planned to propose any additional routeing measures.
vii. Monitoring by radar, AIS, CCTV or other agreed means	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including compliance with MGN 654, including requirements to complete the SAR checklist. Outlines the plans to monitor vessel movements by AIS during construction and operations (see Section 20.3)
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of safety zones.	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including application for safety zones (see Section 20.1). Full details of monitoring and policing procedures will be included as part of the safety zone application.
ix. Creation of an Emergency Response Cooperation Plan with the MCA's Search and Rescue Branch for the construction phase onwards.	✓	**Section 20: Mitigation** Details the embedded mitigation that will apply including compliance with MGN 654, including requirement to produce an ERCoP.
x. Use of guard vessels, where appropriate	✓	**Section 20: Mitigation** As per the mitigations included as part of the SEP and DEP, guard vessels will be used where appropriate
xi. Update NRAs every two years e.g. at testing sites.	✓	Not applicable to the SEP and DEP.
xii. Device-specific or array-specific NRAs	✓	**Section 9: Maximum Design Scenario** All offshore elements have been considered in this NRA.
xiii. Design of OREI structures to minimise risk to contacting vessels or craft	✓	There is no additional risk identified to craft compared to previous offshore wind farms and so no additional measures are identified.
xiv. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 20: Mitigation** Details the embedded mitigation that will be applied. **Section 21: Formal Safety Assessment** Details additional mitigation recommended for consideration within Chapter 13: Shipping and Navigation in order for risks to be ALARP (see Section 21.3.1.1).

[15] As per SI 2007 No 1948 "The Electricity (Offshore Generating Stations) (Safety Zones) (Application Procedures and Control of Access) Regulations 2007.

Table A.2. Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations

The following content is included:	Section	Compliant Yes/No	Comments
A risk claim is included that is supported by a reasoned argument and evidence	7	✓	The impact assessment within Chapter 13: Shipping and Navigation assesses risk to shipping and navigation users based on the findings of the NRA including (but not limited to) baseline data, expert opinion, modelling, outputs of the Hazard Workshops, stakeholder concern and lessons learnt from existing offshore developments.
Description of the marine environment	B3	✓	**Section 10: Existing Environment** Details relevant navigational features in the vicinity of the wind farm sites. **Section 17: Cumulative and Transboundary Overview** Details potential future developments of relevance to the SEP and DEP.
Search and Rescue overview and assessment	3.3	✓	**Section 12: Emergency Response** Details existing baselines SAR resources of relevance to the SEP and DEP. **Section 13: Maritime Incidents** Historic incident data is assessed to determine baseline incident rates. **Section 21: Formal Safety Assessment** Assesses impacts via FSA based on NRA findings. This feeds into impact assessment in Chapter 13: Shipping and Navigation including in relation to emergency response.
Description of the OREI development and how it changes the marine environment	B3	✓	**Section 9: Maximum Design Scenario** Presents project description elements of relevance to shipping and navigation. **Section 19: Collision and Allision Risk Modelling** Provides quantitative assessment of pre and post wind farm allision and collision risk. **Section 21: Formal Safety Assessment** Assesses impacts via FSA based on NRA findings. This feeds into impact

The following content is included:	Section	Compliant Yes/No	Comments
			assessment in Chapter 13: Shipping and Navigation.
Analysis of the marine traffic, including base case and future traffic densities and types.	B1 B2	✓	**Section 14 Vessel Traffic Surveys** Assesses base case traffic volumes, types, and behaviours. **Section 18: Future Case Vessel Traffic** Assesses and considers future case traffic (both pre and post wind farm). **Annex B: Long Term Data Assessment** Assesses additional long term AIS data.
Status of the hazard log • **Hazard Identification** • **Risk Assessment** • **Influences on level of risk** • **Tolerability of risk** • **Risk matrix**	C1 & F1 C2 C3 C4 C5	✓	**Section 3: NRA Methodology** The Hazard Log and workshop methodology is detailed in Section 3.2.1. **Annex A: Hazard Log** Presents the agreed Hazard Log.
Navigation Risk Assessment • **Appropriate risk assessment** • **MCA acceptance for assessment techniques and tools** • **Demonstration of results** • **Limitations**	D1 D2 D3 D4	✓	**Section 2: Guidance and Legislation** MGN 654 and the IMO's FSA guidelines are the primary guidance documents used during the assessment. **Section 4: Consultation** NRA approach and methodology has been discussed and agreed with MCA. **Section 19: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken with the results outlined numerically and graphically (where appropriate).
Risk control log	E1 & G1	✓	**Section 20: Mitigation** Details the embedded mitigation that will be applied. **Section 21: Formal Safety Assessment** Details additional mitigation recommended for consideration within Chapter 13: Shipping and Navigation in order for risks to be ALARP (see Section 21.3.1.1).

Annex B Long Term AIS Data Assessment

B.1 Introduction

535. This annex assesses the available marine traffic data for the SEP and DEP. As required under MGN 654 (MCA, 2021), the NRA and Chapter 13 Shipping and Navigation will consider 28 days of AIS, Radar, and visual observation data as the primary marine traffic data source. When considering a 28 day period in isolation it can exclude certain activities or periods of significance to shipping and navigation. Therefore, in line with good practice assessment procedures, this NRA has also considered a longer term data set covering the entirety of 2019 to ensure a comprehensive picture of the marine traffic baseline can be established, including the capture of any seasonal variation.

536. This approach (i.e., the use of both long term and short term data) has been agreed with both the MCA and Trinity House.

B.1.1 Aims and Objectives

537. The key aims and objectives of this annex are as follows:

- Identify seasonal variations in traffic via assessment of the long term data;
- Determine which variations are not reflected within the short term survey data (and therefore should be fed into the NRA baseline);
- Assess which data set (long term / survey or combination of both) should be utilised for each key NRA element that requires marine traffic data input; and
- Identify and account for any potential effects of the COVID-19 situation on the survey data (see Section B.2).

B.2 Effects of COVID-19

538. It is noted that while the primary purpose of the longer term data set is to ensure a comprehensive baseline can be established by ensuring seasonal variations are captured, in the case of the SEP and DEP, the consideration of longer term data also ensures that any tangible effects of the COVID-19 situation on the short term survey data can be identified, noting that the initial summer survey incorporated into the PEIR NRA was undertaken in July / August 2020, and the second survey in January / February 2021. As such some associated impact upon shipping levels or patterns may be present within the data. As per Section 4.2 of the NRA, the MCA and Trinity House were content with a summer 2020 survey on the assumption that additional long term data prior to the pandemic was considered in tandem with appropriate consultation with the relevant stakeholders.

539. Comparison between the survey data and the long term 2019 data is made in Section B.5.

B.3 Data Sources

B.3.1 Shipping and Navigation Study Areas

540. This annex has assessed the long term data within a shipping and navigation study area defined as a 10nm buffer of the SEP and DEP sites. Two other shipping and navigation study areas have also been defined and used where relevant throughout this annex, the DEP shipping and navigation study area and the SEP shipping and navigation study area, respectively, these shipping and navigation study areas are presented in Figure B.1. These are analogous to the shipping and navigation study areas used within the NRA (see Section 5.3 of the NRA for full details).

541. Note the two shipping and navigation study areas share a common area between the SEP and DEP wind farm sites therefore vessels that were observed within this area may be counted twice within figures showing the number of vessels observed within each of the respective shipping and navigation study areas.

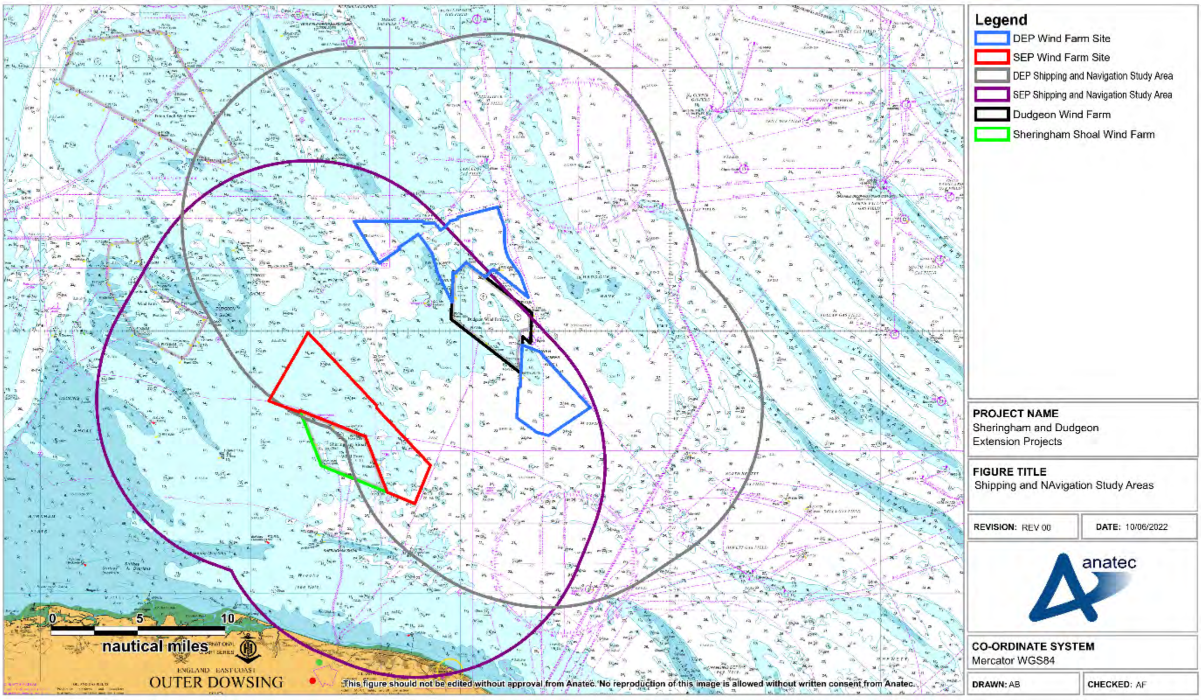

Figure B.1. Shipping and Navigation Study Areas

B.3.2 Long Term 2019 Data

542. The AIS data was collected from coastal receivers for the entirety of 2019 (i.e., the 1st January 2019 to the 31st December 2019). Any traffic deemed to be temporary in nature (e.g., surveys) has been excluded.

543. Data coverage was observed to be generally good, however it should be considered that due to the distance offshore some of the further extents of the shipping and navigation study areas may have experienced some coverage issues under certain

conditions. On this basis, the main routes (see Section 15 of the NRA) have been validated against Anatec's internal routeing database to ensure any underrepresentation is accounted for.

544. Approximately 4% downtime was observed throughout the entirety of 2019.

B.3.3 Survey Data

545. Other general limitations associated with the use of AIS data (e.g., carriage requirements) are discussed in full within Section 7.3 of the NRA.

B.4 Long Term Assessment

B.4.1 Overview

546. An overview plot of all data recorded during 2019 within the shipping and navigation study areas (excluding any temporary traffic) is shown in Figure B.2, colour coded by vessel type.

547. Notable levels of wind farm traffic were recorded at the existing Dudgeon, Sheringham, and Race Bank Offshore Wind Farms, and it is observed that other vessel types generally avoided these boundaries.

548. Noting the presence of various gas platforms in the shipping and navigation study areas, O&G vessel activity was observed to be prominent within the eastern extent of the DEP shipping and navigation study area. The relevant gas platform locations are included in Figure B.3, and discussed in more detail in Section 10.2 of the NRA.

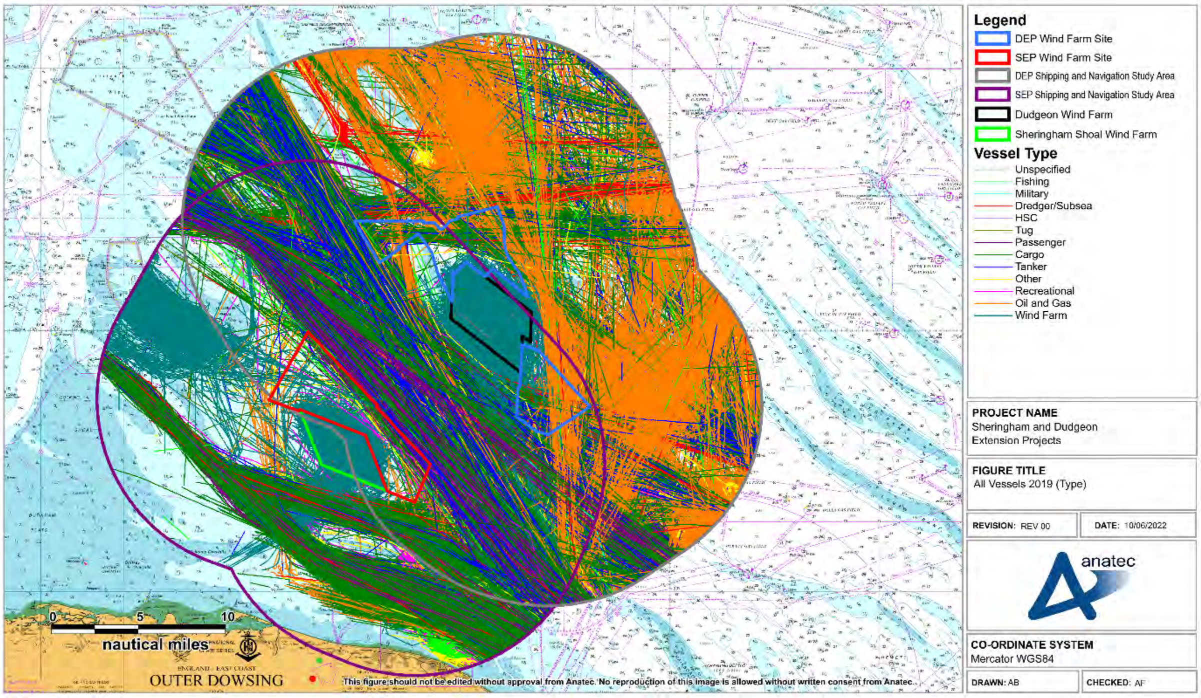

Figure B.2. All Vessels (2019)

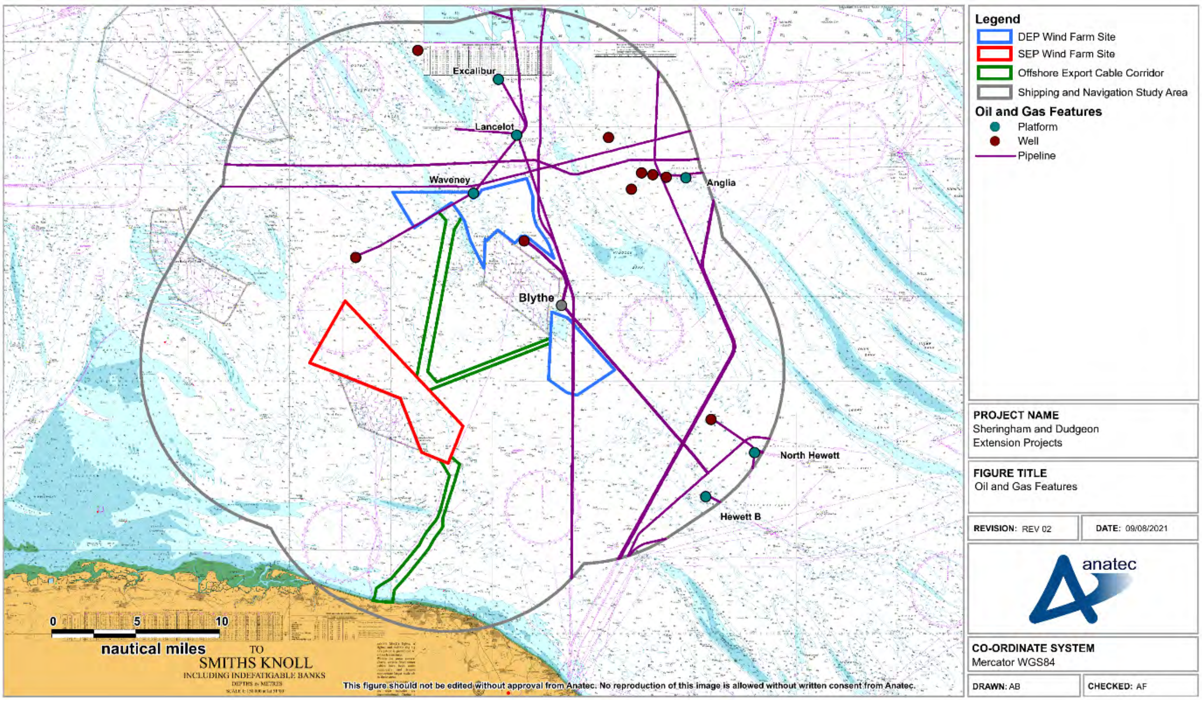

Figure B.3. Oil and Gas Infrastructure within the Shipping and Navigation Study Areas

B.4.2 Vessel Count

549. The average numbers of vessels with and without wind farm support vessels recorded per day for each month of 2019 for the SEP and DEP shipping and navigation study areas are presented in Figure B.4 and Figure B.5, respectively.

550. The busiest month for the DEP shipping and navigation study area was March with approximately 67 unique vessels per day including wind farm vessels. The quietest month for the DEP shipping and navigation study area was December with 55 unique vessels per day including wind farm vessels. Overall, for the DEP shipping and navigation study area showed minimal fluctuation in vessel numbers throughout the year.

551. The busiest month for the SEP shipping and navigation study area were February and March with approximately 80 unique vessels per day including wind farm vessels. The quietest month for the SEP shipping and navigation study area was December with 68 unique vessels per day including wind farm vessels. Overall, for the SEP shipping and navigation study area showed minimal fluctuation in vessel numbers throughout the year.

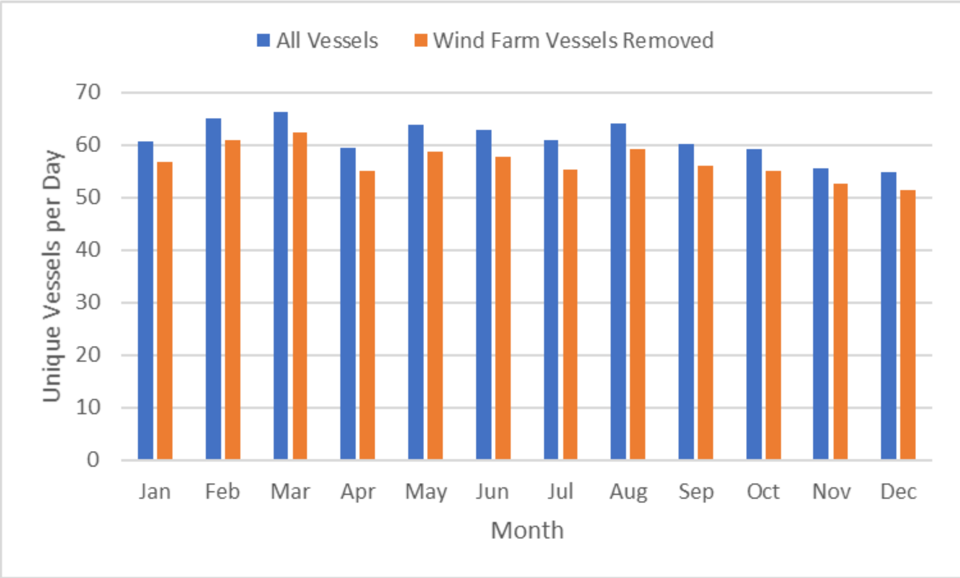

Figure B.4. Vessels per Day per Month within the DEP Shipping and Navigation Study Area

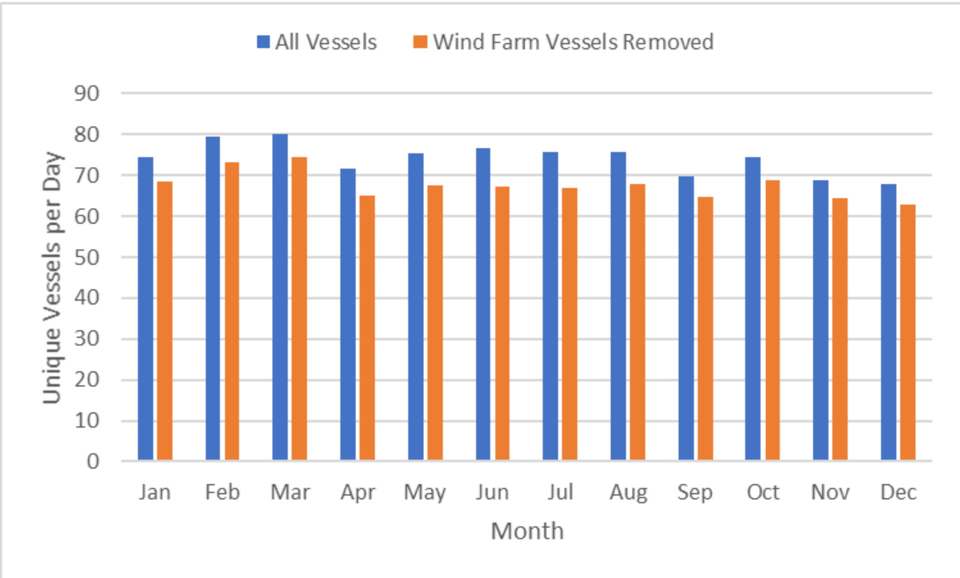

Figure B.5. Vessels per Day per Month within the DEP Shipping and Navigation Study Area

B.4.3 Vessel Type

552. The distribution of vessel types recorded during the study period within the SEP shipping and navigation study area and the DEP shipping and navigation study area are presented in Figure B.6 and Figure B.7, respectively. Note that vessel types detected in low numbers during the study period have been incorporated into the "other" category.

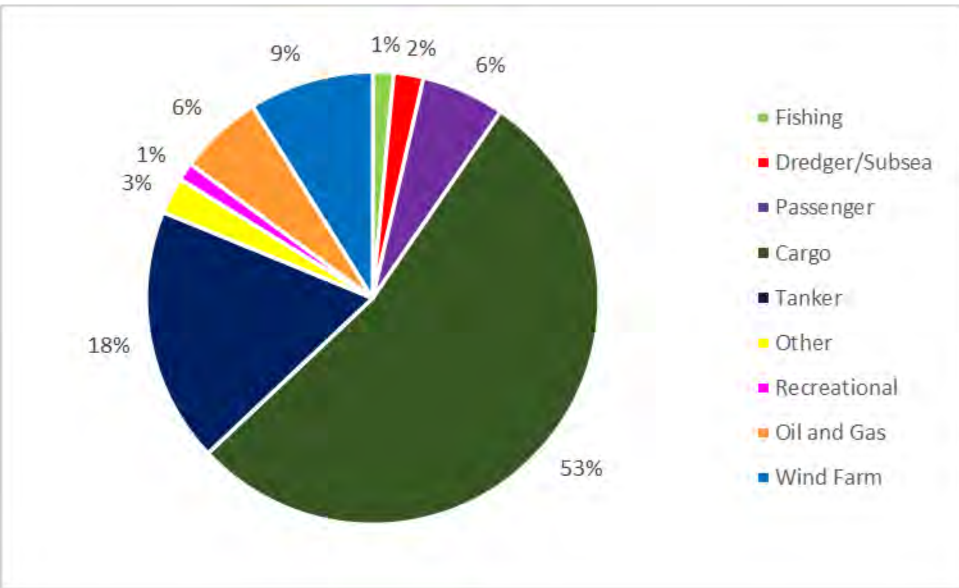

Figure B.6. SEP Shipping and Navigation Study Area Vessel Type Distribution

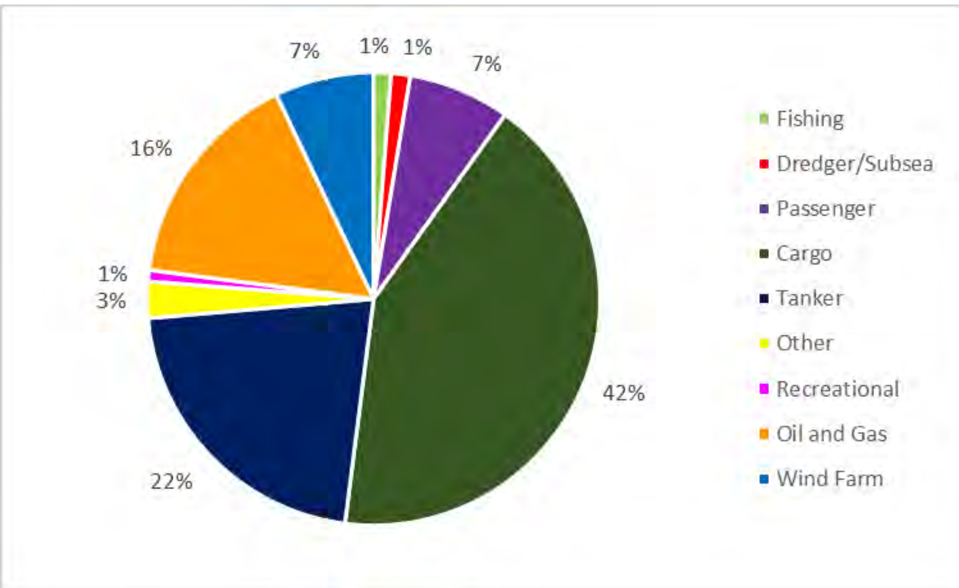

Figure B.7. DEP Shipping and Navigation Study Area Vessel Type Distribution

553. As can be seen from Figure B.6, the most common vessel type recorded within the SEP shipping and navigation study area was cargo, with such vessels accounting for approximately 53% of all traffic recorded. Other notable types include tankers (18%), wind farm vessels (9%), O&G vessels (6%), and passenger vessels (6%).

554. As can be seen from Figure B.7, the most common vessel type recorded within the DEP shipping and navigation study area was also cargo, with such vessels accounting for approximately 42% of all traffic recorded. Other notable types included tankers (22%), oil and gas vessels (16%), wind farm vessels (7%), and passenger vessels (7%).

B.4.4 Commercial Vessels

B.4.4.1 Overview

555. Figure B.8 presents the commercial vessels recorded via AIS within the shipping and navigation study areas during the study period.

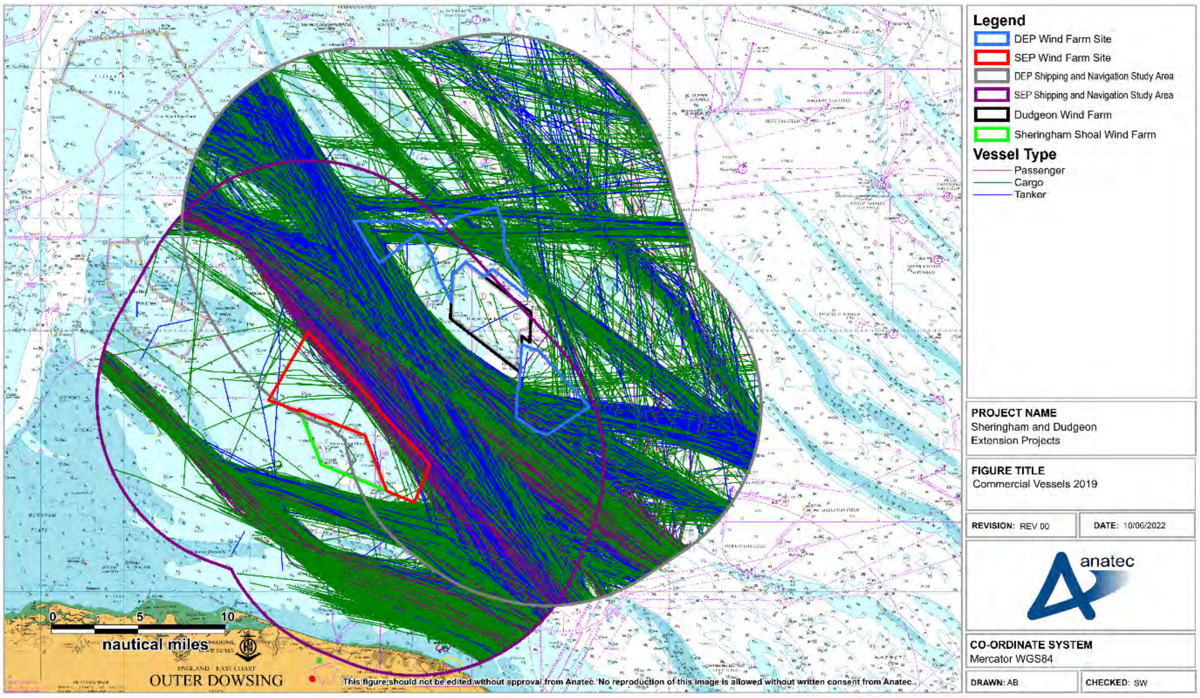

Figure B.8. Commercial Vessels (2019)

B.4.4.2 Analysis

556. The majority of the commercial traffic within the shipping and navigation study areas are on well defined routes with these comprising the routes that were used within the NRA (see Section 15). Notably there was clear northwest to southeast traffic between the existing SEP and DEP sites. A coastal route was also observed within the southern area of the SEP shipping and navigation study area. The DEP wind farm site had a small number of commercial vessels transiting through it, on average three cargo vessels per day and one tanker per day, respectively. The SEP wind farm site had limited numbers of commercial vessels transiting through it.

557. A breakdown of the number of unique vessels for each commercial vessel type intersecting the respective wind farm site and shipping and navigation study areas is presented in Figure B.9.

558. For the SEP shipping and navigation study area on average throughout the entire study period there were four to five passenger vessels per day, 39 to 40 cargo vessels per day, and 13 to 14 tankers per day, respectively.

559. For the DEP shipping and navigation study area on average throughout the entire study period there were four to five passenger vessels per day, 26 cargo vessels per day, and 13 tankers per day, respectively.

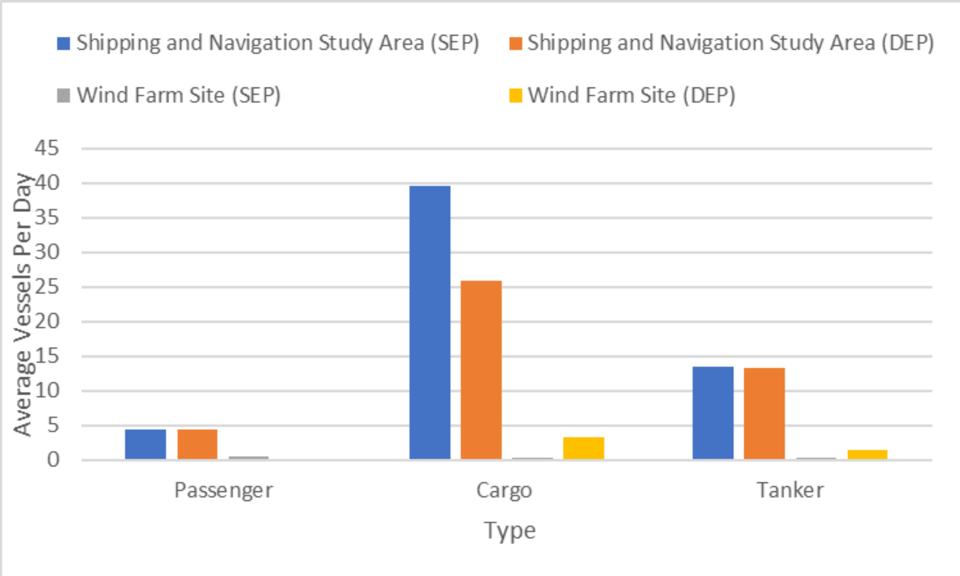

Figure B.9. Average Number of Commercial Vessel Throughout the Survey Period

560. Figure B.10 - Figure B.12 present the average number of unique commercial vessels for each vessel type detected per month for the wind farm site and shipping and navigation study areas, respectively.

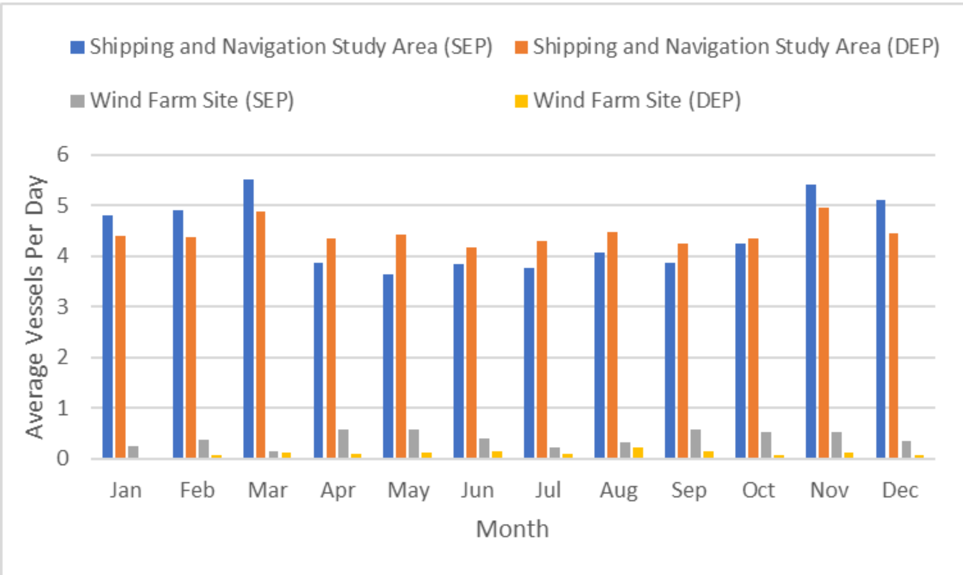

Figure B.10. Average number of Passenger Vessels per Day per Month

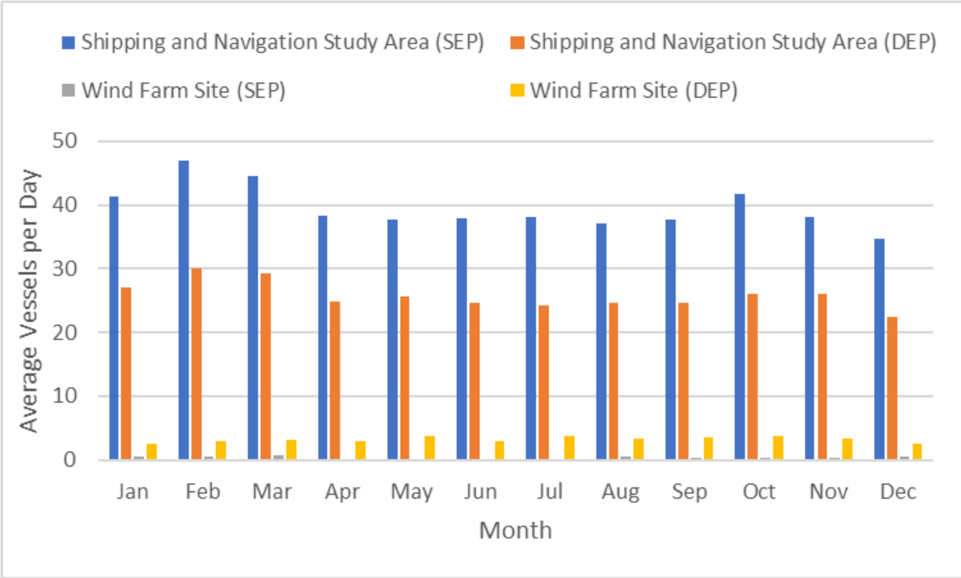

Figure B.11. Average number of Cargo Vessels per Day per Month

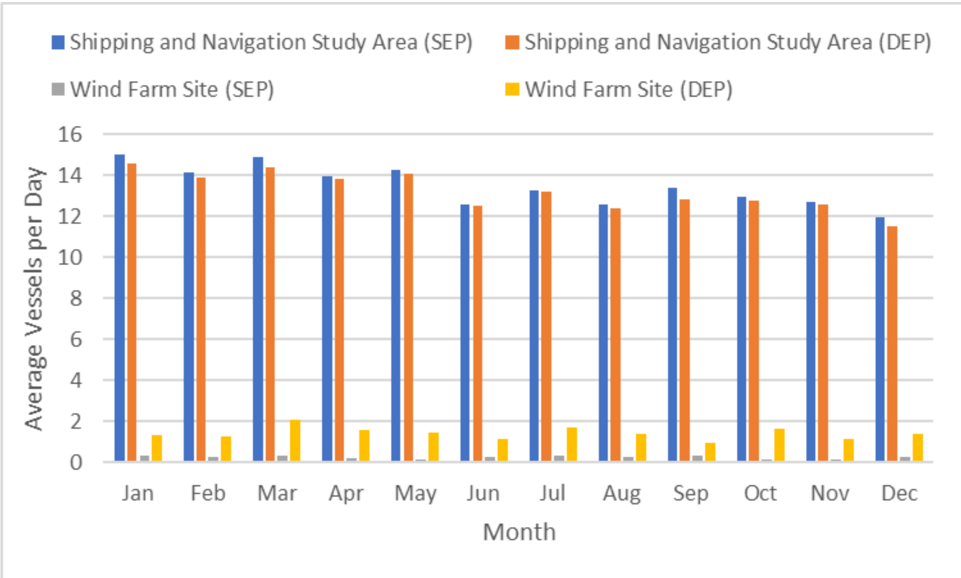

Figure B.12. Average number of Tankers per Day per Month

561. Passenger vessels showed minimal seasonal variation both within the respective shipping and navigation study areas and within the two wind farm sites. A very small number of passenger vessels transited either the DEP or SEP wind farm sites.

562. Cargo vessels also showed minimal seasonal variation with the busiest month for both the SEP shipping and navigation study area and the DEP shipping and navigation study area being February with approximately 47 unique cargo vessels (SEP shipping and navigation study area) and 30 unique cargo vessels (DEP shipping and navigation study area), respectively. The quietest month for the SEP shipping and navigation study area was August with 37 unique cargo vessels. The quietest month for the DEP shipping

and navigation study area was December with 22 unique cargo vessels. A limited number of cargo vessels transited either the DEP or SEP wind farm sites.

563. Tankers similarly showed minimal seasonal variation. The busiest months for the SEP shipping and navigation study area were January and April with approximately 15 unique vessels per day. The quietest month for the SEP shipping and navigation study area was December with approximately 12 unique vessels per day. The busiest month for the DEP shipping and navigation study area was January with approximately 15 unique tankers per day. The quietest month for the DEP shipping and navigation study area was December with approximately 12 unique tankers per day.

564. Table B.1 and Table B.2 presents a summary of the average number of vessels within each of the shipping and navigation study areas during the busiest month, quietest month, and the average throughout the entire study period for the SEP shipping and navigation study area and the DEP shipping and navigation study area, respectively.

Table B.1.: Quietest, Busiest and Average Number of Commercial Vessels per Day per Month for the SEP Shipping and Navigation Study Areas

Vessel Type	Quietest Month (vessels per day)	Busiest Month (vessels per day)	Average (vessels per day)
Passenger	4	5	4
Cargo	37	47	39
Tanker	12	15	13

Table B.2.: Quietest, Busiest and Average Number of Commercial Vessels per Day per Month for the DEP Shipping and Navigation Study Areas

Vessel Type	Quietest Month (vessels per day)	Busiest Month (vessels per day)	Average (vessels per day)
Passenger	4	5	4
Cargo	22	30	26
Tanker	12	15	13

B.4.4.3 Summary

565. A limited number of commercial vessels transited through either of the wind farm sites throughout the study period. There was also limited seasonal variation observed for any commercial vessel types.

566. The majority of the commercial vessel traffic was observed to transit through the shipping and navigation study areas using the routes defined within the NRA.

B.4.5 Fishing Vessels

B.4.5.1 Overview

567. Figure B.13 presents the fishing vessels recorded via AIS within the shipping and navigation study areas during the study period. It should be considered that as this vessel traffic assessment is AIS only, it is likely to be under representative of actual fishing vessel levels. Non AIS fishing activity has been assessed within Section 14.1.3.7 of the NRA, and additional details are provided within Chapter 12 (Commercial Fisheries) of the ES.

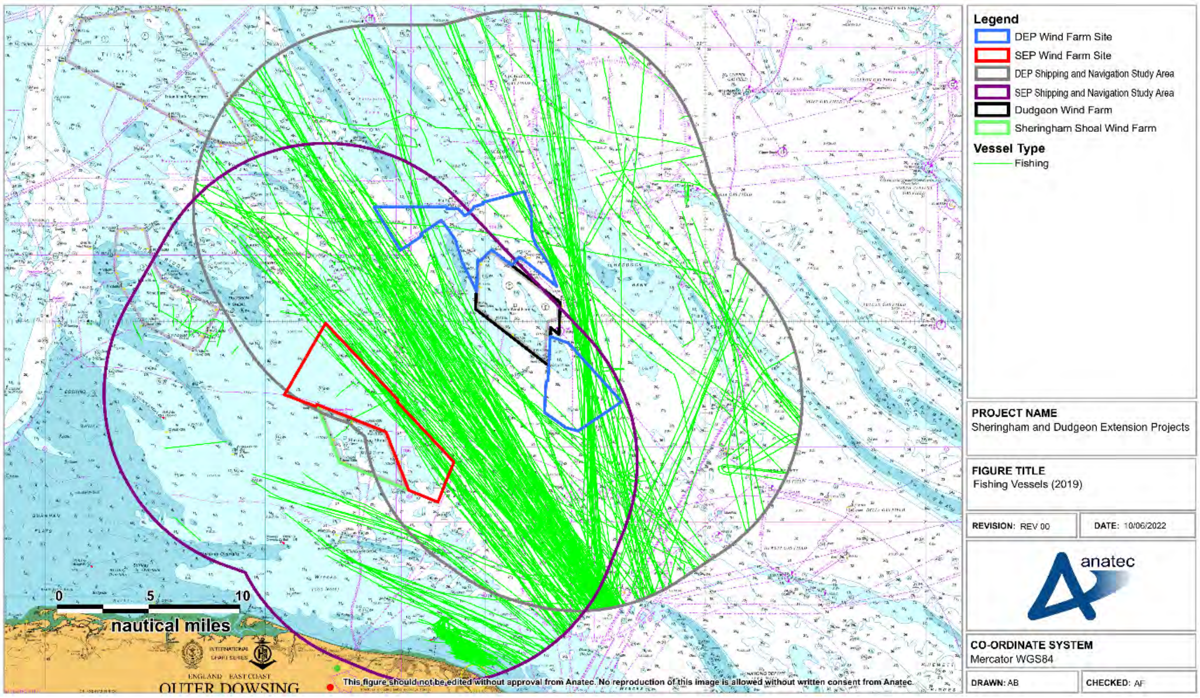

Figure B.13. Fishing Vessels 2019

B.4.5.2 Analysis

568. A speed assessment was undertaken to determine the behaviour of fishing vessels within the shipping and navigation study areas. Figure B.14 presents the results of this speed assessment. The average number of fishing vessels engaged in fishing and transiting per day for each month is then summarised for the shipping and navigation study areas and wind farm sites in Figure B.15 and Figure B.16.

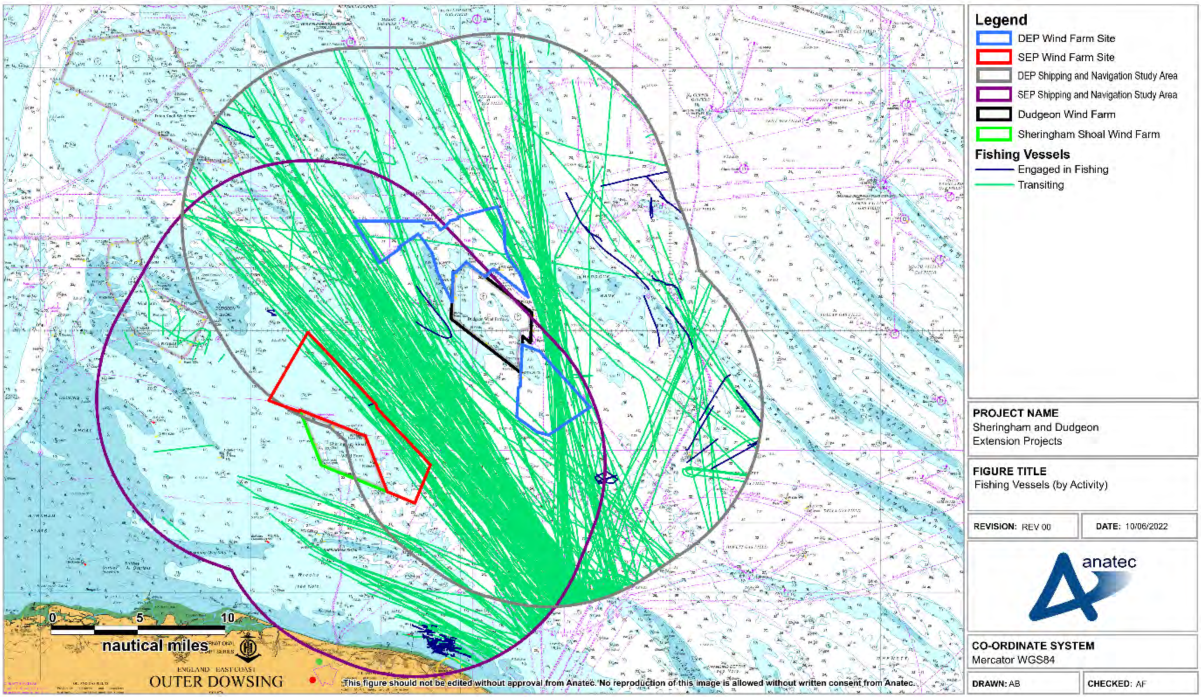

Figure B.14. Fishing Vessels (by Activity)

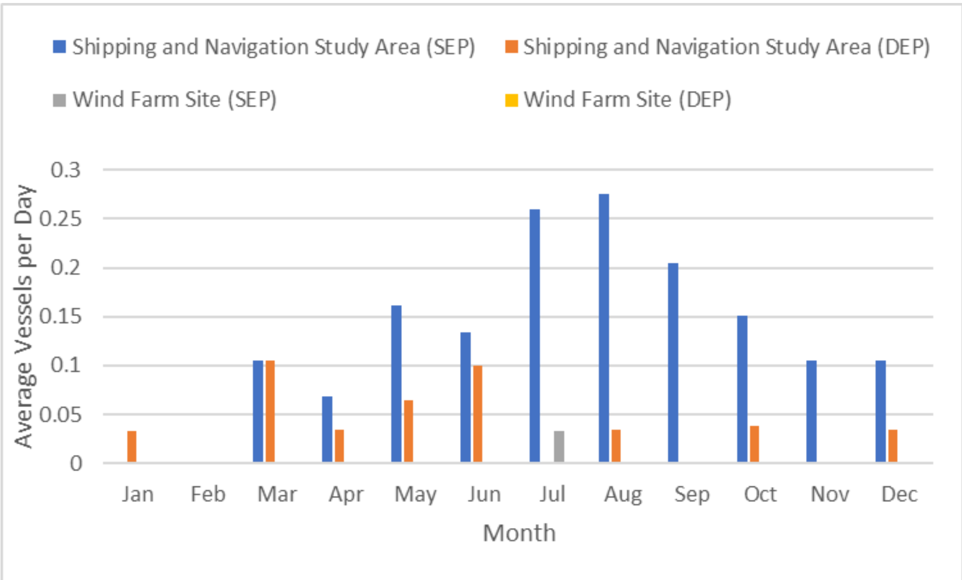

Figure B.15. Fishing Vessels Engaged in Fishing per Day by Month

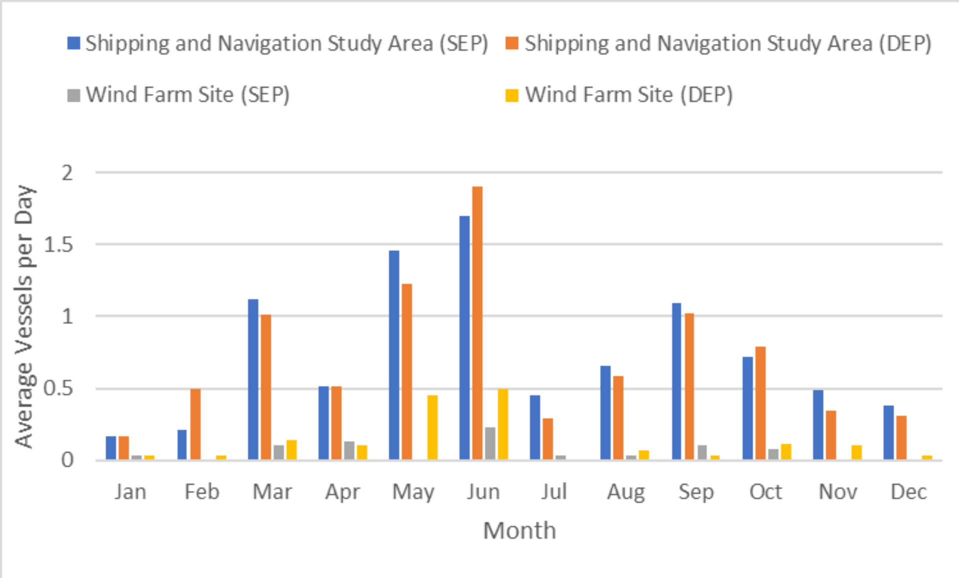

Figure B.16. Fishing Vessels Transiting per Day by Month

569. Only a small number of the fishing vessels detected during the study period were actively engaged in fishing throughout the year, noting that this only includes fishing vessels transmitting via AIS, therefore may be an underestimate. Fishing vessels actively engaged in fishing were mostly detected within the coastal regions in the southern extent of the SEP shipping and navigation study area.

570. Transiting fishing vessels showed some seasonal variation for both shipping and navigation study areas. The busiest month for fishing vessels was June for both SEP shipping and navigation study area and DEP shipping and navigation study area with approximately one to two unique transiting fishing vessels detected for both areas, respectively. The quietest month for both SEP shipping and navigation study area and DEP shipping and navigation study area was January with approximately one unique fishing vessel every six days.

571. A small number, approximately one transiting fishing vessel every two days, was observed within the DEP wind farm site during May and June. Throughout the rest of the year a negligible amount of fishing vessels were observed within either of the wind farm sites.

B.4.5.3 Summary

572. The majority of the fishing vessels detected throughout the study period were transiting through the area with a small number of fishing vessels engaged in fishing within the coastal region of the SEP shipping and navigation study area.

573. Fishing vessels showed some seasonal variation throughout the year with a maximum number of two unique vessels observed for both shipping and navigation study areas during June and a minimal number (one every six days) of fishing vessels observed within January.

B.4.6 Oil and Gas Vessels

B.4.6.1 Overview

574. Figure B.17 presents the O&G vessels recorded via AIS within the shipping and navigation study areas during the study period. The gas platforms within either of the shipping and navigation study areas are presented in Figure B.3 for reference.

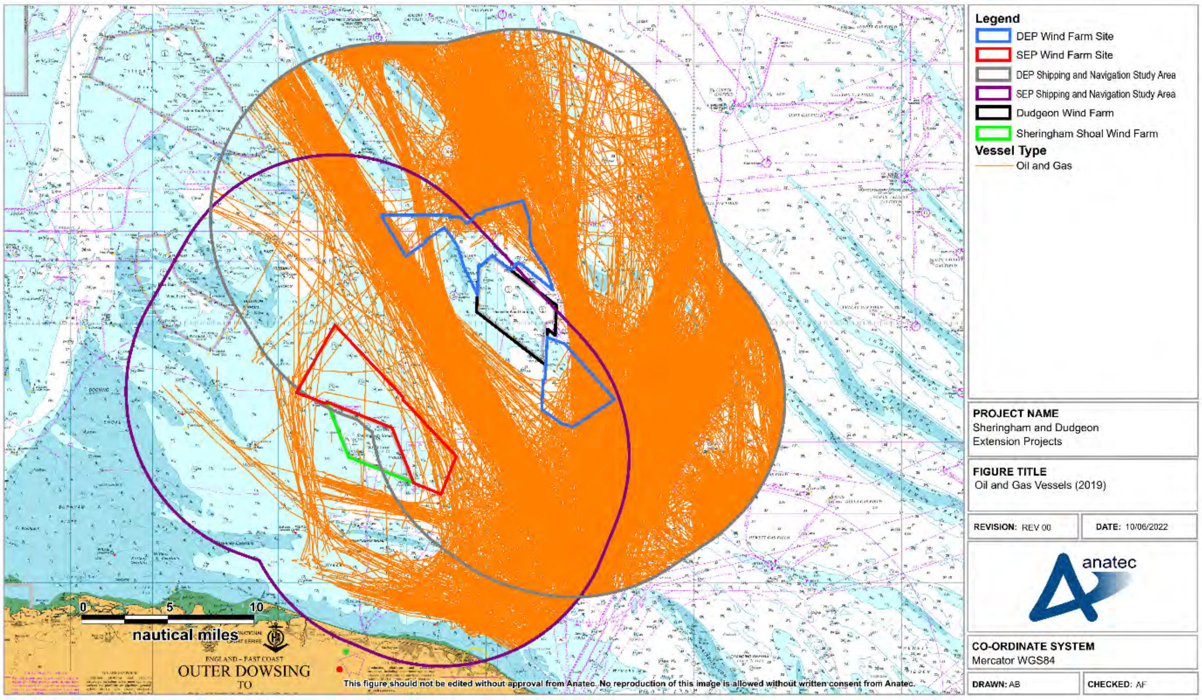

Figure B.17. Oil and Gas Vessels (2019)

B.4.6.2 Analysis

575. O&G vessels were observed to utilise a number of routes similar to the routes that other commercial vessels utilise to transit through the area (see Section B.4.4). O&G vessels were also concentrated to the eastern section of the DEP shipping and navigation study area, the area within which a number of gas platforms are located (see Figure B.3).

576. A breakdown of the number of unique O&G vessels intersecting the respective wind farm sites and shipping and navigation study areas is presented in Figure B.18.

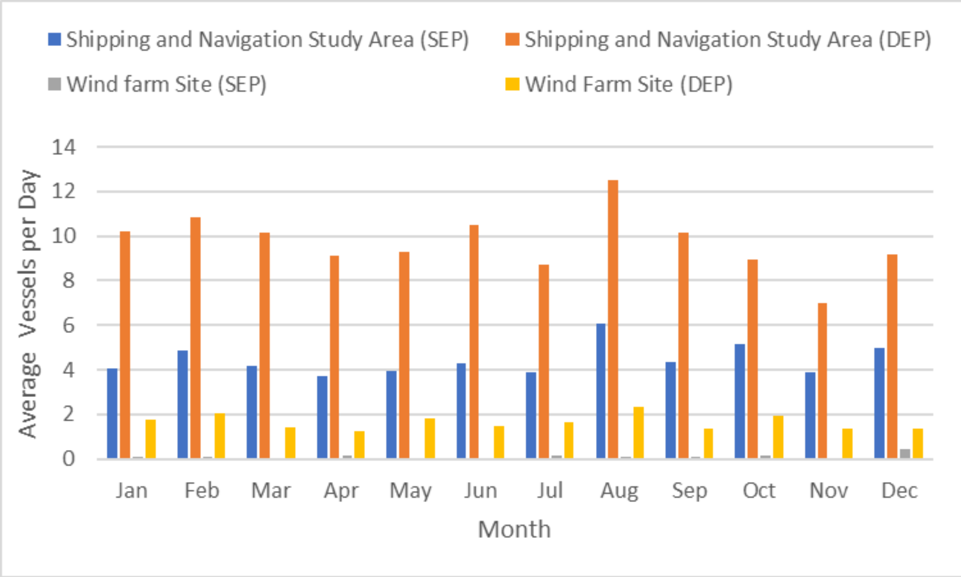

Figure B.18. Average Number of Oil and Gas Vessels per Day

577. For the SEP shipping and navigation study area on average throughout the entire study period there was approximately four unique O&G vessels per day.

578. For the DEP shipping and navigation study area on average throughout the entire study period there was approximately 10 unique O&G vessels per day.

579. The busiest month for the SEP shipping and navigation study area was August with approximately six unique O&G vessels per day. The quietest month for the SEP shipping and navigation study area was April with three to four unique O&G vessels per day.

580. The busiest month for the DEP shipping and navigation study area was August with approximately 13 unique O&G vessels per day. The quietest month for the DEP shipping and navigation study area was November with seven unique O&G vessels per day.

581. The SEP wind farm site had negligible levels of O&G vessels throughout the entire study period. The DEP wind farm site had on average approximately one to two unique O&G vessels per day.

B.4.6.3 Summary

582. O&G vessels showed minimal seasonal variation during the study period within both the DEP shipping and navigation study area and the SEP shipping and navigation study area with some fluctuations observed from month to month.

583. O&G vessels were observed to utilise a number of the routes defined within the NRA through the shipping and navigation study areas. A significant number of O&G vessels

were observed in the western section of the DEP shipping and navigation study area where a number of gas platforms are located.

B.4.7 Marine Aggregate Dredgers

B.4.7.1 Overview

584. Figure B.19 presents the marine aggregate dredgers recorded via AIS within the shipping and navigation study areas during the study period.

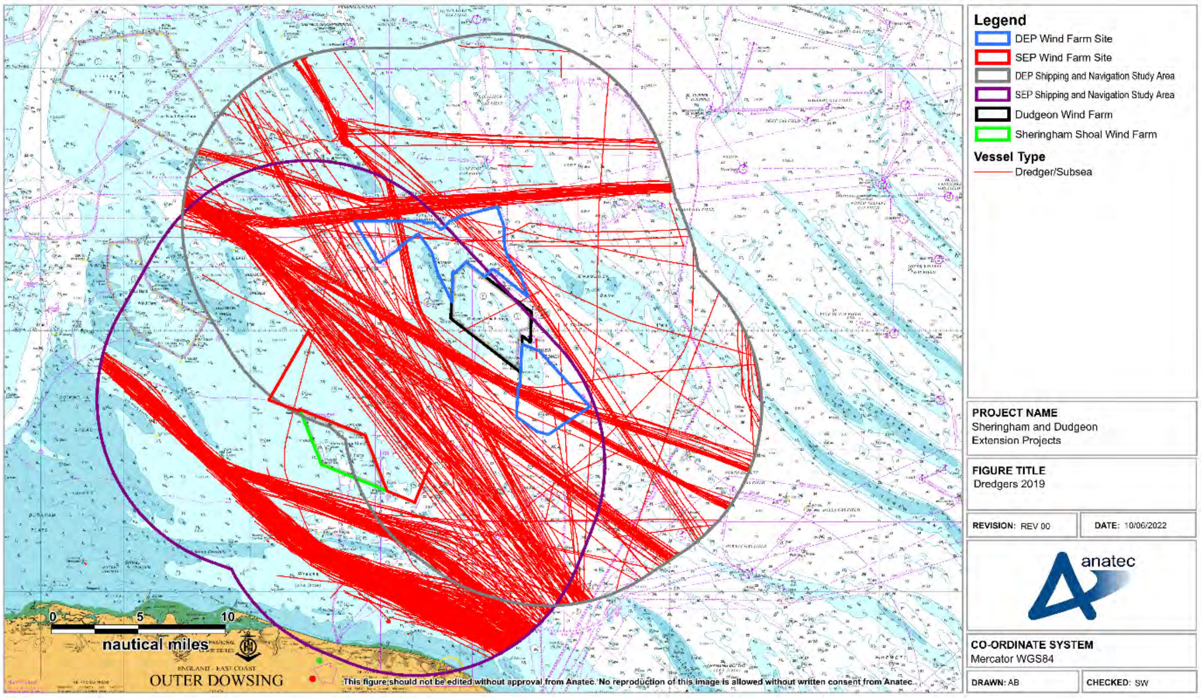

Figure B.19. Marine Aggregate Dredgers (2019)

585. The majority of marine aggregate dredger vessels transited across both shipping and navigation study areas using the routes defined within sections 15 and 14.1.3.6 of the NRA.

B.4.7.2 Analysis

586. A breakdown of the number of unique marine aggregate dredgers intersecting the respective wind farm sites and shipping and navigation study areas is presented in Figure B.20.

587. For the SEP shipping and navigation study area on average throughout the entire study period there were one to two marine aggregate dredgers per day.

588. For the DEP shipping and navigation study area on average throughout the entire study period there was one marine aggregate dredger per day.

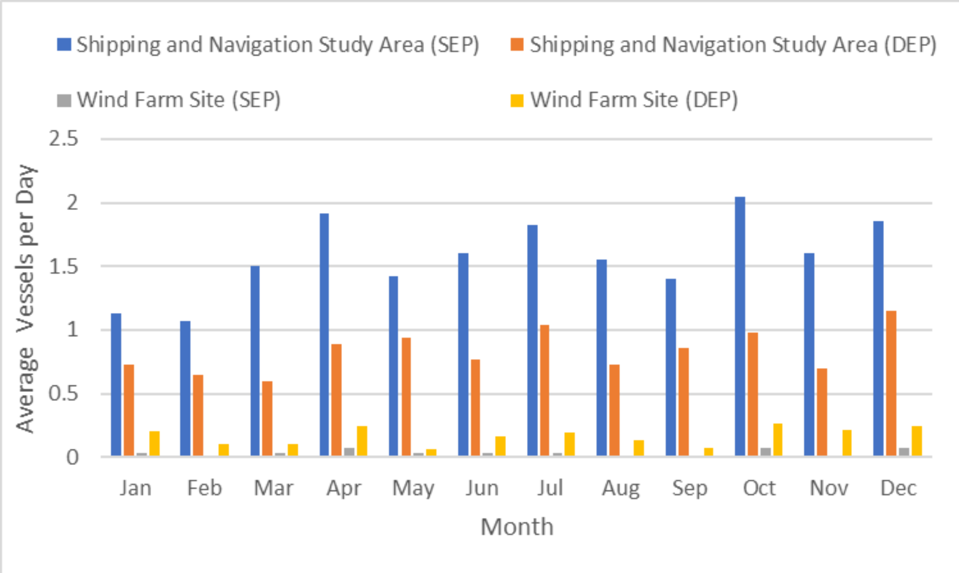

Figure B.20. Average Number of Marine Aggregate Dredgers per Day per Month

589. The busiest month for the SEP shipping and navigation study area was October with approximately two unique marine aggregate dredger vessels per day. The quietest months for the SEP shipping and navigation study area were January and February with approximately one unique marine aggregate dredger per day. There was a negligible number of marine aggregate dredgers that transited through the SEP wind farm site throughout the study period.

590. The busiest month for the DEP shipping and navigation study area were July and December with approximately one to two unique marine aggregate dredger vessels per day. The quietest month for DEP shipping and navigation study area was March with less than one unique marine aggregate dredger per day. There was a small number of marine aggregate dredgers that transited through the DEP wind farm site that showed minimal seasonal variation.

B.4.7.3 Summary

591. Marine aggregate Dredgers showed minimal seasonal variation during the study period within both the DEP shipping and navigation study area and SEP shipping and navigation study area with some fluctuations observed month to month.

592. Marine aggregate Dredgers were observed to utilise a number of the routes defined within the NRA through the shipping and navigation study areas.

B.4.8 Recreation Vessels

B.4.8.1 Overview

593. Figure B.21 presents the recreational vessels recorded via AIS within the shipping and navigation study areas during the study period.

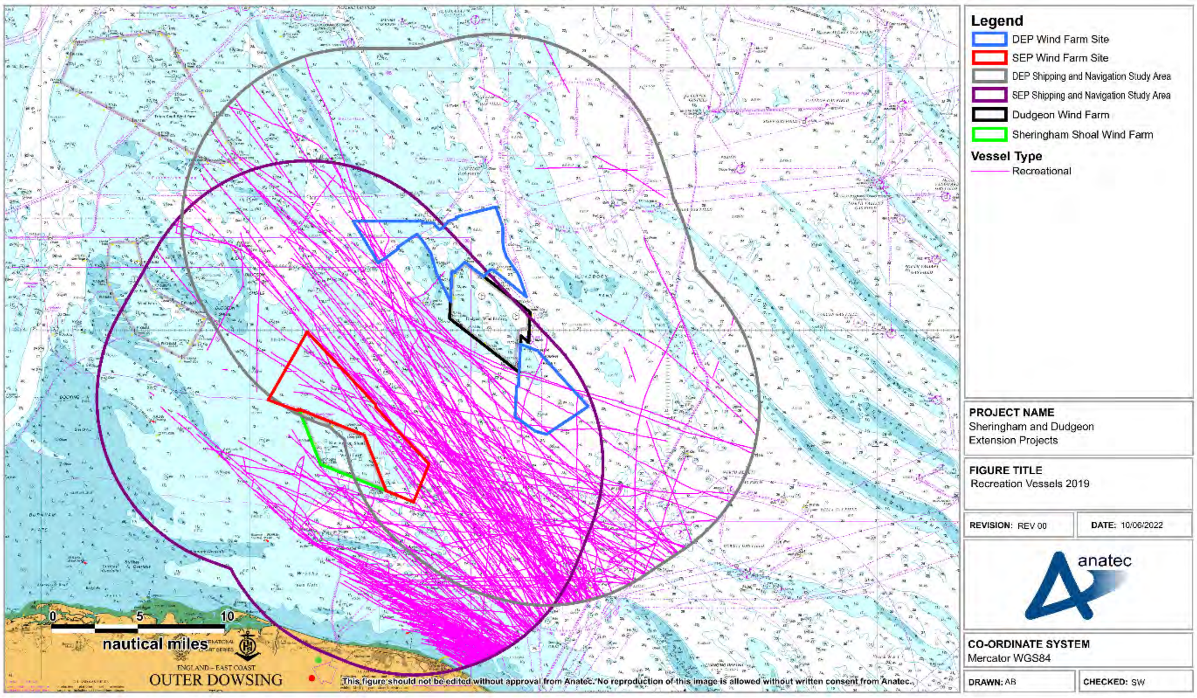

Figure B.21. Recreational Vessels (2019)

594. The majority of recreational vessels transited within the coastal region to the south of the SEP shipping and navigation study area. A significant number of recreational vessels also transited through the free sea room between the existing Dudgeon wind farm and Sheringham wind farm.

B.4.8.2 Analysis

595. A breakdown of the number of unique recreational vessels intersecting the respective wind farm sites and shipping and navigation study areas is presented in Figure B.22.

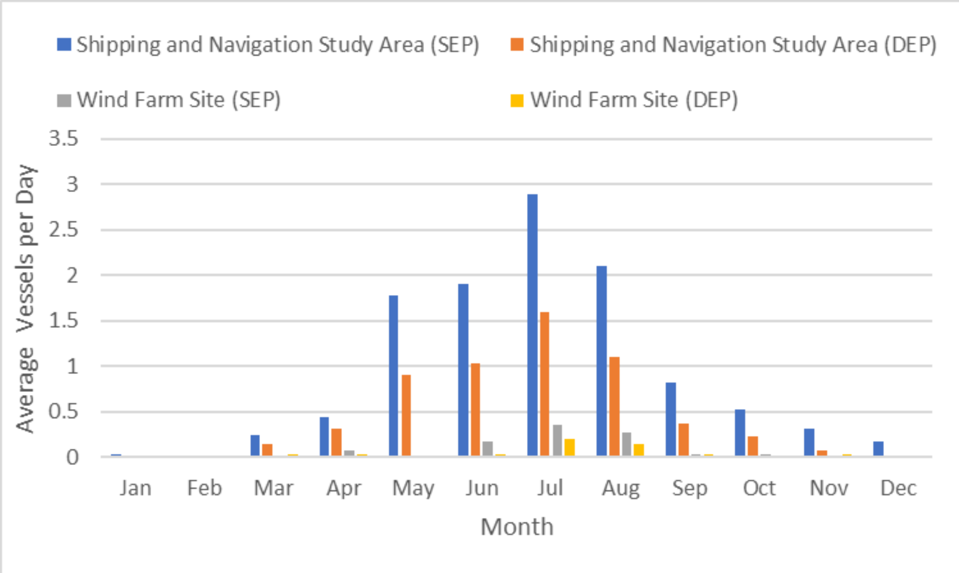

Figure B.22. Average Number of Recreational Vessels per Day per Month

596. For the SEP shipping and navigation study area on average throughout the entire study period there were one recreational vessel per day, noting that the majority of these were observed throughout summer months.

597. For the DEP shipping and navigation study area on average throughout the entire study period there were one recreational vessel every two days, noting the majority of these were observed throughout summer months.

598. The busiest month for the SEP shipping and navigation study area was July with approximately two to three unique recreational vessels per day. A clear seasonal variation was observed for recreational vessels within the SEP shipping and navigation study area with very limited numbers of recreational vessels observed throughout the winter months. A small number of recreational vessels were observed to transit through the SEP wind farm site with all of these transits occurring throughout the summer months.

599. The busiest month for the DEP shipping and navigation study area was July with approximately one to two unique recreational vessels per day. A clear seasonal variation was observed for recreational vessels within the DEP shipping and navigation study area with very limited numbers of recreational vessels observed throughout the winter months. A negligible number of recreational vessels were observed to transit through the DEP wind farm site.

B.4.9 Summary

600. Recreational vessels showed seasonal variation within both DEP shipping and navigation study area and the SEP shipping and navigation study area. A minimal number of recreational vessels were observed within both of the wind farm sites.

601. Recreational vessels were generally observed within the coastal regions of the SEP shipping and navigation study area.

B.5 Survey Data Comparison

602. As per Section 5 of the NRA, at PEIR stage a total of 28 days of survey data (AIS, radar, visual observation data) has been collected during July/August 2020 and January/February 2021. This section summarises comparison of the survey data against the long term 2019 data.

603. Figure B.23 presents the vessels detected throughout the 28-day study period for the shipping and navigation study areas.

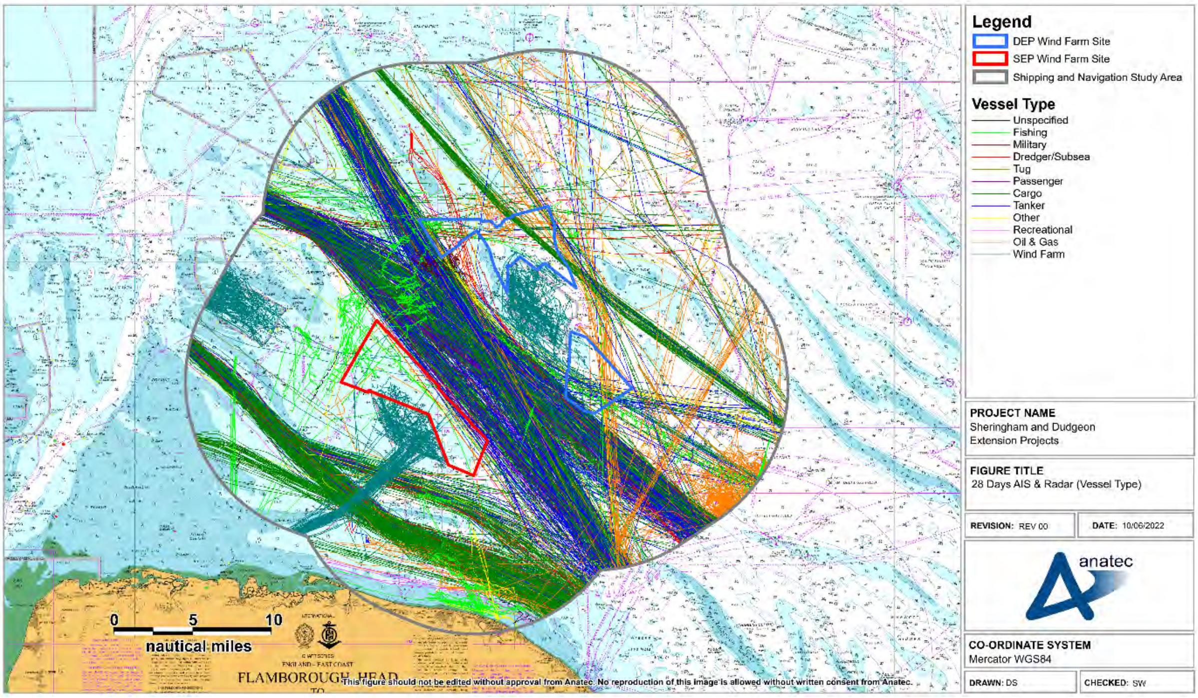

Figure B.23. 28 Days Survey Data (Type)

604. The routeing of vessels during the summer survey period was on the whole similar to the 2019 AIS data and comparable to the routes presented within the NRA (Section 15). A number of commercial vessel routes were observed between the two existing Sheringham Shoal and Dudgeon wind farms with a number of coastal routes also present. O&G vessel routeing was present within the western section of the DEP shipping and navigation study area with a number of these destined for gas platforms located within the western section of the DEP shipping and navigation study area (see Figure B.3).

605. Fishing vessels were observed both transiting, generally using similar routes to commercial vessels through the area, and engaged in fishing, especially within the coastal region within the southern section of the SEP shipping and navigation study area. A comparison of the average number of each vessel type analysed in the

previous sections detected throughout the 2019 study period against the average number of each vessel type detected throughout the summer survey period for the SEP shipping and navigation study area and the DEP shipping and navigation study area are presented in Table B.4 and Table B.4.

Table B.3.: Comparison of the Number of Each Vessel Type Detected During 2019 and the Summer Survey Data SEP Shipping and Navigation Study Area

Vessel Type	12 Months AIS Data (Vessels per Day)			2020/2021 Survey Vessels per Day)
	Quietest Month	Busiest Month	Average	Average
Passenger	4	5	4	3
Cargo	37	47	39	38
Tanker	12	15	13	12
Fishing	<1	2	1	3
Oil and Gas	4	6	4	4
Marine Aggregate Dredgers	1	2	1-2	1-2
Recreational	0	3	1	0-1

Table B.4.: Comparison of the Number of Each Vessel Type Detected During 2019 and the Summer Survey Data DEP Shipping and Navigation Study Area

Vessel Type	12 Months AIS Data (Vessels per Day)			2020/2021 Survey Vessels per Day)
	Quietest Month	Busiest Month	Average	Average
Passenger	4	5	4	3-4
Cargo	22	30	26	23
Tanker	12	15	13	12
Fishing	<1	2	0-1	2
Oil and Gas	7	13	10	8
Marine Aggregate Dredgers	<1	1	0-1	1
Recreational	0	1-2	0-1	0-1

B.6 Conclusion

606. A year of 2019 AIS data has been analysed to validate the 2020 summer survey data and 2021 winter survey data at SEP and DEP within the respective study area. This data has been used to identify any seasonal variation (including any not reflected within the short term survey data), and to identify and account for any potential effect the COVID-19 situation may have had on the survey data

607. The main type of vessels detected within the DEP shipping and navigation study area during 2019 were cargo vessels (42%), tankers (22%), and O&G vessels (16%). Similarly, the main type of vessels detected during the 2020 summer survey and 2021 winter survey within the DEP wind farm study area were cargo vessels (41%), tankers (21%), and O&G vessels (15%). Smaller but significant numbers of passenger vessels were also detected during both periods. Overall, the vessel types detected within the DEP shipping and navigation study area were similar between the 2020/2021 surveys and the year of 2019 AIS data presented within this report.

608. The main type of vessels detected within the SEP shipping and navigation study area during 2019 were cargo vessels (53%), tankers (18%), and O&G vessels (6%). The main type of vessels detected during the 2020 summer survey and 2021 winter survey within the SEP wind farm site were cargo vessels (53%), tankers (17%), wind farm vessels (10%), and O&G vessels (6%). Overall, the vessel types detected within the SEP shipping and navigation study area were similar between the 2020/2021 surveys and the year of 2019 AIS data presented within this report.

609. The average number of vessels within the DEP shipping and navigation study area were similar between the two data sets.

610. The average number of vessels within the SEP shipping and navigation study area were similar between the two data sets.

611. The routeing that vessels utilised within the DEP shipping and navigation study area during the summer 2020 and winter 2021 surveys was also similar to the AIS 2019 data set.

612. The routeing that vessels utilised within the SEP shipping and navigation study area during the summer 2020 and winter 2021 surveys was also similar to the AIS 2019 data set.

613. In conclusion, the 2020/2021 surveys and 2019 AIS only datasets showed largely the same trends with regards to vessels types and vessel numbers within the SEP and DEP shipping and navigation study areas. Therefore, the summer and winter survey data sets are considered to be reflective of the respective study areas and thus will correctly inform the impacts and risks for the NRA.

Annex C Consequences

614. This Appendix presents an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the impact of the structures within the wind farm sites.

615. The significance of the impact of the SEP and DEP is also assessed based on risk evaluation criteria and comparison with historical accident data in UK waters[16].

C.1 Risk Evaluation Criteria

C.1.1 Risk to People

616. Regarding the assessment of risk to people two measures are considered, namely:

- Individual risk; and
- Societal risk.

C.1.1.1 Individual Risk

617. Individual risk considers whether the risk from an incident to a particular individual changes significantly due to the presence of the structures within the wind farm sites. Individual risk considers not only the frequency of the incident and the consequence (likelihood of death), but also the individual's fractional exposure to that risk, i.e., the probability of the individual being in the given location at the time of the incident.

618. The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the structures within the wind farm sites are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of SEP and DEP relative to the UK background individual risk levels.

619. Annual risk levels to crew (the annual risk to an average crew member) for different vessel types are presented in Figure C.1, which also includes upper and lower bounds for risk acceptance criteria as suggested in IMO Maritime Safety Committee (MSC) 72/16 (IMO MSC, 2001). The annual individual risk level to crew falls within the ALARP region for each of the vessel types presented.

[16] For the purposes of this assessment, UK waters is defined as the UK Exclusive Economic Zone and UK territorial waters means within the 12nm limit from the British Isles, excluding the Republic of Ireland.

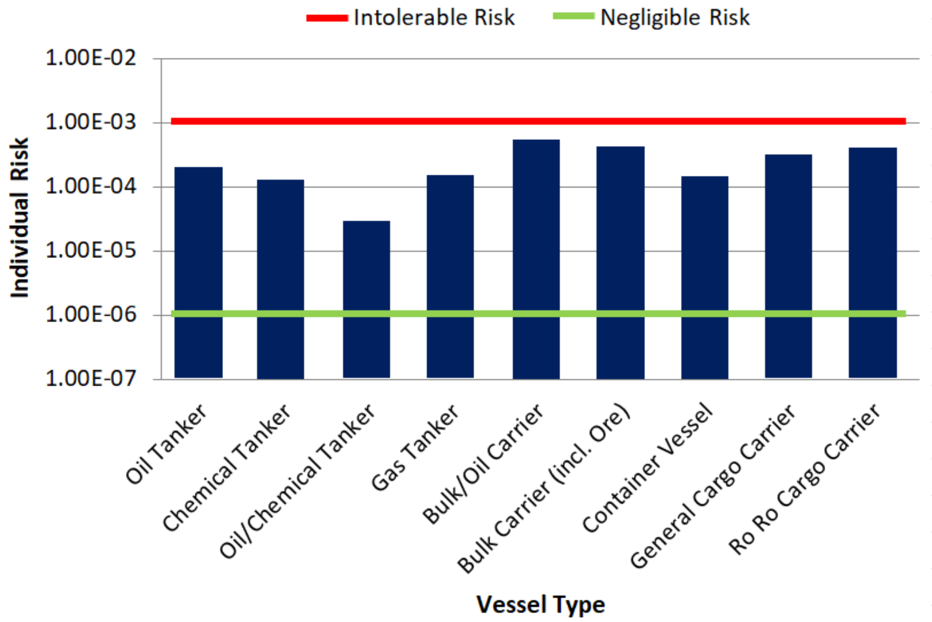

Figure C.1 Individual Risk Levels and Acceptance Criteria per Vessel Type

620. The typical bounds defining the ALARP regions for decision making within shipping are presented in Table C.1. For a new vessel, the target upper bound for ALARP is set lower since new vessels are expected to benefit (in terms of design) from changes in legislation and improved maritime safety.

Table C.1 Individual Risk ALARP Criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
Third party	10^{-6}	10^{-4}
New vessel target	10^{-6}	Above values reduced by one order of magnitude

621. On a UK basis, the MCA have presented individual risks for various UK industries based on HSE data from 1987 to 1991. The risks for different industries are presented in Figure C.2.

622. The individual risk for sea transport of 2.9×10^{-4} per year is consistent with the worldwide data presented in Figure C.1, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

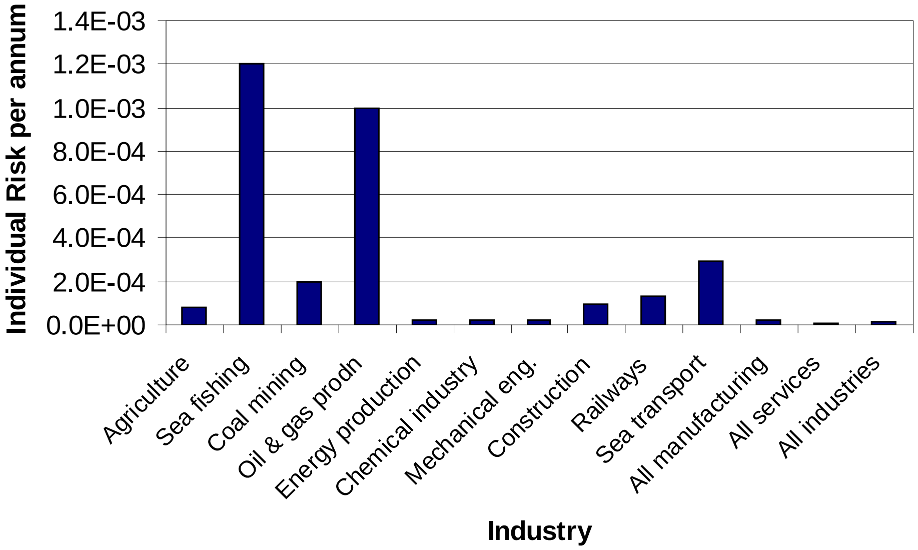

Figure C.2 Individual Risk per Year for various UK Industries

C.1.1.2 Societal Risk

623. Societal risk is used to estimate risks of incidents affecting many persons(catastrophes) and acknowledging risk averse or neutral attitudes. Societal risk includes the risk to every person, even if a person is only exposed to risk on one brief occasion. For assessing the risk to a large number of affected people, societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

624. Within this assessment, societal (navigational based) risk can be assessed for SEP and DEP, giving account to the change in risk associated with each incident scenario caused by the introduction of the structures within the wind farm sites. Societal risk may be expressed as:

- Annual fatality rate where frequency and fatality are combined into a convenient one-dimensional measure of societal risk(also known as PLL); and
- F-N diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

625. When assessing societal risk this study focuses on PLL, which accounts for the number of people likely to be involved in an incident (which is higher for certain vessel types) and assesses the significance of the change in risk compared to background risk levels.

C.1.2 Risk to Environment

626. For risk to the environment the key criteria considered in terms of the risk due to SEP and DEP is the potential volume of oil spilled from the vessel involved in an incident.

627. It is recognised there will be other potential pollution, e.g., hazardous containerised cargoes; however oil is considered the most likely pollutant and the extent of

predicted oil spills will provide an indication of the significance of pollution risk due to SEP and DEP compared to UK background pollution risk levels.

C.2 Marine Accident Investigation Branch Incident Data

C.2.1 All Incidents in UK Waters

628. All British-flagged commercial vessels are required to report incidents to the MAIB. Non-British flagged vessels do not have to report an incident to the MAIB unless they are located at a UK port or within 12 nm territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report incidents to the MAIB; however a significant proportion of such incidents are reported to and investigated by the MAIB.

629. The MCA, harbour authorities and inland waterway authorities also have a duty to report incidents to MAIB. Therefore, whilst there may be a degree of under-reporting of incidents with minor consequences, those resulting in more serious consequences, such as fatalities, are likely to be reported.

630. Only incidents occurring in UK waters have been considered within this assessment for which the MAIB data is most comprehensive. It is also noted that incidents occurring in ports/harbours and rivers/canals have been excluded since the causes and consequences may differ considerably from an incident occurring offshore, which is the location of most relevance to SEP and DEP.

631. Taking into account these criteria, a total of 12,093 accidents, injuries and hazardous incidents were reported to the MAIB in the 20-year period between 2000 and 2019 involving 13,965 vessels (some incidents such as collisions involved more than one vessel).

632. The locations of all incidents reported in the vicinity of the UK are presented in Figure C.3, colour-coded by incident type[17]. The majority of incidents occur in coastal waters. The distribution of incidents by year is then presented in Figure C.4.

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

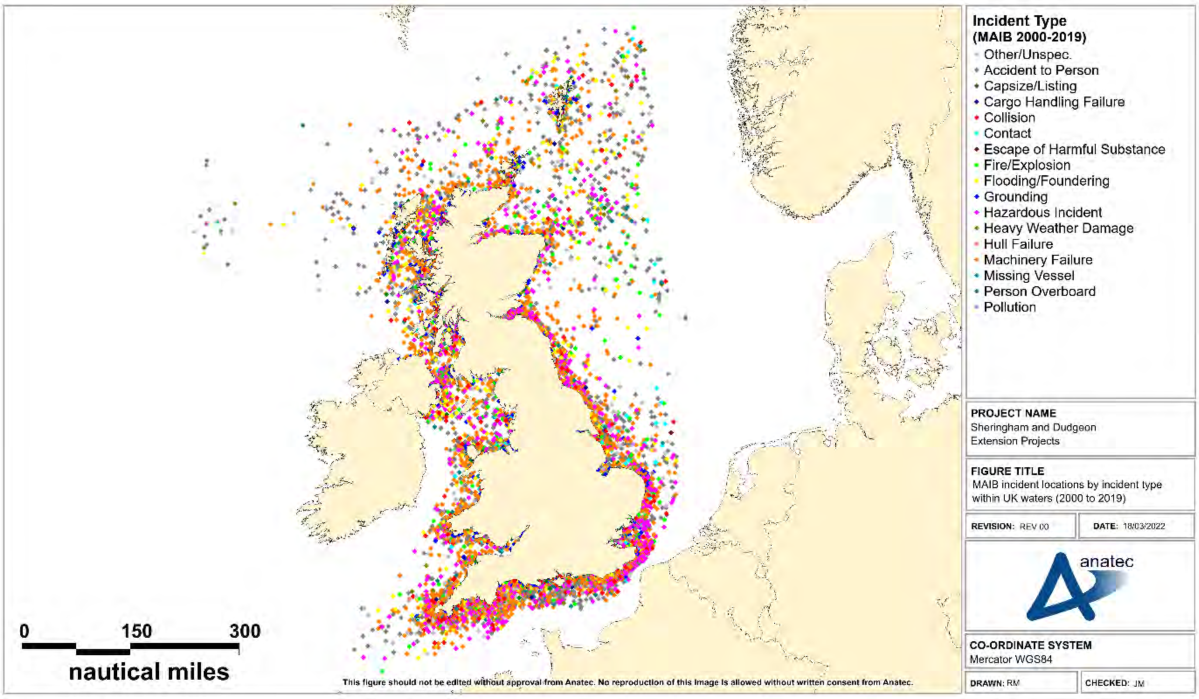

Figure C.3 MAIB Incident Locations by Incident Type within UK Waters (2000-2019)

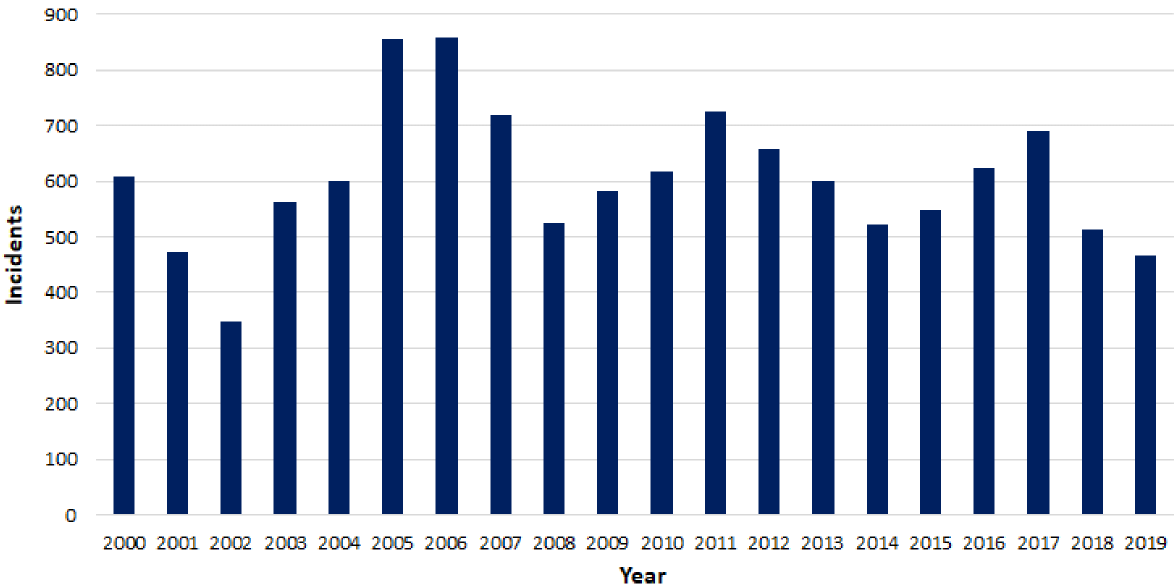

Figure C.4 MAIB Unique Incidents per Year within UK Waters (2000-2019)

633. The average number of unique incidents per year was 605. There has generally been a fluctuating trend in incidents over the 20-year period.

634. The distribution of incidents in UK waters by incident type is presented in Figure C.5.

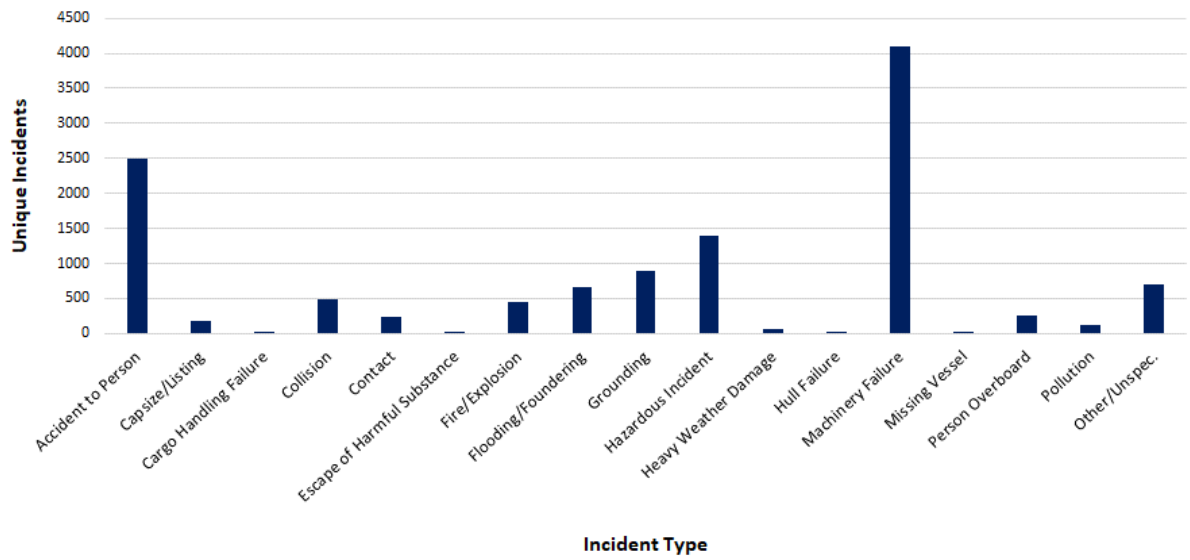

Figure C.5 MAIB Incidents by Incident Types Breakdown within UK Waters (2000-2019)

635. The most common incident types were "Machinery Failure" (34%), "Accident to Person" (21%) and "Hazardous Incident" (12%). "Collisions" and "Contacts" represented 4% and 2% of the total incidents, respectively.

636. The distribution of incidents in UK waters by vessel type is presented in Figure C.6.

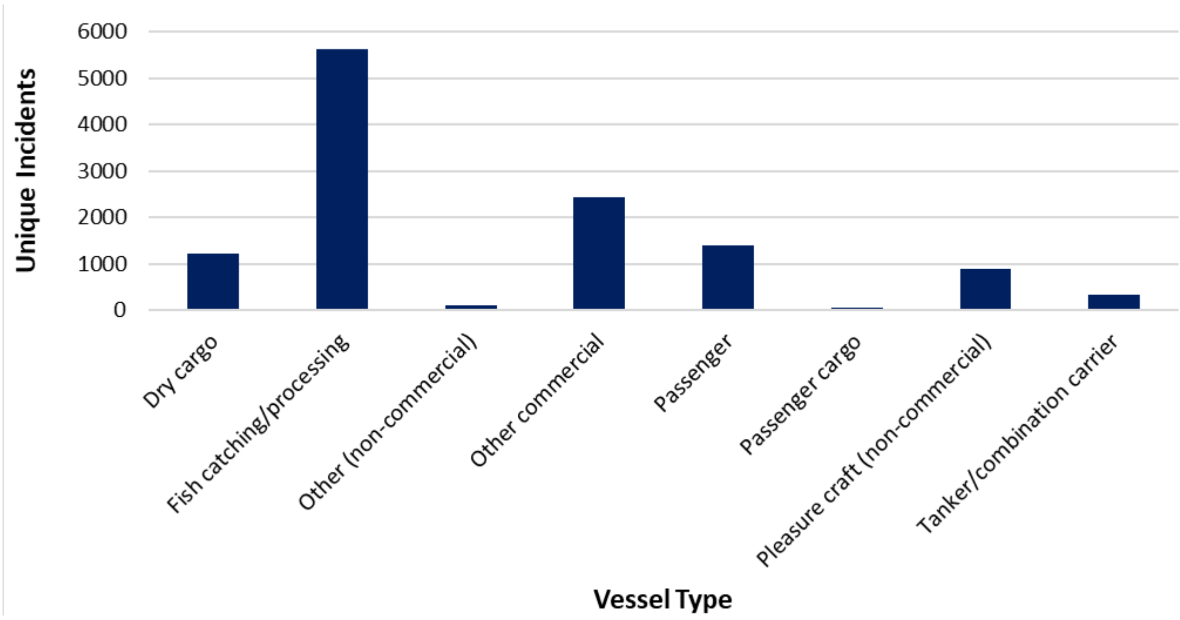

Figure C.6 MAIB Incidents by Vessel Type within UK Waters (2000-2019)

637. The most frequent vessel types involved in incidents were fishing vessels (46%), other commercial vessels (20%) (including offshore industry vessels, tugs, workboats and pilot vessels) and dry cargo vessels (10%).

638. A total number of fatalities 373 reported in the MAIB incidents from 2000 to 2019, corresponding to an average of 19 fatalities per year.

639. The distribution of fatalities in UK waters by vessel type and person category (crew, passenger and other) is presented in Figure C.7.

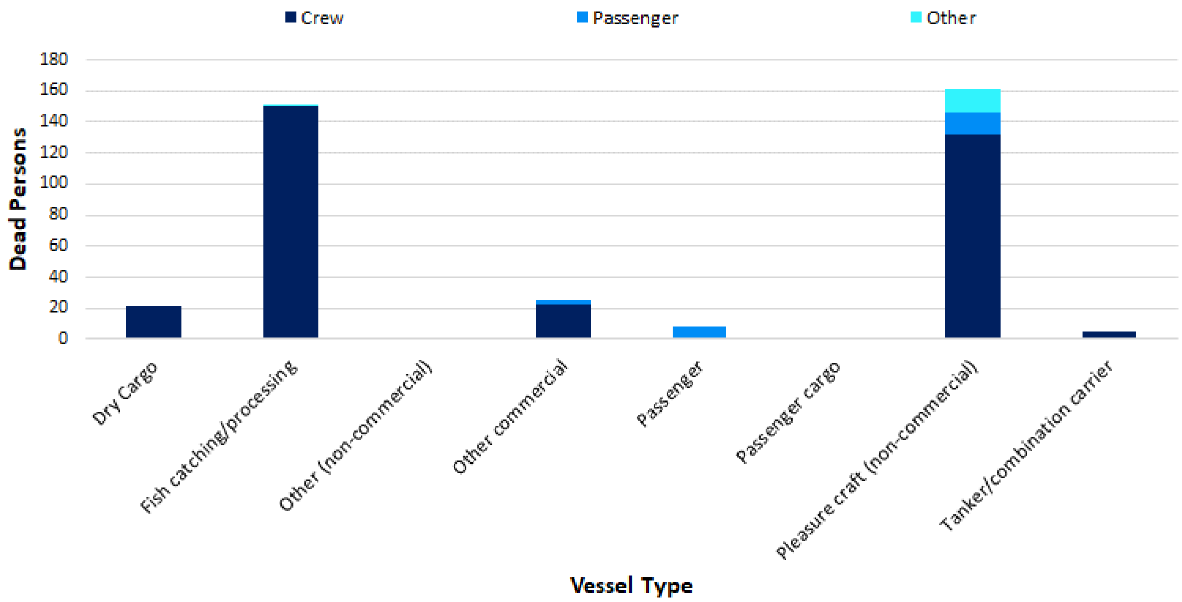

Figure C.7 MAIB Fatalities by Personnel Category within UK Waters (2000-2019)

640. The majority of fatalities occurred pleasure craft (43%) and fishing vessels (40%), mainly involving crew members (89%).

C.2.2 Collision Incidents

641. The MAIB define a collision incident as "*ships striking or being struck by another ship, regardless of whether the ships are underway, anchored or moored"* (MAIB, 2013).

642. A total of 481 collision incidents were reported to the MAIB in UK waters between 2000 and 2019 involving 1,090 vessels (in a small number of cases the other vessel involved was not logged).

643. The locations of collision incidents reported in proximity to the UK are presented in Figure C.8. Following this, the distribution of collision incidents per year is presented in Figure C.9.

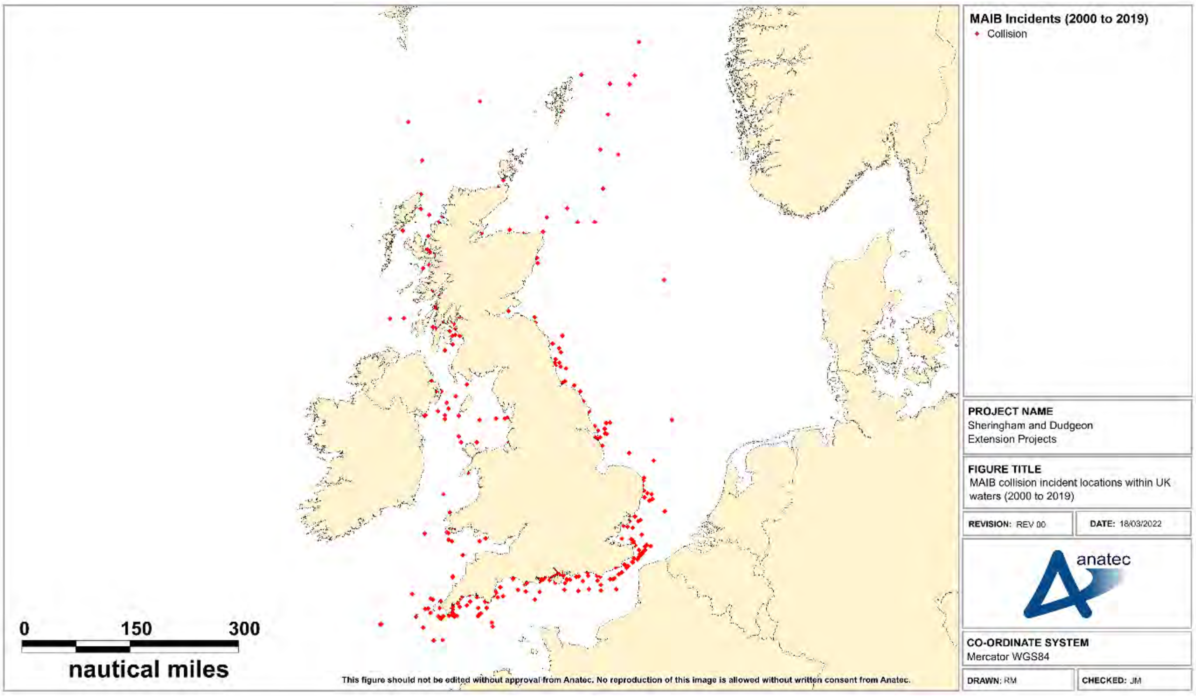

Figure C.8 MAIB Collision Incident Locations within UK Waters (2000-2019)

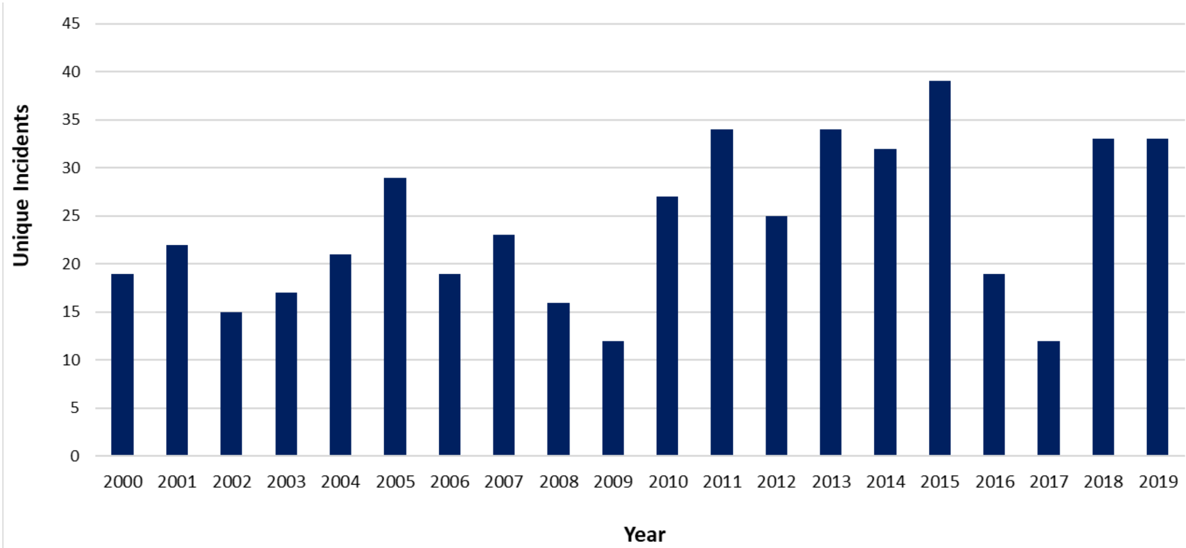

Figure C.9 MAIB Annual Collision Incidents within UK Waters (2000-2019)

644. The average number of collision incidents per year was 14. There has been a slight increasing trend in collision incidents overall during the study period, which may be due to better reporting of less serious incidents in recent years.

645. The most frequent vessel types involved in collision incidents were other commercial vessels (29%), fishing vessels (24%), non-commercial pleasure craft (23%) and dry cargo vessels (12%).

646. A total of six fatalities were reported in MAIB collision incidents within UK waters between 2000 and 2019. Details of each of these fatal incidents reported by the MAIB are presented in Table C.2.

Table C.2 Fatal Collision Incidents (MAIB 2000-2019)

Date	Description	Fatalities
October 2001	A dry cargo vessel and a chemical tanker collided in the south-west traffic lane of the Dover Strait TSS to the south-east of Hastings. Although the weather and visibility were good, both watchkeepers were too late to take effective avoiding action. The collision resulted in the sinking of the dry cargo vessel from which five out of six crew members were rescued.	1
July 2005	A collision between two powerboats near Castle Point, St. Mawes resulted in the death of one of the helmsmen. The incident occurred during the night with both vessels unlit whilst transiting through the area. Both helmsmen had consumed alcohol prior to the incident which is suspected to have caused reduced peripheral vision, deterioration of judgment and slower reaction times from both helmsmen, resulting in the collision.	1
October 2007	A fishing vessel was involved in a collision with a coastal general cargo vessel. The collision took place about 21 miles off the Humber near the Rough gas field. Neither of the vessels was found to be keeping an effective lookout. The weather at the time was good with fair to good visibility. As a result of the collision, the fishing vessel suffered major structural damage and sank within seconds. Of the four crew onboard, three managed to get into a life raft and abandon the vessel, sadly the fourth member of crew was not recovered.	1
August 2010	An Italian registered passenger ferry collided with a British registered fishing vessel around four miles off St Abb's Head. As a result of the collision, the fishing vessel sank. The skipper was recovered from the sea but, despite an extensive search by the rescue services and a large number of local fishing vessels, the remaining crew member was lost.	1
June 2015	A collision occurred between a Rigid-hulled Inflatable Boat (RIB) and the yacht that had been carrying the RIB earlier the same day. One 36-year old man was seriously injured as a result of the incident and was airlifted to hospital before being pronounced dead later in the evening. It is believed that there were originally a dozen or so people aboard the motorboat, with the majority being taken ashore by the Cowes and Gosport lifeboats. Local rescue crews towed the RIB from the scene into Cowes, with the larger motorboat being escorted by a police launch.	1

Date	Description	Fatalities
June 2018	Emergency services were called to West Bay, Bridport following a fatal crash during a power boat race. One of the power boats taking part in the offshore circuit racing event overturned after colliding with another. A man from Canterbury, understood to be the boat's pilot, was pronounced dead at the scene.	1

C.2.3 Contact Incidents

647. The MAIB define a contact incident as "*ships striking or being struck by an external object. The objects can be: floating object (cargo, ice, other or unknown); fixed object, but not the sea bottom; or flying object*" (MAIB, 2013).

648. A total of 235 contact incidents were reported to the MAIB within UK waters between 2000 and 2019 involving 270 vessels. (in a small number of cases the contact involved a moving vessel and a stationary vessel).

649. The locations of contact incidents reported in proximity to the UK are presented in Figure C.10. Following this, the distribution of contact incidents per year is presented in Figure C.11.

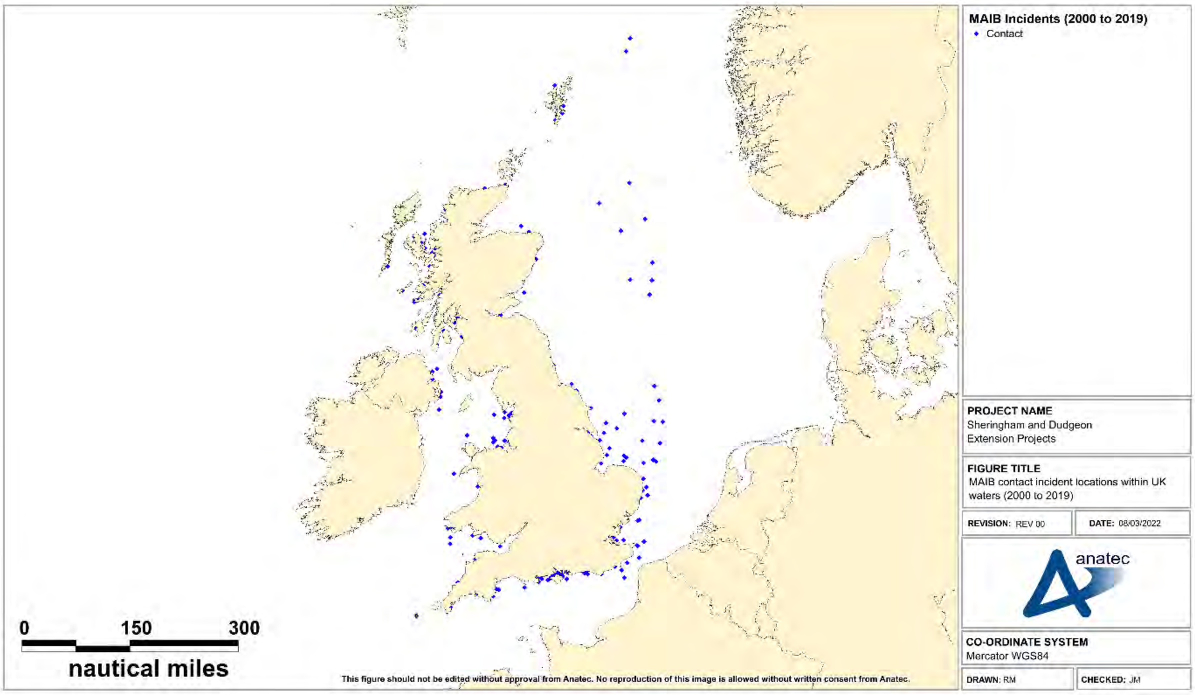

Figure C.10 MAIB Contact Incident Locations within UK waters (2000-2019)

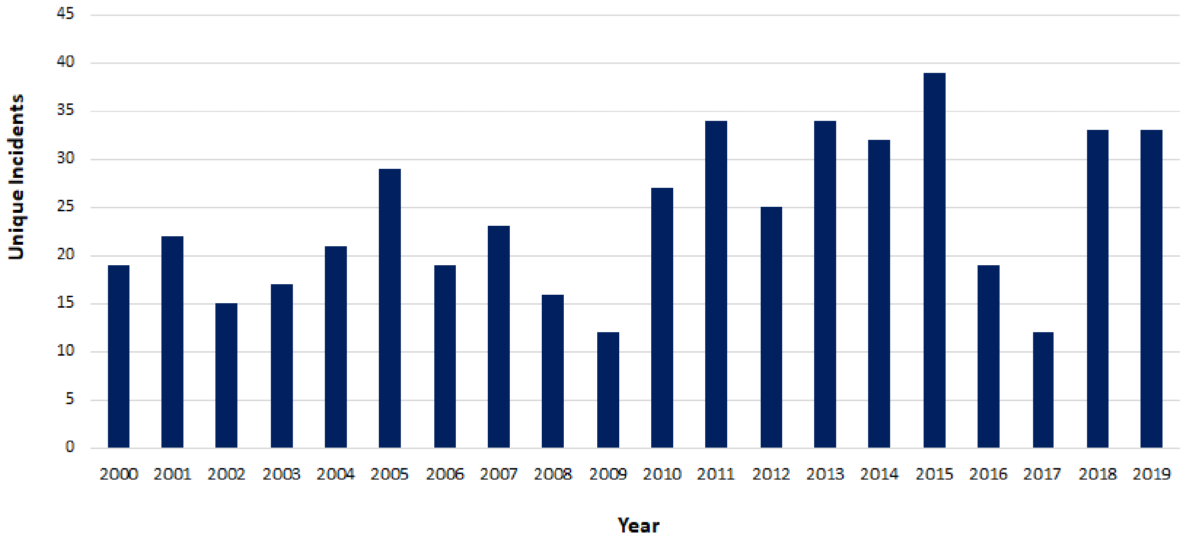

Figure C.11 MAIB Contact Incidents per Year within UK Waters (2000-2019)

650. The average number of contact incidents per year was 12. As with collision incidents there has been a slight increasing trend overall during the 20-year period, which may be due to improved reporting of less serious incidents in recent years.

651. The distribution of vessel types involved in contact incidents is presented in Figure C.12.

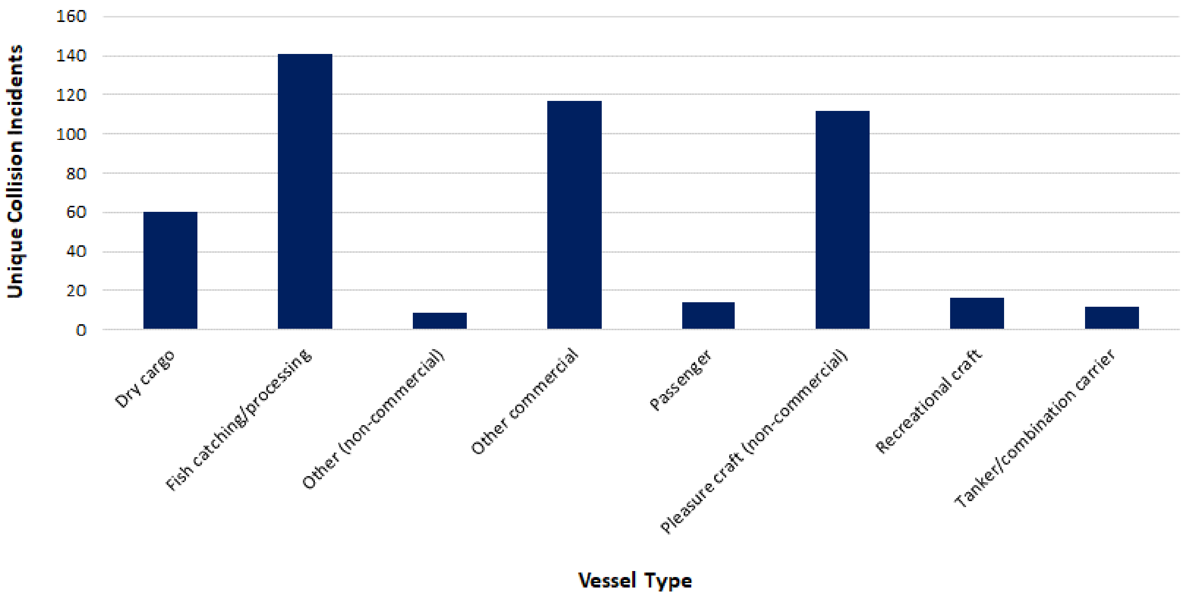

Figure C.12 MAIB Contact Incidents by Vessel Type within UK Waters (2000-2019)

652. The most frequent vessel types involved in contact incidents were other commercial vessels (43%), fishing vessels (15%) and non-commercial pleasure craft (13%).

653. A total of one fatality was reported in MAIB contact incidents within UK waters between 2000 and 2019. Details of the fatal incident reported by the MAIB is presented in Table C.3.

Table C.3 Description of Fatal MAIB Contact Incidents (2000-2019)

Date	Description	Fatalities
June 2012	The owner of a 6m RIB took two friends from his home port on the West coast of Scotland to an Island approximately 20 miles away to attend a music festival. The three men attended the overnight event and the boat owner then set off home alone on his RIB. A local ferryman saw the RIB approaching the harbour at about 40 knots and later heard a loud bang. When he moved his ferry he saw a damaged RIB and a body floating in the water. The alarm was raised and the body was recovered. The RIB owner had suffered fatal head injuries as a result of hitting the RIB's console on impact with the jetty. The RIB was badly damaged around the bow and the fenders on the jetty were also damaged. The post mortem report revealed that the deceased had more than twice the UK drink driving alcohol limit in his blood when the accident occurred. The deceased had also taken recreational drugs.	1

C.3 Fatality Risk

C.3.1 Incident Data

654. This section uses the MAIB incident data along with information on average manning levels per vessel type to estimate the probability of a fatality in a maritime incident associated with SEP and DEP.

655. As per the NRA, SEP and DEP are assessed to have the potential to affect the following incidents:

- Vessel to vessel collision;
- Powered vessel to structure allision;
- Drifting vessel to structure allision; and
- Fishing vessel to structure allision.

656. Of these incident types, only vessel to vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in Section C.2.2 is considered to be directly applicable to these types of incidents.

657. The other scenarios of powered vessel to structure allision, drifting vessel to structure allision and fishing vessel to structure allision are technically contacts since they would

involve a vessel striking an immobile object in the form of a wind turbine or OSP. From Section C.2.3 it can be seen that only one of the 235 contact incidents reported by MAIB between 2000 and 2019 resulted in a fatality, with the contact occurring with a jetty in the approaches to the harbour.

658. As the mechanics involved in a vessel contacting a wind turbine may differ in severity from striking, for example, a buoy, quayside or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for the allision incident types.

C.3.2 Fatality Probability

659. Six of the 481 collision incidents reported by the MAIB within UK waters between 2000 and 2019 resulted in one or more fatalities. This gives a 1.2% probability that a collision incident will lead to a fatal accident.

660. To assess the fatality risk for personnel onboard a vessel (crew, passenger or other) the number of persons involved in the incidents needs to be estimated. Table C.4 presents the average number of POB estimated for each category of vessel navigating in proximity to the Project. For passenger vessels this is based upon information available for the specific vessels recorded in the vessel traffic survey data. For other vessel categories, this is based upon information available from the MAIB incident data.

Table C.4 Estimated Average POB by Vessel Category

Vessel Category	Sub Categories	Source of Estimated Average POB	Estimated Average POB
Cargo/freight	Dry cargo, other commercial, service ship, etc.	MAIB incident data	15
Tanker	Tanker/combination carrier	MAIB incident data	22
Passenger	RoRo passenger, cruise liner, etc.	Vessel traffic survey data / online information	856
Fishing	Trawler, potter, dredger, etc.	MAIB incident data	3.3
Recreational	Yacht, small commercial motor yacht, etc.	MAIB incident data	3.3

661. It is recognised that these average POB numbers can be substantially higher or lower on an individual vessel basis depending upon the size, subtype, etc., but applying reasonable averages is considered sufficient for this analysis, particularly when noting

that the average POB for the dominant vessel category (passenger) is based upon the vessel traffic survey data where possible.

662. Using the average number of persons carried along with the vessel type information involved in collision incidents reported by the MAIB gives an estimated 17,848 POB the vessels involved in the collision incidents.

663. Based on six fatalities, the overall fatality probability in a collision for any individual onboard is approximately 3.4×10^{-4} per collision.

664. It is considered inappropriate to apply this rate uniformly as the statistics indicate that the fatality probability associated with smaller craft, such as fishing vessels and recreational vessels is higher. Therefore, the fatality probability has been subdivided into three categories of vessel as presented in Table C.5.

Table C.5 Collision Incident Fatality Probability by Vessel Category (2000-2019)

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	1	16,256	6.2×10^{-5}
Fishing	Trawler, Potter, Dredger, etc.	2	880	2.3×10^{-3}
Pleasure Craft	Yacht, small commercial motor vessel, etc.	3	713	4.2×10^{-3}

665. The risk is higher by two orders of magnitude for POB small craft compared to larger commercial vessels.

C.3.3 Fatality Risk due to SEP and DEP

666. The base case and future case annual collision frequency levels pre and post SEP and DEP are summarised in Table C.6.

Table C.6 Summary of Annual Collision and Allision Risk Results

Allision / Collision Scenario	Base Case (0%)			Future Case (10%)			Future Case (20%)		
	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	0.104 (1 in 10 years)	0.118 (1 in 8 years)	1.39×10^{-2} (1 in 72 years)	0.126 (1 in 8 years)	0.143 (1 in 7 years)	1.68×10^{-2} (1 in 60 years)	0.150 (1 in 7 years)	0.170 (1 in 6 years)	1.99×10^{-2} (1 in 50 years)

Allision / Collision Scenario	Base Case (0%)			Future Case (10%)			Future Case (20%)		
	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change	Pre Wind Farm	Post Wind Farm	Change
Powered vessel to structure allision	N/A	1.62×10^{-3} (1 in 618 years)	1.62×10^{-3} (1 in 618 years)	N/A	1.78×10^{-3} (1 in 562 years)	1.78×10^{-3} (1 in 562 years)	N/A	1.94×10^{-3} (1 in 515 years)	1.94×10^{-3} (1 in 515 years)
Drifting vessel to structure allision	N/A	1.11×10^{-3} (1 in 898 years)	1.11×10^{-3} (1 in 898 years)	N/A	1.23×10^{-3} (1 in 816 years)	1.23×10^{-3} (1 in 816 years)	N/A	1.34×10^{-3} (1 in 748 years)	1.34×10^{-3} (1 in 748 years)
Fishing vessel to structure allision	N/A	2.72×10^{-2} (1 in 37 years)	2.72×10^{-2} (1 in 37 years)	N/A	2.99×10^{-2} (1 in 34 years)	2.99×10^{-2} (1 in 34 years)	N/A	3.26×10^{-2} (1 in 31 years)	3.26×10^{-2} (1 in 31 years)
Total	**0.104 (1 in 10 years)**	**0.148 (1 in 7 years)**	**0.0438 (1 in 23 years)**	**0.126 (1 in 8 years)**	**0.176 (1 in 6 years)**	**0.0497 (1 in 20 years)**	**0.150 (1 in 7 years)**	**0.206 (1 in 5 years)**	**0.0558 (1 in 18 years)**

667. From the detailed results of the collision and allision risk modelling, the distribution of the predicted change in annual collision and allision frequency by vessel type due to SEP and DEP for the base case and future case are presented in Figure C.13.

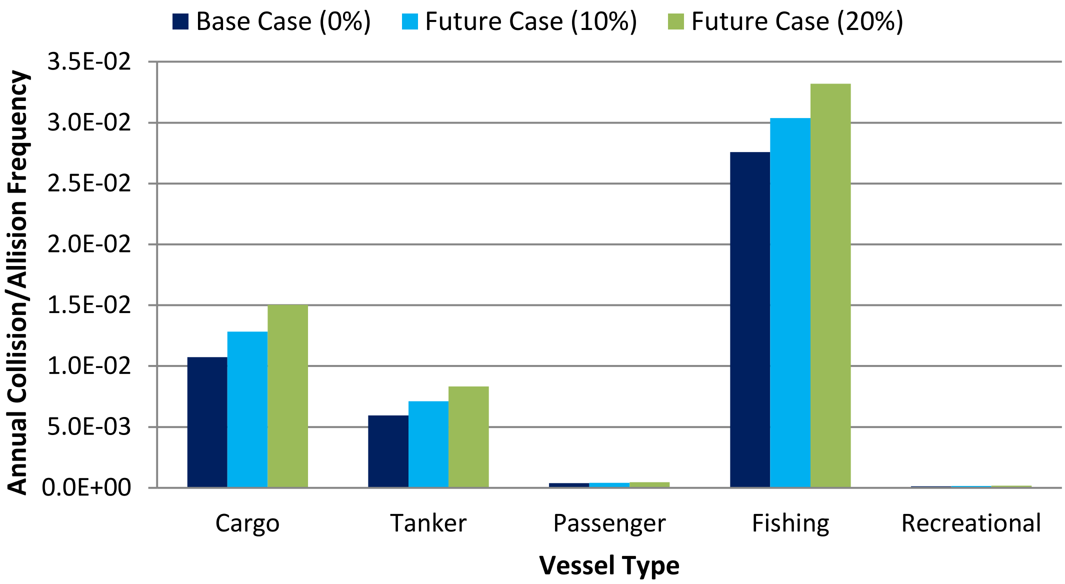

Figure C.13 Change in Annual Collision and Allision Frequency by Vessel Type

668. The majority of change in allision risk was observed to be associated with fishing vessels. This was due to the increase in allision risk to fishing vessels. Full details are provided in Section 19.2.2.4, but it is noted that the modelling conservatively assumes no change in baseline fishing activity post wind farm, and that most likely consequences of a fishing vessel allision are low impact / speed contact.

669. Combining the annual collision and allision frequency (Table C.6), the estimated number of POB for each vessel type (Table C.4) and the estimated fatality probability for each vessel type category (Table C.5), the annual increase in Potential Loss of Life (PLL) due to the presence of the SEP and DEP for the base case is estimated to be 2.43×10^{-4} which equates to one additional fatality in 4,100 years. The annual increase in PLL due to the impact of SEP and DEP for the 10% future case is estimated to be 2.72×10^{-4}, which equates to one additional fatality in approximately 3,700 years, while the 20% future case is estimated to be 3.02×10^{-4} (one in 3,300 years).

670. The estimated incremental increases in PLL due to SEP and DEP, distributed by vessel type and for the base case and future cases, are presented in Figure C.14.

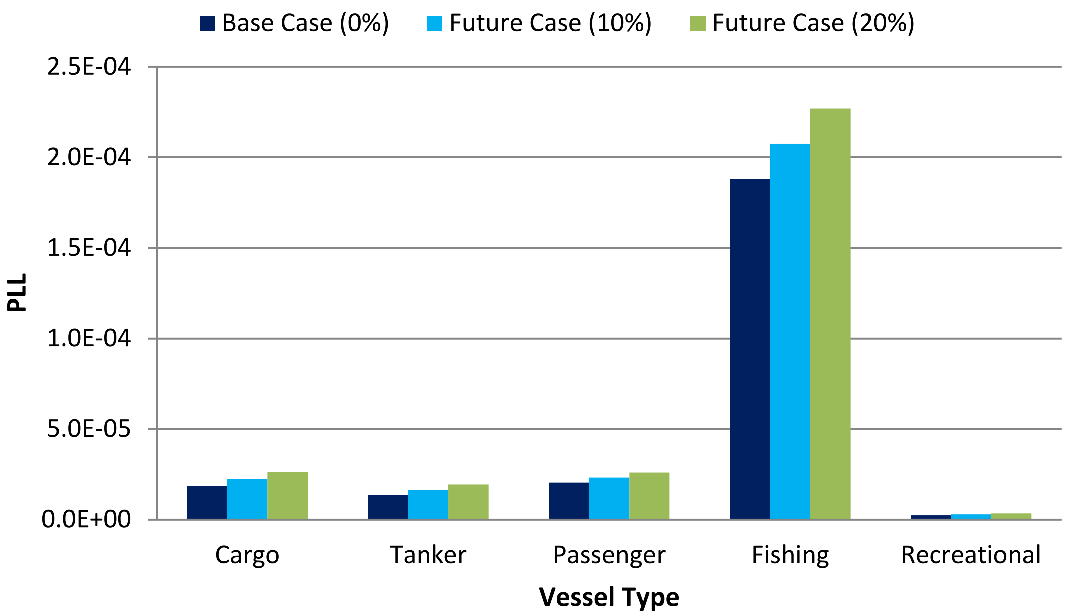

Figure C.14 Estimated change in Annual PLL by Vessel Type

671. As shown, the majority of change in PLL was associated with fishing vessels. This is reflective of the allision risk to fishing vessels and the estimated fatality probability being higher than for other vessel types (see Table C.5).

672. Converting the PLL to individual risk per annum (IRPA) based on the average number of people exposed by vessel type, the results are presented in Figure C.15.

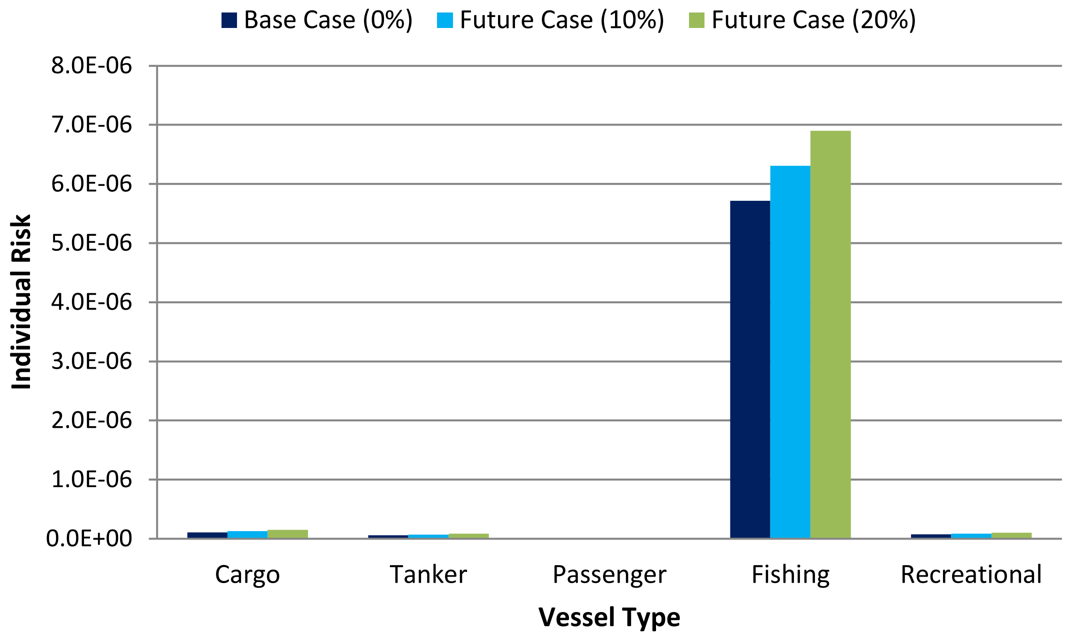

Figure C.15 Estimated change in Individual Risk by Vessel Type

673. The significant majority of individual risk was observed to be associated with fishing vessels, which is as expected given the estimated change in PLL for these vessels (see Figure C.14) and low POB (see Table C.4).

C.3.4 Significance of Increase in Fatality Risk

674. The overall increase in PLL estimated due to SEP and DEP is 2.43×10^{-4}, which equates to one additional fatality in 4,100 years. In comparison to MAIB statistics, which indicate an average of 20 fatalities per year in UK territorial waters, this is considered a small change.

675. In terms of individual risk to people, the change for commercial vessels attributed to SEP and DEP (approximately 1.7×10^{-7} for the base case) is very low when compared to the background risk level for the UK sea transport industry of 2.9×10^{-4} per year.

676. For fishing vessels, the change in individual risk attributed to SEP and DEP (approximately 5.72×10^{-6} for the base case) is considered very low compared to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

C.4 Pollution Risk

C.4.1 Historical Analysis

677. The pollution consequences of a collision in terms of oil spill depend upon the following criteria:

- Spill probability (i.e., likelihood of outflow following an incident); and

- Spill size (volume of oil).

678. Two types of oil spill are considered in this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

679. The research undertaken as part of the DfT's MEHRAs project (DfT, 2001) has been used as it was comprehensive and based on worldwide marine oil spill data analysis. From this research, the overall probability of a spill per accident was calculated based on historical accident data for each accident type as presented in Figure C.16.

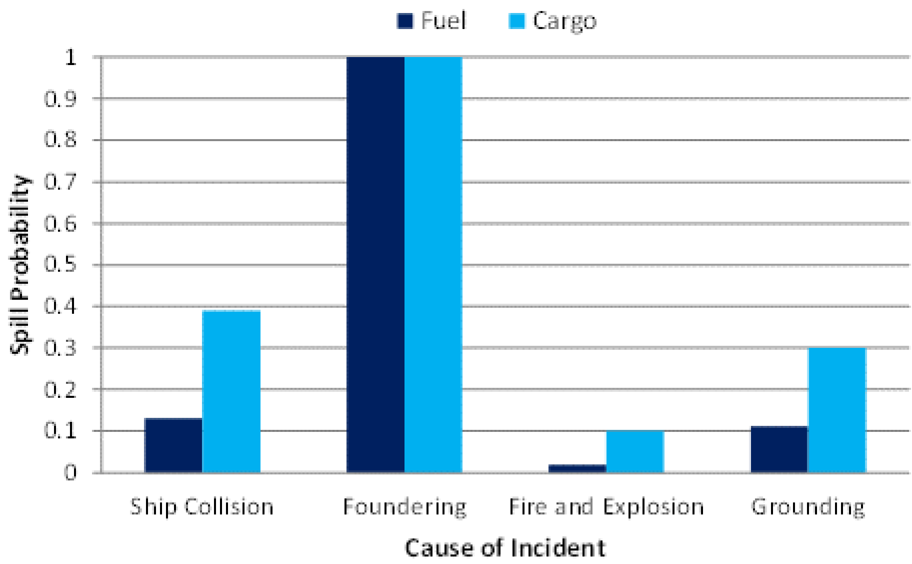

Figure C.16 Probability of an Oil Spill Resulting from an Incident

680. Therefore, it was estimated that 13% of vessel collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

681. In the event of a bunker spill, the potential outflow of oil depends upon the bunker capacity of the vessel. Historical bunker spills from vessels have generally been limited to a size below 50% of the bunker capacity, and in most incidents much lower. For the types and sizes of vessels exposed to the SEP and DEP, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

682. For cargo spills from laden tankers, the spill size can vary significantly. The ITOPF reported the following spill size distribution for tanker collisions between 1974 and 2004:

- 31% of spills below seven tonnes;
- 52% of spills between seven and 700 tonnes; and
- 17% of spills greater than 700 tonnes.

683. Based upon this data and the tankers transiting in proximity to SEP and DEP, an average spill size of 400 tonnes is considered a conservative assumption.

684. For fishing vessel collisions, comprehensive statistical data is not available. Consequently, it is conservatively assumed that 50% of all collisions involving fishing vessels will lead to oil spill with the quantity spilled being on average five tonnes. Similarly for recreational vessels, due to a lack of data 50% of collisions are conservatively assumed to lead to a spill with an average size of one tonne.

C.4.2 Pollution Risk due to SEP and DEP

685. Applying the above probabilities to the annual collision and allision frequency by vessel type (presented in Table C.6) and the average spill size per vessel, the amount of oil spilled per year due to the impact of SEP and DEP is estimated to be 1.14 tonnes per year for the base case, 1.35 tonnes per year for the 10% future case and 1.42 tonnes per year for the 20% future case.

686. The estimated increase in tonnes of oil spilled distributed by vessel type for the base and future cases are presented in Figure C.17.

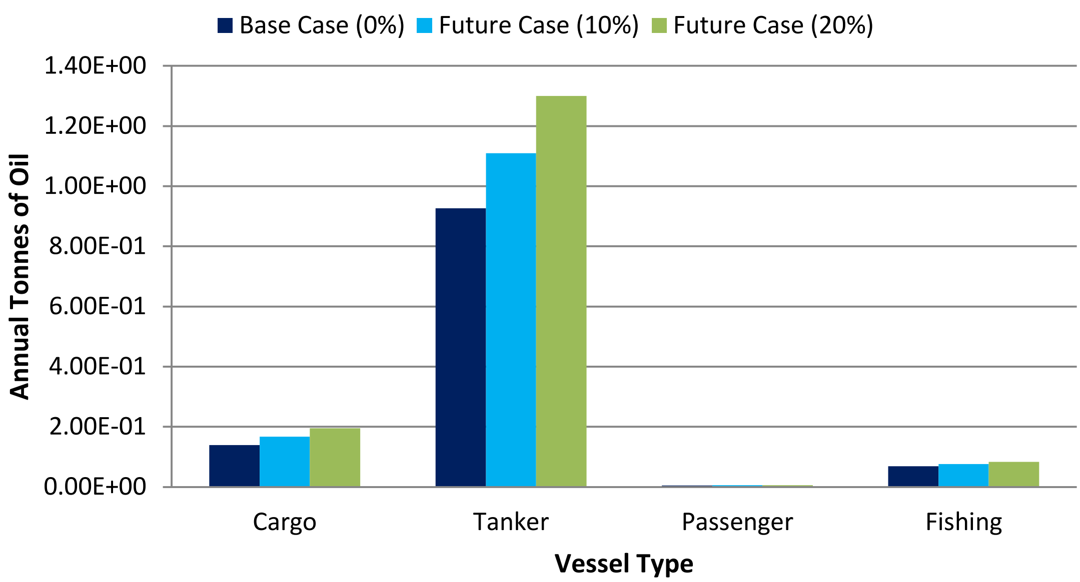

Figure C.17 Estimated Change in Pollution by Vessel Type

687. The majority of the change in spill risk was observed to be associated with tankers, which is indicative of the potential spill size associated with these vessels.

C.4.3 Significance of increase in Pollution Risk

688. To assess the significance of the increased pollution risk from vessels caused by SEP and DEP, historical oil spill data for the UK has been used as a benchmark.

689. From the MEHRAs research, the annual average tonnes of oil spilled in the UK waters due to maritime incidents in the 10 year period from 1989 to 1998 was 16,111. This is based on a total of 146 reported oil pollution incidents of greater than one tonne (smaller spills are excluded as are incidents which occurred within port or harbour areas or resulting from operational errors or equipment failure). Commercial vessel spills accounted for approximately 94% of the total while fishing vessel incidents accounted for approximately 6%.

690. The overall increase in pollution estimated due to SEP and DEP of 0.007% (increase over the 16,111 average) is considered very low compared to the historical average pollution quantities from marine accidents in UK waters.

C.5 Conclusions

691. This appendix has quantitatively assessed the fatality and pollution risk associated with SEP and DEP in the event of a collision or allision incident occurring. The assessment indicates that the fatality risk associated with fishing vessels is greatest while pollution risk associated with tankers is greatest.

692. Overall, the impact of SEP and DEP on people and the environment is relatively low compared to the existing background risk levels in UK waters. However, it should be noted that this is the localised impact of a single wind farm development project and there will be additional maritime risks associated with other offshore wind farm developments in the area and the UK as a whole.

693. Discussion of relevant mitigation measures and monitoring is provided in Section 21 of the NRA.

Annex D Visual Observation Logs

694. As detailed in Section 7, two 14 day MGN 654 (MCA, 2021) compliant surveys have been undertaken for the SEP and DEP. These included collection of AIS, Radar, and visual observation data. The visual observation data included details / identifiers of any vessels recorded via Radar that could also be identified visually. The relevant details are given in Table D.1.

Table D.1 Visual Observation Logs for the Summer 2020 Survey

Date	Time	Vessel Type	Vessel Length
24/07/2020	09:10	Fishing	10m
	18:10	Fishing (Potter)	14-16m
25/07/2020	05:55	Possible Fishing (Potter)	10-12m
	07:30	Unknown	n/a
	19:30	Unknown	n/a
	07:10	Unknown	n/a
	14:30	Possible Fishing (Potter)	n/a
28/07/2020	13:05	Possible Fishing (Potter)	10-12m
	08:30	Possible Fishing	n/a
	17:30	Unknown	n/a
	20:35	Possible Fishing	n/a
30/07/2020	05:25	Fishing (Potter)	12-15m
	10:45	Possible Fishing	n/a
	10:47	Possible Fishing	n/a
	12:40	Fishing (Potter)	10-12m
31/07/2020	04:45	Fishing (Potter)	10-12m
	09:05	Possible Fishing	n/a
	13:24	Small Fishing	6m
01/08/2020	09:00	Fishing (Potter)	12m
	11:50	Pleasure Boat	12m
	13:00	Possible Fishing (Potter)	12m
	14:15	Unknown	n/a

Date	Time	Vessel Type	Vessel Length
02/08/2020	08:40	Unknown	n/a
	14:15	Unknown	n/a
03/08/2020	08:40	Fishing	10m
	14:30	Small Fishing	n/a
04/08/2020	03:50	Possible Fishing (Potter)	n/a
	05:55	Fishing (Potter)	10-12m
	18:30	Unknown	n/a
		Unknown	n/a
06/08/2020	09:00	Fishing (Potter)	10-12m
	09:20	Fishing (Potter)	n/a
	12:50	Fishing (Potter)	10m
	17:30	Unknown	n/a
	18:20	Fishing (Scalloper)	n/a
26/01/2021	10:50	Fishing	12-15m
27/01/2021	07:00	Unknown	n/a
	14:00	Fishing	10-12m
28/01/2021	01:50	Fishing (Potter)	12m
	03:05	Fishing	10-15m
31/01/2021	13:05	Fishing (Potter)	12m
	17:20	n/a	n/a
01/02/2021	09:40	Possible Fishing	12-15m
03/02/2021	09:25	n/a	n/a
	14:00	Possible Fishing	n/a
	20:20	Possible Fishing	n/a
04/02/2021	11:32	Fishing	15m
	14:40	Fishing	12-15m
	15:00	n/a	n/a
05/02/2021	09:00	n/a	n/a
	14:05	n/a	n/a
11/02/2021	08:25	Possible Fishing	n/a

Date	Time	Vessel Type	Vessel Length
	04:11	Fishing	n/a
	10:20	Fishing	n/a

Annex E Regular Operator Letter

equinor

Sender: [redacted]

Date: 16th September 2020
Ref: A4523-EQ-ROL-1

Stakeholder Consultation on Impacts Relating to Shipping and Navigation for the Proposed Dudgeon and Sheringham Shoal Wind Farm Extension Projects

Dear Stakeholder,

As you may be aware, Equinor New Energy Ltd (Equinor) is intending to submit applications for extensions to the existing Sheringham Shoal and Dudgeon offshore wind farms, which have been operational since 2012 and 2017, respectively.

Following a Scoping Report for both projects submitted to the Planning Inspectorate in October 2019, Equinor are now in the process of preparing a Navigation Risk Assessment (NRA) which will accompany the Preliminary Environmental Information Report (PEIR). Consultation outputs arising from this process will feed into the subsequent Environmental Statement (ES), with the NRA updated where necessary.

An overview of the Dudgeon and Sheringham Shoal extension projects is given in Figure 1. The Dudgeon extension project is located 16 nautical miles (nm) from shore and covers an area of approximately 30 square nautical miles (nm²) (103 square kilometres (km²)). The Sheringham Shoal extension project is located approximately 9 nm from shore and covers an area of approximately 27 nm² (92.3 km²).

Figure 1: Overview of the Dudgeon and Sheringham Shoal Extension Projects

Page 1.

[redacted]

equinor

Further information is available at: [redacted]

Anatec has been contracted by Equinor to provide technical support on shipping and navigation during the consent process, and to coordinate consultation with stakeholders. Therefore, we are writing to you on Equinor's behalf to request any comments you may have on the projects, which will help inform the NRA.

The Environmental Impact Assessment process requires that Equinor identify potential impacts that the Dudgeon and Sheringham Shoal extension projects may have upon shipping and navigation, and to ensure consultation is carried out comprehensively and consistently. As part of this consultation process, Anatec have assessed 12 months of Automatic Identification System (AIS) data to identify any regular operators of the area. This assessment has shown that your company's vessel(s) has regularly navigated within, and/or in the vicinity of, the Dudgeon and Sheringham Shoal extension projects, and consequently your company has been identified as a potential Marine Stakeholder. We therefore invite your feedback on the projects, including any impact they may have upon the navigation of vessels.

We would be grateful if you could provide us with any comments or feedback that you may have by the 9th October 2020. This will allow us to incorporate your input into the NRA currently being undertaken.

We would also be grateful if you could forward a copy of this information to any vessel operators/owners you feel may be interested in commenting.

We would be particularly interested in any comments on the following:

- Whether the proposal to construct the Dudgeon and Sheringham Shoal extension projects is likely to impact the routeing of any specific vessels / routes, including the nature of any change in regular passage;
- Whether any aspect of the projects poses any safety concerns to your vessels, including any adverse weather routeing;
- Whether you would choose to make passage internally through the arrays of structures; and
- Whether you would be interested in participating in a Hazard Workshop for the projects, where stakeholders would be given opportunity to discuss the projects and the potential impacts arising to shipping and navigation users (likely to be held post PEIR).

Responses should be sent via email to [redacted] Should you have any queries about the published information or require any further information to support your review, please do not hesitate to contact us.

Yours sincerely,

[redacted]

Annex F Hazard Log

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely							Worst Case Consequences	Realistic Worst Case							Further Mitigation	Additional Comments
							Frequency	Consequences: People	Consequences: Environ	Consequences: Property	Consequences: Busines	Consequences: Average	Risk		Frequency	Consequences: People	Consequences: Environ	Consequences: Property	Consequences: Busines	Consequences: Average	Risk		
Commercial Vessels																							
C1	Displacement from wind farm sites resulting in increased Collision Risk	Increased collision risk involving commercial vessels due to displacement from historical routes and reduction in available sea room	C/D	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts - Lighting and marking	Build out of wind farm sites Adverse weather	Increased encounters between third party vessels that do not impact on compliance with COLREGS	5	1	1	1	2	1.3	**Tolerable**	Increased encounters between third party vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	4	4	4	4.0	**Broadly Acceptable**		General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern. The CoS reiterated concerns over general loss of sea room on a cumulative basis but also specific sections of the wind farm sites (as per previous CoS consultation). Operators agreed it was unlikely commercial vessels would transit through the wind farm sites. O&G vessels do so under certain circumstances at other projects, however it was considered unlikely they would do so in the case of DEP&SEP.
C2	Displacement arising from increased wind farm traffic leading to increased Collision Risk	Deviations to third-party transits arising from changes to planned passage to avoid wind farm traffic.	C/D	- COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information	Build out of wind farm sites Ineffective promulgation of information	Frequent requirement to undertake minor deviations but without impact on navigational safety.	5	1	1	1	2	1.3	**Tolerable**	Increased encounters (third party to third party and third party) leading to increase in collision risk.	1	4	4	4	4	4.0	**Broadly Acceptable**	Project vessel procedures including defined transit routeing to and between sites. Project vessel procedures in place that are promulgated on a targeted basis to specific operators.	General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern.
C3	Restriction of Adverse Weather Routeing	Activities or infrastructure within the wind farm sites may restrict existing adverse weather routes used by commercial operators.	C/D	- Promulgation of information - Display on nautical charts	Build out of wind farm sites Adverse weather	Negligible deviations required to ensure safe passage in adverse conditions.	4	1	1	1	1	1.0	**Broadly Acceptable**	Significant deviation required during adverse conditions to account for activities and structures within or between the wind farm sites leading to increased collision / allision risk.	1	4	4	4	4	4.0	**Broadly Acceptable**		General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern.

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely	Consequences					Risk	Worst Case Consequences	Realistic Worst Case	Consequences					Risk	Further Mitigation	Additional Comments
							Frequency	People	Environ	Property	Busines	Average			Frequency	People	Environ	Property	Busines	Average			
C4	Collision With Projects Vessels	Increased collision risk between a commercial vessel and a project vessel associated with construction/decommissioning	C/D	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate - Lighting and marking	Presence of project vessels associated with construction/decommissioning Third party users not aware project vessels are engaged in construction/decommissioning operations. Ineffective promulgation of information	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	4	4	4	4.0	Broadly Acceptable	Project vessel procedures including defined transit routeing to and between sites. Project vessel procedures in place that are promulgated on a targeted basis to specific operators.	
C5	Allision	Increased allision risk for commercial vessels due to presence of pre-commissioned structures	C/D	- Safety zones - Lighting and Marking - MGN 654 - Promulgation of information - Guard vessels where appropriate - Display on nautical charts - Layout design	Presence of pre-commissioned structures Human error or navigational error Mechanical or technical failure (vessel) Adverse weather Unfamiliarity with project Failure of Aid to Navigation Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	4	4	4	4.0	Tolerable		
C6	Anchor interaction	Increased anchor snagging risk for commercial vessels due to subsea cables and cable protection	C/D	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on or drags anchor over an installed cable/protection but no interaction occurs.	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on, or drags anchor over, an installed cable/protection resulting in damage to the cable/protection and/or anchor	2	3	1	2	2	2.0	Broadly Acceptable		
C7	Displacement from wind farm sites resulting in increased Collision Risk	Increased collision risk involving commercial vessels due to displacement from historical routes and reduction in available sea room	O	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts	Build out of wind farm sites Adverse weather	Increased encounters between third party vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels that do not impact on compliance with COLREGS	1	4	4	4	4	4.0	Broadly Acceptable		General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern. The CoS reiterated concerns over general loss of sea room on a cumulative basis but also specific sections of the wind farm sites (as per previous CoS consultation). Operators agreed it was unlikely commercial vessels would transit through the wind farm sites. O&G vessels do so under certain circumstances at other projects, however it was considered unlikely they would so in the case of DEP&SEP.
C8	Displacement arising from increased wind farm traffic leading to increased Collision Risk	Deviations to third party transits arising from changes to planned passage to avoid wind farm traffic.	O	- COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information	Build out of wind farm sites Ineffective promulgation of information	Frequent requirement to undertake minor deviations but without impact on navigational safety.	5	1	1	1	2	1.3	Tolerable	Increased encounters (third party to third party and third party) leading to increase in collision risk.	1	4	4	4	4	4.0	Broadly Acceptable	Project vessel procedures including defined transit routeing to and between sites. Project vessel procedures in place that are promulgated on a targeted basis to specific operators.	General operator consensus was that individual deviations did not pose a navigation safety risk, however there was a commercial concern.

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely							Worst Case Consequences	Realistic Worst Case							Further Mitigation	Additional Comments
								Consequences					Risk			Consequences					Risk		
							Frequency	People	Environ	Property	Busines	Average			Frequency	People	Environ	Property	Busines	Average			
C9	Restriction of Adverse Weather Routeing	Activities or infrastructure within the wind farm sites may restrict existing adverse weather routes used by commercial operators.	O	- Promulgation of information - Display on nautical charts	Adverse weather Build out of wind farm sites	Negligible deviations required to ensure safe passage in adverse conditions.	4	1	1	1	1	1.0	Broadly Acceptable	Significant deviation required during adverse conditions to account for activities and structures within or between the wind farm sites leading to increased collision / allision risk.	1	4	4	4	4	4.0	Broadly Acceptable		
C10	Collision With Projects Vessels	Increased collision risk between a commercial vessel and a project vessel associated with operation and maintenance	O	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate	Presence of project vessels associated with operation and maintenance Third party users not aware project vessels are engaged in operations Ineffective promulgation of information	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	4	4	4	4.0	Broadly Acceptable	Project vessel procedures including defined transit routeing to and between sites. Project vessel procedures in place that are promulgated on a targeted basis to specific operators.	
C11	Allision	Increased allision risk for commercial vessels due to presence of structures	O	- Lighting and Marking - MGN 654 - Promulgation of information - Display on nautical charts - Layout design	Presence of structures Human error or navigational error Mechanical or technical failure resulting in a vessel drifting Adverse weather Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	4	4	4	4.0	Tolerable		
C12	Anchor interaction	Increased anchor snagging risk for commercial vessels due to subsea cables and cable protection	O	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on or drags anchor over an installed cable/protection but no interaction occurs.	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on or drags anchor over an installed cable/protection resulting in damage to the cable/protection and/or anchor	1	3	1	2	2	2.0	Broadly Acceptable		
Full build out of wind farm sites																							
F1	Displacement resulting in increased Collision Risk	Increased collision risk involving fishing vessels due to temporary displacement from historical routes and reduction in available sea room	C/D	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts - Lighting and marking	Build out of wind farm sites Adverse weather	Increased encounters between third party vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	3	3	3	3.3	Broadly Acceptable		

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely – Frequency	Realistic Most Likely – Consequences – People	Realistic Most Likely – Consequences – Environ	Realistic Most Likely – Consequences – Property	Realistic Most Likely – Consequences – Busines	Realistic Most Likely – Consequences – Average	Realistic Most Likely – Risk	Worst Case Consequences	Realistic Worst Case – Frequency	Realistic Worst Case – Consequences – People	Realistic Worst Case – Consequences – Environ	Realistic Worst Case – Consequences – Property	Realistic Worst Case – Consequences – Busines	Realistic Worst Case – Consequences – Average	Realistic Worst Case – Risk	Further Mitigation	Additional Comments
F2	Collision With Projects Vessels	Increased collision risk between a commercial fishing vessel and a project vessel associated with construction/decommissioning	C/D	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate	Presence of project vessels associated with construction/decommissioning Third party users not aware project vessels are engaged in construction/decommissioning operations Ineffective promulgation of information	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	3	4	2	2	3	2.8	Broadly Acceptable		
F3	Allision	Increased allision risk for commercial fishing vessels due to presence of pre-commissioned structures	C/D	- Safety zones - Lighting and Marking - MGN 654 - Promulgation of information - Guard vessels where appropriate - Display on nautical charts - Layout design	Presence of pre-commissioned structures Human error or navigational error Mechanical or technical failure (vessel) Adverse weather Failure of Aid to Navigation Failure to take note of advisory safe passing distance Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	2	4	3	3.3	Broadly Acceptable		
F4	Anchor interaction	Increased anchor snagging risk for commercial fishing vessels due to subsea cables and cable protection *Note impacts associated with commercial fishing gear are outside of the scope of the NRA process, and will be therefore be assessed separately.	C/D	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on, or drags anchor over an installed cable/protection but no interaction occurs	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on, or drags anchor over, an installed cable/protection resulting in damage to the cable/protection and/or anchor leading to risks to vessel stability	2	4	2	4	3	3.3	Broadly Acceptable	Targeted promulgation of information with regards to any cable exposures.	It was confirmed during the workshop that safety impacts associated with gear snagging will be assessed within the ES.
F5	Displacement resulting in increased Collision Risk	Increased collision risk involving commercial fishing vessels due to displacement from historical transits to fishing grounds and reduction in available sea room	O	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts - Lighting and marking	Build out of wind farm sites Adverse weather	Increased encounters between third party vessels that do not impact on compliance with COLREGS	3	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	3	3	3	3.3	Broadly Acceptable		
F6	Collision With Projects Vessels	Increased collision risk between a commercial fishing vessel and a project vessel associated with operation and maintenance	O	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate	Presence of project vessels associated with operation and maintenance Third party users not aware project vessels are engaged in operations Ineffective promulgation of information	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	3	4	2	2	3	2.8	Broadly Acceptable		

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely							Worst Case Consequences	Realistic Worst Case							Further Mitigation	Additional Comments
							Frequency	Consequences: People	Environ	Property	Busines	Average	Risk		Frequency	Consequences: People	Environ	Property	Busines	Average	Risk		
F7	Allision	Increased allision risk for commercial fishing vessels due to presence of structures	O	- Lighting and Marking - MGN 654 - Promulgation of information - Display on nautical charts - Layout design	Presence of structures Human error or navigational error Mechanical or technical failure resulting in a vessel drifting Adverse weather Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	2	4	3	3.3	Broadly Acceptable		
F8	Anchor interaction	Increased anchor snagging risk for commercial fishing vessels due to subsea cables and cable protection *Note impacts associated with commercial fishing gear are outside of the scope of the NRA process, and will be therefore be assessed separately.	O	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on, or drags anchor over an installed cable/protection but no interaction occurs	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on, or drags anchor over an installed cable/protection resulting in damage to the cable/protection and/or anchor. Risks to vessel stability.	1	2	1	2	2	1.8	Broadly Acceptable	Targeted promulgation of information with regards to any cable exposures.	It was confirmed during the workshop that safety impacts associated with gear snagging will be assessed within the ES.
Recreational Vessels (2.5 to 24 metres)																							
R1	Displacement resulting in increased Collision Risk	Increased collision risk involving recreational vessels due to temporary displacement from historical cruising routes and reduction in available sea room	C/D	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts - Lighting and marking	Build out of wind farm sites Adverse weather	Increased encounters between third party vessels that do not impact on compliance with COLREGS	3	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels that do impact on compliance with COLREGS and result in increased collisions	1	4	2	2	2	2.5	Broadly Acceptable		
R2	Collision With Projects Vessels	Increased collision risk between a recreational vessel and a project vessel associated with construction/decommissioning	C/D	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate	Presence of project vessels associated with construction/decommissioning Third party users not aware project vessels are engaged in construction/decommissioning operations	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	5	1	1	1	1	1.0	Tolerable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	3	4	2	2	3	2.8	Broadly Acceptable	Project vessel procedures in place that are promulgated on a targeted basis to specific recreational clubs / organisations.	RYA noted concern related particularly to nearshore areas and ports/harbours in relation to project vessel interactions.
R3	Allision	Increased allision risk for recreational vessels due to presence of pre-commissioned structures	C/D	- Safety zones - Lighting and Marking - MGN 654 - Promulgation of information - Guard vessels where appropriate - Display on nautical charts - Layout design	Presence of pre-commissioned structures Human error or navigational error Mechanical or technical failure (vessel) Adverse weather Failure of Aid to Navigation Failure to take note of advisory safe passing distance Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	3	4	3	3.5	Broadly Acceptable		

Hazard ID	Hazard Type	Hazard Title	Phase (C/O/D)	Embedded Mitigations	Possible Causes	Most Likely Consequences	Realistic Most Likely: Frequency	Consequences: People	Consequences: Environ	Consequences: Property	Consequences: Busines	Consequences: Average	Risk	Worst Case Consequences	Realistic Worst Case: Frequency	Consequences: People	Consequences: Environ	Consequences: Property	Consequences: Busines	Consequences: Average	Risk	Further Mitigation	Additional Comments
R4	Anchor interaction	Increased anchor snagging risk for recreational vessels due to subsea cables and cable protection	C/D	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on, or drags anchor over, an installed cable/protection but no interaction occurs	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on, or drags anchor over, an installed cable/protection resulting in damage to the cable/protection and/or anchor Risks to vessel stability	2	4	1	4	4	3.3	Broadly Acceptable		RYA noted the "general boating areas" aspect of the Coastal Atlas should be considered when defining target burial depths.
R5	Displacement resulting in increased Collision Risk	Increased collision risk involving recreational vessels due to temporary displacement from historical cruising routes and reduction in available sea room	O	- Layout Approval - MGN 654 - Promulgation of information - Display on nautical charts - Lighting and marking	Build out of wind farm sites Adverse weather	Increased encounters that do not impact on compliance with COLREGS	3	1	1	1	1	1.0	Broadly Acceptable	Increased encounters that do impact on compliance with COLREGS and result in increased collisions	1	4	2	2	2	2.5	Broadly Acceptable		
R6	Collision With Projects Vessels	Increased collision risk between a recreational vessel and a project vessel due to the presence of project vessels associated with operation and maintenance	O	- Safety zones - COLREGs and SOLAS - Project vessel procedures - Marine Coordination - Promulgation of information - Guard vessels where appropriate	Presence of project vessels associated with operation and maintenance Third party users not aware project vessels are engaged in operations	Increased encounters between third party vessels and project vessels that do not impact on compliance with COLREGS	4	1	1	1	1	1.0	Broadly Acceptable	Increased encounters between third party vessels and project vessels that do impact on compliance with COLREGS and result in increased collisions	3	4	2	2	3	2.8	Broadly Acceptable		RYA noted concern over nearshore areas and ports/harbours in relation to project vessel interactions.
R7	Allision	Increased allision risk for recreational vessels due to presence of structures	O	- Lighting and Marking - MGN 654 - Promulgation of information - Display on nautical charts - Layout design	Presence of structures Human error or navigational error Mechanical or technical failure resulting in a vessel drifting Adverse weather Ineffective promulgation of information	Vessel passes structure at an unsafe distance and has to make last minute adjustment to course/speed	4	1	1	1	1	1.0	Broadly Acceptable	Vessel allides with structure resulting in damage to vessel, injury and potentially pollution	2	4	3	4	3	3.5	Broadly Acceptable		
R8	Anchor interaction	Increased anchor snagging risk for recreational vessels due to subsea cables and cable protection	O	- Promulgation of information - Guard vessels where appropriate - Cable monitoring - Display on nautical charts - Cable burial risk assessment	Presence of subsea cables or cable protection Human error or navigational error Mechanical or technical failure Adverse weather	Vessel anchors on, or drags anchor over, an installed cable/protection but no interaction occurs	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on, or drags anchor over, an installed cable/protection resulting in damage to the cable/protection and/or anchor Risks to vessel stability	1	2	1	2	3	2.0	Broadly Acceptable		RYA noted the "general boating areas" aspect of the Coastal Atlas should be considered when defining target burial depths.
R9	Grounding	Increased risk of grounding for recreational vessels due to cable protection	O	- MGN 654 - Promulgation of information - Guard vessels where appropriate - Display on nautical charts - Cable burial risk assessment	Reduction of water depths following installation of cable protection	Vessel transits over a area of reduced clearance causing vibration etc. but does not make contact	4	1	1	1	1	1.0	Broadly Acceptable	Vessel makes contact with cable protection resulting in damage to the vessel, injury and potentially pollution	2	4	1	4	3	3.0	Broadly Acceptable		Raised as key RYA concern during Hazard Workshop. Mitigations will be in place as per MGN 654.

All Vessels																							
A1	Interference with marine navigation, communications and position fixing equipment	Presence of structures, export and inter-array cables may interfere with equipment used on board all vessels.	O	- MGN 654 - Promulgation of information - Display on nautical charts - Cable burial risk assessment	Build out of wind farm sites and presence of structures Human error relating to adjustment of Radar controls	Infrastructure has no effect upon the Radar, communications and navigation equipment on a vessel	5	1	1	1	1	1.0	Tolerable	Minor level of Radar interference due to the wind farm infrastructure	3	1	1	1	2	1.3	Broadly Acceptable		
Emergency response																							
E1	Emergency response	Presence of structures may restrict access/response for existing emergency responders	C/O/D	- COLREGs and SOLAS - Project vessel procedures - Layout Approval - MGN 654 - Marine Coordination - ERCoP - Promulgation of information	Wind farm array not designed to facilitate responder access Adverse weather	Delay to response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to loss of life	1	5	5	5	5	5.0	Tolerable	Ongoing consultation on layouts with MCA and Trinity House	CoS queried SAR access in relation to the existing sites. Relevant requirements of MGN 654 in this regard will apply.