FIVE ESTUARIES OFFSHORE WIND FARM

VOLUME 9, REPORT 10: NAVIGATIONAL RISK ASSESSMENT

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Five Estuaries Offshore Wind Farm Navigational Risk Assessment

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Presented to	Five Estuaries Offshore Wind Farm Limited
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04	8 November 2023	Initial draft for ES
05	10 January 2024	Updated following VE OWFL review
06	31 January 2024	Updated following further VE OWFL review

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Glossary of Terms

Term	Definition
Allision	The act of striking or contact of a moving vessel against a stationary object.
Automatic Identification System (AIS)	A system by which vessels automatically broadcast their identity, key statistics including location, destination, length, speed and current status, e.g., under power. Most commercial vessels and European Union (EU) fishing vessels over 15 m length are required to carry AIS.
Cable Burial Risk Assessment	Risk assessment to determine suitable burial depths for cables, based upon hazards such as anchor strike, fishing gear interaction and seabed mobility.
Collision	The act or process of colliding (crashing) between two moving objects.
Design Envelope	A description of the range of possible elements that make up the VE design options under consideration, as set out in detail in **Volume 6, Part 2, Chapter 1: Offshore Project Description**. This envelope is used to define VE for Environmental Impact Assessment purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Embedded mitigation measure	A commitment made by Five Estuaries Offshore Wind Farm Limited (VE OWFL) (the Applicant) to reduce and/ or eliminate the potential for significant risks.
Environmental Statement (ES)	A document reporting the findings of the Environmental Impact Assessment (EIA) and produced in accordance with the EIA Directive as transposed into United Kingdom (UK) law by the EIA Regulations.
Formal Safety Assessment (FSA)	A structured and systematic process for assessing the risks and costs (if applicable) associated with shipping activity.
Future Case	The assessment of risk based on the predicted growth in future shipping densities and traffic types as well as foreseeable changes in the marine environment.
Hazard	A potential threat to human life, health, property, or the environment.
International Maritime Organization (IMO) Routeing	Predetermined shipping routes established by the IMO.
Main Commercial Route	Defined transit route (mean position) of commercial vessels identified within the specified shipping and navigation study area.
Marine Environmental High Risk Area (MEHRA)	Area in United Kingdom (UK) coastal waters where vessel Masters are advised of the need to exercise more caution than usual, i.e., crossing areas of high environmental sensitivity where there is a risk of pollution from commercial shipping.
Marine Guidance Note (MGN)	A system of guidance notes issued by the Maritime and Coastguard Agency (MCA) which provide significant advice relating to the improvement of the safety of shipping at sea, and to prevent or minimise pollution from shipping.
Maximum Design Scenario (MDS)	The combination of realistic parameters for VE anticipated to produce the worst-case consequences.
Navigational Risk Assessment (NRA)	A document which assesses the overall impact to shipping and navigation of a proposed Offshore Renewable Energy Installation (OREI) based upon Formal Safety Assessment (FSA).

Term	Definition
Offshore Renewable Energy Installation (OREI)	As defined by Marine Guidance Note (MGN) 654 (Merchant and Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response (Maritime and Coastguard Agency (MCA), 2021). For the purposes of this report and in keeping with the consistency of the Environmental Impact Assessment, OREI can mean offshore wind turbines and the associated electrical infrastructure such as offshore substations.
Radio Detection and Ranging (Radar)	An object-detection system which uses radio waves to determine the range, altitude, direction or speed of objects.
Regular Operator	Commercial operator whose vessel(s) are observed to transit through a particular region on a regular basis.
The Applicant	Five Estuaries Offshore Wind Farm Limited (VE OWFL), the developer of the Five Estuaries Offshore Wind Farm (VE).
Traffic Separation Scheme (TSS)	A traffic management route system ruled by the International Maritime Organization (IMO). The traffic lanes (or clearways) indicate the general direction of the vessels in that zone; vessels navigating within a TSS all sail in the same direction or they cross the lane at an angle as close to 90 degrees (°) as possible.
Significance of risk	The combination of frequency of occurrence and severity of consequence of a hazard.
User	The sufferer of a risk arising from a hazard.
Unique Vessel	An individual vessel identified on any particular calendar day, irrespective of how many tracks were recorded for that vessel on that day. This prevents vessels being over counted. Individual vessels are identified using their Maritime Mobile Service Identity (MMSI).
Vessel Traffic Service (VTS)	A service implemented by a Competent Authority designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area.

Abbreviations Table

Abbreviation	Definition
AC	Alternating Current
AEZ	Archaeological Exclusion Zone
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ALB	All-Weather Lifeboat
ARPA	Automatic Radar Plotting Aid
ATBA	Area to be Avoided
AW189	AgustaWestland 189
BBC	British Broadcasting Corporation
BEIS	Department for Business, Energy & Industrial Strategy
BWEA	British Wind Energy Association
BMAPA	British Marine Aggregate Producers Association
CAA	Civil Aviation Authority
CBA	Cost Benefit Analysis
CD	Chart Datum
CHIRP	Confidential Human Factors Incident Reporting Programme
COLREGs	Convention on International Regulations for Preventing Collisions at Sea
CSIP	Cable Specification and Installation Plan
CTV	Crew Transfer Vessel
DECC	Department of Energy and Climate Change
DESNZ	Department for Energy Security & Net Zero
DW	Deep Water
DF	Direction Finding
DfT	Department for Transport
DSC	Digital Selective Calling
DWR	Deep Water Route
DWT	Dead Weight Tonnage
E	East
ECC	Export Cable Corridor
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field

Abbreviation	Definition
ERCoP	Emergency Response Cooperation Plan
ETG	Expert Topic Group
FRB	Fast Rescue Boat
FSA	Formal Safety Assessment
ft	Foot
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GRP	Glass Reinforced Plastic
GT	Gross Tonnage
HAT	Highest Astronomical Tide
HHA	Harwich Haven Authority
HM Government	His Majesty's Government
HMCG	His Majesty's Coastguard
HMSO	His Majesty's Stationary Office
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ILB	Inshore Lifeboat
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
JRCC	Joint Rescue Coordination Centre
kHz	Kilohertz
km	Kilometre
kt	Knot
LOA	Length Overall
LPG	Liquified Petroleum Gas
m	Metre
MAIB	Marine Accident Investigation Branch
MARIN	Maritime Institute Netherlands
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
MEHRA	Marine Environmental High Risk Area
MEPC	Marine Environment Protection Committee

Abbreviation	Definition
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MRCC	Maritime Rescue Coordination Centre
MRSC	Maritime Rescue Sub-Centre
MSC	Mediterranean Shipping Company
MSI	Maritime Safety Information
MSP	Marine Spatial Planning
N	North
NAVTEX	Navigational Telex
nm	Nautical Mile
nm^2	Square Nautical Mile
NIP	Navigation Installation Plan
NPS	National Policy Statement
NRA	Navigational Risk Assessment
NSIP	Nationally Significant Infrastructure Project
NUC	Not Under Command
O&M	Operations and Maintenance
OREI	Offshore Renewable Energy Installation
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PEC	Pilot Exemption Certificate
PEIR	Preliminary Environmental Information Report
PEXA	Practice and Exercise Area
PIANC	World Association for Waterborne Transport Infrastructure
PINS	The Planning Inspectorate
PLA	Port of London Authority
PLL	Potential Loss of Life
QHSE	Quality, Health, Safety and Environment
Radar	Radio Detection and Ranging
RNLI	Royal National Lifeboat Institution
Ro-Pax	Roll-on/Roll-off Passenger
RORC	Royal Ocean Racing Club
Ro-Ro	Roll-on/Roll-off (Cargo)
RYA	Royal Yachting Association

Abbreviation	Definition
SAR	Search and Rescue
SCADA	Supervisory Control and Data Acquisition
SLoO	Single Line of Orientation
SMS	Safety Management System
SOLAS	International Convention for the Safety of Life at Sea
SONAR	Sound Navigation Ranging
SOV	Service Operation Vessel
SPS	Significant Peripheral Structure
TCE	The Crown Estate
TSS	Traffic Separation Scheme
UECC	United European Car Carriers
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
US	United States
VE	Five Estuaries Offshore Wind Farm
VE OWFL	Five Estuaries Offshore Wind Farm Limited
VHF	Very High Frequency
VTS	Vessel Traffic Service
WGS84	World Geodetic System 1984
WTG	Wind Turbine Generator

1 Introduction

1.1 Background

1. Anatec was commissioned by Five Estuaries Offshore Wind Farm Limited (VE OWFL) (hereafter referred to as 'the Applicant'), to undertake a Navigational Risk Assessment (NRA) for the proposed Five Estuaries Offshore Wind Farm (VE). This NRA presents information on VE relative to the existing and estimated future navigational activity and forms the technical Appendix which provides supporting information to **Volume 6, Part 2, Chapter 9: Shipping and Navigation**.

1.2 Navigational Risk Assessment

2. An Environmental Impact Assessment (EIA) is a process which identifies the environmental effects of a proposed development, both negative and positive. An important requirement of the EIA for offshore projects is the NRA. Following the Maritime and Coastguard Agency (MCA) methodology (MCA, 2013) and Marine Guidance Note (MGN) 654 (MCA, 2021), this NRA includes:

- Outline of methodology applied in the NRA;
- Summary of consultation undertaken with shipping and navigation stakeholders to date;
- Lessons learnt from previous Offshore Wind Farm (OWF) developments;
- Summary of the project description relevant to shipping and navigation;
- Baseline characterisation of the existing environment;
- Discussion of potential impacts on navigation, communication and position fixing equipment;
- Cumulative and transboundary overview;
- Future case vessel traffic characterisation;
- Collision and allision risk modelling;
- Assessment of navigational risk (following the Formal Safety Assessment (FSA) process);
- Outline of embedded mitigation measures; and
- Completion of MGN 654 Checklist.

3. Potential hazards are considered for each phase of development (including cumulative) as follows:

- Construction;
- Operations and Maintenance (O&M); and
- Decommissioning.

4. The assessment of VE is based on a parameter-based design envelope approach, which is recognised in the Overarching National Policy Statement (NPS) for Energy (EN-1) (Department for Energy Security & Net Zero (DESNZ), 2023), the NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023), and Planning Inspectorate

Advice Note Nine: Rochdale Envelope (The Planning Inspectorate (PINS), 2018). The design envelope includes conservative assumptions to form a Maximum Design Scenario (MDS) which is considered and assessed for all risks. Further details on the design envelope are provided in Section 6.

5. The shipping and navigation baseline and risk assessment has been undertaken based upon the information available and responses received at the time of preparation, including the MDS as discussed above.

2 Guidance and Legislation

2.1 Legislation

6. 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) (DESNZ, 2023). Additionally, planning policy on NSIP for ports is contained in the NPS for Ports (Department for Transport (DfT), 2012). **Volume 6, Part 2, Chapter 9: Shipping and Navigation** summarises the relevant matters within NPS EN-3 and the NPS for Ports, and where they are considered in **Volume 6, Part 2, Chapter 9: Shipping and Navigation** and/or this NRA.

2.2 Primary Guidance

7. The primary guidance documents used during the assessment are the following:

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

8. MGN 654 highlights issues that shall be considered when assessing the effect on navigational safety from offshore renewable energy developments, proposed in United Kingdom (UK) internal waters, UK territorial sea, or the UK Exclusive Economic Zone (EEZ).

9. The MCA require that their methodology (Annex 1 to MGN 654) is used as a template for preparing NRAs. It is centred on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with mitigation (see Section 3.2). Across **Volume 6, Part 2, Chapter 9: Shipping and Navigation** and the NRA, both base and future case levels of risk have been identified, in addition to the measures required to ensure that both the future case remains broadly acceptable or tolerable with mitigation.

2.3 Other Guidance

10. Other guidance documents used during the assessment are as follows:

- MGN 372 Amendment 1 (Merchant and Fishing) OREIs: Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2022);
- 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) Position on Offshore Renewable Energy Developments: Paper 1 (of 4) – Wind Energy (RYA, 2019);
- Standard Marking Schedule for Offshore Installations (Department of Energy and Climate Change (DECC), 2011); and
- UK Marine Policy Statement (His Majesty’s (HM) Government, 2011).

2.4 Lessons Learnt

11. There is considerable benefit for the Applicant in the sharing of lessons learnt within the offshore industry. The NRA (and **Volume 6, Part 2, Chapter 9: Shipping and Navigation**), and in particular the risk assessment undertaken from Section 18, includes general consideration for lessons learnt and expert opinion from previous OWF developments and other sea users, capitalising on the UK’s position as a leading generator of offshore wind power.

3 Navigational Risk Assessment Methodology

3.1 Formal Safety Assessment Methodology

12. A shipping and navigation user can only be exposed to a risk caused by a hazard if there is a pathway through which a risk can be transmitted between the source activity and the user. In cases where a user is exposed to a risk, the overall significance of risk to the user is determined. This process incorporates a degree of subjectivity and is reliant upon data, defined risk assessment criteria and expert judgement. The assessments presented herein for shipping and navigation users have considered the following criteria:

- Baseline data and assessment;
- Expert opinion;
- Level of stakeholder concern including output of the Hazard Workshop;
- Time and/or distance of any deviation;
- Number of transits of specific vessels and/or vessel types; and
- Lessons learnt from existing offshore developments.

13. It is noted that, with regards to commercial fishing vessels, the methodology and assessment has been applied to hazards considering commercial fishing vessels in transit. A separate methodology and assessment have been applied in **Volume 6, Part 2, Chapter 8: Commercial Fisheries** to consider hazards on commercial fishing vessels including safety risks which are directly related to commercial fishing activity (rather than commercial fishing vessels in transit) and risks of a commercial nature.

3.2 Formal Safety Assessment Process

14. The IMO FSA process (IMO, 2018) as approved by the IMO in 2018 under Maritime Safety Committee – Marine Environment Protection Committee (MEPC).2/circ. 12/Rev.2 has been applied to the risk assessment within this NRA and informs **Volume 6, Part 2, Chapter 9: Shipping and Navigation**.

15. 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 risks of the more important hazards identified in step 1);
- Step 3 – Risk control options (identification of measures to control and reduce the identified risks);
- 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

16. A key tool used in the NRA process is the Hazard Workshop which ensures that all hazards are identified, and the corresponding risks qualified in discussion with relevant stakeholders. Table 3.1 and Table 3.2 define the severity of consequence and the frequency of occurrence rankings that have been used to assess risks within the hazard log, completed based on the outputs of the Hazard Workshop.

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

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 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably probable	1 per 1 to 10 years
5	Frequent	Yearly

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

Table 3.3 Tolerability Matrix and Risk Rankings

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

	Unacceptable (high risk)
	Tolerable with Mitigation (intermediate risk)
	Broadly Acceptable (low risk)

18. Once identified, the significance of risk will be assessed with the inclusion of risk control measures (mitigations) to ensure it is ALARP. Further risk control measures may be required to further mitigate a hazard in accordance with the ALARP principles. Broadly Acceptable and Tolerable with Mitigation risks are ALARP, whilst Unacceptable risks are not considered to be ALARP.

3.3 Methodology for Cumulative Risk Assessment

19. The hazards identified in the FSA are also assessed for cumulative risks with the inclusion of other offshore developments. Given the varying type, status and location of developments, a tiered approach to cumulative risk assessment has been applied, splitting developments into separate tiers depending on the following factors:

- Project status;
- Distance to the array areas and offshore export cable corridor (ECC);
- Level of interaction with baseline traffic relevant to VE;
- Level of concern raised during consultation; and
- Data confidence.

20. An aggregate of the criteria is used to determine the tier of each development.

21. The tiers are summarised in Table 3.4, with the level of assessment undertaken for each tier included. It should be noted that quantitative assessment of long term displacement of main commercial routes (Tiers 1 and 2 only) is limited to potential OWF developments – it is anticipated that displacement due to marine aggregate areas and subsea cables will be limited to situations where associated activities are ongoing (based on experience) and so these developments are assessed only

qualitatively. In the absence of any available information to the contrary, it is assumed as a worst case that cumulative developments will be fully built out.

22. The maximum distance within which developments are considered for the cumulative risk assessment is dependent upon the type of development:

- OWFs – up to 50 nautical miles (nm) from the array areas and up to 5 nm from the offshore ECC;
- Marine aggregate areas – up to 30 nm from the array areas and up to 5 nm from the offshore ECC; and
- Subsea cables – up to 2 nm from the array areas and offshore ECC.

23. These distances have been selected on the basis that at greater distances there is no direct pathway between VE and other developments.

24. Projects meeting the assessment criteria are detailed in Section 14.1.

Table 3.4 Cumulative Risk Assessment Screening Summary

Tier	Development Status	Distance from VE	Interaction with Baseline Traffic	Consultation Responses	Data Confidence	Level of Cumulative Risk Assessment
N/A	Operational or under construction	N/A	N/A	N/A	N/A	None – considered as part of the baseline assessment
1	Consented	*Offshore wind farms:* ▪ Up to 10 nm from the array areas; or ▪ Up to 2 nm from the offshore ECC. *Marine aggregate areas:* ▪ Up to 10 nm from the array areas; or ▪ Up to 2 nm from the offshore ECC. *Subsea cables:* ▪ Up to 2 nm from the array areas; or ▪ Up to 2 nm from the offshore ECC.	▪ May impact a main commercial route passing within 1 nm of the array areas or offshore ECC; and/or ▪ Interacts with traffic which may be directly displaced by the array areas or offshore ECC.	Raised as having a potential cumulative effect.	High	Detailed qualitative and quantitative assessment of displacement of main commercial vessels.
2	Scoped	*Offshore wind farms:* ▪ Between 10 and 25 nm from the array areas; or ▪ Between 2 and 5 nm from the offshore ECC. *Marine aggregate areas:* ▪ Between 10 and 20 nm from the array areas; or ▪ Between 2 and 5 nm from the offshore ECC.	▪ May impact a main commercial route passing within 1 nm of the array areas or offshore ECC; and/or ▪ Interacts with traffic which may be directly displaced by the array areas or offshore ECC.	Raised as having a potential cumulative effect.	Medium	Detailed qualitative and quantitative assessment of displacement of main commercial vessels.

Tier	Development Status	Distance from VE	Interaction with Baseline Traffic	Consultation Responses	Data Confidence	Level of Cumulative Risk Assessment
3	Pre scoping or early development	*Offshore wind farms:* ▪ Between 25 and 50 nm from the array areas.	▪ Does not impact a main commercial route passing within 1 nm of the array areas; and ▪ Does not interact with traffic which may be directly displaced by the array areas.	No concerns raised.	Low	High level qualitative assumptions of displacement of main commercial vessels only.

3.4 Study Areas

3.4.1 Array Areas

25. Two distinct but overlapping study areas have been applied around the array areas, as shown in Figure 3.2.

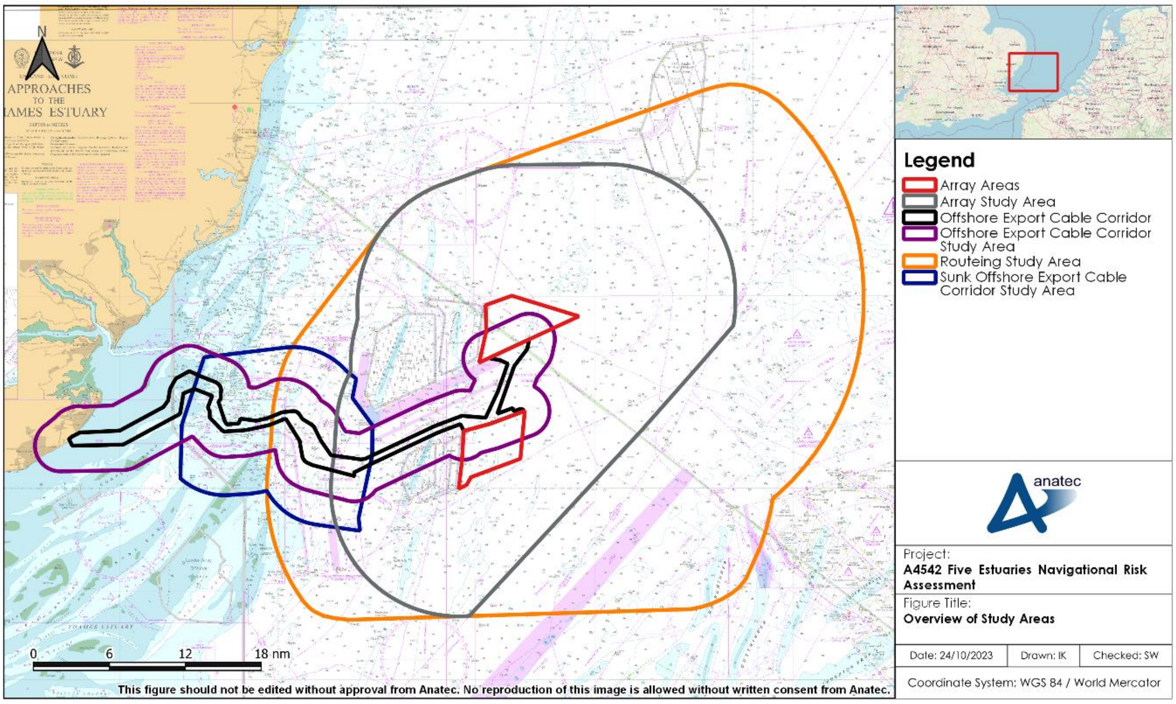

Figure 3.2 Overview of Study Areas

26. The first is a buffer generally of 10 nm around the array areas (hereafter the 'array traffic study area') but with the portion of a complete 10 nm buffer intersecting the North Hinder Junction and North Hinder South Traffic Separation Scheme (TSS) excluded. This study area has been defined to provide local context to the analysis of risks by capturing vessel traffic movements and historical incident data within and in proximity to the array areas. Exclusion of the areas incorporating the North Hinder Junction and North Hinder South TSS ensures that the high volume of vessel traffic known to utilise these areas do not skew the analysis.

27. The second is a buffer of up to around 20 nm around the array areas (hereafter the 'array routeing study area'), with the buffer particularly extended to the east and south-east. This study area has been defined for the purpose of establishing the main commercial routes operated in the region and is used for post wind farm collision and allision risk modelling. Use of this study area ensures that vessel traffic utilising the North Hinder Junction and North Hinder South TSS is adequately characterised in the baseline and risk assessment, as appropriate.

28. The notion of two distinct study areas to cover the array areas was first developed at the Scoping stage and has been discussed and agreed with stakeholders during consultation, including the MCA and Trinity House. Additionally, an amendment to the array routeing study area – involving an extension to the western extent to incorporate the Sunk TSS North and Sunk TSS South fully – requested by the UK Chamber of Shipping during consultation was made between the Scoping and Preliminary Environmental Information Report (PEIR) stages.

3.4.2 Offshore Export Cable Corridor

29. A minimum 2 nm buffer has been applied around the full offshore ECC (hereafter the 'offshore ECC study area') as shown in Figure 3.2. As with the array traffic study area, the offshore ECC study area has been defined to capture relevant users and their movements within, and near, the offshore ECC.

30. An additional study area associated with a section of the offshore ECC has also been applied (hereafter the 'Sunk offshore ECC study area') as shown in Figure 3.2. This study area incorporates up to a 5 nm buffer of the offshore ECC with the eastern extent incorporating the Sunk Outer Precautionary Area and the western extent covering up to the NE Gunfleet west cardinal mark. This study area was defined based on feedback from Harwich Haven Authority (HHA) and has been used to provide further context of vessel movements in sections of the offshore ECC considered more sensitive during consultation.

4 Consultation

4.1 Stakeholders Consulted in the Navigational Risk Assessment Process

31. Key shipping and navigation stakeholders have been consulted in the NRA process. The following stakeholders have been consulted via dedicated meetings:

- MCA;
- Trinity House;
- UK Chamber of Shipping;
- Cruising Association;
- Sunk Vessel Traffic Service (VTS);
- HHA;
- Port of London Authority (PLA);
- London Gateway;
- Port of Felixstowe;
- Brightlingsea Harbour Commissioners;
- Stena Line;
- DFDS Seaways;
- CLdN; and
- Hanson Aggregates Marine.

32. Meetings have included the Hazard Workshop (see Section 4.2), Expert Topic Group (ETG) meetings (in August and December 2021), and standalone consultation meetings held both prior to and following the Scoping and PEIR stages including consultation on site refinements. Consultation includes the Scoping Opinion and Section 42 of which relevant points have been outlined within **Volume 6, Part 2, Chapter 9: Shipping and Navigation.**

33. Additionally, the Sunk VTS User Group have been consulted (in January 2021 and January 2022) and the British Marine Aggregate Producers Association (BMAPA) were approached to coordinate consultation with marine aggregate dredger stakeholders. The RYA have also been approached as part of the consultation phase.

34. As well as consulting with the above organisations, two rounds of consultation with Regular Operators identified from the vessel traffic survey data and long-term vessel traffic data have been undertaken. Identified Regular Operators were provided with an overview of VE and offered the opportunity to provide comment and participate in the Hazard Workshop. The full Regular Operator letters are provided in Appendix C.

35. The first round of consultation (undertaken based on the long-term vessel traffic data only) included the five main commercial ferry operators in the region: Stena Line, DFDS Seaways, CLdN, P&O Ferries, and United European Car Carriers (UECC). The second round of consultation (undertaken following collection of the vessel traffic survey data) included a further 18 Regular Operators:

- A2B-online;
- BF Ship Management;
- BMAPA;
- Britannia Aggregates;
- Cemex UK Marine;
- Eckero Shipping;
- Euro Marine Logistics;
- Hanson Aggregates;
- Holwerda Shipmanagement;

- Intrada Ship Management (Scotline);
- James Fisher and Sons;
- K Line;
- Koole Terminals;
- Mann Lines;
- Mediterranean Shipping Company (MSC);
- Tarmac Marine;
- Toyofuji Shipping; and
- Van Oord.

36. DFDS Seaways, CLdN, Tarmac Marine, Hanson Aggregates Marine, Stena Line, Intrada Ship Management, A2B-online, and MSC provided feedback directly.

4.2 Hazard Workshop

37. A key element of the consultation phase was the Hazard Workshop – a meeting of local and national marine stakeholder to identify and discuss potential shipping and navigation hazards. Using the information gathered from the Hazard Workshop, a hazard log (see Appendix B) was produced for use as input into the risk assessment undertaken from Section 18. This ensured that expert opinion and local knowledge was incorporated into the risk assessment, and that the hazard log was site-specific.

4.2.1 Hazard Workshop Attendance

38. The Hazard Workshop was held in London on 20 October 2022, featuring a hybrid of in-person and remote attendance. The Hazard Workshop was attended by the organisations listed below:

- MCA;
- UK Chamber of Shipping;
- Cruising Association;
- Sunk VTS;
- HHA;
- PLA;
- London Gateway;
- Port of Felixstowe;
- Brightlingsea Harbour Commissioners;
- Stena Line;
- DFDS Seaways; and
- Hanson Aggregates Marine.

4.2.2 Hazard Workshop Process and Hazard Log

39. During the Hazard Workshop, key maritime hazards associated with the construction, O&M, and decommissioning of VE (including future case and cumulative) were identified and discussed. Where appropriate, hazards were considered by vessel type to ensure risk control options could be identified on a type-specific basis.

40. Following the Hazard Workshop, the risks associated with the identified hazards were ranked in the hazard log based upon the discussions held during the workshop, with appropriate embedded mitigation measures identified, including any additional measures required to reduce the risks to ALARP. The hazard log was then provided to the Hazard Workshop attendees for comment and their feedback incorporated into the NRA.

41. The hazard log has been used to inform the risk assessment from Section 18 and is provided in full in Appendix B.

4.2.2.1 Hazard Workshop Follow-Up

42. A Hazard Workshop follow-up was held in January 2024, gathering organisations from the Hazard Workshop itself to review updates to the design of VE and any effect on the risk rankings identified in the hazard log.

43. Attendees included MCA, UK Chamber of Shipping, RYA, Cruising Association, Sunk VTS, HHA, PLA, London Gateway, and Port of Felixstowe.

44. Feedback received has been addressed in the hazard log as provided in Appendix B.

4.3 Section 42 Responses

45. All relevant stakeholders were provided the PEIR for review, with responses received from MCA, Trinity House, UK Chamber of Shipping (including a joint position with DFDS Seaways and Stena Line), HHA, PLA, London Gateway, RYA, and Greater Gabbard Offshore Winds Ltd.

46. These responses have been considered and addressed across **Volume 6, Part 2, Chapter 9: Shipping and Navigation** and the NRA, and have resulted in several post PEIR meetings with stakeholders to further discuss the points raised. The key action resulting from Section 42 feedback has been a refinement to the offshore ECC (see Section 6.1.1).

4.4 Consultation Responses

47. Various responses have been received from stakeholders during consultation undertaken in the NRA process, including via conference calls, email correspondence, the Scoping Opinion (PINS, 2021), Hazard Workshop, and Section 42. The key issues raised and where they are addressed within **Volume 6, Part 2, Chapter 9: Shipping and Navigation** and/or the NRA is provided in Table 9.2 of **Volume 6, Part 2, Chapter 9: Shipping and Navigation**.

5 Data Sources

48. This section summarises the main data sources used to characterise the shipping and navigation baseline relative to VE.

5.1 Summary of Data Sources

49. The main data sources used to characterise the shipping and navigation baseline relative to VE are outlined in Table 5.1. These data sources have been updated where available from those used within the Scoping Report.

Table 5.1 Data Sources Used to Inform the Shipping and Navigation Baseline

Data	Source(s)	Purpose
Vessel traffic	Winter vessel traffic survey data consisting of Automatic Identification System (AIS), Radio Detection and Ranging (Radar), and visual observations for the array traffic study area (14 days, 15 January 2022 – 29 January 2022) recorded from a dedicated survey vessel on-site.	Characterising vessel traffic movements within, and in proximity to, the array areas in line with MGN 654 (MCA, 2021) requirements.
	Summer vessel traffic survey data consisting of AIS, Radar, and visual observations for the array traffic study area (14 days, 15 June 2022 – 29 June 2022) recorded from a dedicated survey vessel on-site.	
	AIS data for the array traffic study area (12 months, 2019) (hereafter the 'long-term vessel traffic data') recorded from coastal receivers.	Validation of the vessel traffic surveys and characterising seasonal variations.
	Anatec's ShipRoutes database (2022).	Secondary source for characterising vessel traffic movements including cumulatively within, and in proximity to, VE.
	Winter vessel traffic data consisting of AIS for the offshore ECC study area (14 days, 15 January 2022 – 29 January 2022) recorded from coastal receivers and a dedicated survey vessel at the array areas.	Characterising vessel traffic movements within, and in proximity to, the offshore ECC in line with MGN 654 requirements.
	Summer vessel traffic data consisting of AIS for the offshore ECC study area (14 days, 15 June 2022 – 29 June 2022) recorded from terrestrial receivers and a dedicated survey vessel at the array areas.	
	AIS data for the Sunk offshore ECC study area (12 months, 2022) recorded from coastal receivers.	

Data	Source(s)	Purpose
	RYA Coastal Atlas of Recreational Boating 2.1 (RYA, 2019).	Secondary source for characterising recreational vessel traffic movements.
Maritime incidents	Maritime Accident Investigation Branch (MAIB) marine accidents database (2002 – 2021)	Review of maritime incidents within, and in proximity to, VE.
	Royal National Lifeboat Institution (RNLI) incident data (2013 – 2022).	
	DfT UK civilian Search and Rescue (SAR) helicopter taskings (2015 – 2023).	
Other navigational features	Admiralty Charts 1183, 1610, 1630, and 2052 (United Kingdom Hydrographic Office (UKHO), 2022).	Characterising other navigational features within, and in proximity to, VE
	Admiralty Sailing Directions Dover Strait Pilot NP28 (UKHO, 2020) and *Admiralty Sailing Directions North Sea (West) Pilot NP54* (UKHO, 2021).	
Weather	Wind direction data modelled by Vortex.	Characterising weather conditions in proximity to VE for use as input to the collision and allision risk modelling.
	Significant wave height data recorded by Fugro between December 2010 and May 2012.	
	Tidal data provided by Admiralty Charts 1610 and 1630 (UKHO, 2022).	
	Visibility data provided in Admiralty Sailing Directions North Sea (West) Pilot NP54 (UKHO, 2021).	
	Case Studies of Past Weather Events (Met Office, 2019).	Identifying periods of adverse weather in proximity to VE coinciding with the long-term vessel traffic data.

5.2 Vessel Traffic Surveys

50. The vessel traffic surveys were undertaken by the guard vessel *Karima* (IMO number 7,427,403), in agreement with the MCA and Trinity House. This includes granting from the MCA (received in January 2024) of an exemption to the MGN 654 24-month requirement between completion of vessel traffic surveys and the submission of the consent application.

51. A number of vessel tracks recorded during the survey period were classified as temporary (non-routine), such as those undertaking surveys or acting as guard vessels. These were therefore excluded from the characterisation of the vessel traffic baseline.

52. The 28-day dataset (winter and summer 2022) is assessed in full in Section 10.

5.3 Long-Term Vessel Traffic Data

53. The long-term vessel traffic data consisting of AIS covering 12 months in 2019 was collected from coastal receivers. This dataset was agreed with the MCA and Trinity House. Taking into account the distance offshore of VE, the long-term vessel traffic data is considered comprehensive for the array traffic study area. The assessment of this dataset allowed seasonal variations to be captured.

54. The dataset is assessed in full in Appendix D.

5.4 Data Limitations

5.4.1 Automatic Identification System Data

55. 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 500 GT not engaged on international voyages, passenger vessels irrespective of size built on or after 1 July 2002, and fishing vessels over 15 metres (m) length overall (LOA).

56. Therefore, for the vessel traffic surveys larger vessels were recorded on AIS, while smaller vessels without AIS installed (including fishing vessels under 15 m LOA and recreational craft) were recorded, where possible, on the Automatic Radar Plotting Aid (ARPA) Radar on board the *Karima*. A proportion of smaller vessels also carry AIS voluntarily, typically utilising a Class B AIS device.

5.4.2 Historical Incident Data

57. Although all UK commercial vessels are required to report accidents to the MAIB, non-UK vessels do not have to report unless they are in a UK port or within 12 nm territorial waters (noting that the array traffic study area is in the majority located outside 12 nm territorial waters) or carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB.

58. The RNLI incident data cannot be considered comprehensive of all incidents in the array traffic study area. Although hoaxes and false alarms are excluded, any incident to which an RNLI resource was not mobilised has not been accounted for in this dataset.

59. As per agreement with the UK Chamber of Shipping 20 years of incident data has been considered including the most recent 10 years being included within quantification of risk.

5.4.3 United Kingdom Hydrographic Office Admiralty Charts

60. The UKHO admiralty charts are updated periodically and therefore the information shown may not reflect the real time features within the region with total accuracy. However, during consultation input has been sought from relevant stakeholders

regarding the navigational features baseline. Where relevant the use of navigational features has been discussed with relevant stakeholders.

6 Project Description Relevant to Shipping and Navigation

61. The NRA reflects the design envelope which is detailed in full in **Volume 6, Part 2, Chapter 1: Offshore Project Description**. The following subsections outline the maximum extent of VE for which any shipping and navigation hazards are assessed.

6.1 Array Areas and Offshore Export Cable Corridor

62. The array areas are located approximately 20 nm south of the East Suffolk coast and separated by approximately 4.8 nm. The total area covered by the array areas is approximately 37 nautical mile squared (nm^2), comprised of the northern array area of 19 nm^2 and the southern array area covering 18 nm^2. Charted water depths within the array areas range between 31 and 57 m below Chart Datum (CD). The offshore ECC has a length of 43 nm, with landfall at Holland-on-Sea. The total area covered by the offshore ECC is approximately 49 nm^2 and water depths range between zero (nearshore) and 60 m below CD.

63. The key coordinates defining the boundary of the array areas are illustrated in Figure 6.1 and provided in Table 6.1.

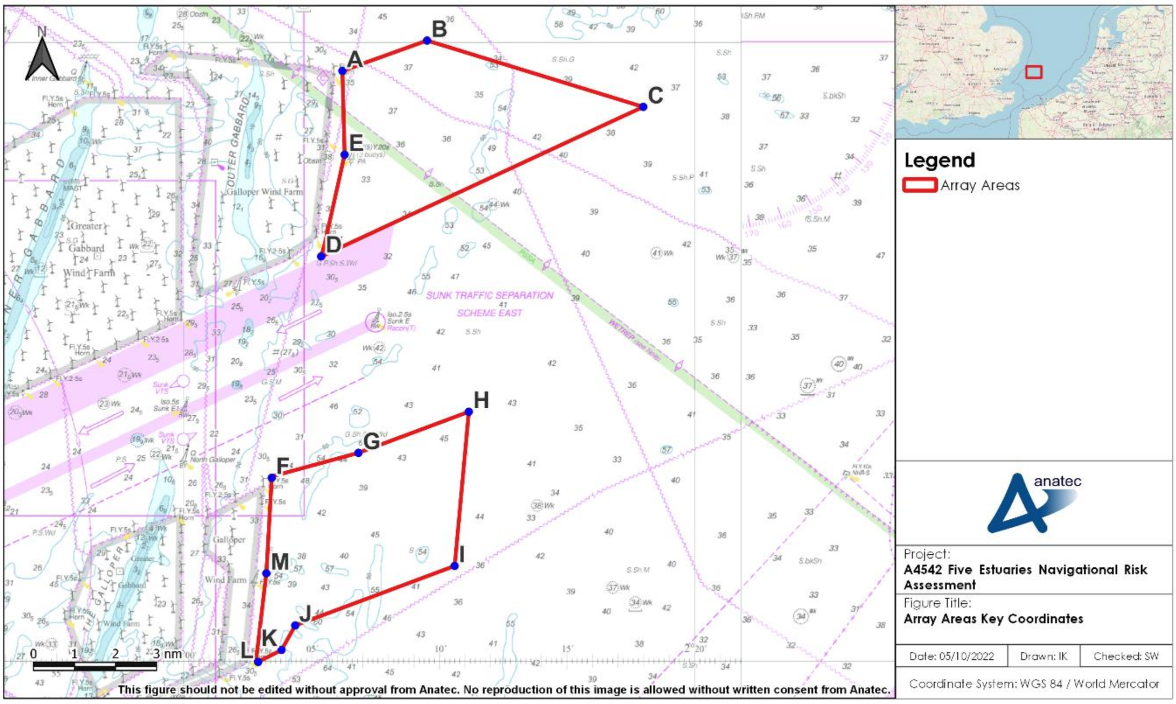

Figure 6.1 Array Areas Key Coordinates

Table 6.1 Array Areas Key Coordinates (World Geodetic System 1984 (WGS84))

Point	Latitude	Longitude	Point	Latitude	Longitude
A	51° 59′ 17.25″ North (N)	002° 06′ 11.51″ East (E)	H	51° 51′ 02.08″ N	002° 11′ 08.84″ E
B	52° 00′ 01.31″ N	002° 09′ 30.63″ E	I	51° 47′ 17.65″ N	002° 10′ 35.58″ E
C	51° 58′ 25.04″ N	002° 17′ 59.27″ E	J	51° 45′ 50.90″ N	002° 04′ 20.40″ E
D	51° 54′ 47.97″ N	002° 05′ 21.54″ E	K	51° 45′ 15.14″ N	002° 03′ 48.28″ E
E	51° 57′ 15.66″ N	002° 06′ 16.68″ E	L	51° 44′ 55.36″ N	002° 02′ 47.50″ E
F	51° 49′ 25.95″ N	002° 03′ 25.56″ E	M	51° 47′ 06.90″ N	002° 03′ 12.48″ E
G	51° 50′ 02.29″ N	002° 06′ 49.22″ E			

6.1.1 Site Refinement

6.1.1.1 Array Areas

64. Initial consultation meetings highlighted concern from stakeholders with regards to traffic congestion to/from the North Hinder Junction caused by the size and boundary of the northern array area. Following this feedback assessment work was undertaken to identify future case routeing for various array area designs to observe how cumulative densities changed.

65. Following this assessment work and consultation with stakeholders including through the Scoping Opinion (see Section 4.3) a refined northern array area was agreed which mitigated impacts on navigation safety i.e., traffic hotspots and increased collision risk. The southern array area remains unchanged from the Scoping stage.

66. Figure 6.2 presents the refinement of the array areas from the Scoping stage.

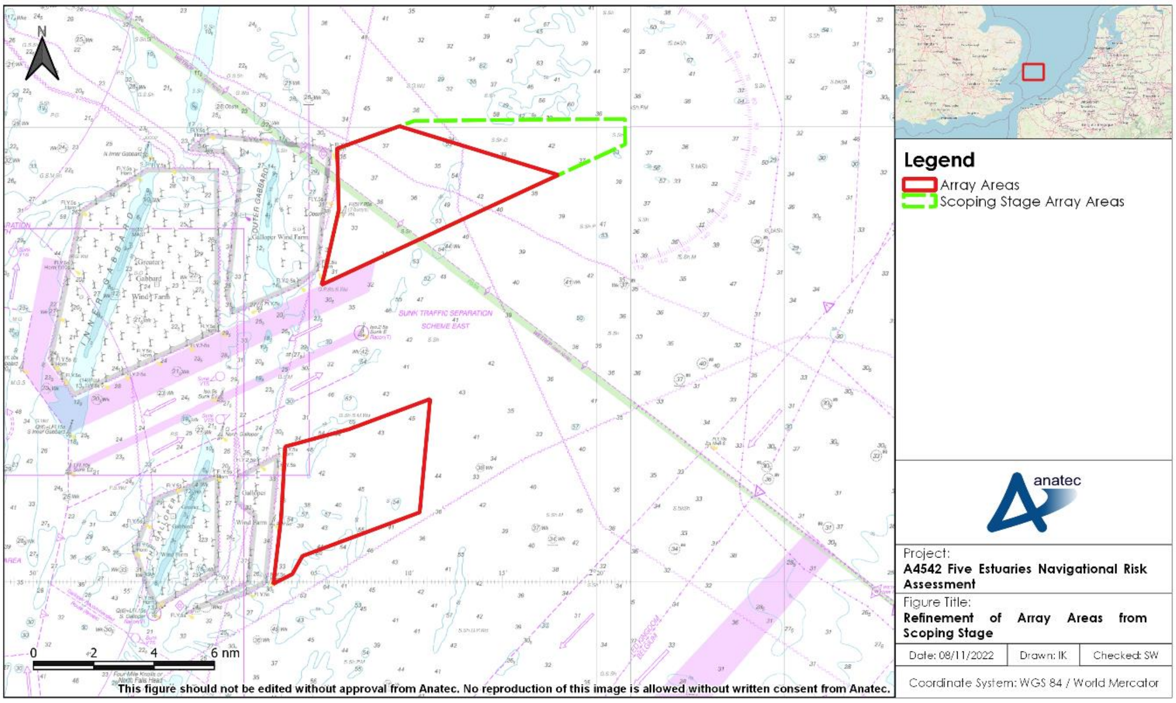

Figure 6.2 Refinement of Array Areas from Scoping Stage

67. The northern boundary of the northern array area has been pulled southward but pivoted on an existing vertex along the northern boundary, broadly creating a trapezium. This change creates additional sea room immediately north and east of the northern array area and an angle parallel with the direction of heavily trafficked commercial ferry routes (see Section 11.2).

68. The refinement of the northern array area represents a 23% reduction for the northern array area and a 14% reduction for the array areas as a whole.

69. Benefits of the refinement of the northern array area (which have been welcomed by the MCA, Trinity House, and UK Chamber of Shipping) include:

- Minimises displacement to heavily trafficked commercial ferry routes and allows course adjustments to be made earlier;
- Increased sea room for adverse weather routeing to safely continue;
- Allows optimal alignment on entry/exit into/out of the North Hinder Junction;
- Minimises collision risk for crossing traffic since interaction of existing hotspots is minimised;
- Increased sea room for vessels awaiting orders in/out of the Sunk routeing measure;
- Increased sea room for the Royal Ocean Racing Club (RORC) North Sea Race; and
- Navigation corridor between the northern array area and East Anglia Two is offset at eastern extent creating additional sea room for transits and adjusting heading.

70. In particular, Trinity House raised the ability for vessels to achieve optimal alignment on entry/exit into/out of the North Hinder Junction and have since acknowledged that vessels approaching the North Hinder Junction will be able to maintain their existing approach with the refined northern array area.

71. The effect of the refinement of the northern array area is particularly noteworthy when considering the highest areas of collision risk within the array routeing study area based on the modelling outputs (see Section 16.4.2). The highest risk areas in the post wind farm scenario are associated with the heavily trafficked routes within the North Hinder routeing measures, but there are also hotspots where routeing traffic crosses, including directly east of the northern array area. However, the evolution of these hotspots from the pre wind farm scenario are minor, i.e., the hotspots already existed to some extent in the pre wind farm scenario. This was acknowledged during consultation with the MCA, Trinity House, Stena Line, and DFDS Seaways.

6.1.1.2 Offshore Export Cable Corridor

72. Detailed consultation with stakeholders in relation to the offshore ECC has been ongoing since before the Scoping Report was submitted and has included discussions relating to possible options for the routeing of the offshore ECC (see Section 1.3 of **Volume 6, Part 2, Chapter 9: Shipping and Navigation**).

73. The offshore ECC was refined for the PEIR stage and has been further refined for the ES stage, with the latter changes reflecting the preferred option which was presented at the PEIR stage. Refinements made in response to concerns raised to date (which have been welcomed by HHA) include:

- Less obtrusive location relative to Sunk pilot boarding station;
- Avoidance of the Harwich Deep Water Channel and recommended deep water route leading in/out of it;
- Crossing perpendicular to Sunk deep water route;
- Avoidance of areas where Trinity deep water route is further constrained by navigational features;
- Retention of deepest areas where the Sunk and trinity deep water routes are crossed; and
- Avoidance of Sunk Inner and Sunk Deep Water (DW) anchorage areas.

74. Figure 6.3 presents the refinement of the offshore ECC from the PEIR stage. Following this, Figure 6.4 presents a detailed view of the refinement of the offshore ECC from the PEIR stage, focusing on the Sunk Inner Precautionary Area.

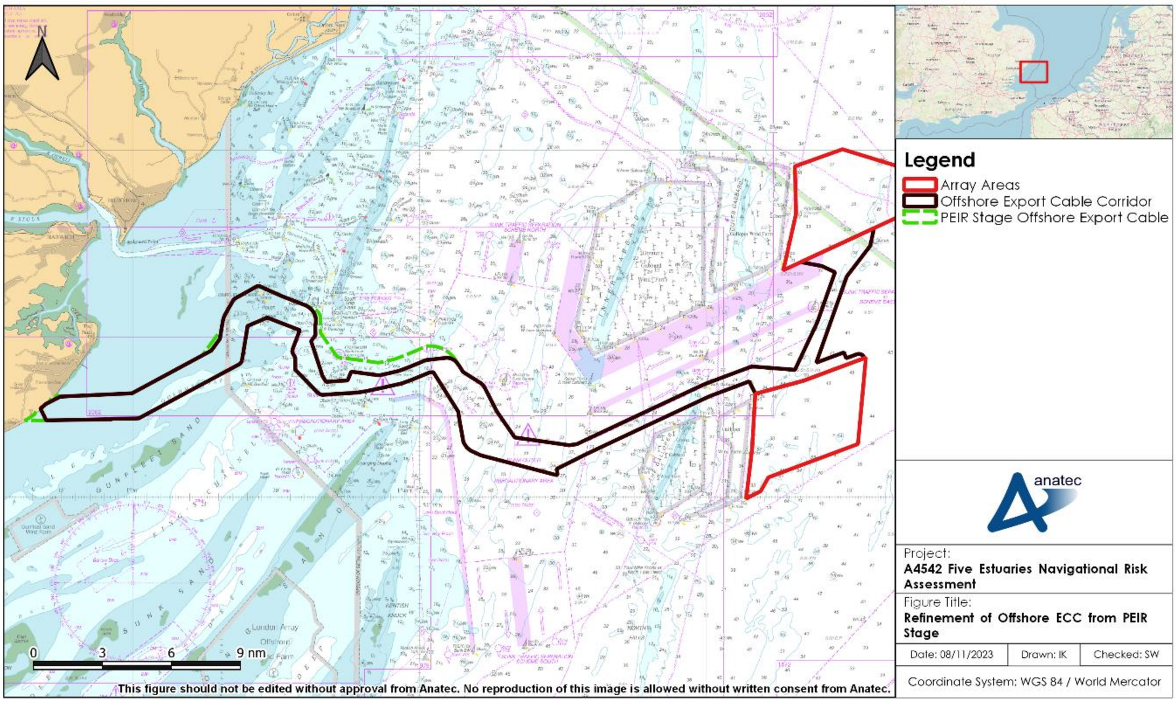

Figure 6.3 Refinement of Offshore ECC from PEIR Stage

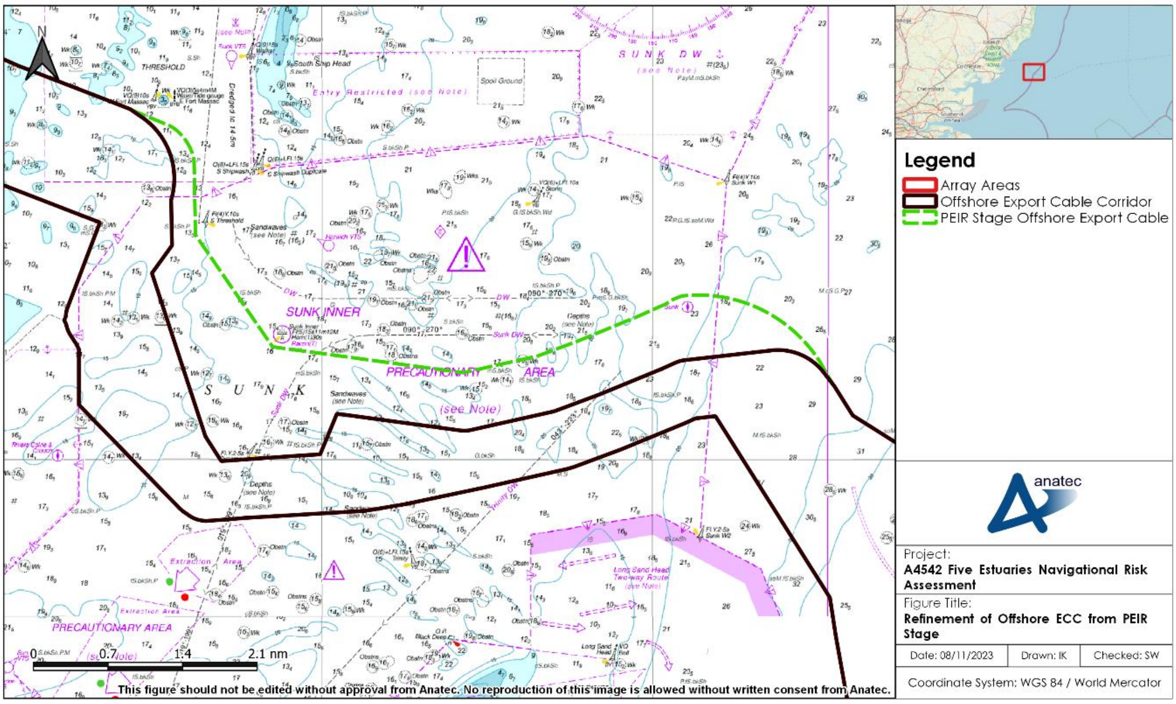

Figure 6.4 Detailed View of Refinement of Offshore ECC from PEIR Stage

6.2 Surface Infrastructure

6.2.1 Indicative Worst Case Array Layout

75. Up to 81 surface structures will be installed, consisting of 79 Wind Turbine Generators (WTG) and two Offshore Substation Platforms (OSP). All surface structures will be located within the array areas.

76. Although the final infrastructure locations have not yet been defined, an indicative worst-case layout has been determined for shipping and navigation and is presented in Figure 6.5.

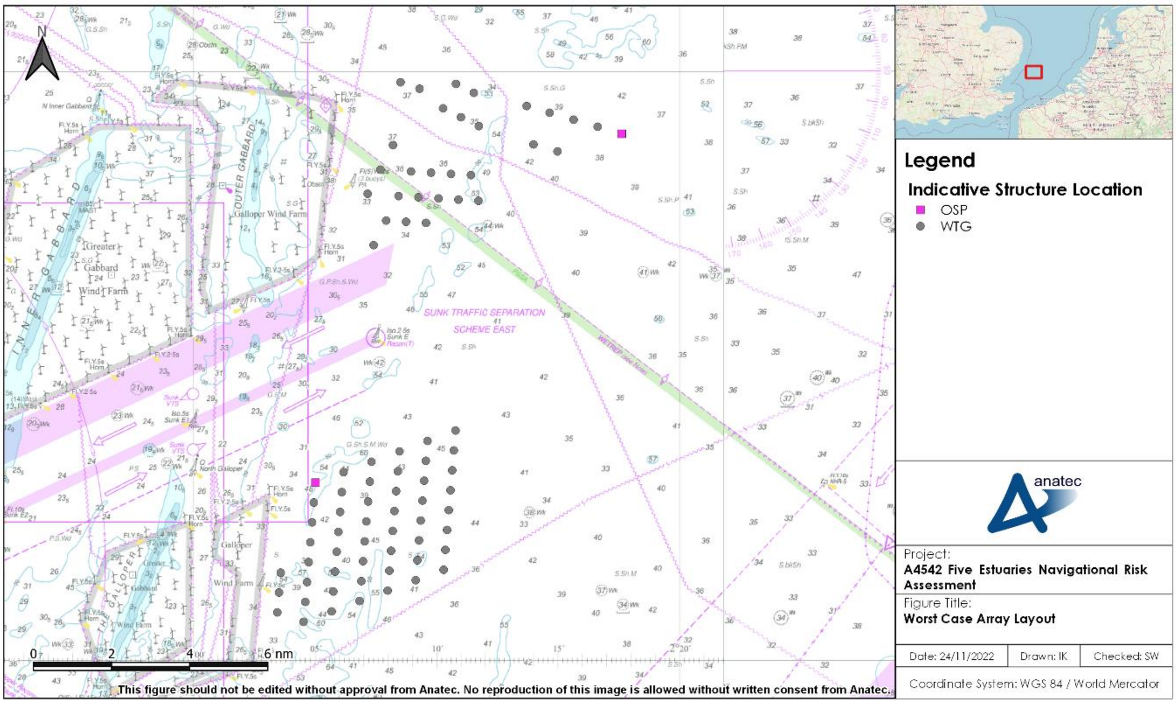

Figure 6.5 Worst Case Array Layout for Shipping and Navigation

77. The worst-case scenario for shipping and navigation includes:

- Full build out of the array areas;
- Minimum spacing of 830 m (measured centre-to-centre) between WTGs;
- Minimum spacing of 500 m (measured tip-to-topside) between WTGs and OSPs'
- OSPs located in proximity to areas where exposure to vessel to structure allision risk is deemed to be greatest;
- Single Line of Orientation (SLoO) for the northern array area (noting southern array may also proceed with a SLoO);
- Minimum setback of 1 nm (measured tip-to-tip) from the Galloper Offshore Wind Farm (assuming layout does not align with Galloper Offshore Wind Farm – if it did a smaller setback could be used); and
- Setback of up to 1,000 m from existing subsea cables in the northern array.

78. The above worst case assumptions are for the purposes of modelling /risk assessment only and the final array layout will need to be agreed with the MCA and Trinity House post consent. The final array layout will include an allowance for micrositing within a 50 m radius of any one WTG. There are no plans to designate the array areas as an Area to be Avoided (ATBA).

79. Should a SLoO layout be taken forward – based on constraints such as third-party subsea cables, sandwaves, and Archaeological Exclusion Zones (AEZ) – then as part of MGN 654 compliance a safety justification for a SLoO layout will be completed to support the layout approval process with the MCA and Trinity House.

6.2.2 Wind Turbine Generators

80. The WTGs within the indicative layout each have a maximum rotor diameter of 360 m and a minimum upper blade tip height of 28 m above Mean High Water Springs (MHWS), noting that these values represent the worst-case for shipping and navigation and are above the minimum requirement of 22 m above MHWS.

81. Four-legged piled jacket foundations have been considered as the MDS for shipping and navigation as this foundation type provides the maximum structure dimensions at the sea surface. The MDS WTG measurements assuming use of four-legged piled jacket foundations are provided in Table 6.2, noting that the values provided are specific to the worst-case selected for shipping and navigation, and do not necessarily represent the maximum values within the design envelope overall.

Table 6.2 MDS for Shipping and Navigation – WTGs

Parameter	MDS for Shipping and Navigation
Foundation type	Four-legged piled jacket
Dimensions at sea surface[1]	38.5×38.5 m
Maximum blade tip height (above MHWS)	420 m
Minimum air gap (above MHWS)	28 m
Maximum rotor diameter	360 m

82. Other foundation types under consideration include monopiles, three-legged jackets with suction buckets, mono suction caisson, four-legged jackets with suction buckets, and gravity based structures (monopile or multi-leg). Descriptions of each foundation type under consideration are provided in **Volume 6, Part 2, Chapter 1: Offshore Project Description**.

[1] At the time of the collision and allision risk modelling being undertaken the WTG foundation and OSP topside dimensions at the sea surface were 50×50 m and 125×110 m, respectively. The design envelope has been refined since, although the modelling results obtained are still considered to represent a realistic worst case.

6.2.3 Offshore Substation Platforms

83. The OSPs may be installed on monopile, six-legged jacket, suction bucket monopile, six-legged jacket with suction bucket, or gravity-based foundations, but will have maximum topside dimensions[2] of 125x100 m.

6.3 Subsea Cables

84. Various types of subsea cables will be installed and can be categorised as array cables, export cables, or interconnector cables. Each of these is summarised in the following subsections, noting that all cables will carry High Voltage Alternating Current (HVAC). Any potential High Voltage Direct Current (HVDC) cables comprising long distance interconnector cables would be third party operated and therefore not a direct part of VE.

6.3.1 Array Cables

85. The array cables will connect individual WTGs to OSPs. Up to 108 nm of array cables will be required, with the final length dependent on the final array layout. There will be up to 26 array cable crossings, and an indicatively a maximum of eight repairs/ replacements throughout the O&M phase. All array cables will be installed within the array areas.

6.3.2 Export Cables

86. The export cables will carry the energy generated by the WTGs from the array areas to shore. Up to two export cables will be required (a decrease from four at the PEIR stage) with a length of up to 53 nm per cable and will be installed within the offshore ECC. There will be up to 30 export cable crossings (including consideration of North Falls, NeuConnect, and Sea Link) and an indicative separation between the export cables of between 50 and 200 m, which may vary given the need to avoid AEZs and seabed obstructions. Indicatively there will be a maximum of nine repairs throughout the O&M phase.

6.3.3 Interconnector Cables

87. Should an OSP be installed within each of the array areas an interconnector cable(s) may be used to link the two OSPs. Such cable(s) will be located within the array areas and offshore ECC.

6.3.4 Cable Burial

88. Where available, the primary means of cable protection will be by seabed burial. The extent and method by which the subsea cables will be buried will depend on the results of a detailed seabed survey of the final cable routes and associated cable burial risk assessment. For the array and export cables the indicative maximum burial depth is 3.5 m with an indicative average cable burial depth of 0.5 m relative to non-mobile seafloor level. Where appropriate, export cables will be buried sufficiently to

ensure there is no interaction with any future spot dredging associated with London Gateway operations around the Sunk and Trinity deep water routes. The selected burial depth may also vary along the length of the offshore ECC to account for variations in ground conditions and anchor strike risk profile.

89. Cable burial will involve either jet-trenching, ploughing, mechanical trenching, dredging, mass flow excavation, or rock cutting. Removal of upper (typically mobile) seabed sediments to ensure industry standard trenching tools can reach a sufficient depth of burial may be required, particularly in potential areas of concern as highlighted in Section 15.4.

90. Where cable burial is not possible, alternative cable protection methods may be deployed which will again be determined within the cable burial risk assessment and as required during installation.

91. Cable protection includes either one of, or a combination of, rock placement, concrete mattresses, flow dissipation devices, protection aprons/ coverings/ cladding/ pipes, and/ or rock bags or equivalent measures.

92. The indicative proportion of protection required is up to 20% of array cables and 10% of export cables. The indicative height of cable protection is 1.0 m for the array cables and 1.1 m for the export cables, increasing to 1.4 m for cable crossings.

6.4 Construction Phase

93. The offshore construction phase will last for approximately up to five years inclusive of site preparation, with four years of installation/commissioning.

94. An indicative construction programme for VE is provided in Figure 6.6.

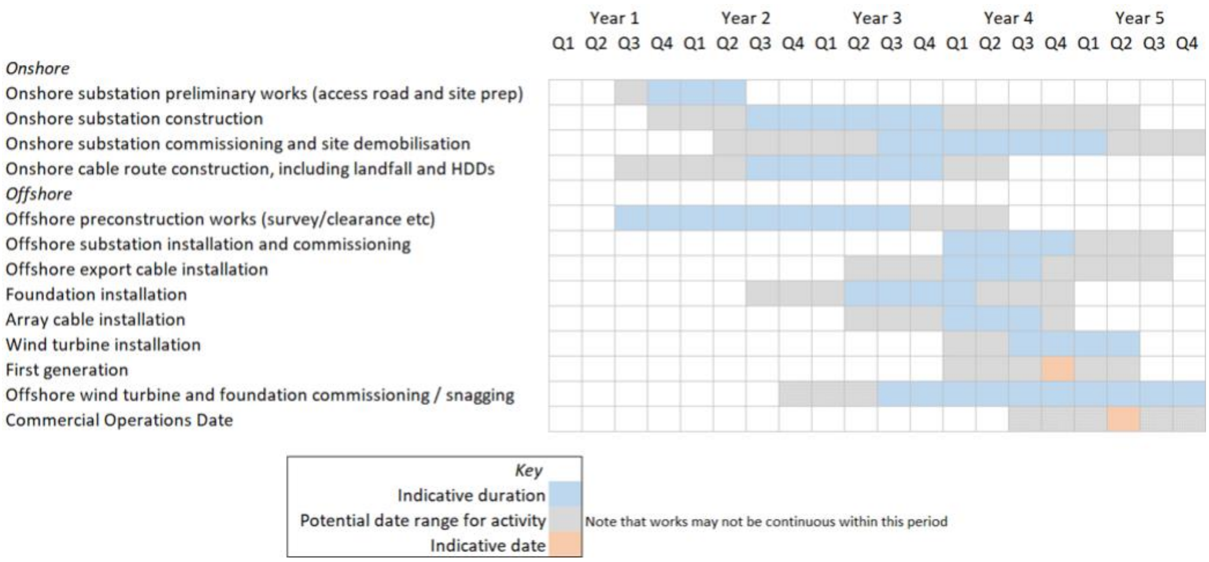

Figure 6.6 Indicative Construction Programme

95. Additional granularity for export cable lay and burial operations will be outlined in a future version of the Navigation Installation Plan (NIP) – see Section 21.4 and **Volume 9, Report 20: Outline Navigation Installation Plan**.

96. An application for safety zones associated with surface infrastructure (array areas) will be sought during the construction phase, including 500 m around ongoing construction activities and 50 m around installed structures pre commissioning (see Section 21).

97. A maximum number of 35 construction vessels may be located on-site simultaneously, with a maximum of 4,311 round trips to port throughout the construction phase. Table 6.3 provides a breakdown of the installation activities and vessel types during the construction phase.

Table 6.3 Breakdown of Construction Vessel Peak Numbers

Construction Element	Vessel Type	Peak Vessels	Maximum Round Trips to Port
Foundations	WTG and OSP foundation installation vessels	38	1,359
WTGs and OSPs	WTG installation vessels (including tugs and feeders)	10	71
	OSP topside installation vessels (including tugs and feeders)	4	8
Other installation vessels	Commissioning (including accommodation vessels)	5	130
	Other vessels	15	2,300
Cable installation (including seabed preparation)	Array cable installation vessels (including support, cable protection and anchor handling vessels)	12	166
	Export cable installation vessel spreads (including support, cable protection and anchor handling vessels)	12	278
Maximum total construction vessels		**96**	**4,311**
Indicative peak vessels on-site simultaneously		**35**	**N/A**

98. Additionally, a maximum of 530 return trips may be made by up to two helicopters during the construction phase.

6.5 Operations and Maintenance Phase

99. The maximum operational life of VE is 40 years. Throughout the O&M phase, a maximum of 27 O&M vessels may be located on-site simultaneously with a maximum

of 1,776 annual round trips to port. Table 6.4 provides a breakdown of the installation activities and vessel types during the construction phase.

Table 6.4 Breakdown of O&M Vessel Peak Numbers

Vessel Type	Peak Number On-Site Simultaneously	Maximum Annual Round Trips to Port
Jack-up vessels	3	9
SOVs	2	52
CTVs	9	1,642
Lift vessels	3	8
Cable maintenance vessels	2	1
Auxiliary vessels	8	64
Total	**27**	**1,776**

100. Additionally, a maximum of 125 return trips annually may be made by helicopters during the O&M phase.

6.6 Decommissioning Phase

101. Decommissioning works will generally be the reverse of the construction works and involve similar types and numbers of vessels as well as helicopters. The decommissioning duration of the offshore infrastructure may take up to three years, with cables left *in situ* preferred – the best environmental option will be considered at the time of decommissioning.

102. A Decommissioning Plan will be developed prior to the start of decommissioning works (see Section 22.9), with the nature of the works determined by legislation and guidance at the time.

6.7 Maximum Design Scenario

103. The MDS for each shipping and navigation hazard is provided in Table 6.5 and is based on the parameters described in the previous subsections.

Table 6.5 MDS for Shipping and Navigation by Hazard

Potential Hazard	Phase(s)	MDS for Shipping and Navigation	Justification
Vessel displacement and increased collision risk	Construction/ decommissioning	▪ Single phase of construction of up to five years and decommissioning of up to three years; ▪ Full build out of the array areas; ▪ Buoyed construction/decommissioning area encompassing the maximum extent of the array areas; ▪ Presence of 500 m construction safety zones and 50 m pre commissioning safety zones around surface piercing structures; ▪ Up to two export cables each of 53 nm length; ▪ Indicative separation of between 50 and 200 m between export cables; and ▪ Up to 35 construction/decommissioning vessels on-site simultaneously.	Largest possible extent of infrastructure, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on vessel displacement and subsequent collision risk involving third-party vessels.
	O&M	▪ Maximum operational life of 40 years; ▪ Full build out of the array areas; ▪ Presence of 500 m safety zones during major maintenance around surface piercing structures; and ▪ Up to 27 O&M vessels on-site simultaneously and up to 1,776 annual round trips to port.	

Potential Hazard	Phase(s)	MDS for Shipping and Navigation	Justification
Third-party with project vessels collision risk	Construction/ decommissioning	▪ Single phase of construction of up to five years and decommissioning of up to three years; ▪ Full build out of the array areas; ▪ Buoyed construction/decommissioning area encompassing the maximum extent of the array areas; ▪ Presence of 500 m construction safety zones and 50 m pre commissioning safety zones around surface piercing structures; ▪ Up to two export cables each of 53 nm length; ▪ Indicative separation of between 50 and 200 m between export cables; and ▪ Up to 35 construction/decommissioning vessels on-site simultaneously and up to 4,311 round trips to port.	Largest possible extent of infrastructure, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on vessel to vessel collision risk involving a third-party vessel and a project vessel.
	O&M	▪ Maximum operational life of 40 years; ▪ Full build out of the array areas; ▪ Presence of 500 m safety zones during major maintenance around surface piercing structures; and ▪ Up to 27 O&M vessels on-site simultaneously and up to 1,776 annual round trips to port.	

Potential Hazard	Phase(s)	MDS for Shipping and Navigation	Justification
Reduced access to local ports and harbours and reduction in under keel clearance	Construction/ decommissioning	▪ Single phase of construction of up to five years and decommissioning of up to three years; ▪ Full build out of the array areas; ▪ Buoyed construction/decommissioning area encompassing the maximum extent of the array areas; ▪ Presence of 500 m construction safety zones and 50 m pre commissioning safety zones around surface piercing structures; ▪ Up to 108 nm of array cables; ▪ Up to two export cables each of 53 nm length; ▪ Indicative separation of between 50 and 200 m between export cables; ▪ Indicative maximum proportion of array cable protection requirement of 20%; ▪ Indicative maximum proportion of export cable protection requirement of 10%; ▪ Up to 26 array cable crossings; ▪ Up to 30 export cable crossings; ▪ Indicative height of protection for array cables (excluding crossings) of 1.0 m and 1.4 m when including crossings; ▪ Indicative height of protection for export cables (excluding crossings) of 1.1 m and 1.4 m when including crossings; and ▪ Up to 35 construction/decommissioning vessels on-site simultaneously and up to 4,311 round trips to port.	Largest possible extent of infrastructure, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on access to local ports and harbours and reduction in under keel clearance.

Potential Hazard	Phase(s)	MDS for Shipping and Navigation	Justification
	O&M	▪ Maximum operational life of 40 years; ▪ Full build out of the array areas; ▪ Presence of 500 m safety zones during major maintenance around surface piercing structures; ▪ Up to 108 nm of array cables; ▪ Up to two export cables each of 53 nm length; ▪ Indicative separation of between 50 and 200 m between export cables; ▪ Indicative maximum proportion of array cable protection requirement of 20%; ▪ Indicative maximum proportion of export cable protection requirement of 10%; ▪ Up to 26 array cable crossings; ▪ Up to 30 export cable crossings; ▪ Indicative height of protection for array cables (excluding crossings) of 1.0 m and 1.4 m when including crossings; ▪ Indicative height of protection for export cables (excluding crossings) of 1.1 m and 1.4 m when including crossings; and ▪ Up to 27 O&M vessels on-site simultaneously and up to 1,776 annual round trips to port.	
Creation of allision risk	O&M	▪ Maximum operational life of 40 years; ▪ Full build out of the array areas; ▪ Minimum spacing of 830 m between array structures; ▪ OSP locations as per Figure 6.5; ▪ Up to 79 WTGs on four-legged suction bucket jackets with sea surface dimensions of 38.5×38.5 m; and ▪ Up to two OSPs with topside dimensions of 125×100 m.	Largest possible extent of surface infrastructure, greatest number of surface structures and greatest duration resulting in the maximum spatial and temporal effect on vessel to structure allision risk.

Potential Hazard	Phase(s)	MDS for Shipping and Navigation	Justification
Anchor interaction with subsea cables	O&M	▪ Maximum operational life of 40 years; ▪ Up to 108 nm of array cables; ▪ Up to two export cables each of 53 nm length; ▪ Indicative separation of between 50 and 200 m between export cables; ▪ Indicative maximum burial depth for all subsea cables of 3.5 m; ▪ Indicative maximum proportion of array cable protection requirement of 20%; ▪ Indicative maximum proportion of export cable protection requirement of 10%; ▪ Up to 26 array cable crossings; ▪ Up to 30 export cable crossings; ▪ Indicative height of protection for array cables (excluding crossings) of 1.0 m and 1.4 m when including crossings; and ▪ Indicative height of protection for export cables (excluding crossings) of 1.1 m and 1.4 m when including crossings.	Largest possible extent of subsea infrastructure and greatest duration resulting in the maximum spatial and temporal effect on anchor interaction with subsea cables.
Reduction of emergency response capability	O&M	▪ Maximum operational life of 40 years; ▪ Full build out of the array areas; ▪ Up to 79 WTGs; ▪ Up to two OSPs; ▪ Array layout as per Figure 6.5; and ▪ Up to 27 O&M vessels on-site simultaneously and up to 1,776 annual round trips to port.	Largest possible extent, greatest number of surface structures, greatest number of simultaneous vessel activities and greatest duration resulting in the maximum spatial and temporal effect on emergency response capability.

7 Navigational Features

104. A plot of navigational features in proximity to the array areas and offshore ECC is presented in Figure 7.1. Following this, the key navigational features in proximity to the Sunk TSS are presented in Figure 7.2. Each of the features shown is discussed in the following subsections and have been identified using the most detailed UKHO Admiralty Charts available.

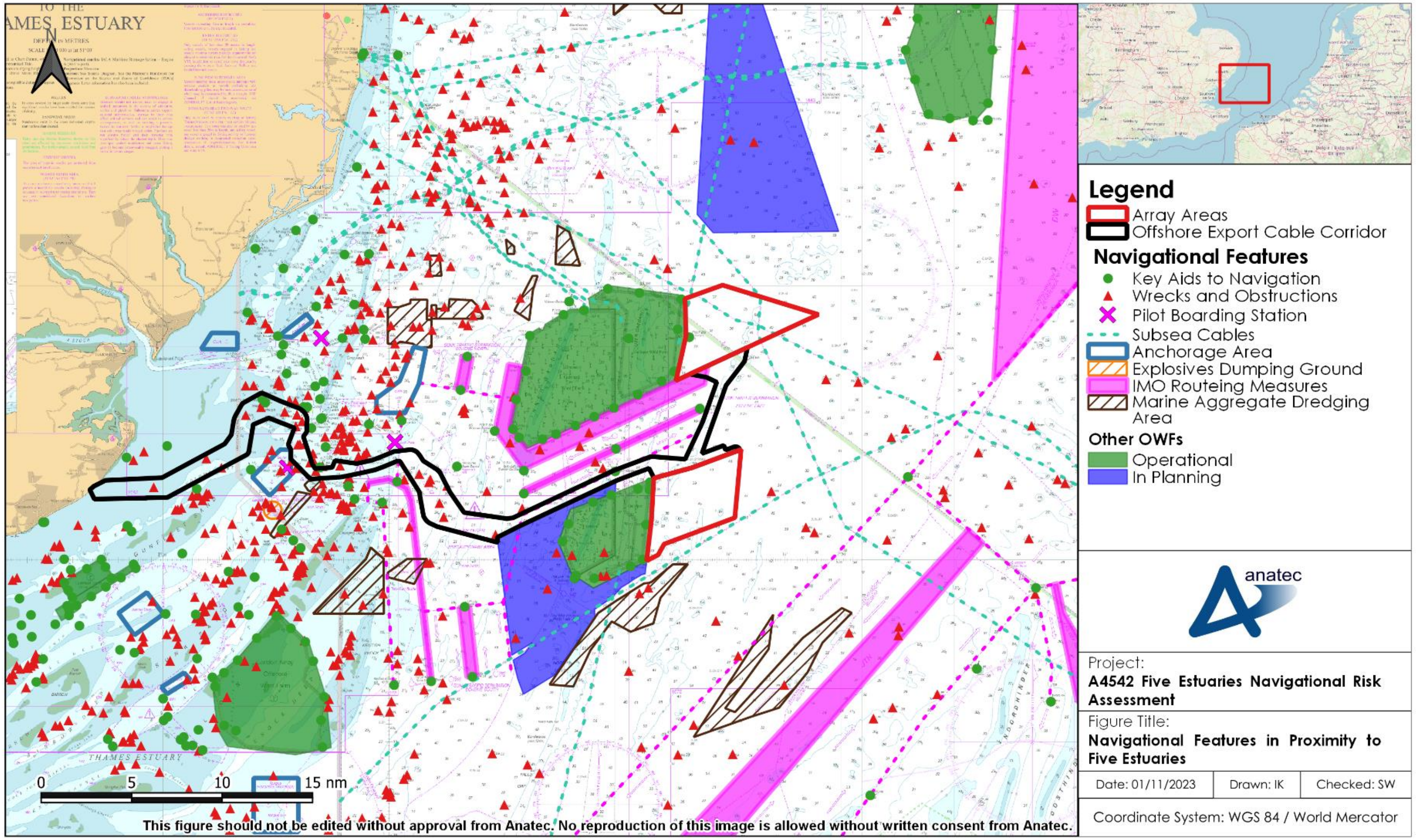

Figure 7.1 Navigational Features in Proximity to VE

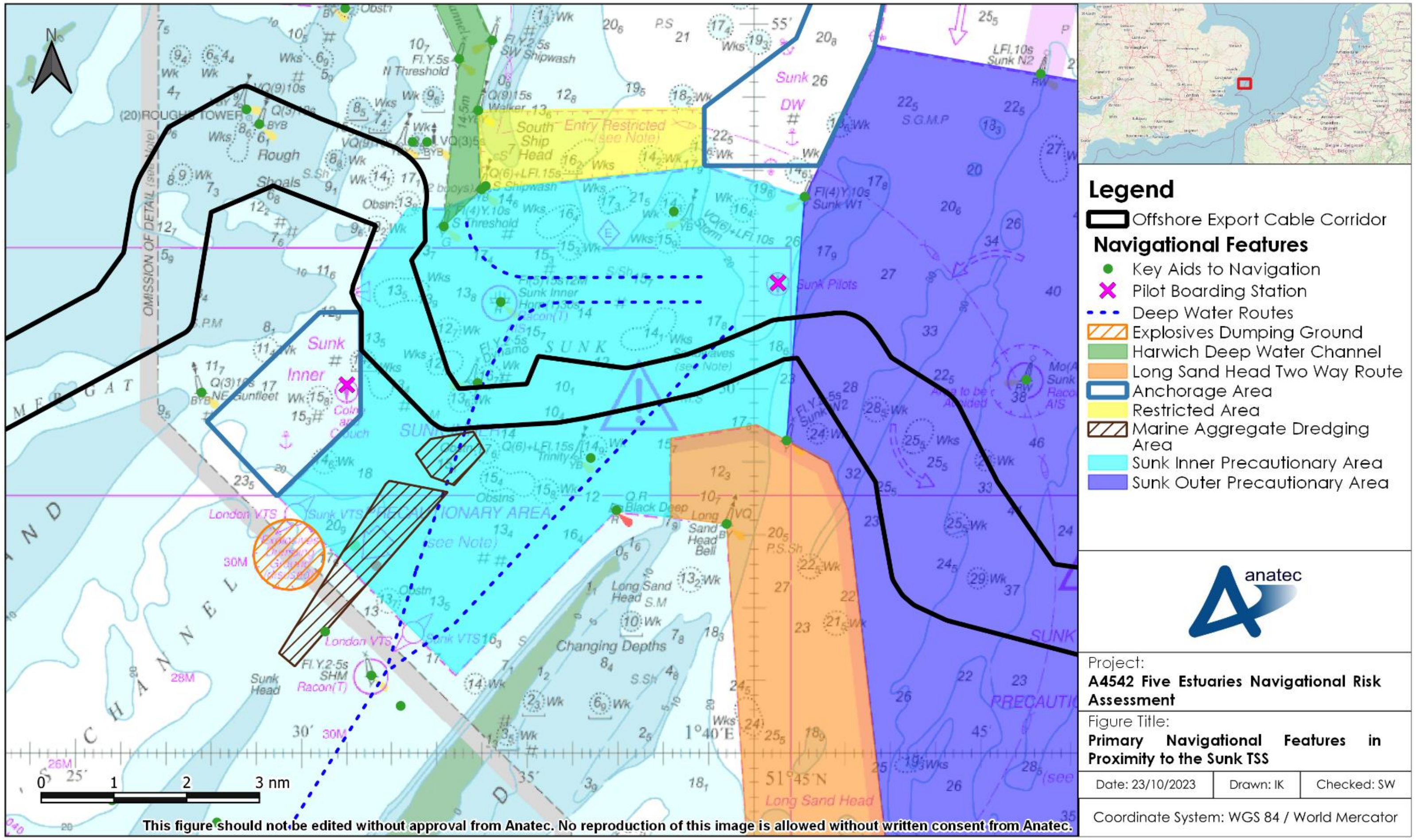

Figure 7.2 Key Navigational Features in Proximity to the Sunk Routeing Measure

7.1 Other Offshore Wind Farm Developments

105. A plot of nearby other OWF developments in proximity to VE is colour-coded by development status and presented in Figure 7.3.

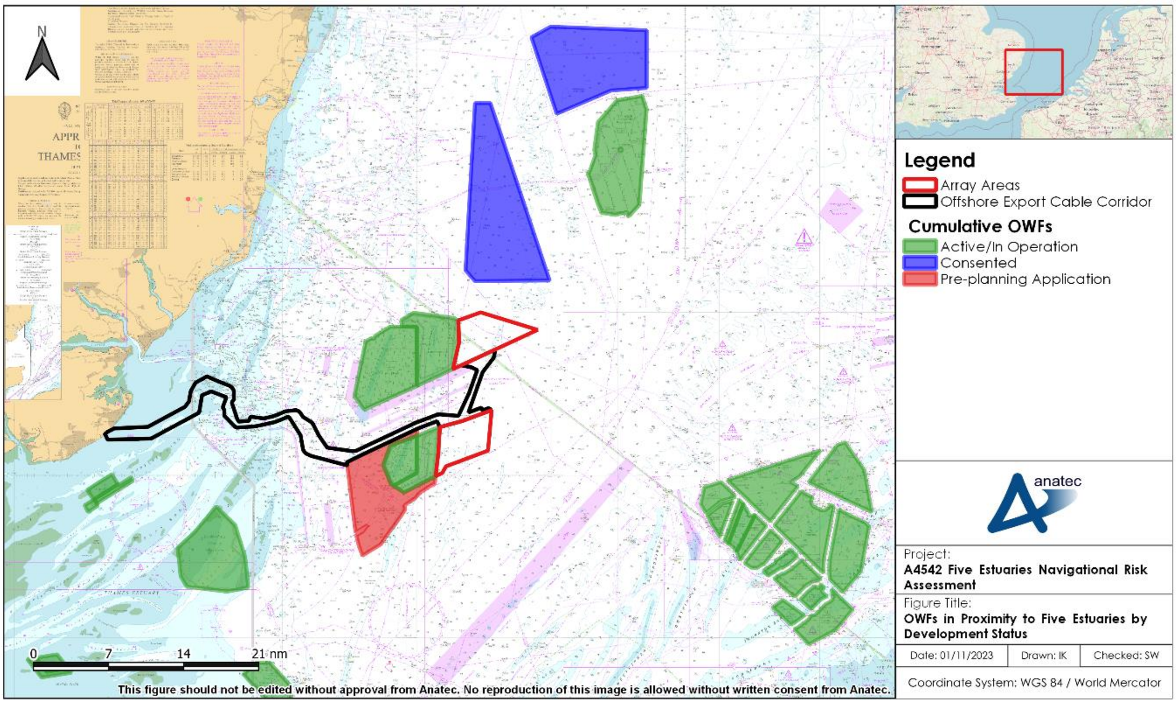

Figure 7.3 OWFs in Proximity to Five Estuaries by Development Status

106. The closest OWF developments to the array areas are Galloper (operational, directly to the west), Greater Gabbard OWF (operational, 1.9 nm to the west), and East Anglia Two OWF (consented, 2.9 nm to the north). It is noted that these distances are measured between the consented boundaries of the respective developments.

107. Other UK OWF developments in the region include North Falls (scoped), East Anglia One (operational), East Anglia One North (consented), London Array (operational), Gunfleet Sands (operational), and Kentish Flats (operational). The offshore ECC passes directly north of North Falls.

108. Non-UK nearby developments include Borssele, Mermaid, Nobelwind, Norther, Northwester 2, Northwind, Rentel, Seastar and Thornton Bank (all operational).

7.2 IMO Routeing Measures

109. The IMO routeing measures in proximity to VE are presented in Figure 7.4.

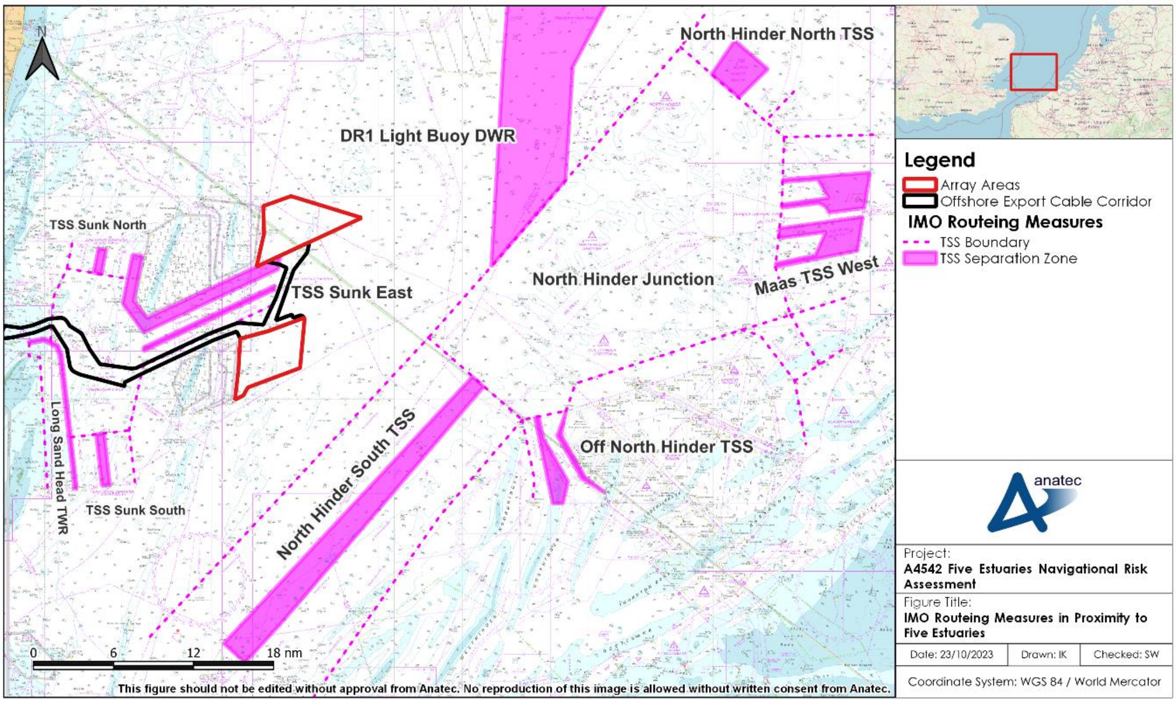

Figure 7.4 IMO Routeing Measures in Proximity to VE

110. The main IMO routeing measure in proximity to VE is the Sunk routeing measure, located directly west of (and between) the array areas. This includes the Sunk TSS East, which ends between the array areas. The North Hinder South TSS is located approximately 5.5 nm to the south-east of the array areas at the closest point and connects to the North Hinder Junction. The DR1 Light Buoy Deep Water Route (DWR) is located approximately 10 nm to the east.

111. The offshore ECC passes through the Sunk routeing measure; it passes directly south of the Sunk TSS East before crossing the Sunk Outer and Inner Precautionary Areas, and finally making landfall at Holland-on-Sea. Additionally, the Long Sand Head Two-Way Route is located south of the offshore ECC. This route should only be used when proceeding to/from ports within the Thames and Medway[2] by piloted vessels, vessels operating under a Pilot Exemption Certificate (PEC), and licensed dredgers working in designated dredging areas (UKHO, 2020).

7.3 Ports, Harbours, and Related Facilities

112. The closest port or harbour to the array areas is the Port of Felixstowe (UK) located on the Suffolk coast. The Admiralty Sailing Directions describe the Port of Felixstowe as possessing "*the largest container terminal in the United Kingdom*", and which also "*handles significant quantities of forest products and general cargo*" (UKHO, 2020).

[2] Throughout this NRA the term 'ports within the Thames and Medway' refers to all ports and harbours located within or in the approaches to the River Thames and River Medway.

113. Harwich Haven (UK) is located on the Suffolk coast and is described by the Admiralty Sailing Directions as being in "*two separate areas; Harwich Navyard […] and Harwich International Port*" (UKHO, 2020). Both areas are able to handle Roll-on/Roll-off cargo (Ro-Ro) vessels, with Harwich International Port also containing a cruise terminal, berths for handling general and bulk cargoes (including grain), and a tanker berth.

114. The Sunk VTS is operated from Harwich Operations Centre, with participation "*mandatory for all vessels over 50 GT and vessels licensed to carry 12 or more passengers. These vessels should obtain permission before entering the area and maintain very high frequency (VHF) contact thereafter.*" (UKHO, 2020).

115. Although located further from VE, ports associated with the River Thames including the PLA, London Gateway and Medway Ports are relevant to the region given the high proportion of vessel movements relating to these ports (see Section 7.3.1) and access via deep water routes in proximity to the offshore ECC (see Section 7.3.3).

7.3.1 Vessel Arrivals

116. The number of vessel arrivals at ports in the region, as reported by the DfT, is presented in Figure 7.5. These statistics exclude some vessel movements which occur within port or harbour limits, but nevertheless give a clear indication of the relative traffic levels and trends.

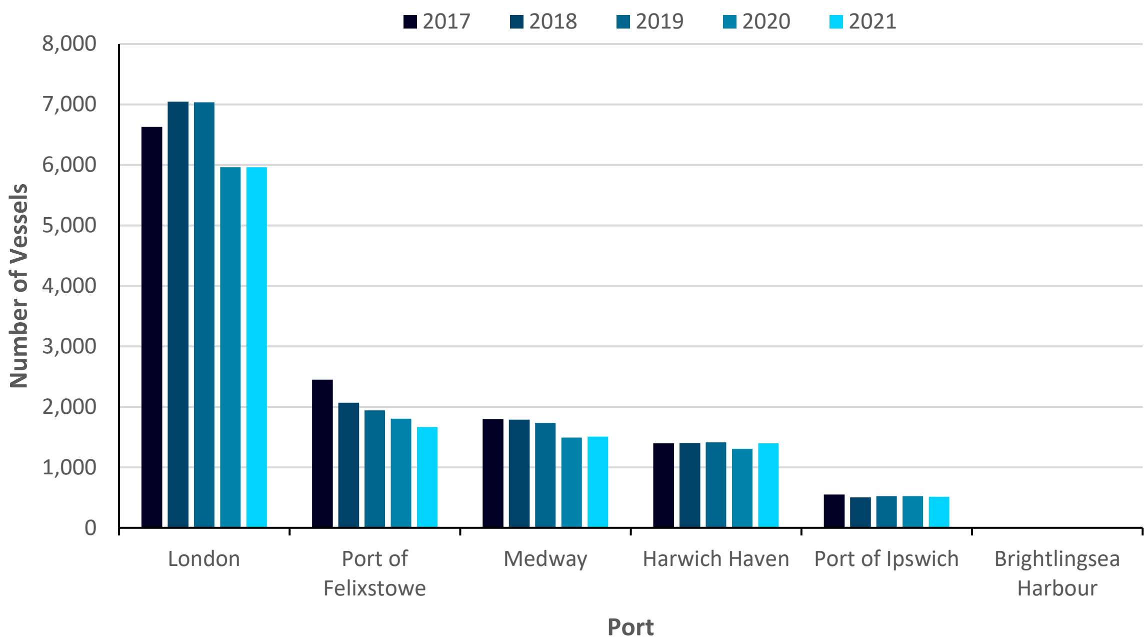

Figure 7.5 Vessel Arrivals to Commercial Ports in Proximity to VE

117. As a collective, London ports are the most frequented commercial ports in the area followed by the Port of Felixstowe; however, a slight downward trend in vessel

arrivals is observed in recent years for the Port of Felixstowe, even after accounting for decreases associated with the COVID-19 pandemic.

7.3.2 Pilot Boarding Stations

There are two pilot boarding stations within the offshore ECC study area (see Figure 7.1) – the Rivers Colne and Crouch pilot station (located 0.5 nm south-west of the offshore ECC), and the Sunk pilot station (located within the offshore ECC itself). The Admiralty Sailing Directions describe that "*ameoll vessels approaching the [Sunk] pilot station are obliged to pass through the Sunk Outer Precautionary Area and its associated TSSs where they are required to comply with the rules of Sunk VTS".*

7.3.3 Deep Water Routes and Channels

118. There are three deep water routes located within the Sunk Inner Precautionary Area (see Figure 7.1). These routes are charted for use by deep-draught vessels entering or leaving the major ports in the region and are designed to avoid the shallowest waters. The minimum charted water depths across these deep water routes is 13 m below CD on the Trinity deep water route, although charted water depths are generally at least 15 m below CD[3].

119. The offshore ECC crosses both the Trinity and Sunk deep water routes, with these routes adjoining further south before heading into ports within the Thames and Medway. The remaining deep water route curves north to direct traffic in/out of the Harwich Deep Water Channel which is dredged to 16 m.

7.4 Designated Anchorage Areas

120. The majority of anchoring locations within the region are all located inshore of the array areas, where there are numerous dedicated anchorages. The closest anchorage location to the array areas is the designated Sunk DW anchorage, located approximately 14 nm to the west. This anchorage area is located 1.5 nm north of the offshore ECC. The closest anchorage location to the offshore ECC is the Sunk Inner anchorage, directly to the south. Both of these anchorage areas, along with the vessels recorded anchoring within, are included in Figure 10.37.

7.5 Marine Aggregate Dredging Areas

121. Several marine aggregate dredging areas are present within the area surrounding VE, as illustrated in Figure 7.1. The closest marine aggregate dredging areas lie immediately south of the offshore ECC (Longsand A509/1 and A509/2) and are operated by Tarmac Marine. There are also groups of marine aggregate dredging areas to the north and south of the offshore ECC, as well as to the south-east of the array areas.

[3] As stated by the UKHO, water depths are "*subject to siltation and liable to change*".

7.6 Subsea Cables

122. There are a number of existing subsea cables in proximity to the array areas, including three which pass through the northern array area: Atlantic Crossing 1, Concerto 1 North, and Farland. The BritNed subsea cable passes in close proximity to the south-eastern corner of the southern array area (see Figure 7.1).

123. There are five existing subsea cables crossing the offshore ECC; these are all cables associated with Greater Gabbard and Galloper which cross the Sunk TSS East.

124. It is acknowledged that there are a number of proposed subsea cable developments in the region; these are considered as part of the cumulative screening in Section 14.1.3.

7.7 Key Aids to Navigation

125. There are various key aids to navigation located within the region, with the majority marking the Greater Gabbard and Galloper OWFs or the Sunk routeing measure. There are no aids to navigation within the array areas, although a collection of three metocean buoys is located within the northern array area.

126. The North Galloper north cardinal mark, located on the edge of the eastbound lane of the Sunk TSS East, is within the offshore ECC. Moving further inshore, the offshore ECC avoids most aids to navigation within the Sunk Outer and Inner Precautionary Areas, including the Storm south cardinal buoy, Sunk Inner light vessel and South Threshold special mark. The Dynamo special mark is located within the offshore ECC as are the cardinal marks associated with the Roughs Tower, a disused World War II installation.

7.8 Charted Wrecks

127. There are various charted wrecks or obstructions located in the region. None are located within the array areas although a number are located within the offshore ECC with charted depths highly dependent upon the location – the closest inshore is 8 m below CD and the furthest offshore is 28 m below CD.

7.9 Other Navigational Features

7.9.1 Restricted Areas

128. There is a restricted area located approximately 0.6 nm north of the offshore ECC. Only vessels under 20 m length, sailing vessels, vessels engaged in fishing, and vessels meeting certain pilotage requirements are allowed to enter this area. Additionally, vessels may not leave this area via the western limit between the South Shipwash south cardinal mark and Walker west cardinal mark (UKHO, 2020).

7.9.2 Military Areas and Explosives Dumping Grounds

129. There are no charted military areas in proximity to VE. However, a practice and exercise area (PEXA) used by the Royal Navy intersects the array areas. Disused explosive dumping grounds are located approximately 2.2 nm south-west of the offshore ECC and 8.2 nm north-west of the array areas.

7.9.3 Spoil Grounds and Other Dumping Grounds

130. The offshore ECC passes around a disused spoil ground directly west of the Sunk Inner Precautionary Area.

131. There are no charted spoil grounds or other dumping grounds in proximity to VE.

7.9.4 Marine Environment High Risk Areas

132. There are Marine Environment High Risk Areas (MEHRA) located on the Sussex coast on both sides of the entrances to Harwich Haven and the Port of Felixstowe. At the closest point, these MEHRAs are located approximately 2.0 nm north of the offshore ECC, close to the landfall location. MEHRAs 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).

8 Meteorological Ocean Data

133. This section presents meteorological and oceanographic statistics local to VE. The data presented in this section had been used as input to the collision and allision risk modelling (see Section 16).

8.1 Wind

134. Based on wind direction data modelled by Vortex at a nearby location and at 10 m height, the proportion of the wind direction within each 30-degree interval is presented in Figure 8.1 in the form of a wind rose. It can be seen that winds are predominantly from the south-west.

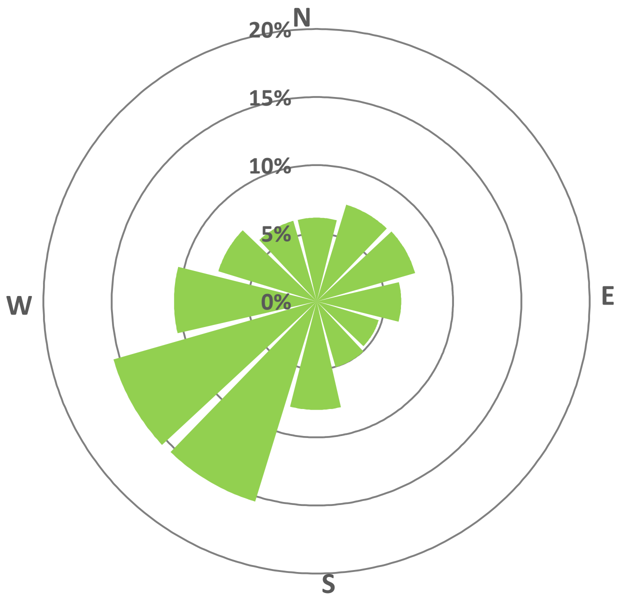

Figure 8.1 Wind Direction Distribution

8.2 Wave

135. Based on significant wave height data recorded by Fugro between December 2010 and May 2012 at a location in proximity to the array area, the proportion of the sea state within each of three defined ranges, where the sea state is based upon significant wave height, is presented in Table 8.1. It should be noted that the percentages presented are rounded to one decimal place.

Table 8.1 Sea State Distribution

Sea State	Proportion (%)
Calm (<1 m)	54.1
Moderate (1 to 5 m)	45.9

Sea State	Proportion (%)
Severe (≥5 m)	0.0

8.3 Visibility

136. Based on information provided in the Admiralty Sailing Directions (UKHO, 2021), the proportion of poor visibility (defined as the proportion of a year where the visibility can be expected to be less than 1 kilometre (km)) is 3%.

8.4 Tide

137. From UKHO Admiralty Charts 1610 and 1630, currents within and in proximity to Five Estuaries are set in a generally north to south direction on the flood tide and north to south direction on the ebb tide. The greatest peak flood tidal rate is 2.3 knots (kt), and the greatest peak ebb tidal rate is 2.2 kt. The peak speed and corresponding direction data for the flood and ebb tides for the relevant tidal diamonds on UKHO Admiralty Charts 1610 and 1630 are presented in Table 8.2.

Table 8.2 Peak Ebb and Flood Tidal Data in Proximity to Five Estuaries

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (knots)	Direction (°)	Speed (kt)
1610	B	207	2.3	032	2.2
	C	205	2.2	026	2.1
	E	213	2.1	036	2.1
	F	199	2.2	022	1.9
	G	211	1.7	039	1.7
	H	204	2.1	030	1.9
	J	215	1.8	037	1.7
	K	217	1.7	044	1.6
1630	A	203	2.1	019	2.2
	B	216	2.0	033	1.8
	F	210	1.7	024	1.7

138. Based upon the available data, no hazards are expected at high water that would not also be expected at low water, and vice versa. The wind farm structures are not expected to result in any additional risk to the existing tidal streams in relation to their effect on existing shipping and navigation users.

9 Emergency Response and Incident Overview

139. This section summarises the existing SAR resources in the region, and issues being considered in relation to VE.

9.1 Search and Rescue Helicopters

140. In July 2022, the Bristow Group were awarded a new 10-year contract by the MCA (as an executive agency of the DfT) beginning in September 2024 to provide helicopter SAR operations in the UK. Bristow have been operating the service since April 2015.

141. The SAR helicopter service is currently operated out of 10 base locations around the UK, with the closest to VE located at Lydd, approximately 63 nm to the south-west. This base operates two AgustaWestland 189 (AW189) helicopters.

142. The DfT has produced data on civilian SAR helicopter activity in the UK by the Bristow Group on behalf of the MCA between April 2015 and March 2023.

143. The locations of SAR helicopter taskings within both the array traffic and offshore ECC study areas are presented in Figure 9.1, colour-coded by tasking type.

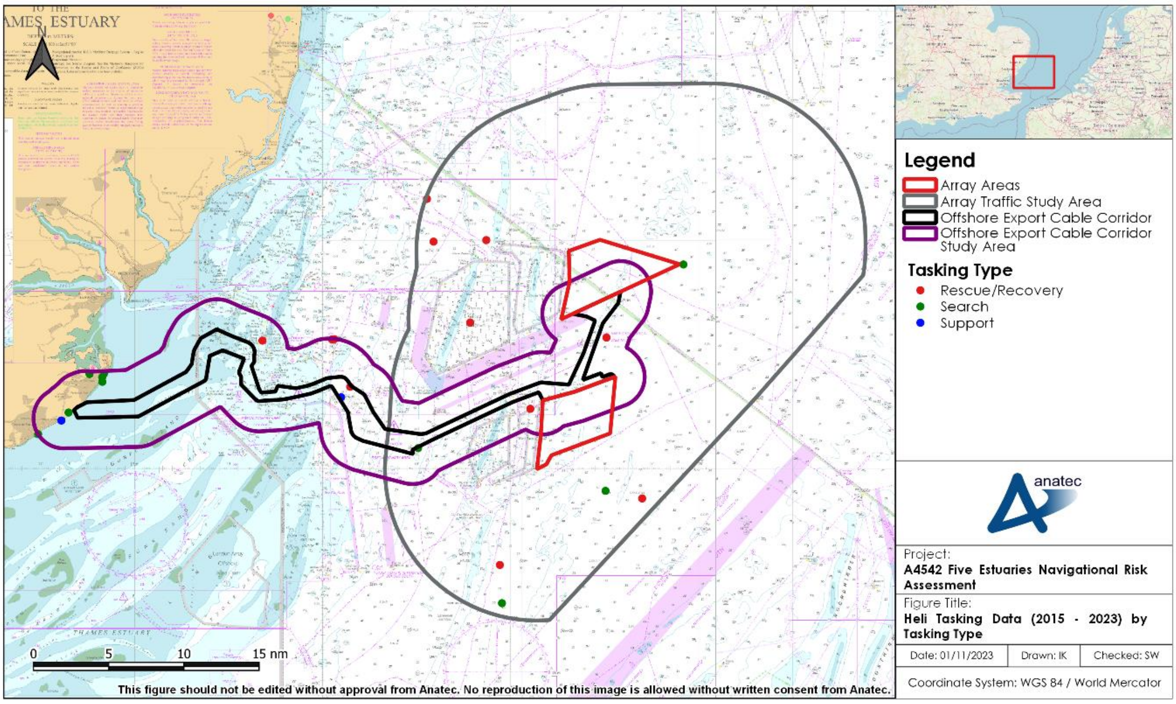

Figure 9.1 Heli Tasking Data (2015 – 2023) by Tasking Type

144. There were 12 unique SAR incidents within the array traffic study area between April 2015 and March 2023. Apart from one tasking which originated from the

Humberside base, all others originated from the Lydd base. Of the 12 taskings, eight were rescue/recovery, with the other four being search only.

145. There were 15 unique SAR incidents within the offshore ECC study area between April 2015 and March 2023. All taskings originated from the Lydd base. Of the 15 taskings, six were rescue/recovery, with the other seven being search only, and two being support.

9.2 Royal National Lifeboat Institution

146. The RNLI is organised into six divisions, with the relevant region for VE being 'South-East'. Based out of more than 230 stations around the UK, there are over 400 active lifeboats across the RNLI fleet, including both all-weather lifeboats (ALB) and inshore lifeboats (ILB). RNLI lifeboats are available on a 24-hour basis throughout the year.

147. The closest RNLI station to the array areas is at Aldeburgh, located approximately 21 nm to the north-west, where both an ALB and ILB are in use. It is noted that the RNLI have a strategic performance standard of reaching casualties up to a maximum of 100 nm offshore.

148. The locations of incidents responded to by the RNLI within both the array traffic and offshore ECC study areas between 2013 and 2022 are presented in Figure 9.2, colour-coded by incident type. The same data is presented in Figure 9.3, colour-coded by casualty type. It is noted that hoaxes and false alarms have been excluded from the analysis.

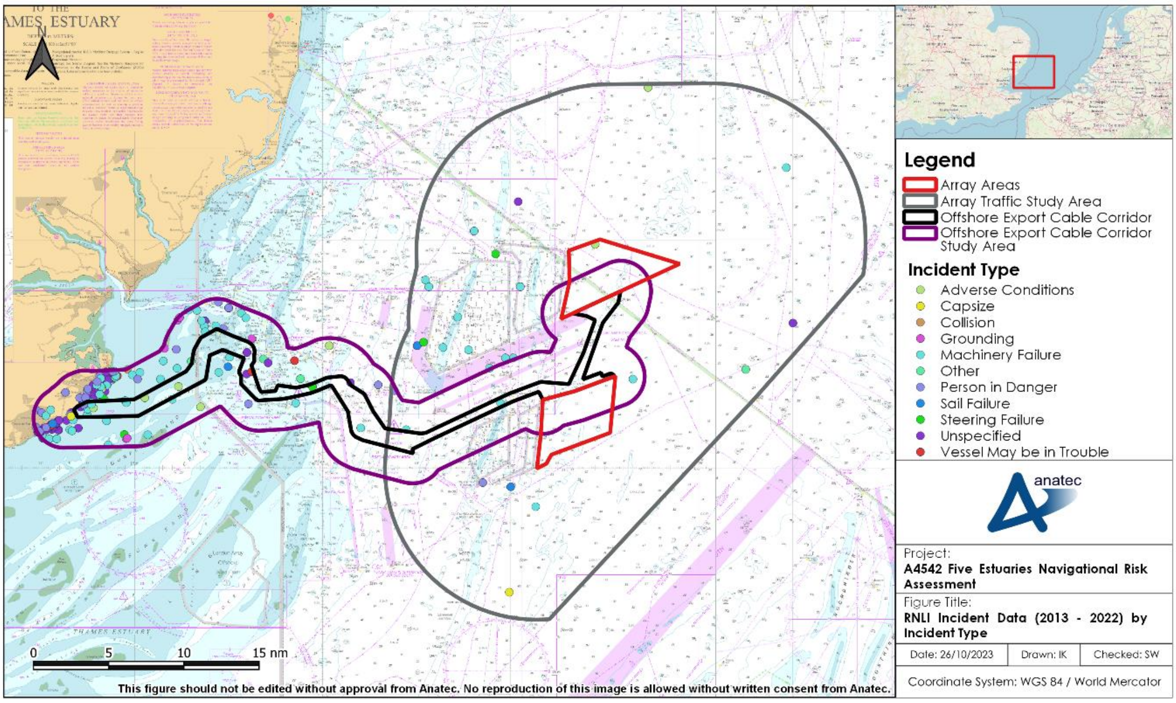

Figure 9.2 RNLI Incident Data (2013 – 2022) by Incident Type

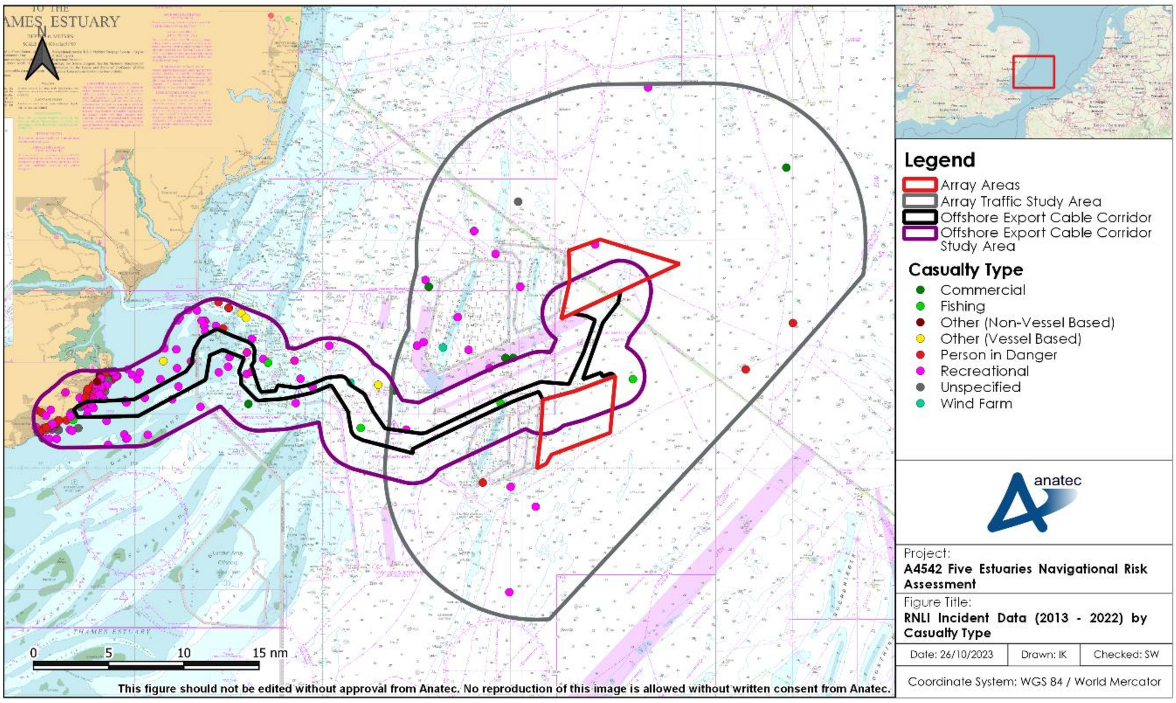

Figure 9.3 RNLI Incident Data (2013 – 2022) by Casualty Type

149. A total of 30 RNLI lifeboat launches to 27 unique incidents were reported within the array traffic study area, corresponding to an average of three unique incidents per year. Incidents were primarily located inshore of the array area.

150. Of the 27 unique incidents in the array traffic study area, the most frequently recorded incident type was machinery failure (60%). Other incident types recorded included person in danger (8%), steering failure (8%), adverse conditions (8%), sail failure (8%), capsize (4%), and ‘other’ (4%).

151. Of the 42 unique incidents in the array traffic study area, the most frequently recorded casualties were recreational vessels (58%) and commercial vessels (19%).

152. One incident was recorded within the array areas – a sailing vessel experiencing adverse conditions.

153. The most common base station recorded for lifeboat launches for incidents within the array traffic study area was Harwich (56%), followed by Walton and Finton (19%). Lifeboat launches were also reported out of the stations at Aldeburgh, Ramsgate, and Margate.

154. A total of 209 RNLI lifeboat launches to 188 unique incidents were reported within the offshore ECC study area, corresponding to an average of 19 unique incidents per year. Incidents were primarily located close to shore.

155. Of the 188 unique incidents in the offshore ECC study area, the most frequently recorded incident types were machinery failure (44%) and person in danger (26%). Other incident types recorded included 'other' (7%), adverse conditions (5%), grounding (5%), vessel may be in trouble (4%), steering failure (3%), collision (3%), sail failure (2%), and capsize (2%).

156. Of the 188 unique incidents in the offshore ECC study area, the most frequently recorded casualties were recreational vessels (560%) and person in danger (29%).

157. A total of 20 unique incidents were recorded within the offshore ECC itself.

158. The most common base station recorded for lifeboat launches within the offshore ECC study area was Walton and Frinton (38%) and Clacton-on-Sea (38%). Lifeboat launches were also reported out of the stations at Harwich and Ramsgate.

9.3 Maritime Rescue Coordination Centres and Joint Rescue Coordination Centres

159. His 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).

160. The HMCG coordinates SAR operations through a network of 11 Maritime Rescue Coordination Centres (MRCC), including a Joint Rescue Coordination Centre (JRCC) based in Hampshire.

161. All of the MCA's operations, including SAR, are divided into 18 geographical regions. Area 7 – "*East Anglia*" – covers the south-east coast of England from the Norfolk-Lincolnshire border to the Essex-Kent border, and therefore covers the area encompassing VE. The closest MRCC to the array areas is the Dover MRCC, located approximately 46 nm to the south-west and presented in Figure 9.4. Additionally, the Maritime Rescue Sub-Centre (MRSC) is located in London, approximately 75 nm to the west.

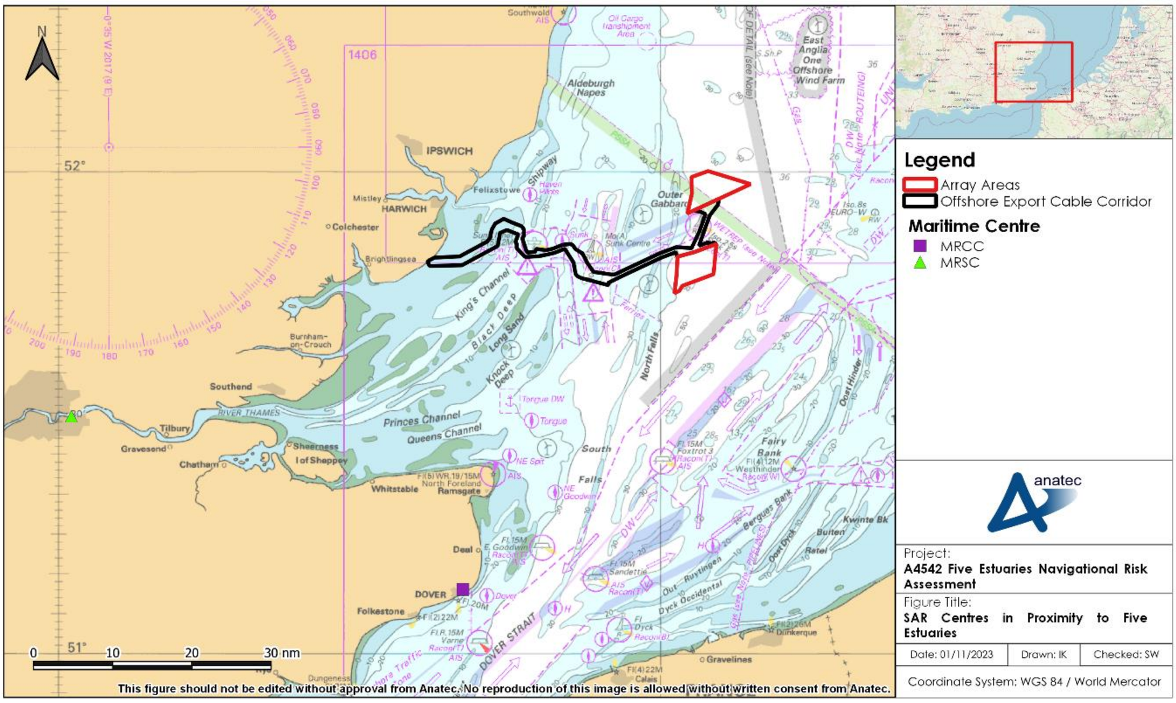

Figure 9.4 SAR Centres in Proximity to Five Estuaries

9.4 Global Maritime Distress and Safety System

162. The Global Maritime Distress and Safety System (GMDSS) is a maritime communications system used for emergency and distress messages, vessel to vessel routeing communications and vessel to shore routine communications. It is implemented globally, and vessels engaged in international voyages are obliged to carry GMDSS certified communication equipment.

163. There are four GMDSS sea areas, and in the UK, it is the responsibility of the MCA to ensure VHF coverage from coastal stations within sea area A1. VE is located within an A1 sea area as shown in Figure 9.5, and therefore in the event of an emergency any vessel located in proximity to VE would be able to contact HMCG via VHF.

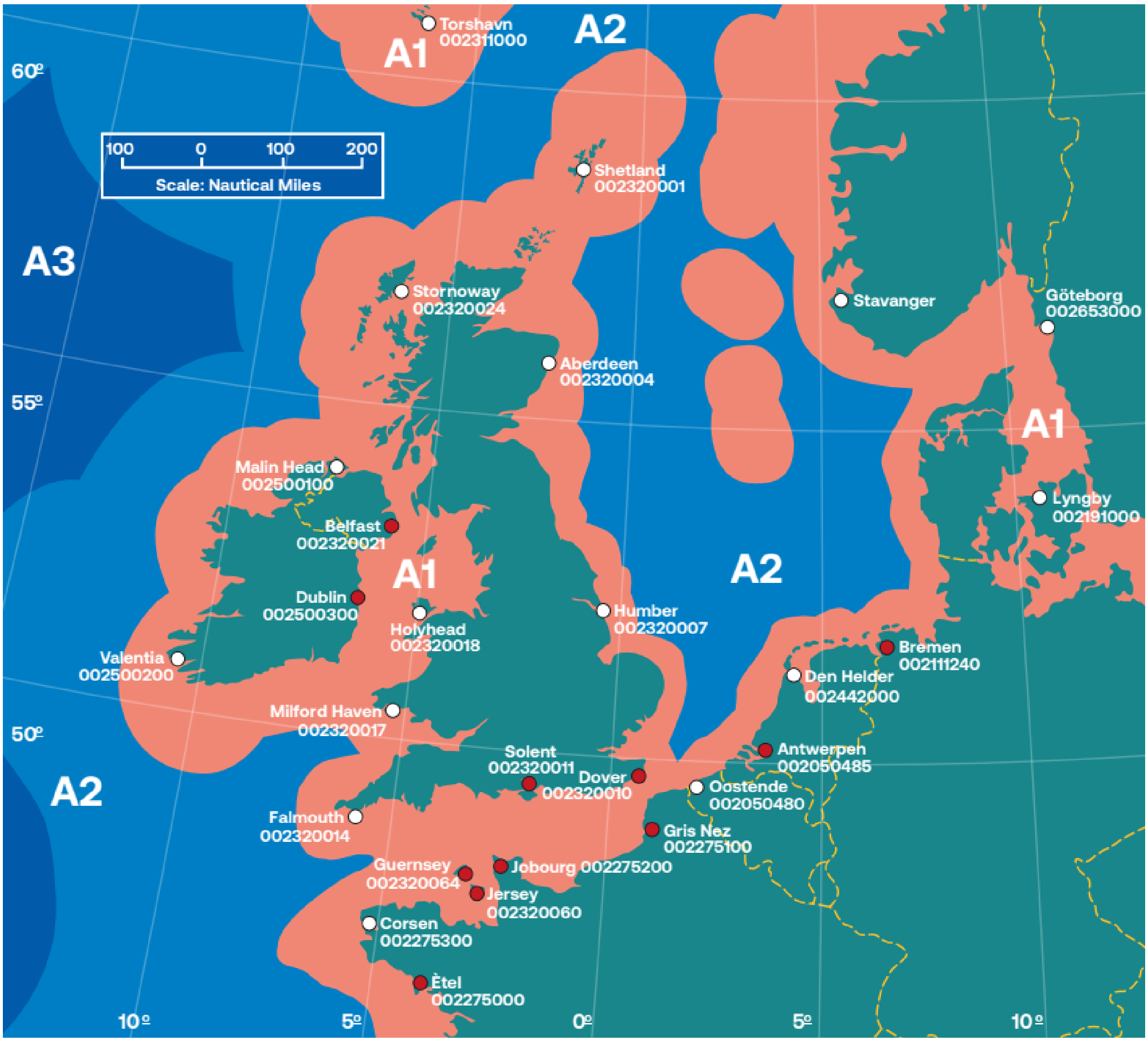

Figure 9.5 GMDSS Sea Areas (MCA, 2021)

9.5 Marine Accident Investigation Branch

164. All UK flagged vessels and non-UK flagged vessels in UK territorial waters (12 nm), a UK port or carrying passengers to a UK port are required to report incidents to the MAIB. Data arising from these reports are assessed within this section, covering the ten-year period between 2012 and 2021.

165. The incidents recorded within the MAIB data between 2012 and 2021 occurring within both the array traffic and offshore ECC study areas are presented in Figure 9.6, colour-coded by incident type. Following this, Figure 9.7 shows the same data colour-coded by the type of vessel(s) involved in each incident.

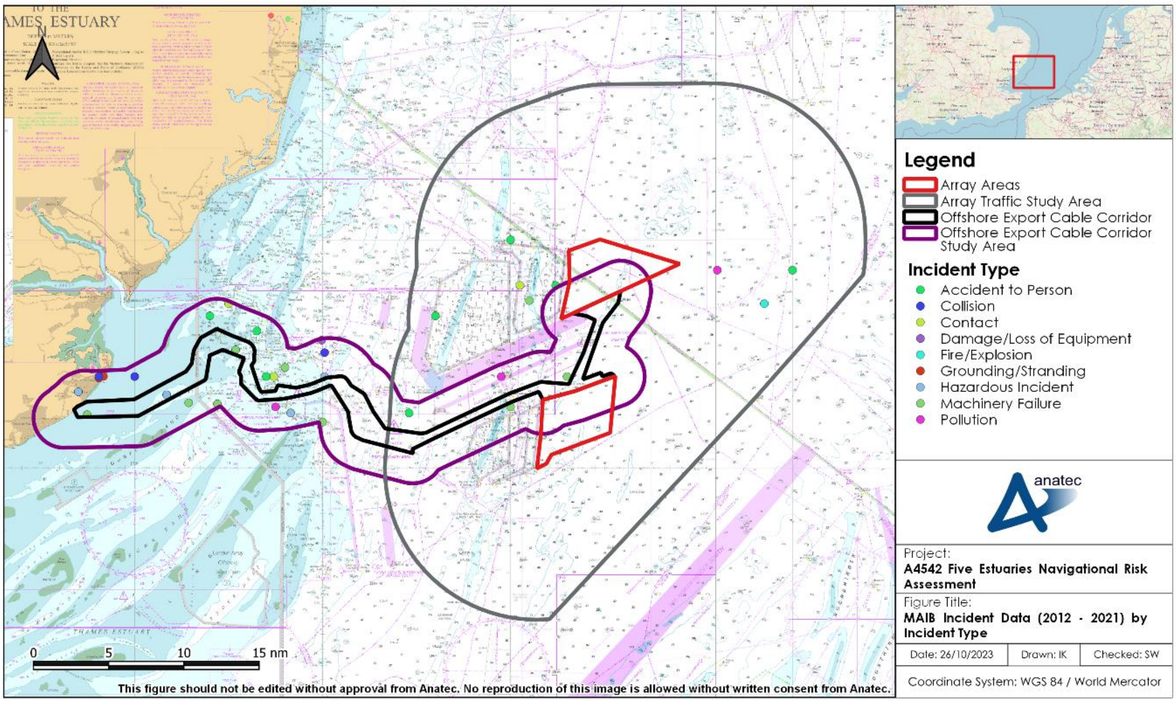

Figure 9.6 MAIB Incident Data (2012 – 2021) by Incident Type

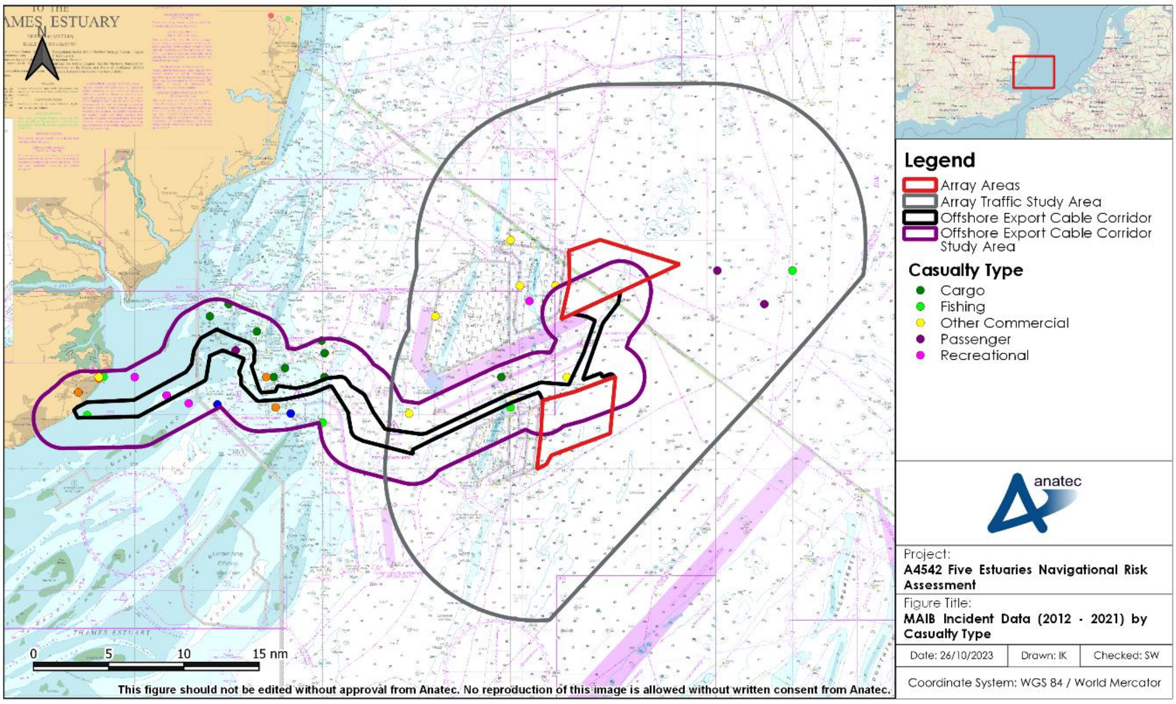

Figure 9.7 MAIB Incident Data (2012 – 2021) by Casualty Type

166. A total of 12 incidents were recorded by the MAIB within the array traffic study area between 2012 and 2021, which corresponds to an average of one incident per year. Throughout the 10-year period, no incidents were recorded within the array areas.

167. The most common incident types recorded within the array traffic study area were accident to person (42%) and machinery failure (25%). The main vessel types involved in incidents were other commercial vessels (50%).

168. A total of 26 incidents were recorded by the MAIB within the offshore ECC study area between 2012 and 2011, which corresponds to an average of two to three incidents per year. Throughout the 10-year period, three incidents were recorded within the offshore ECC.

169. The most common incident types recorded within the offshore ECC study area were machinery failure (31%), accident to person (15%), and hazardous incident (15%). The main vessel types involved in incidents were cargo vessels (38%), fishing vessels (15%), and other commercial vessels (15%).

170. A review of MAIB incident data within the array traffic study area between 2002 and 2011 indicates that the number of incidents in the array traffic study area has decreased over time, with 15 unique incidents recorded in the ten-year period, corresponding to an average of one to two incidents every year. Of the recorded incidents, the most common were accident to person (40%), and the most frequently recorded vessels were other commercial vessels (33%).

171. From the earlier MAIB incident data, the number of incidents in the offshore ECC study area has decreased, with 41 unique incidents recorded in the ten-year period, corresponding to an average of four incidents every year. Of the recorded incidents, the most common were hazardous incidents (44%), and the most frequently recorded were other commercial vessels (34%).

9.6 Historical Offshore Wind Farm Incidents

9.6.1 Incidents Involving UK Offshore Wind Farm Developments

172. As of November 2023, there are 42 operational OWFs in the UK, ranging from the North Hoyle Offshore Wind Farm (fully commissioned in 2003) to the Hornsea Project Two Offshore Wind Farm (fully commissioned in 2022). Between them these developments encompass approximately 21,897 fully operational WTG years.

173. MAIB incident data has been used to collate a list of reported historical collision and allision incidents involving UK OWF developments[4], which is summarised in Table 9.1. 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.

[4] Includes only incidents 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 9.1 Summary of Historical Collision and Allision Incidents Involving UK OWF Developments

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
Project	Allision	7 August 2005	WTG installation vessel allision with WTG base whilst manoeuvring alongside it. Minor damage sustained to a gangway on the vessel, the WTG tower and a WTG blade.	Minor damage to gangway on the vessel	None	MAIB
Project	Allision	29 September 2006	Offshore services vessel allision with rotating WTG blade.	None	None	MAIB
Project	Allision	8 February 2010	Work boat allision with disused pile following human error with throttle controls whilst in proximity. Passenger later diagnosed with injuries and no serious damage sustained by vessel.	Minor	Injury	MAIB
Project / third-party	Collision	23 April 2011	Third-party catamaran collision with project guard vessel within harbour.	Moderate	None	MAIB
Project	Allision	18 November 2011	Cable-laying vessel allision with WTG foundation following watchkeeping failure. Two hull breaches to vessel.	Major	None	MAIB
Project / project	Collision	2 June 2012	Crew Transfer Vessel (CTV) allision with flotel. Nine persons safely evacuated and transferred to nearby vessel before being brought back in to port.	Moderate	None	UK CHIRP
Project	Allision	20 October 2012	Project vessel allision with WTG monopile following human error (misjudgement of distance). Minor damage sustained by vessel.	Minor	None	MAIB
Project	Allision	21 November 2012	Passenger transfer catamaran allision with buoy following navigational error. Vessel abandoned by crew of 12 having been holed, causing extensive flooding but no injuries sustained.	Major	None	MAIB
Project	Allision	21 November 2012	Work boat allision with unlit WTG transition piece at moderate speed following navigational error. Vessel able to proceed to port unassisted with no water	Moderate	None	MAIB

Incident Vessel	Incident Type	Date	Description of Incident	Vessel Damage*	Harm to Persons	Source
			ingress but some structural damage sustained.			
Project	Allision	1 July 2013	Service vessel allision with WTG foundation following machinery failure. Minor damage sustained by vessel.	Minor	None	IMCA Safety Flash
Project	Allision	14 August 2014	Standby safety vessel allision with WTG pile. Oil leaked by vessel which moved away from environmentally sensitive areas until leak was stopped.	Minor with pollution	None	UK CHIRP
Third-party	Allision	26 May 2016	Third-party fishing vessel allision with WTG following human error (autopilot). Lifeboat attended the incident.	Moderate	Injury	Web search (RNLI, 2016)
Project	Allision	16 January 2020	Project vessel allision with WTG. Injury sustained by crew member but vessel able to proceed to port unassisted.	None	Injury	Web search (Vessel Tracker, 2020)
Project	Allision	27 January 2020	Project vessel allision with WTG. Minor damage to vessel and WTG sustained, with no personal injuries.	Minor	None	Marine Safety Forum
Third-party	Allision	9 June 2022	Fishing vessel allision with WTG resulting in damage to vessel and two minor injuries for crew members. RNLI lifeboat escorted vessel under its own power to port.	Minor	Injury	Web search (RNLI, 2022)

(*) As per incident reports.

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

175. As of November 2023, there have been no third-party collisions directly 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.

176. As of November 2023, there have been 13 reported cases of an allision between a vessel and a WTG (under construction, operational or disused) in the UK, with all but two 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 1,680 years per WTG allision incident in the UK, noting that this is a conservative

calculation given that only operational WTG hours have been included (whereas allision incidents counted include non-operational WTGs).

9.6.2 Incidents Involving Non-UK Offshore Wind Farms

177. It is acknowledged that collision and allision incidents involving non-UK OWF developments have also occurred. However, it is not possible to maintain a comprehensive list of such incidents.

178. One high profile non-UK incident which is noted is that involving a bulk carrier in January 2022 which broke its anchor chain during a storm in Dutch waters and collided with a nearby anchored vessel. The vessel began to take on water, leading to all crew members being evacuated by helicopter. The vessel then continued to drift towards shore including through an under construction OWF where it allided with a WTG foundation and a platform foundation before being taken under tow.

9.6.3 Incidents Responded to by Vessels Associated with UK Offshore Wind Farms

179. From news reports, basic web searches and experience at working with existing OWF developments, a list has been collated of historical incidents responded to by vessels associated with UK OWF developments, which is summarised in Table 9.2. The initial cause of these incidents is not related to the OWF in question.

180. Table 9.2 comprises known incidents that were responded to by a wind farm vessel. Additional incidents associated with the construction or operation of OWF are also known to have occurred. These incidents typically involve an accident to person which requires medical attention (including emergency response) but does not affect the operation of the vessel involved. It is noted that these incidents do increase the workload on SAR resources.

Table 9.2 Historical Incidents Responded to by Vessels Associated with UK OWF Developments

Incident Type	Date	Related Development	Description of Incident	Source
Capsize	21 June 2018	Walney Offshore Wind Farm	HMCG issued mayday relay broadcast following trimaran capsize. Support vessel for Walney arrived and recovered two persons from the water who were then winched onboard a Coastguard helicopter.	Web search (4C Offshore, 2018)
Capsize	5 November 2018	Race Bank Offshore Wind Farm	Fishing vessel capsized resulting in two persons in the water. Vessel operating at the nearby Race Bank reported to have assisted with the rescue which also involved a Belgian military helicopter and the RNLI.	Web search (British Broadcasting Corporation (BBC), 2018)

Incident Type	Date	Related Development	Description of Incident	Source
Vessel in distress	15 May 2019	London Array Offshore Wind Farm	Yacht in difficulty sought shelter by tying up to a WTG but suffered damage and a person in the water. Support vessel for London Array identified and secured the casualty vessel and recovered the person in the water. The support vessel raised the alarm to the Coastguard. The Coastguard later instructed the support vessel to return to port and seek medical assistance for the casualty vessel's occupant.	Web search (The Isle of Thanet News, 2019)
Drifting	7 July 2019	Gwynt y Môr Offshore Wind Farm	Speedboat suffered mechanical failure stranding four persons. Support vessel for Gwynt y Môr responded to an 'all-ships' broadcast from the Coastguard and prevented the casualty vessel drifting into the Gwynt y Môr array. The support vessel later towed the casualty vessel back towards port.	Web search (Renews, 2019)
Machinery failure	28 September 2019	Race Bank	Fishing vessel suffered mechanical failure and launched flares. Guard vessel and Service Operation Vessel (SOV) for Race Bank both immediately offered assistance until the MCA's arrival on-scene.	Internal daily progress report received by Anatec
Vessel in distress	13 December 2019	Race Bank	Passing vessel got into difficulty and guard vessel for Race Bank was requested to assist. The Coastguard later requested that the guard vessel tow the casualty vessel into port.	Internal daily progress report received by Anatec
Search	21 May 2020	Walney	Coastguard contacted guard vessel for Walney reporting red flare sighting at the wind farm. Guard vessel proceeded to undertake search but did not find anything to report.	Internal daily progress report received by Anatec
Aircraft crash	15 June 2020	Hornsea Project One	United States (US) jet crashed into sea during routine flight. CTV and SOV for Hornsea Project One joined the search for the missing pilot.	Web search (4C Offshore, 2020)
Fire/ explosion	15 December 2020	Dudgeon Offshore Wind Farm	Fishing vessel experienced explosions on board with crew injured. SOV for Dudgeon deployed its Fast Rescue Boat (FRB) and evacuated the casualty vessel.	Web search (Offshore WIND, 2020)
Vessel in distress	3 June 2021	Robin Rigg	Wind farm CTV fire alarm sounded, with the engine then shut down. A support vessel for Robin Rigg was able to assist in escorting the vessel to port.	Web search (Vessel Tracker, 2021)
Drifting	17 July 2021	Neart na Gaoithe	Small dinghy with two children aboard drifted offshore due to strong winds. A guard vessel associated with Neart na Gaoithe was able to retrieve the children.	Web search (Edinburgh Evening News, 2021)

Incident Type	Date	Related Development	Description of Incident	Source
Allision	9 June 2022	Westermost Rough	Fishing vessel allided with a WTG at Westermost Rough. A supply vessel was among the responders as an RNLI lifeboat escorted the vessel under its own power to port.	Web search (RNLI, 2022))

10 Vessel Traffic Movements

181. This section presents an overview of vessel traffic movements within the array traffic study area, primarily based upon the findings of the summer and winter vessel traffic surveys undertaken in January and June of 2022 (see Section 5.2).

10.1 Array Areas

182. A number of vessel tracks recorded during the survey period were classified as temporary (non-routine), such as those undertaking surveys or acting as guard vessels. These were therefore excluded from the characterisation of the vessel traffic baseline.

183. A plot of the vessel tracks recorded during the 14-day winter survey period within the array traffic study area, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.1. Following this, Figure 10.2 presents the same data converted to a density heat map.

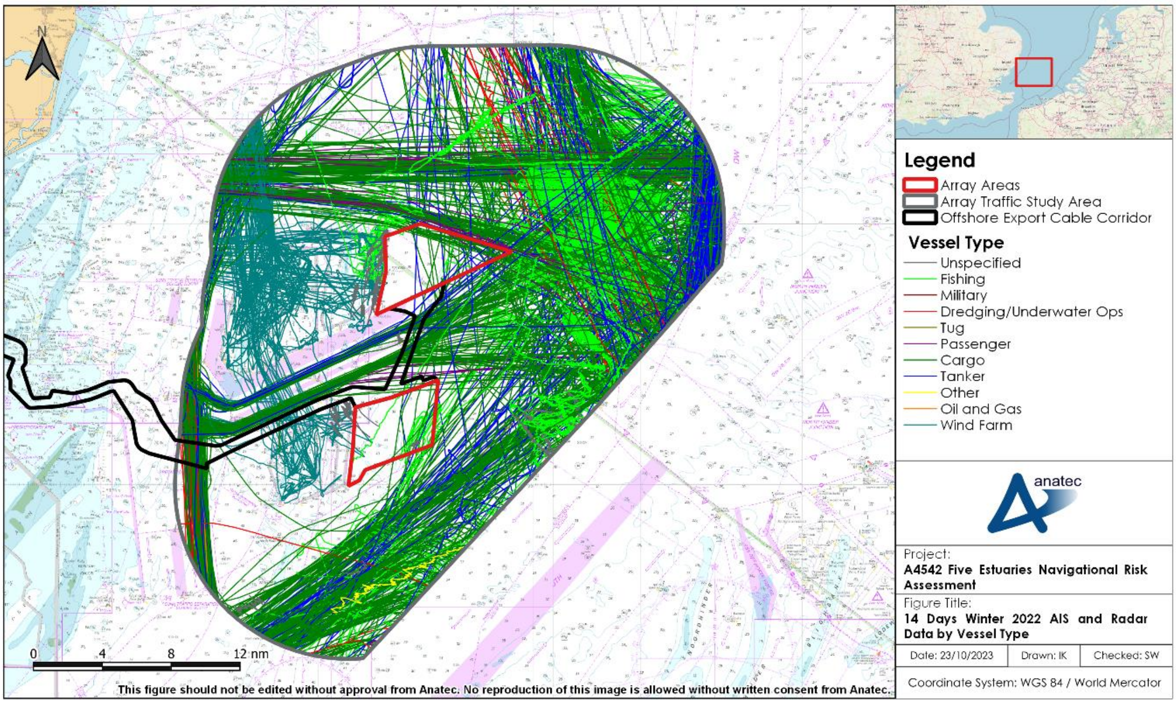

Figure 10.1 14 Days Winter 2022 AIS and Radar Data by Vessel Type (Array Areas)

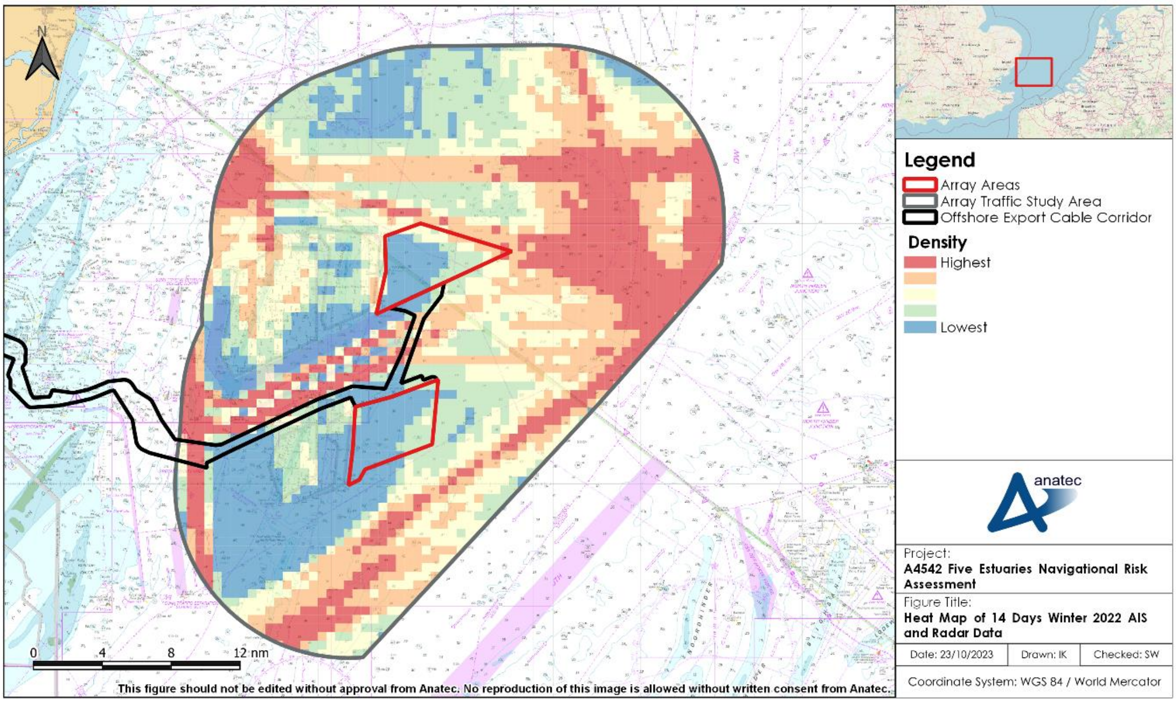

Figure 10.2 Heat Map of 14 Days Winter 2022 AIS and Radar Data (Array Areas)

184. A plot of the vessel tracks recorded during the 14-day summer survey period within the array traffic study area, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.3. Following this, Figure 10.4 presents the same data converted to a density heat map.

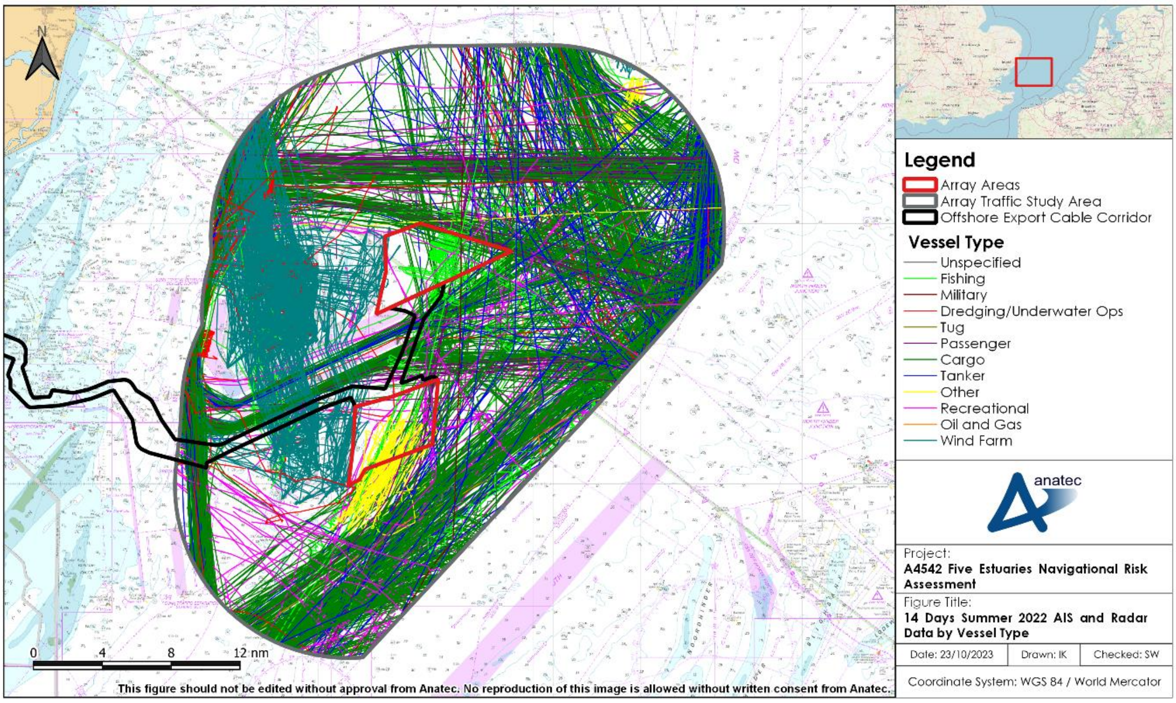

Figure 10.3 14 Days Summer 2022 AIS and Radar Data by Vessel Type (Array Areas)

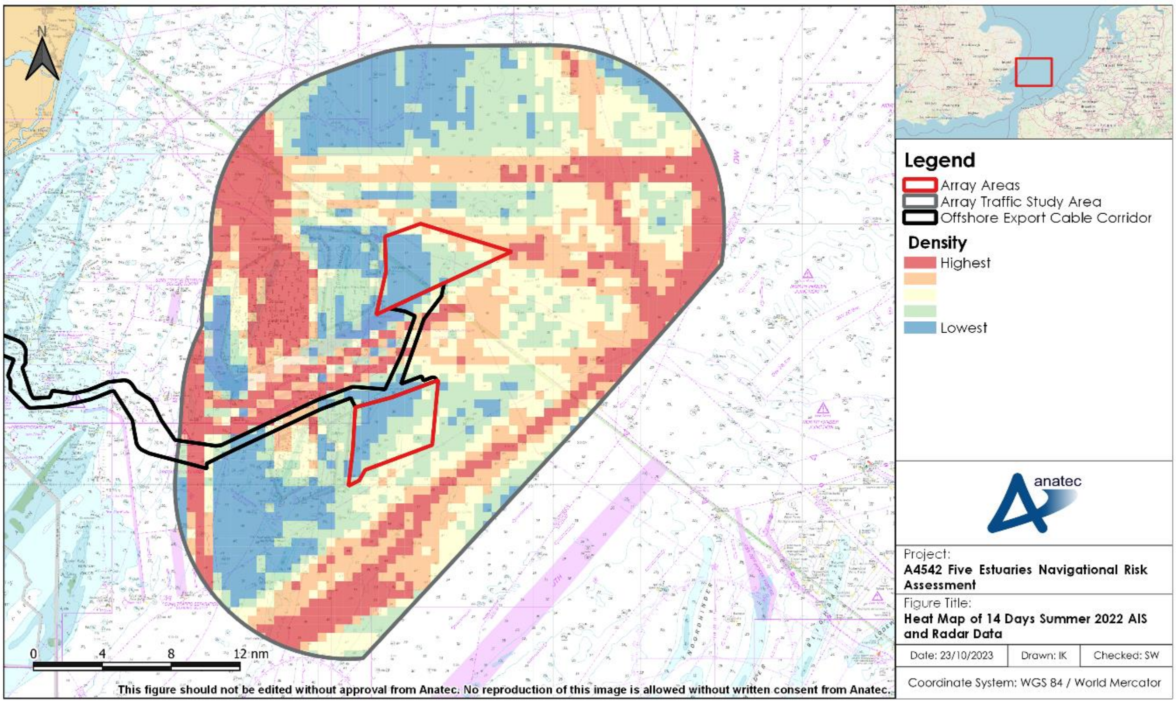

Figure 10.4 Heat Map of 14 Days Summer 2022 AIS and Radar Data (Array Areas)

10.1.1 Vessel Counts

185. For the 14 days analysed in winter, there was an average of 102 unique vessels per day recorded within the array traffic study area. An average of 7-8 unique vessels per day were recorded intersecting the array areas.

186. For the 14 days analysed in summer, there was an average of 116 unique vessels per day recorded within the array traffic study area. An average of 12 unique vessels per day were recorded intersecting the array areas.

187. Figure 10.5 illustrates the daily number of unique vessels recorded within the array traffic study area, as well as intersecting the array area, during the winter survey period. Throughout the winter survey period approximately 7% of vessel traffic recorded within the array traffic study area intersected the array areas.

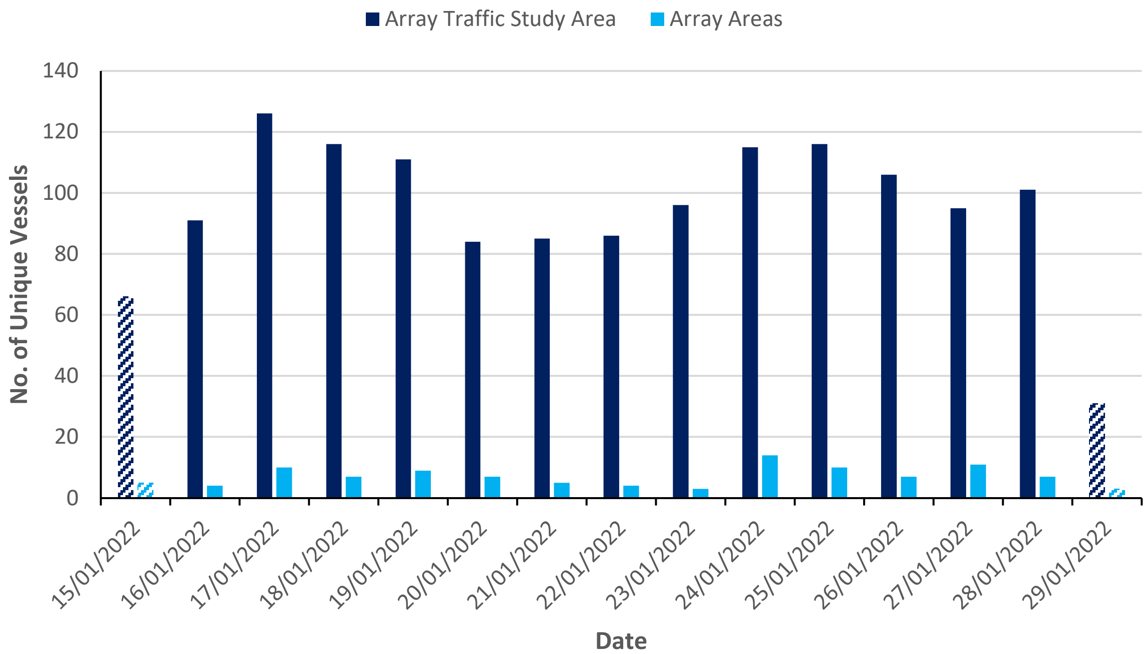

Figure 10.5 Daily Counts within the Array Traffic Study Area and Array Areas (Winter 2022)

188. The busiest day recorded within the array traffic study area throughout the winter survey period was 17 January, when 126 unique vessels were recorded. The busiest day recorded during the winter survey period within the array areas was 24 January, when 14 unique vessels were recorded.

189. The quietest full day recorded within the array traffic study area throughout the winter survey period was 20 January when 84 unique vessels were recorded. The quietest full day recorded within the array areas was 23 January, when three unique vessels were recorded.

190. Figure 10.6 illustrates the daily number of unique vessels recorded within the array traffic study area, as well as intersecting the array area, during the summer survey period. Throughout the summer survey period approximately 10% of vessel traffic recorded within the array traffic study area intersected the array areas.

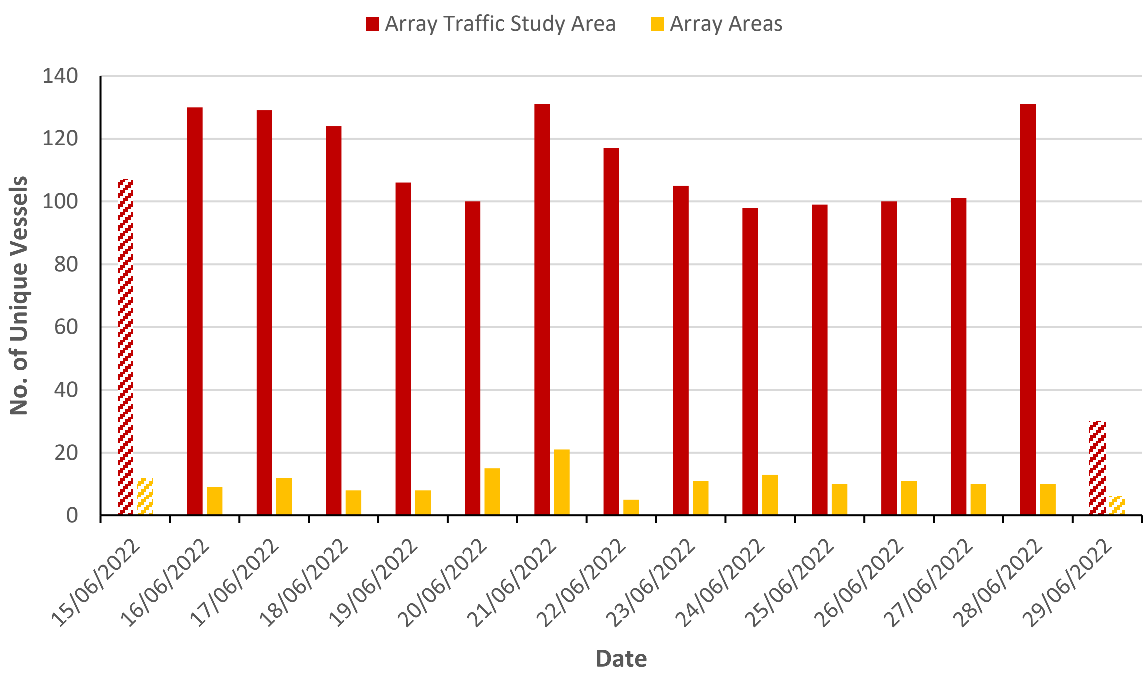

Figure 10.6 Daily Counts within the Array Traffic Study Area and Array Areas (Summer 2022)

191. The busiest days recorded within the array traffic study area throughout the summer survey period were 21 and 28 January 2022, when 132 unique vessels were recorded each. The busiest day recorded during the summer survey period within the array areas was 21 June 2022, when 21 unique vessels were recorded.

192. The quietest full day recorded within the array traffic study area throughout the summer survey period was 24 June 2022 when 99 unique vessels were recorded. The quietest full day recorded within the array areas was 22 June 2022, when five unique vessels were recorded.

10.1.2 Vessel Type

193. The percentage distribution of the main vessel types recorded passing within the array traffic study area, as well as intersecting the array areas, during both survey periods, is presented in Figure 10.7.

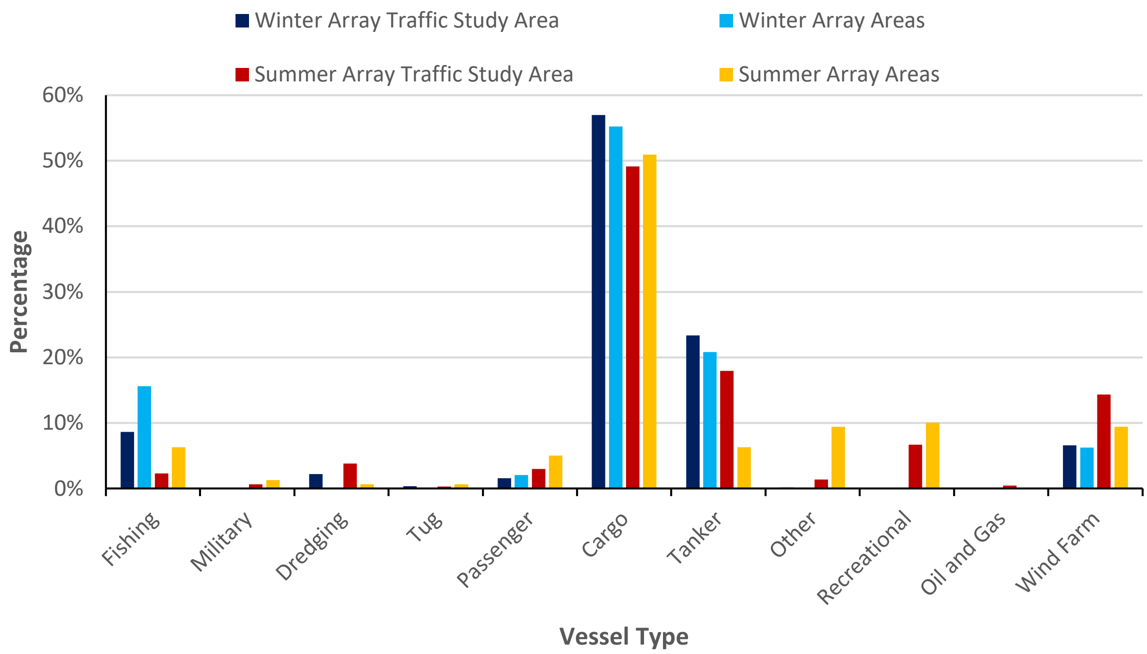

Figure 10.7 Vessel Type Distribution within Array Traffic Study Area and Array Areas

194. Throughout the winter period, the main vessel types within the array traffic study area were cargo vessels (57%), tankers (23%), and fishing vessels (9%). Throughout the summer period, the main vessel types within the array traffic study area were cargo vessels (49%), tankers (18%), and wind farm vessels (14%).

195. The following subsections consider each of the main vessel types individually.

10.1.2.1 Cargo Vessels

196. Tracks of the cargo vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.8.

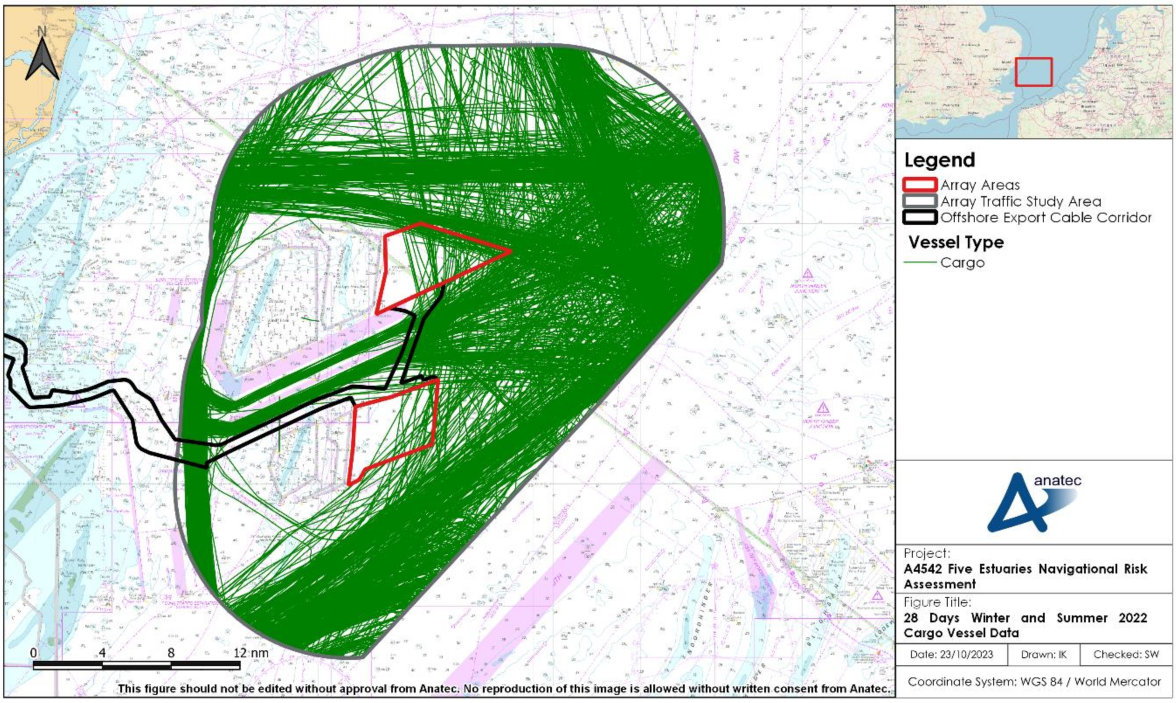

Figure 10.8 28 Days Winter and Summer 2022 Cargo Vessel Data (Array Areas)

197. Throughout the survey periods an average of 56 unique cargo vessels per day were recorded transiting within the array traffic study area. Regular cargo routeing included through the Sunk and North Hinder TSS, as well as east-west to/from Harwich Haven, and north-south along the UK coast to ports on the Humber (UK).

198. The most frequent cargo subtype recorded was Ro-Ro vessels (30%). Other main cargo subtypes included general cargo vessels (29%), container vessels (23%), and bulk carriers (13%).

199. The tracks of Ro-Ro vessels recorded within the array traffic study area during the survey period are colour-coded by operator and presented in Figure 10.9.

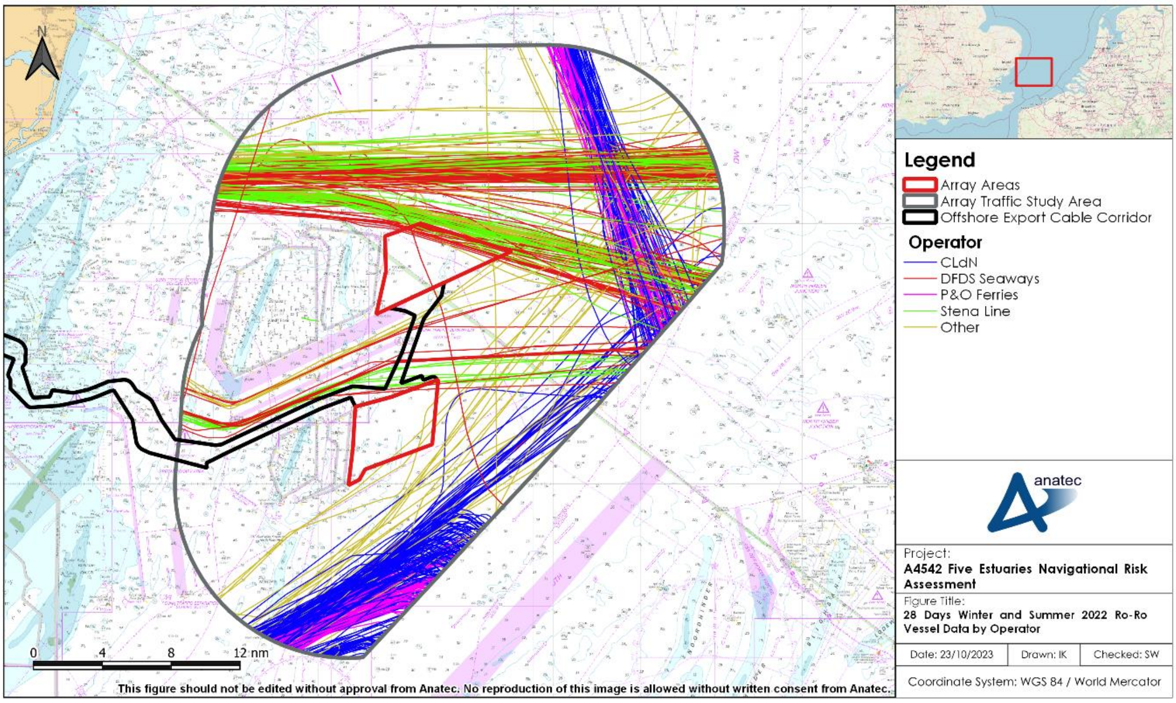

Figure 10.9 28 Days Winter and Summer 2022 Ro-Ro Vessel Data by Operator (Array Areas)

200. The main Ro-Ro operators recorded were CLdN, DFDS Seaways, P&O Ferries, and Stena Line. The typical routes operated were:

- Dagenham Dock–Vlissingen East (Netherlands) (CLdN);
- Port of Felixstowe–Port of Rotterdam (Netherlands) (DFDS Seaways);
- Port of Felixstowe-Vlissingen East (DFDS Seaways);
- Harwich Haven–Port of Rotterdam (Stena Line);
- Killingholme Port (UK)–Port of Zeebrugge (Belgium) (CLdN);
- Purfleet Port (UK)–Port of Zeebrugge (CLdN);
- Purfleet Port–Port of Rotterdam (CLdN);
- Teesport (UK)–Port of Zeebrugge (P&O Ferries); and
- Port of Tilbury (UK)–Port of Zeebrugge (P&O Ferries).

10.1.2.2 Tankers

201. Tracks of the tankers recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.10.

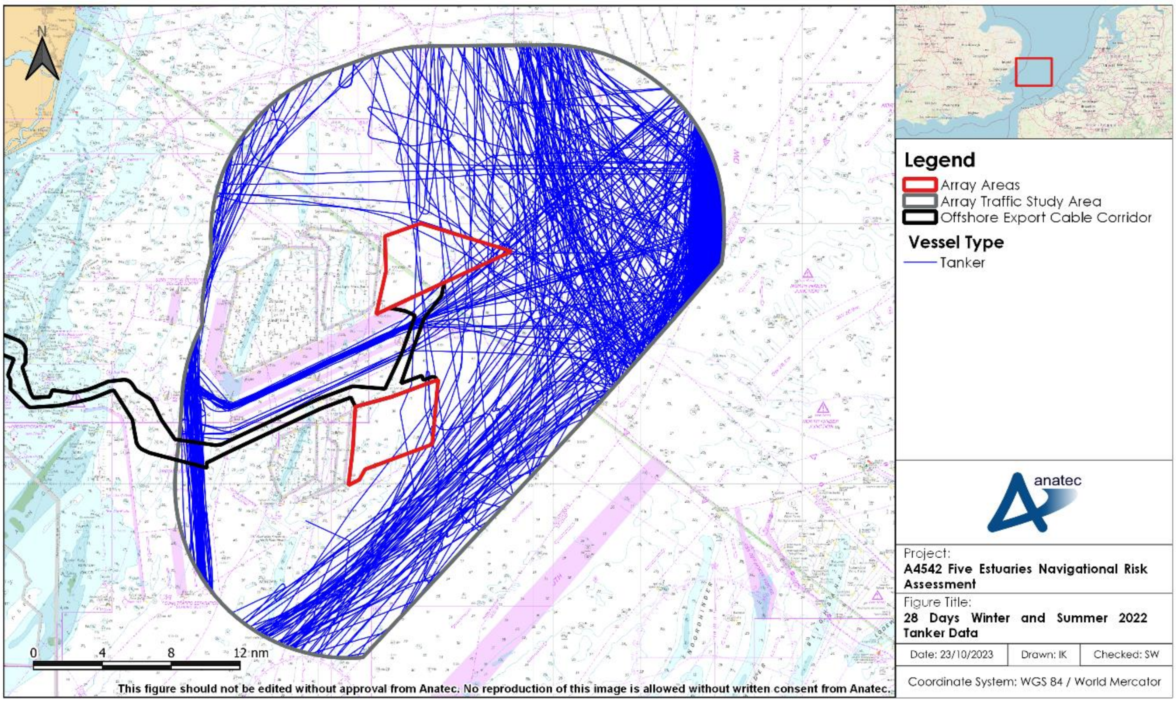

Figure 10.10 28 Days Winter and Summer 2022 Tanker Data (Array Areas)

202. Throughout the survey periods an average of 22 unique tankers per day were recorded transiting within the array traffic study area. Regular tanker routeing was noted through the Sunk and North Hinder TSS, as well as to ports on the Humber.

203. The most frequent tanker subtype recorded was oil/chemical tankers. Other common subtypes included crude oil tankers (18%), Liquefied Petroleum Gas (LPG) tankers (10%), and chemical tankers (10%).

10.1.2.3 Wind Farm Vessels

204. Tracks of the wind farm vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.11.

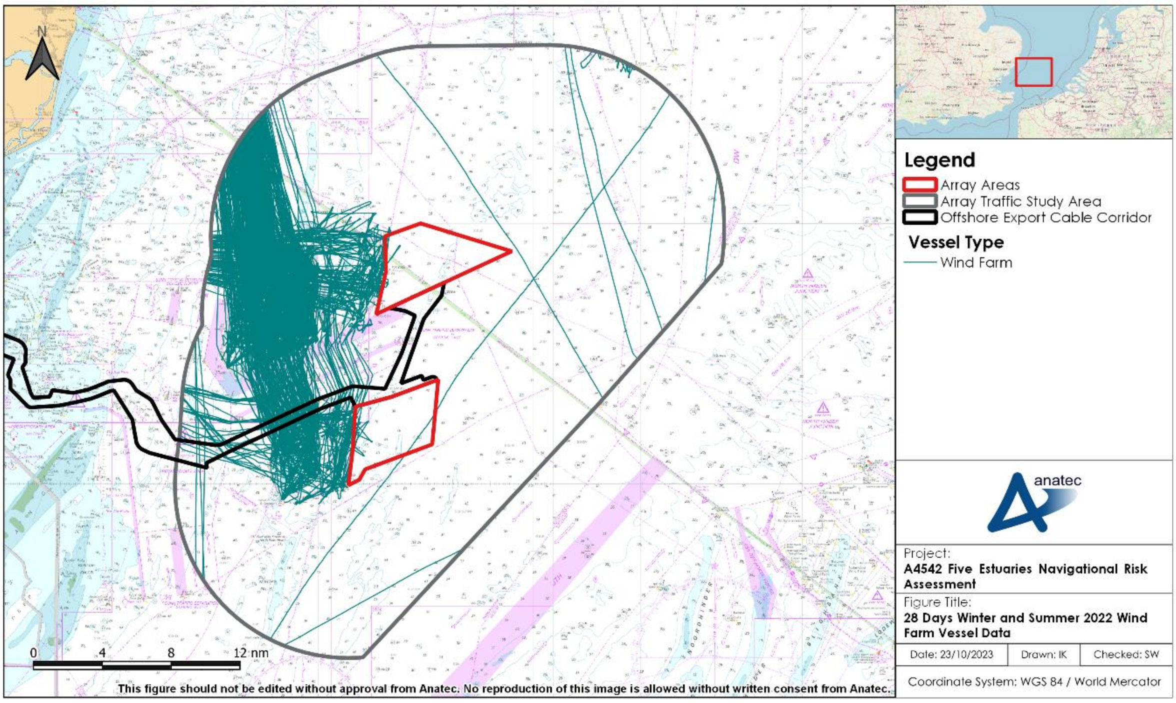

Figure 10.11 28 Days Winter and Summer 2022 Wind Farm Vessel Data (Array Areas)

205. Throughout the survey periods an average of 11 unique wind farm vessels per day were recorded transiting within the array traffic study area.

206. The vast majority of wind farm vessels were involved in operations relating to the Greater Gabbard and Galloper OWFs, with routeing generally out of Harwich Haven and the Port of Lowestoft (UK), respectively. A small number of wind farm vessels were recorded at the northern extent of the array traffic study area and were involved in activity at East Anglia One, with routeing generally out of the Port of Lowestoft (beyond the extent of the array traffic study area).

10.1.2.4 Fishing Vessels

207. Tracks of the fishing vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.12.

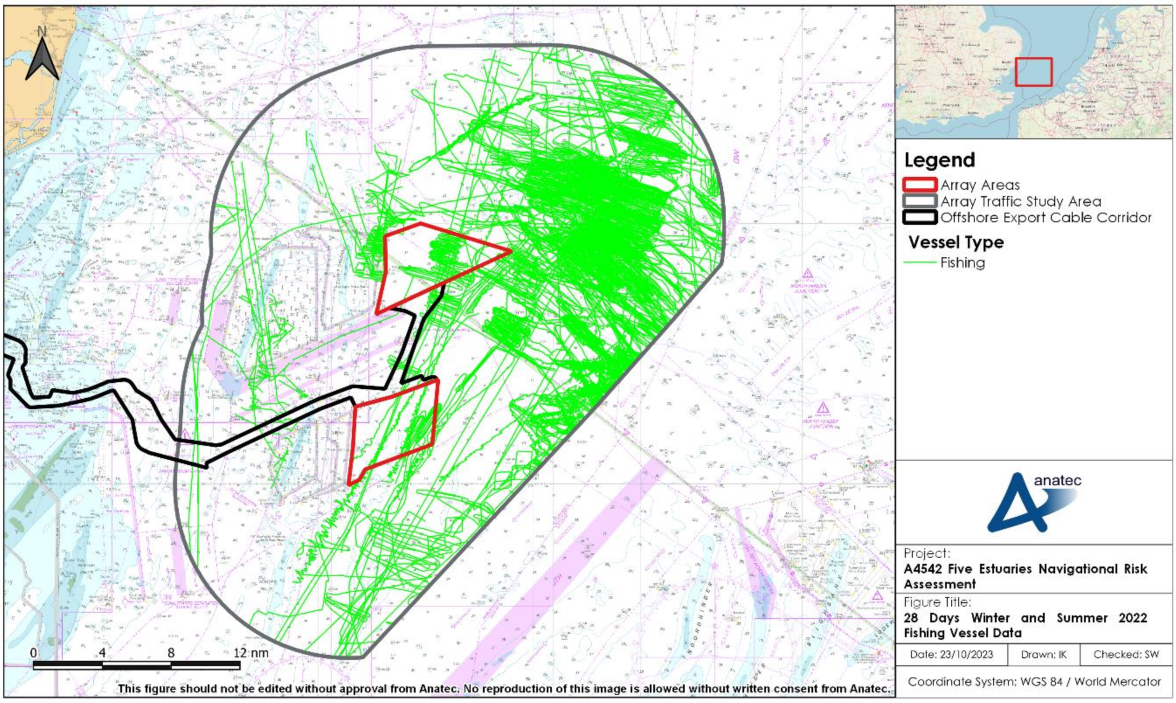

Figure 10.12 28 Days Winter and Summer 2022 Fishing Vessel Data (Array Areas)

208. Throughout the survey periods an average of five to six unique fishing vessels per day were recorded transiting within the array traffic study area. Of the fishing vessels recorded, approximately 85% were recorded via AIS, with 10% recorded on Radar and 5% from visual observations. As AIS is only mandatory for fishing vessels greater than 15 m in length, only 3% of vessels recorded using AIS were under 15 m in length.

209. Based on the average speed and behaviour of vessel tracks, there is a substantial volume of the fishing vessel activity within the array traffic study area that is characteristic of active fishing rather than transits.

210. Fishing gear type could be identified for 48% of the fishing vessels recorded. The most common fishing gear types recorded in the array traffic study area throughout the survey periods were beam trawlers (66%) and long liners (11%).

211. Country of registry could be identified for of all fishing vessels recorded via AIS. The majority of these vessels were from the Netherlands (72%), with vessels from the UK (14%) also common.

10.1.2.5 Recreational Vessels

Vessel Traffic Survey Data

212. Tracks of the recreational vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.13.

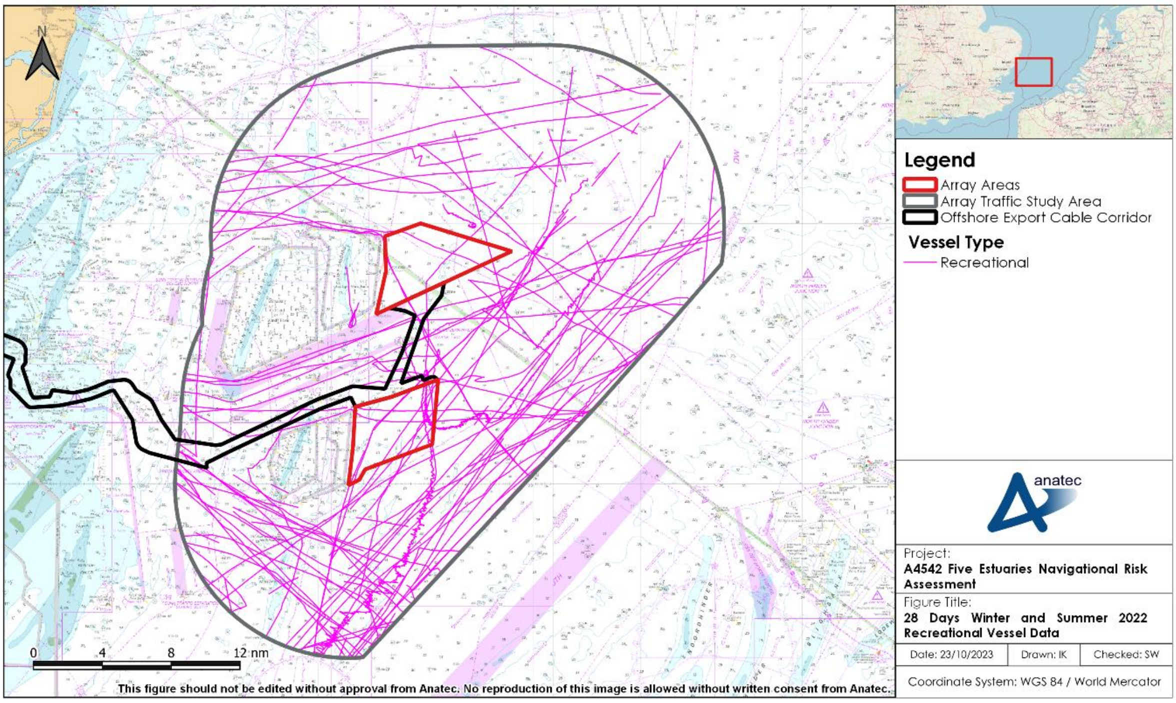

Figure 10.13 28 Days Winter and Summer 2022 Recreational Vessel Data (Array Areas)

213. Throughout the survey periods an average of four unique recreational vessels per day were recorded transiting within the array traffic study area. Seasonality effects were relatively high for recreational vessels, with all recreational vessel tracks recorded in the summer survey period. The vast majority of recreational vessels were recorded on AIS (92%), with 6% recorded on Radar and 2% from visual observations.

214. It is noted that based on data available through the RORC, an annual race is held in the vicinity of the array areas. Although this occurred outside the survey periods, the 2019 race was captured within the long-term dataset (see Section D.5).

RYA Coastal Atlas of Recreational Boating

215. The RYA Coastal Atlas can be used to "*help identify and protect areas of importance to recreational boaters, to advise on new development proposals and in discussions over navigational safety*" (RYA, 2019). The RYA Coastal Atlas includes a heat map indicating the density of recreational activity around the UK coast.

216. Figure 10.14 presents the RYA Coastal Atlas heat map relative to the array areas.

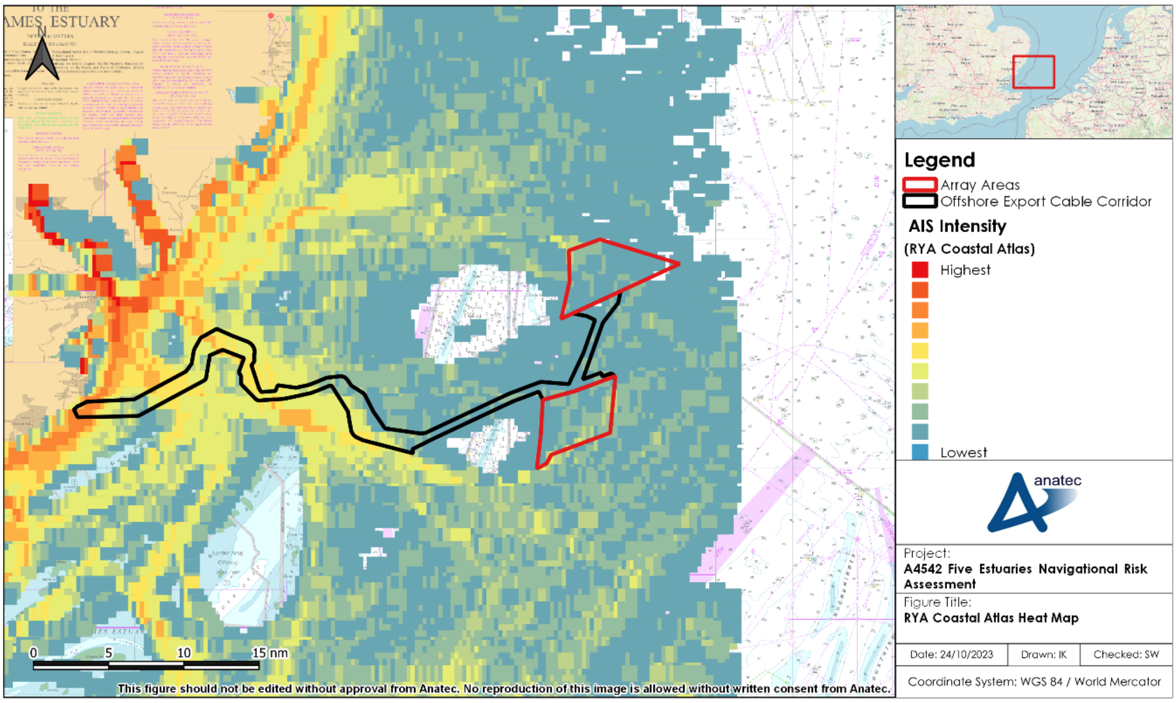

Figure 10.14 RYA Coastal Atlas Heat Map

217. The density of recreational activity within and in proximity to the array areas is generally low, with some areas lacking any recorded data. Some moderately used routeing is observed at the northern extent of the northern array area and southern extent of the southern array area, both of which pass around the existing Greater Gabbard and Galloper.

10.1.2.6 Dredgers

218. Tracks of the dredging vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.15.

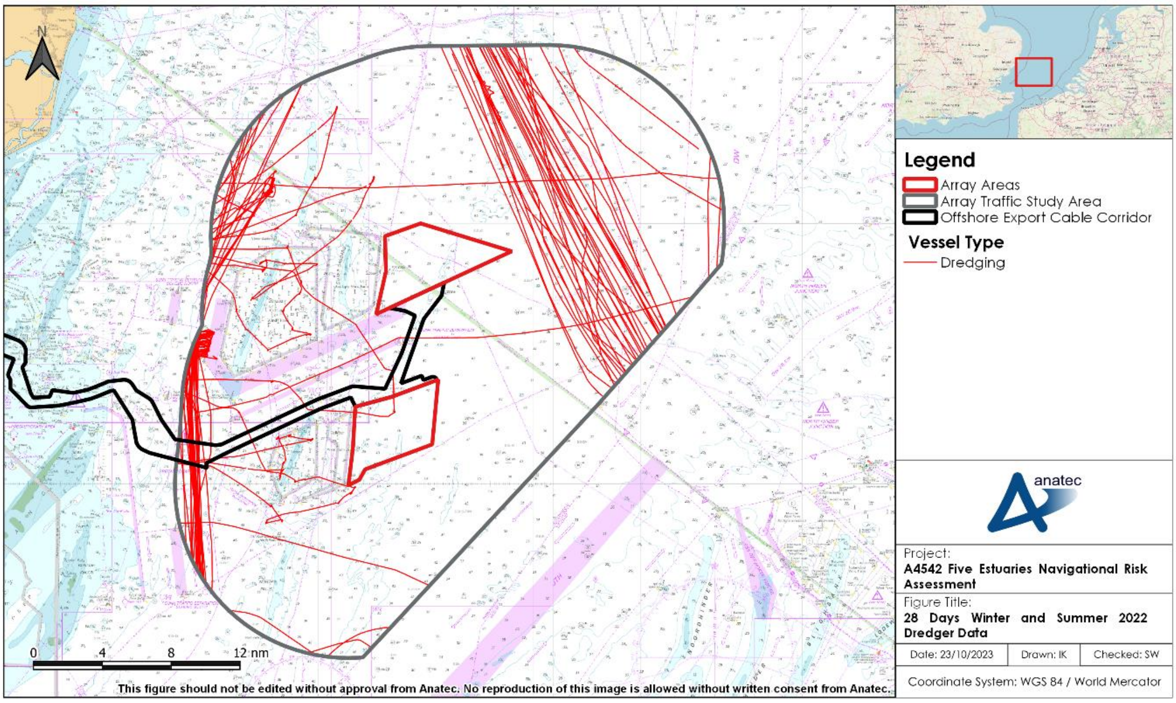

Figure 10.15 28 Days Winter and Summer 2022 Dredger Data (Array Areas)

219. Throughout the survey periods an average of three unique dredging vessels per day were recorded transiting within the array traffic study area.

220. Dredging vessels included those transiting to various marine aggregate dredging areas in proximity to VE (see Section 7), as well as a hopper dredger involved in maintenance operations within the Sunk Outer Precautionary Area at the western extent of the array traffic study area.

10.1.2.7 Passenger Vessels

221. Tracks of the passenger vessels recorded by AIS and Radar within the array traffic study area over both survey periods are presented in Figure 10.16.

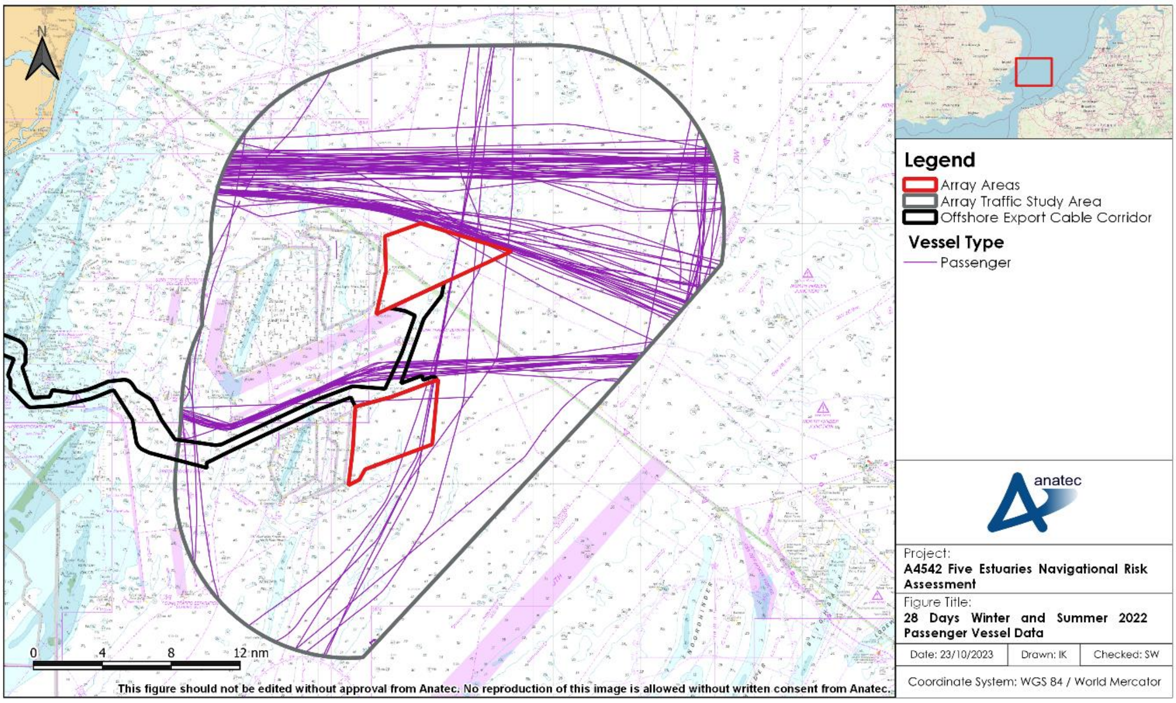

Figure 10.16 28 Days Winter and Summer 2022 Passenger Vessel Data (Array Areas)

222. Throughout the survey periods an average of two to three unique passenger vessels per day were recorded transiting within the array traffic study area.

223. Regular Roll-on/Roll-off passenger (Ro-Pax) routeing between Harwich Haven and the Hook of Holland (Netherlands) was recorded from two vessels operated by Stena Line. These vessels were recorded transiting twice per day in both survey periods. Whilst the westbound transits were to the north of the array areas, the eastbound transits were split between the Sunk routeing measure and to the north of the array areas. The remainder of the passenger vessels recorded in the array traffic study area during the survey period were cruise liners.

10.1.3 Vessel Size

10.1.3.1 Vessel Length

224. Vessel length was available for approximately 97% of vessels recorded throughout the two 14-day survey periods and ranged from 8 m for a sailing vessel to 400 m for a container vessel. The distribution of vessel lengths recorded within the array traffic study area throughout each survey period is presented in Figure 10.17.

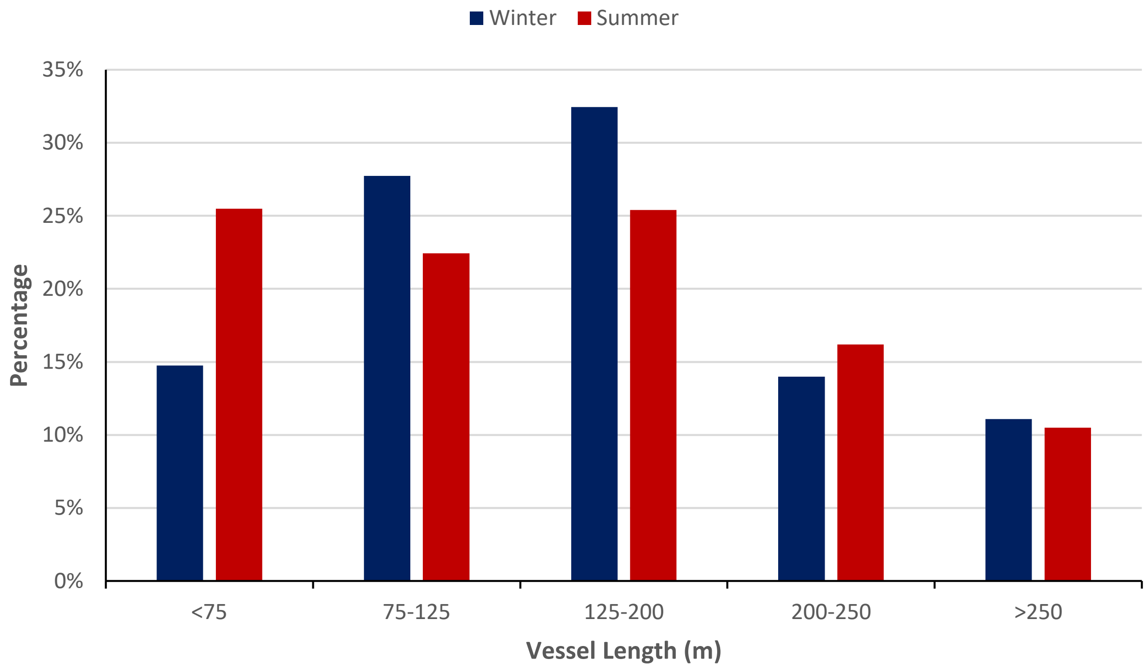

Figure 10.17 Vessel Length Distribution within the Array Traffic Study Area

225. Excluding the proportion of vessels for which length was not available, the average length of vessels within the array traffic study area throughout the winter and summer survey periods was 154 m and 140 m respectively. The difference in average vessel length between the two survey periods may be attributed to the greater presence of small recreational vessels in the summer period.

226. Figure 10.18 presents a plot of the vessel tracks recorded throughout the survey periods, colour-coded by vessel length.

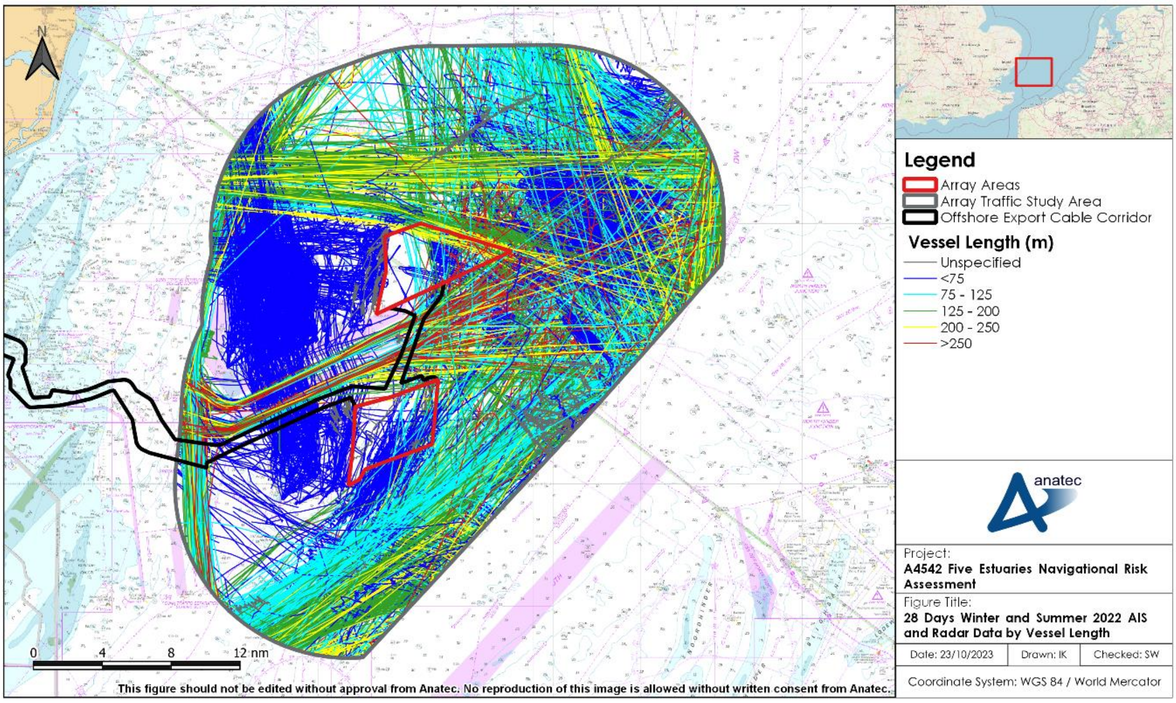

Figure 10.18 28 Days Winter and Summer 2022 AIS and Radar Data by Vessel Length (Array Areas)

227. Vessels of greater length were typically recorded out of the Sunk TSS East and DR1 Light Buoy DWR, with the longest vessels utilising the Sunk TSS. Vessels of smaller length were typically wind farm vessels recorded in proximity to Galloper and Greater Gabbard and fishing vessels engaged in activities.

10.1.3.2 Vessel Draught

228. Vessel draught was available for approximately 89% of vessels recorded throughout the two 14-day survey periods and ranged from 1.2 m for two wind farm support vessels to 21.5 m for an oil products tanker. The distribution of vessel draughts recorded within the array traffic study area throughout each survey period is presented in Figure 10.19.

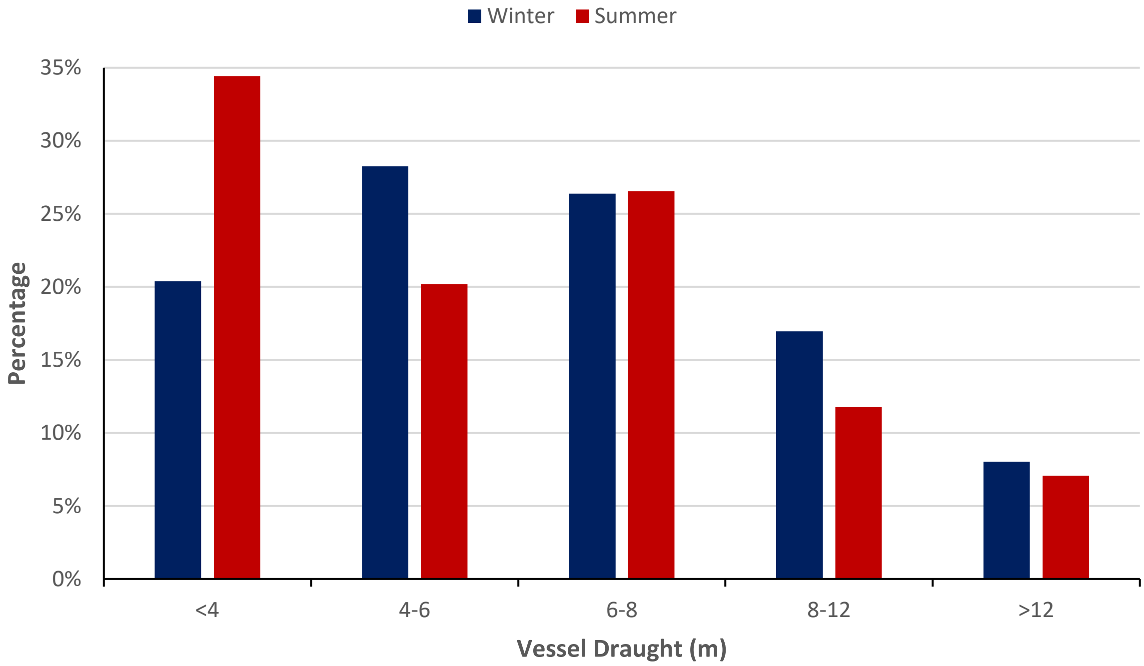

Figure 10.19 Vessel Draught Distribution within the Array Traffic Study Area

229. Excluding the proportion of vessels for which draught was not available, the average draught of vessels within the array traffic study area throughout the winter and summer survey periods was 6.4 m and 5.6 m respectively. The difference in average vessel draught between the two survey periods may, again, be attributed to the greater presence of small recreational vessels in the summer period.

230. Figure 10.20 presents a plot of the vessel tracks recorded throughout the survey periods, colour-coded by vessel draught.

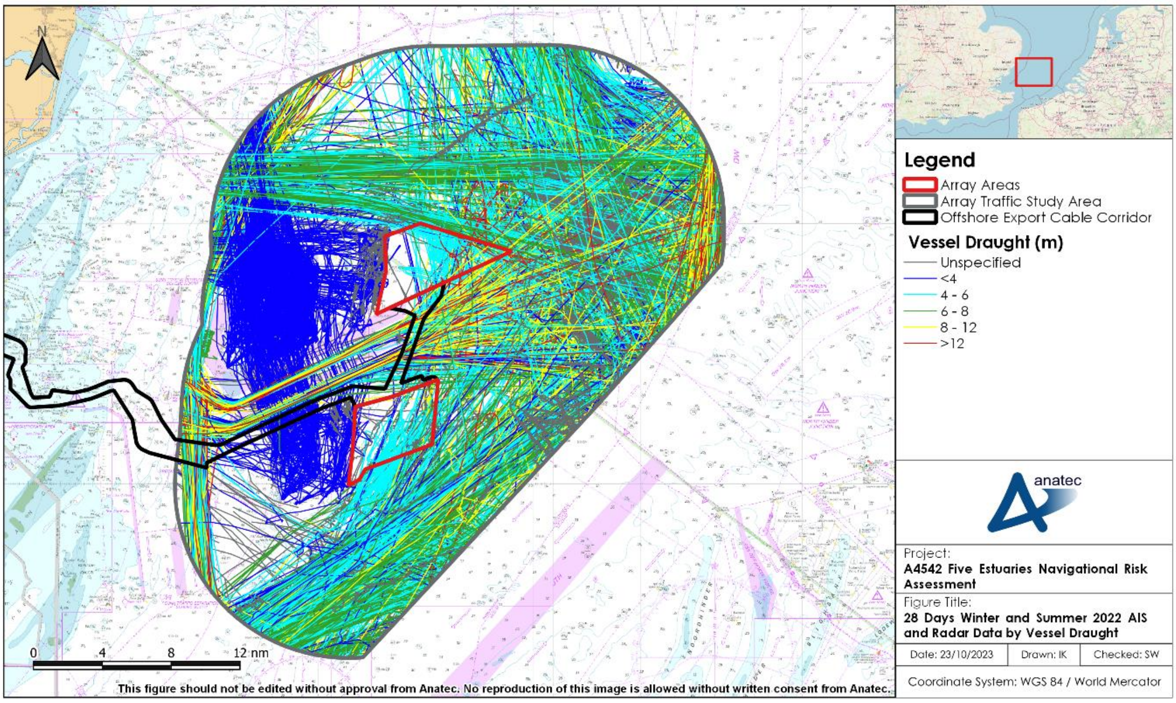

Figure 10.20 28 Days Winter and Summer 2022 AIS and Radar Data by Vessel Draught (Array Areas)

231. Vessels of greater draught were typically recorded out of the Sunk TSS East, with the greatest draughts seen in vessels utilising the DR1 Light Buoy DWR. Vessels of smaller draught were typically wind farm vessels recorded in proximity to Galloper and Greater Gabbard.

10.2 Offshore Export Cable Corridor

232. A number of vessel tracks recorded during the survey period were classified as temporary (non-routine), such as those undertaking surveys. These were therefore excluded from the characterisation of the vessel traffic baseline.

233. A plot of the vessel tracks recorded during the 14-day winter survey period within the offshore ECC study area, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.21. Following this, Figure 10.22 presents the same data converted to a density heat map, with this heat map zoomed to the Sunk Inner Precautionary Area in Figure 10.23.

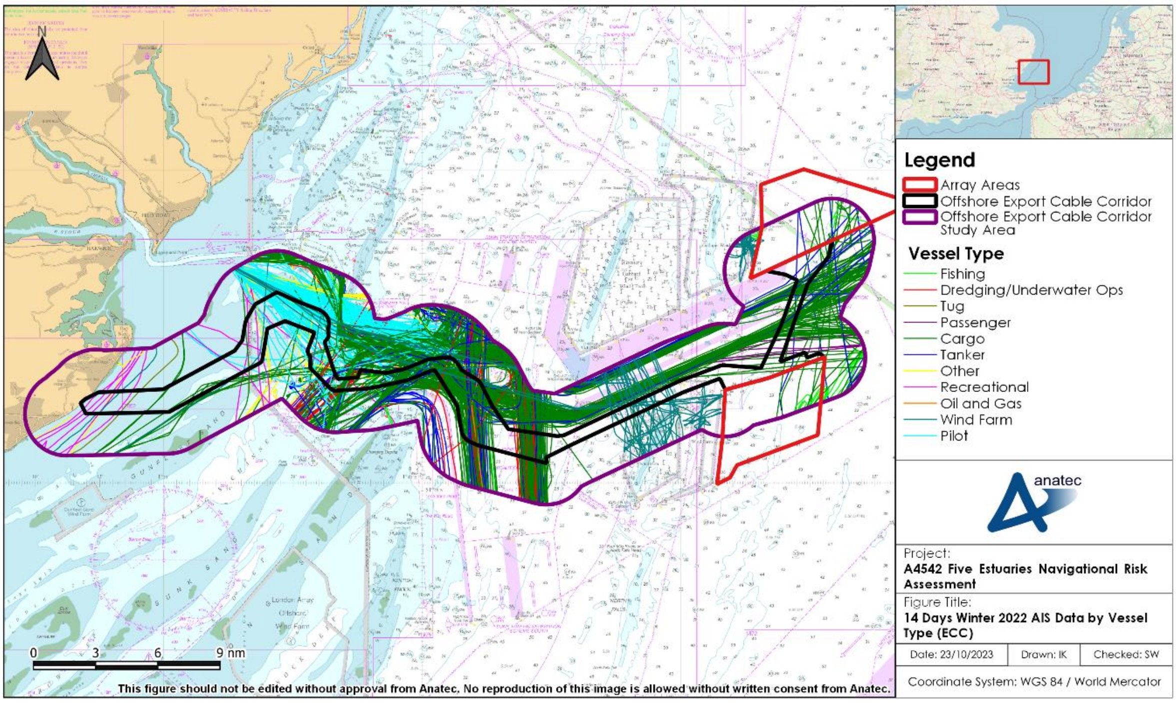

Figure 10.21 14 Days Winter 2022 AIS Data by Vessel Type (Offshore ECC)

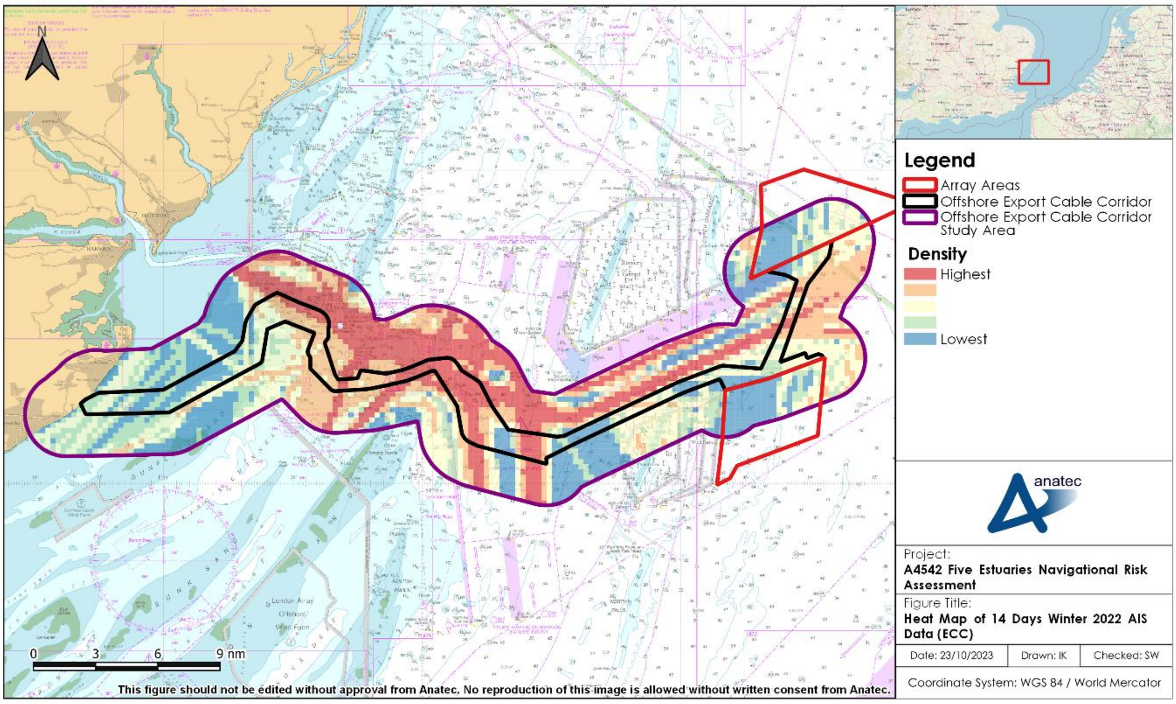

Figure 10.22 Heat Map of 14 Days Winter 2022 AIS Data (Offshore ECC)

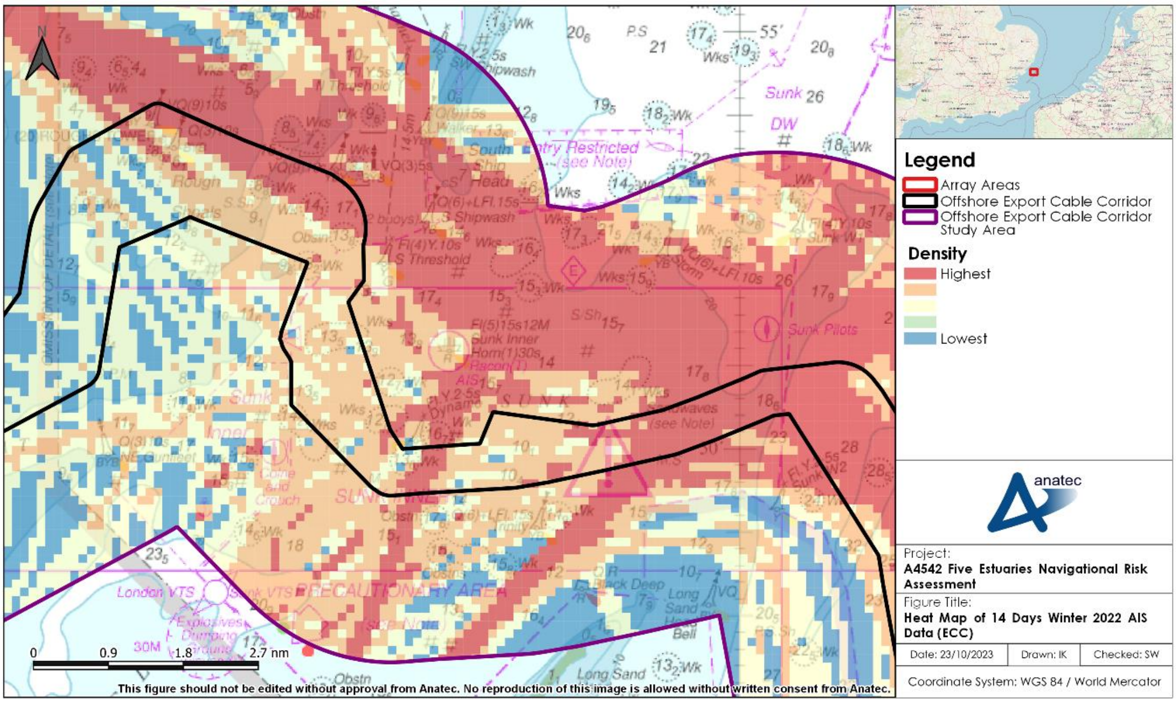

Figure 10.23 Detailed Heat Map of 14 Days Winter 2022 AIS Data (Offshore ECC)

234. A plot of the vessel tracks recorded during the 14-day summer survey period within the offshore ECC study area, colour-coded by vessel type and excluding temporary traffic, is presented in Figure 10.24. Following this, Figure 10.25 presents the same data converted to a density heat map, with this heat map zoomed to the Sunk Inner Precautionary Area in Figure 10.26.

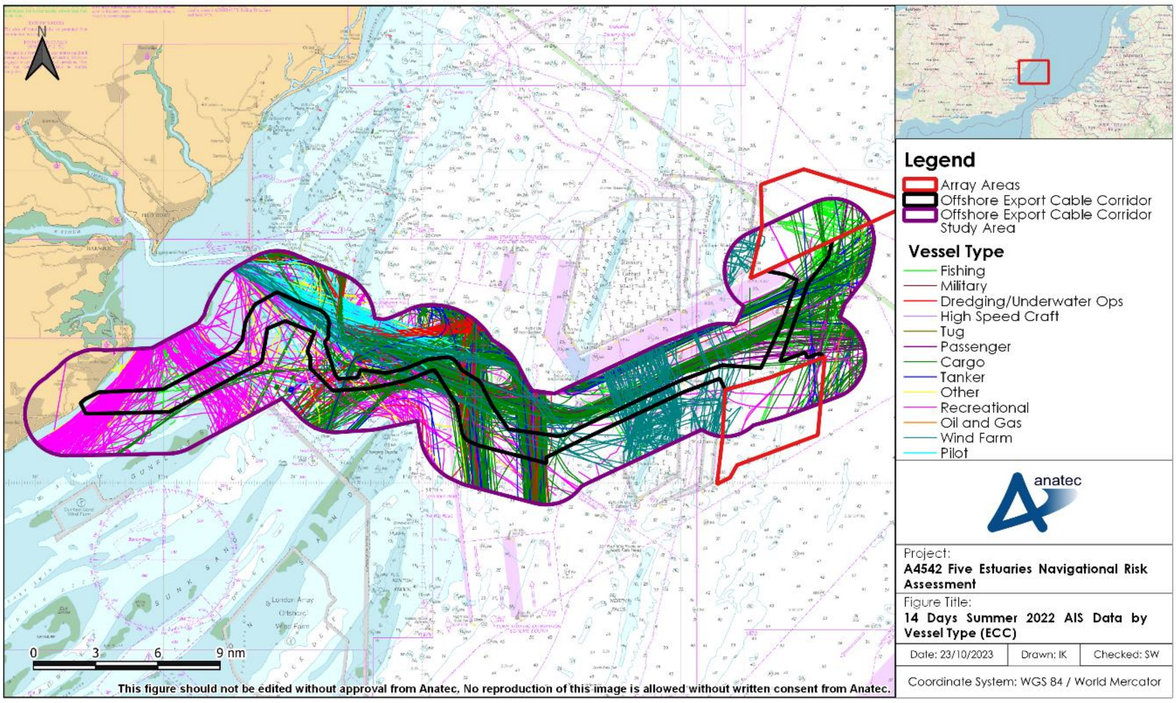

Figure 10.24 14 Days Summer 2022 AIS Data by Vessel Type (Offshore ECC)

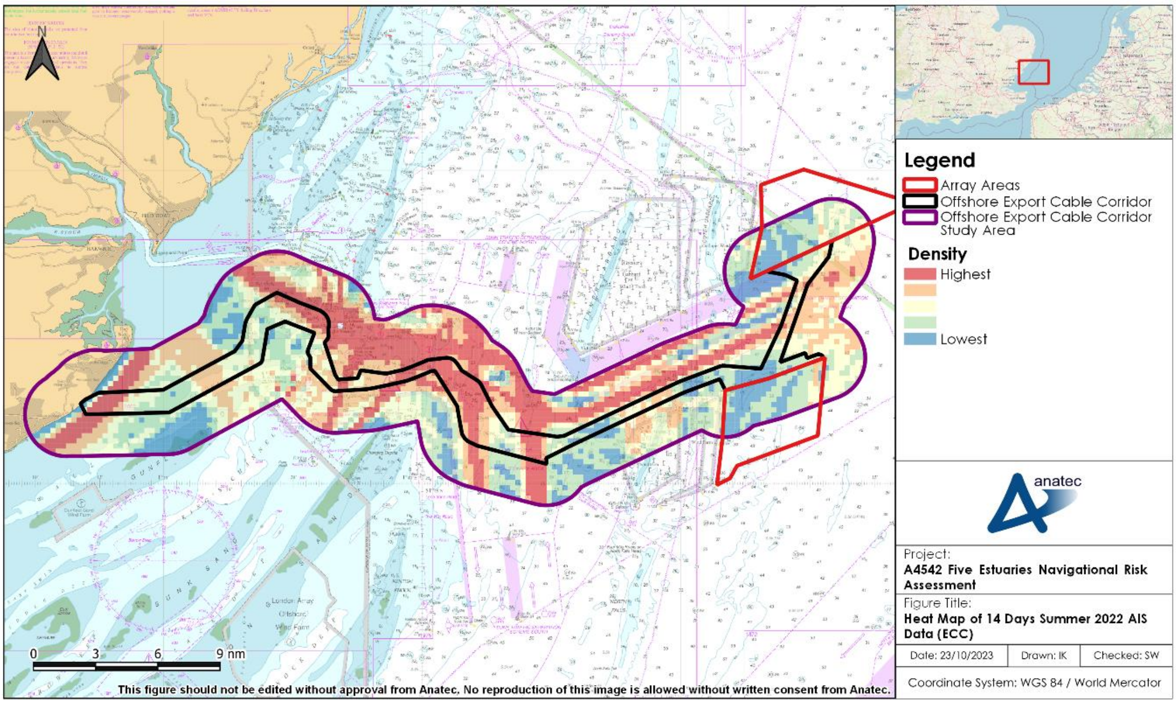

Figure 10.25 Heat Map of 14 Days Summer 2022 AIS Data (Offshore ECC)

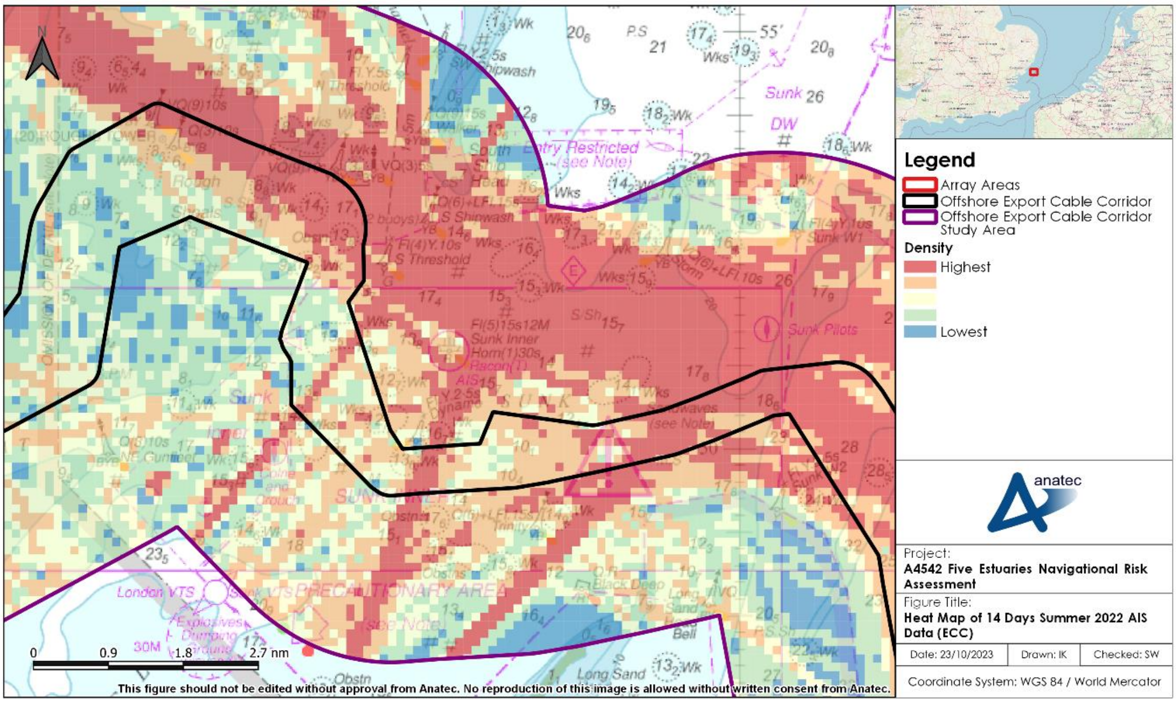

Figure 10.26 Detailed Heat Map of 14 Days Summer 2022 AIS Data (Offshore ECC – Sunk Inner Precautionary Area)

10.2.1 Vessel Counts

235. For the 14 days analysed in winter, there was an average of 46 unique vessels per day recorded within the offshore ECC study area. An average of 38 unique vessels per day were recorded intersecting the offshore ECC.

236. For the 14 days analysed in summer, there was an average of 75 unique vessels per day recorded within the offshore ECC study area. An average of 63 unique vessels per day were recorded intersecting the offshore ECC.

237. Figure 10.27 illustrates the daily number of unique vessels recorded within the offshore ECC study area, as well as intersecting the offshore ECC, during the winter survey period. Throughout the winter survey period approximately 83% of vessel traffic recorded within the offshore ECC study area intersected the offshore ECC.

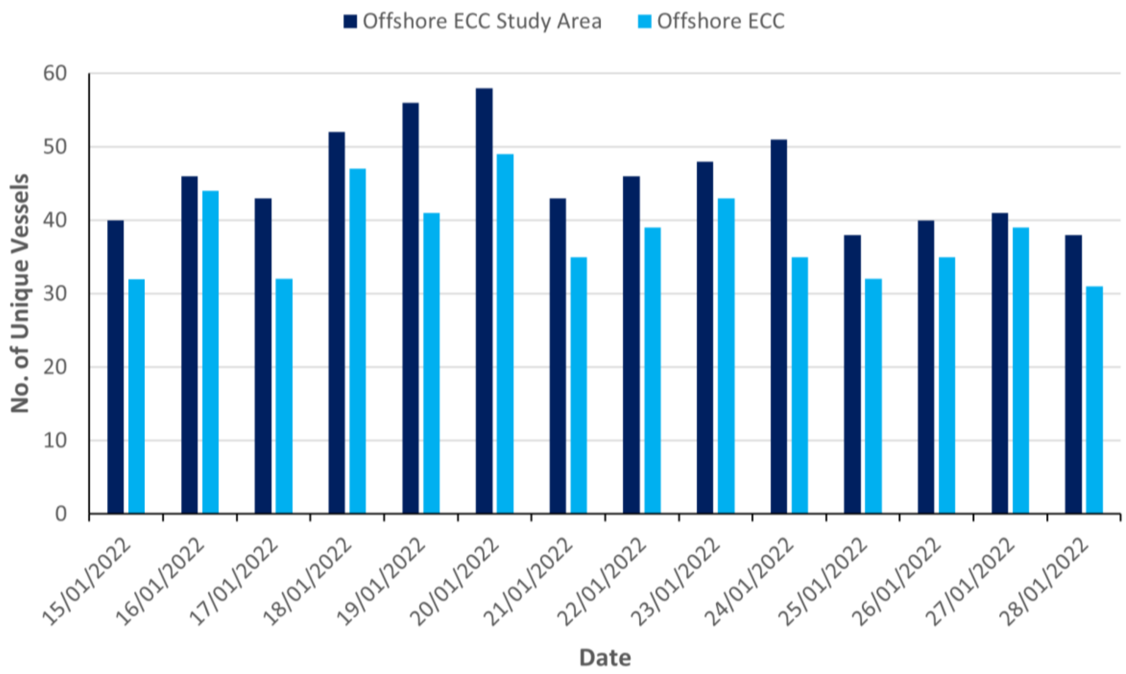

Figure 10.27 Daily Counts within the Offshore ECC Area Study Area and Offshore ECC (Winter 2022)

238. The busiest day recorded within the offshore ECC study area throughout the winter survey period was 20 January 2022, when 58 unique vessels were recorded. The busiest day recorded during the winter survey period within the offshore ECC itself was also 20 January 2022, when 51 unique vessels were recorded.

239. The quietest days recorded within the offshore ECC study area throughout the winter survey period were 25 and 28 January 2022 when 34 unique vessels were recorded each. The quietest day recorded within the array areas was 28 January 2022, when 31 unique vessels were recorded.

240. Figure 10.28 illustrates the daily number of unique vessels recorded within the offshore ECC study area, as well as intersecting the offshore ECC, during the summer survey period. Throughout the summer survey period approximately 84% of vessel traffic recorded within the offshore ECC study area intersected the offshore ECC.

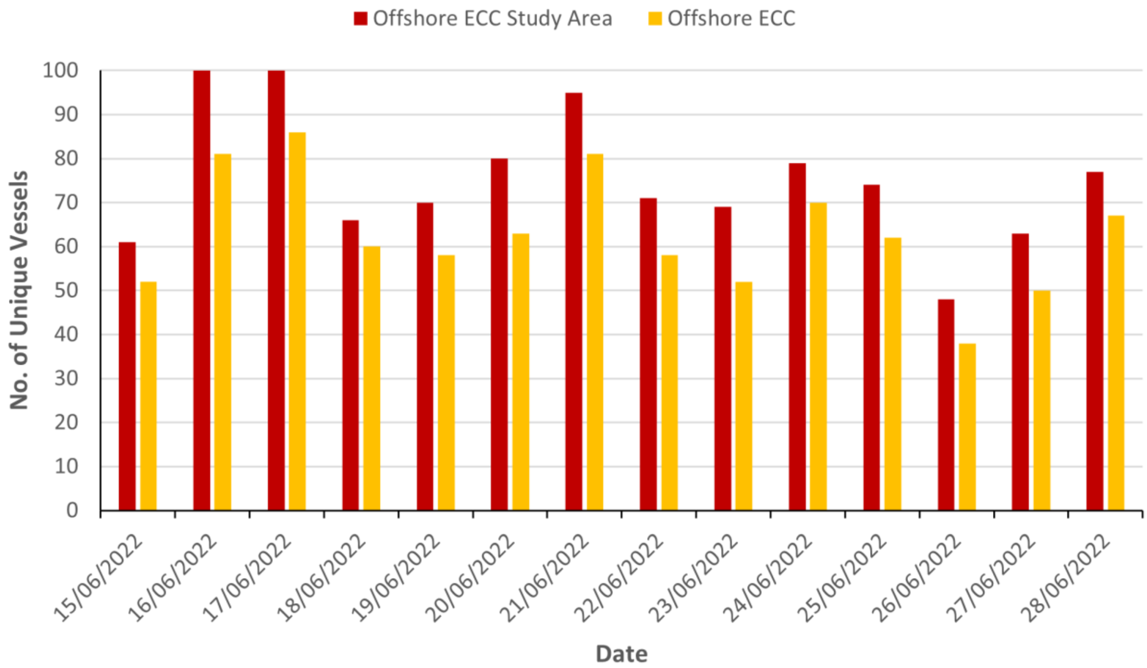

Figure 10.28 Daily Counts within the Offshore ECC Study Area and Offshore ECC (Summer 2022)

241. The busiest days recorded within the offshore ECC study area throughout the summer survey period were 16 and 17 June 2022, when 100 unique vessels were recorded each. The busiest day recorded during the summer survey period within the offshore ECC itself was also 17 June 2022, when 82 unique vessels were recorded.

242. The quietest day recorded within the offshore ECC study area throughout the summer survey period was 26 June 2022 when 45 unique vessels were recorded. The quietest day recorded within the array areas was also 26 June 2022, when 36 unique vessels were recorded.

10.2.2 Vessel Type

243. The percentage distribution of the main vessel types recorded passing within the offshore ECC study area, as well as intersecting the offshore ECC itself, during both survey periods, is presented in Figure 10.29.

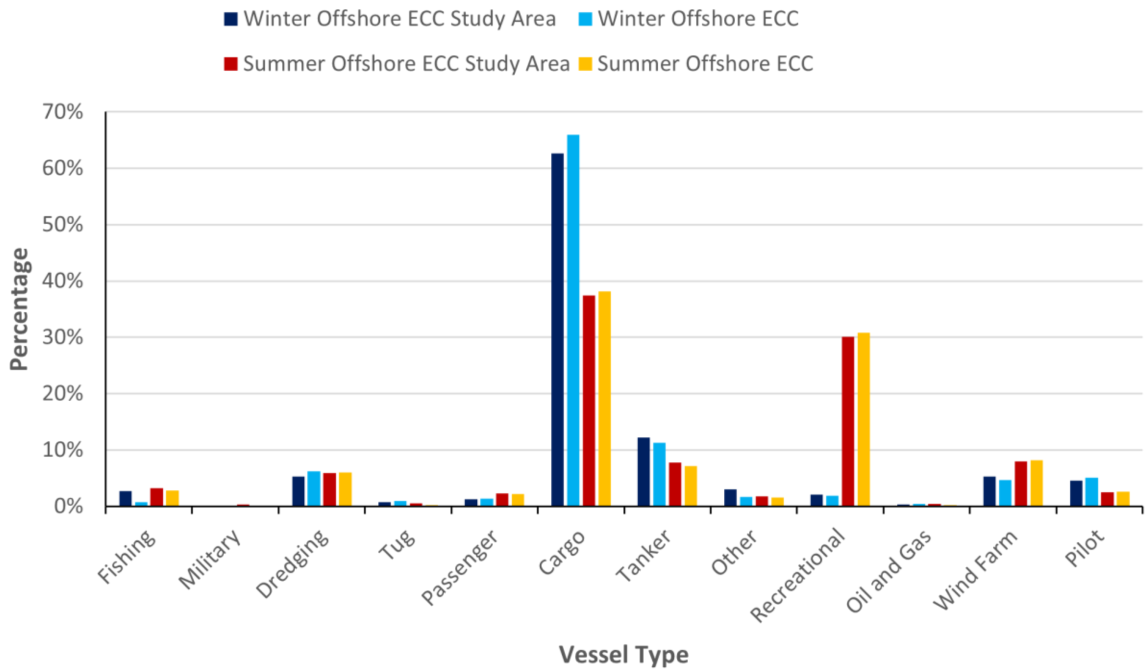

Figure 10.29 Vessel Type Distribution within the Offshore ECC Study Area and Offshore ECC

244. Throughout the winter period, the main vessel types within the offshore ECC study area were cargo vessels (63%), tankers (12%), dredgers (5%), and wind farm vessels (5%). Throughout the summer period, the main vessel types within the offshore ECC study area were cargo vessels (37%), recreational vessels (30%), and wind farm vessels (8%).

245. The following subsections consider each of the main vessel types individually.

10.2.2.1 Cargo Vessels

246. Tracks of the cargo vessels recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.30.

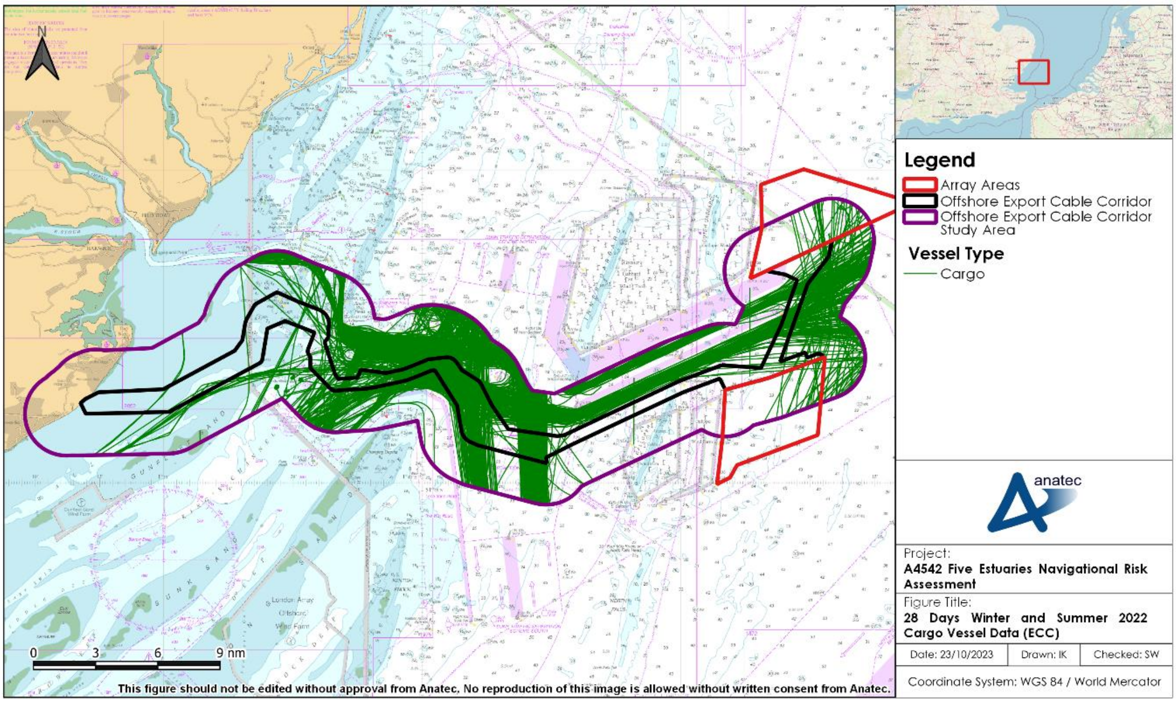

Figure 10.30 28 Days Winter and Summer Cargo Vessel Data (Offshore ECC)

247. Throughout the survey periods an average of 29 unique cargo vessels per day were recorded transiting within the offshore ECC study area.

248. Cargo vessels were primarily recorded routeing through the Sunk routeing measure, frequently transiting between ports within the Thames and Medway, Harwich Haven, the Port of Felixstowe, Belgian ports, and Dutch ports. The most common cargo subtypes recorded in the offshore ECC study area were general cargo vessels (42%) and container vessels (41%).

10.2.2.2 Recreational Vessels

Vessel Traffic Data

249. Tracks of the recreational vessels recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.31.

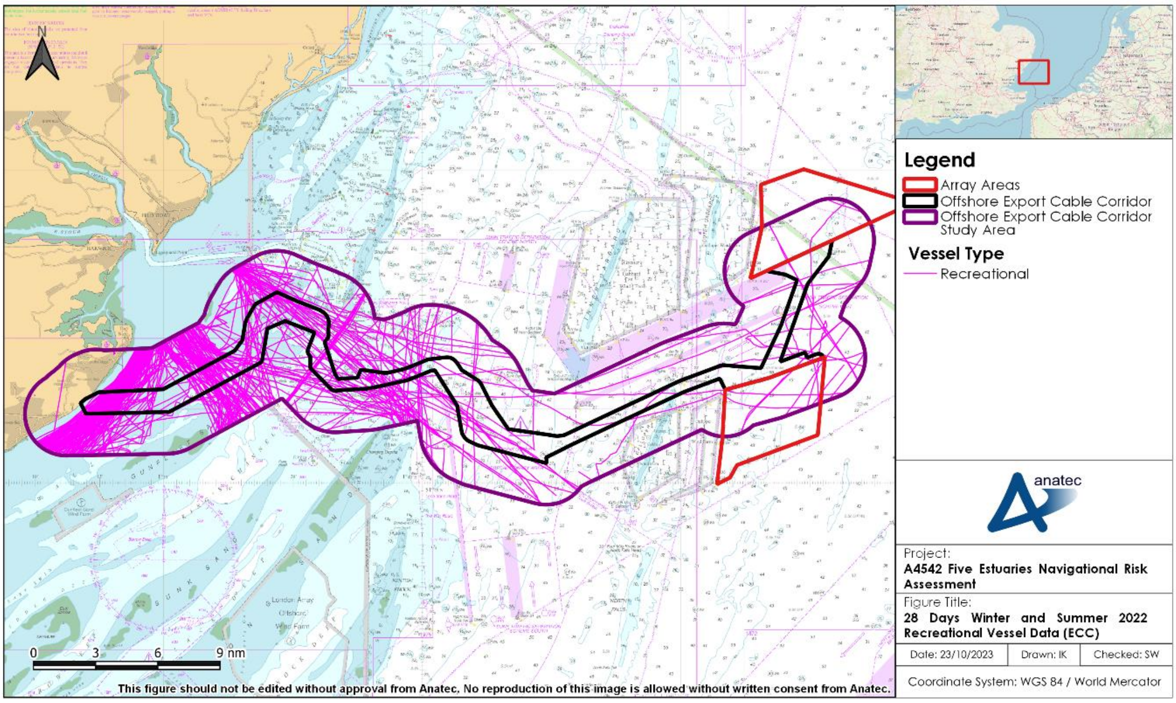

Figure 10.31 28 Days Winter and Summer Recreational Vessel Data (Offshore ECC)

250. Throughout the survey periods an average of 12 unique recreational vessels per day were recorded transiting within the offshore ECC study area. As with the vessel traffic recorded in the array traffic study area, all recreational vessels within the offshore ECC study area were recorded during the summer survey period. The vast majority of recreational vessel tracks were recorded close to shore.

RYA Coastal Atlas of Recreational Boating

251. Figure 10.14 presents the RYA Coastal Atlas heat map relative to the offshore ECC.

252. The density of recreational activity is greatest close to shore, with a clear route following the coast and crossing the offshore ECC. Additional moderately used routes are observed out of Harwich Haven, either crossing the offshore ECC at the Goldmer Gat or headed to/from the Long Sand Head Two-Way Route. These are routes are well reflected in the 28-day vessel traffic data.

253. The density of recreational activity within and in proximity to the array areas is generally low, with some areas lacking any recorded data. Some moderately used routeing is observed at the northern extent of the northern array area and southern extent of the southern array area, both of which pass around the existing Greater Gabbard and Galloper.

10.2.2.3 Tankers

254. Tracks of the tankers recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.32.

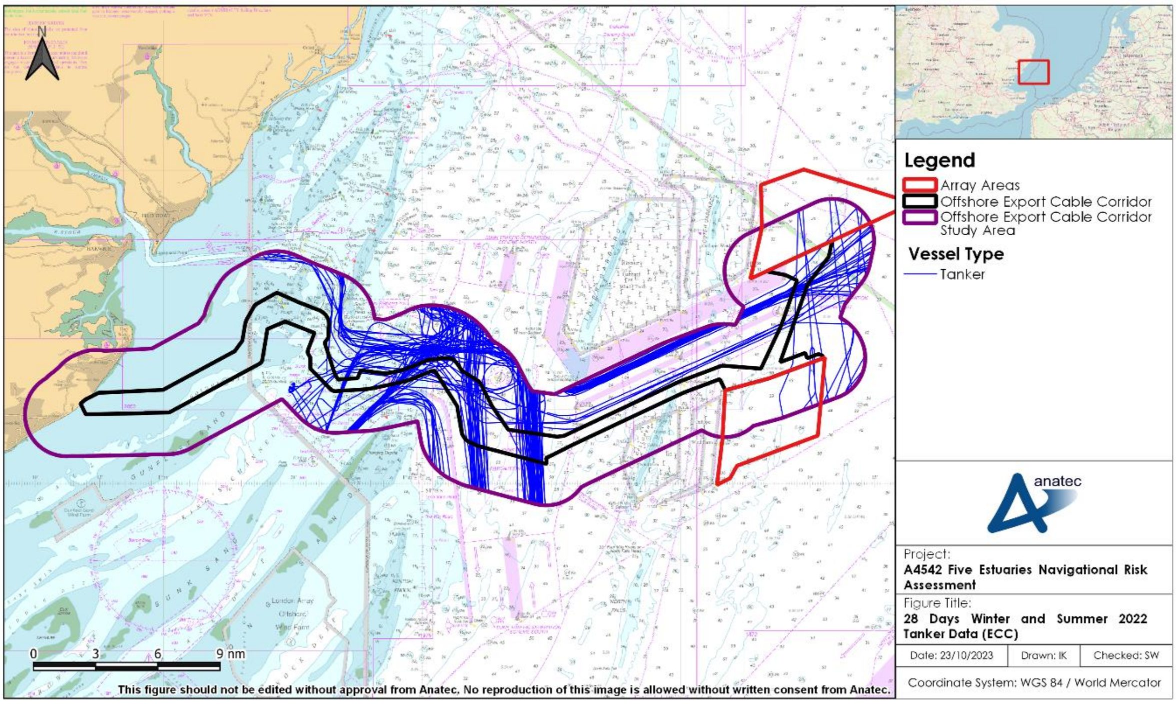

Figure 10.32 28 Days Winter and Summer Tanker Data (Offshore ECC)

255. Throughout the survey periods an average of five to six unique tankers per day were recorded transiting within the offshore ECC study area.

256. Tankers were primarily recorded routeing through the Sunk routeing measure, frequently destined for ports within the Thames and Medway, as well as the Port of Immingham (UK) and Teesport. The most common tanker subtypes recorded in the offshore ECC study area were oil/chemical tankers (47%) and oil products tankers (21%).

10.2.2.4 Wind Farm Vessels

257. Tracks of the wind farm vessels recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.33.

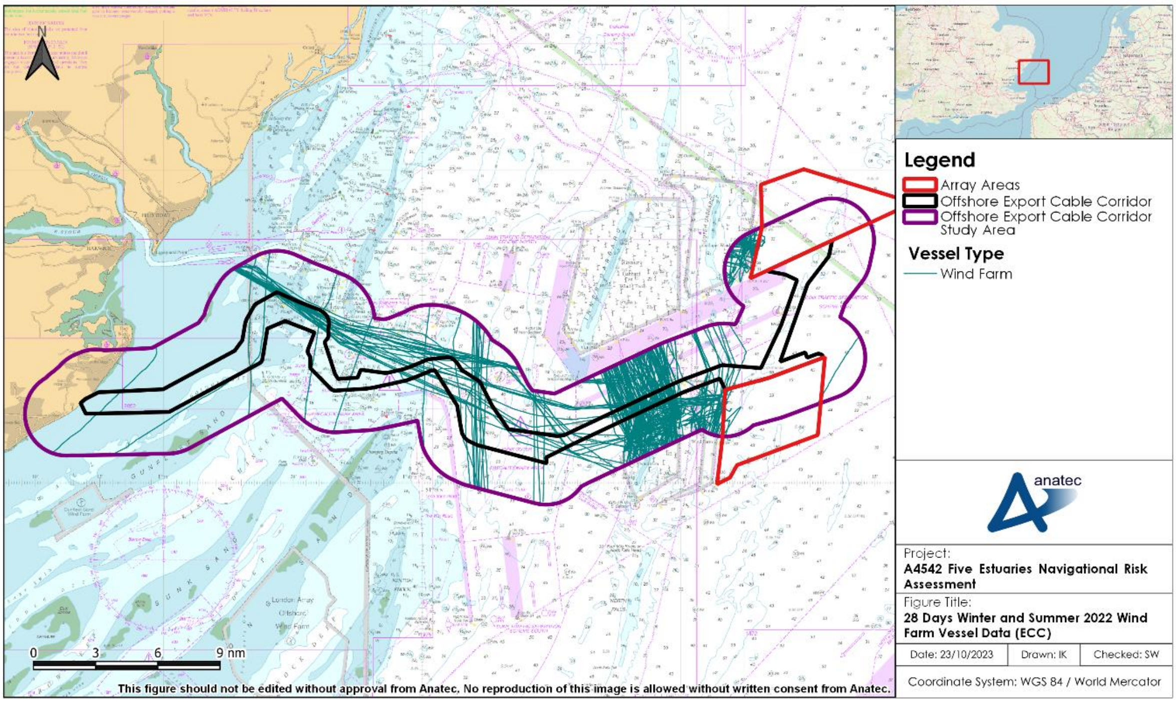

Figure 10.33 28 Days Winter and Summer Wind Farm Vessel Data (Offshore ECC)

258. Throughout the survey periods an average of four unique wind farm vessels per day were recorded transiting within the array traffic study area.

259. As with the array traffic study area, the vast majority of wind farm vessels were involved in operations relating to the Greater Gabbard and Galloper OWFs. This included numerous crossings of the offshore ECC for navigating between Greater Gabbard and Galloper.

10.2.2.5 Pilot Vessels

Vessel Traffic Survey Data

260. Tracks of the pilot vessels recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.34, with the nearby pilot boarding stations included for context.

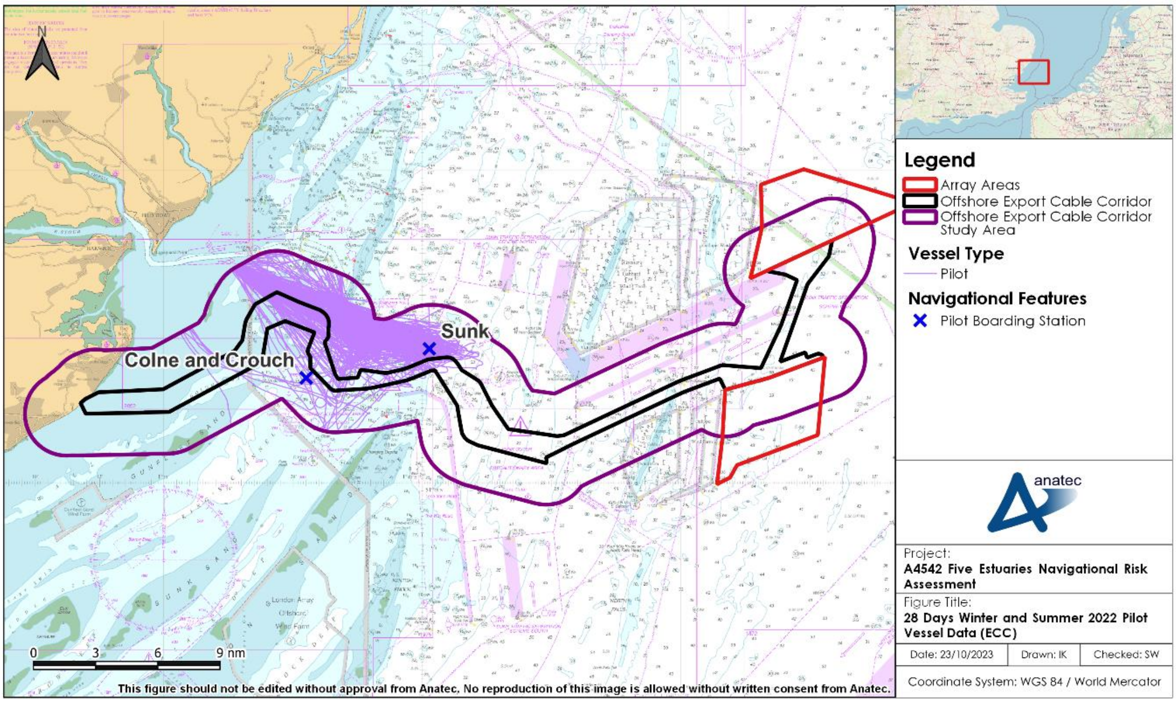

Figure 10.34 28 Days Winter and Summer Pilot Vessel Data (Offshore ECC)

261. Throughout the survey periods an average of two unique pilot vessels per day were recorded transiting within the offshore ECC study area. These pilot vessels were typically involved in operations out of Harwich Haven from pilot boarding stations in the Sunk routeing measure, with the Sunk pilot boarding station utilised primarily over the Colne and Crouch pilot boarding station, and the largest vessels boarded from the Sunk pilot boarding station. This aligns with feedback received by HHA during consultation.

Long-Term Vessel Traffic Data

262. Following PEIR, long-term vessel traffic data recorded via AIS has been considered within the Sunk Inner and Outer Precautionary Areas, including pilot vessels. A density heat map for the pilot vessels recorded within the Sunk offshore ECC study area is presented in Figure 10.35, with the nearby pilot boarding stations again included for context.

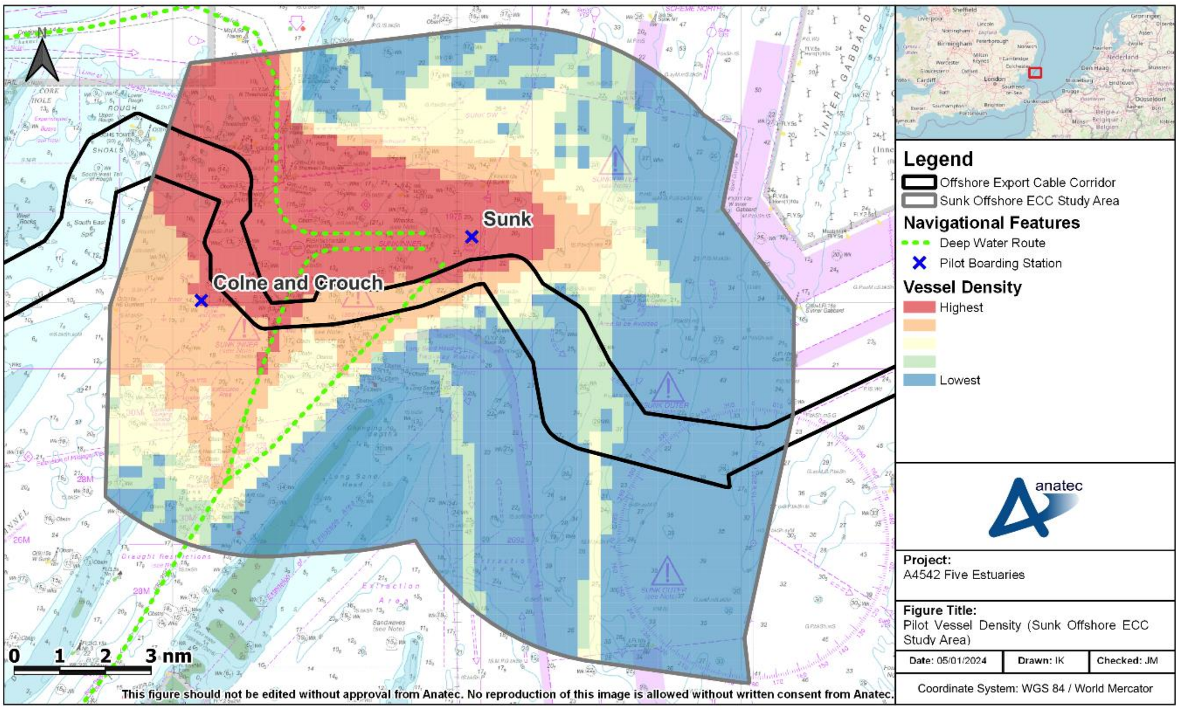

Figure 10.35 Density Heat Map of Pilot Vessels in the Sunk Offshore ECC Study Area

263. The long-term vessel traffic data shows good agreement with the vessel traffic survey data; pilotage is typically operated out of Harwich Haven and the Sunk pilot boarding station is the preferred location for activities. It is also acknowledged that pilot boarding does not occur exclusively in close proximity to the pilot boarding stations. From the long-term vessel traffic data, activities occur throughout the Sunk Inner Precautionary Area and can extend further east, up to 1 to 2 nm east of the Sunk pilot boarding station – this has been corroborated by HHA during consultation.

264. It is noted that although there are notable volumes of pilot vessels within the area, it is the ability to undertake pilotage operations (thus enabling port access) rather than the physical presence of pilot vessels which is considered a navigational issue (and is assessed in Section 19.6).

10.2.2.6 Fishing Vessels

265. Tracks of the fishing vessels recorded by AIS within the offshore ECC study area over both survey periods are presented in Figure 10.36.

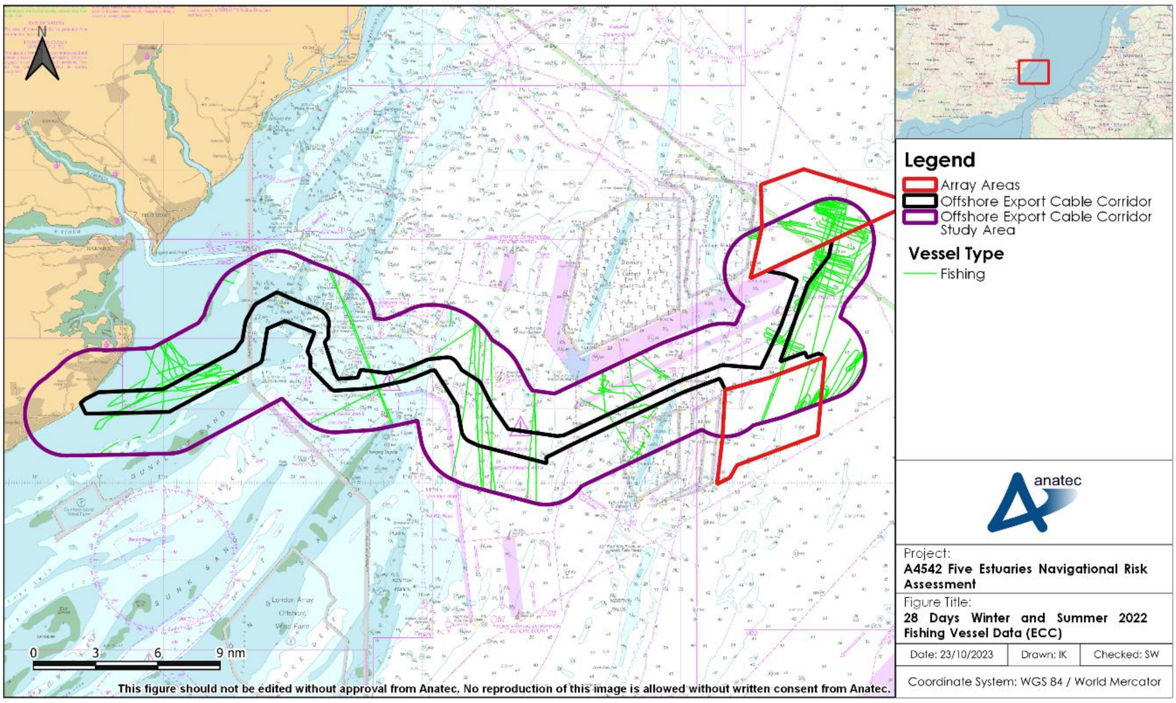

Figure 10.36 28 Days Winter and Summer Fishing Vessel Data (Offshore ECC)

266. Throughout the survey periods an average of two unique fishing vessels per day were recorded transiting within the offshore ECC study area. A higher proportion of fishing vessels within the offshore ECC study area broadcasting over AIS were under 15 m in length compared to the array traffic study area (22%).

267. Based on the average speed and behaviour of vessel tracks, the majority of fishing vessel activity at the eastern and western extents of the offshore ECC study area were characteristic of active fishing, with the vessels at the centre transiting.

268. Fishing gear type could be identified for 76% of the fishing vessels recorded. The most common fishing gear types recorded in the offshore ECC study area throughout the survey periods were again beam trawlers and long liners (33% each).

269. Country of registry could be identified for of all fishing vessels, with the majority being from the UK (53%). Fishing vessels from the Netherlands (27%) and France (16%) were also commonly recorded.

10.2.3 Anchored Vessels

270. 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.

271. For this reason, those vessels which travelled at a speed of less than 1 kt for more than 30 minutes had their corresponding vessel tracks individually checked for patterns characteristic of anchoring activity. The tracks of vessels likely to be at anchor within the offshore ECC study area during the survey periods are presented in Figure 10.37, with the charted anchorages in proximity to the offshore ECC provided for context.

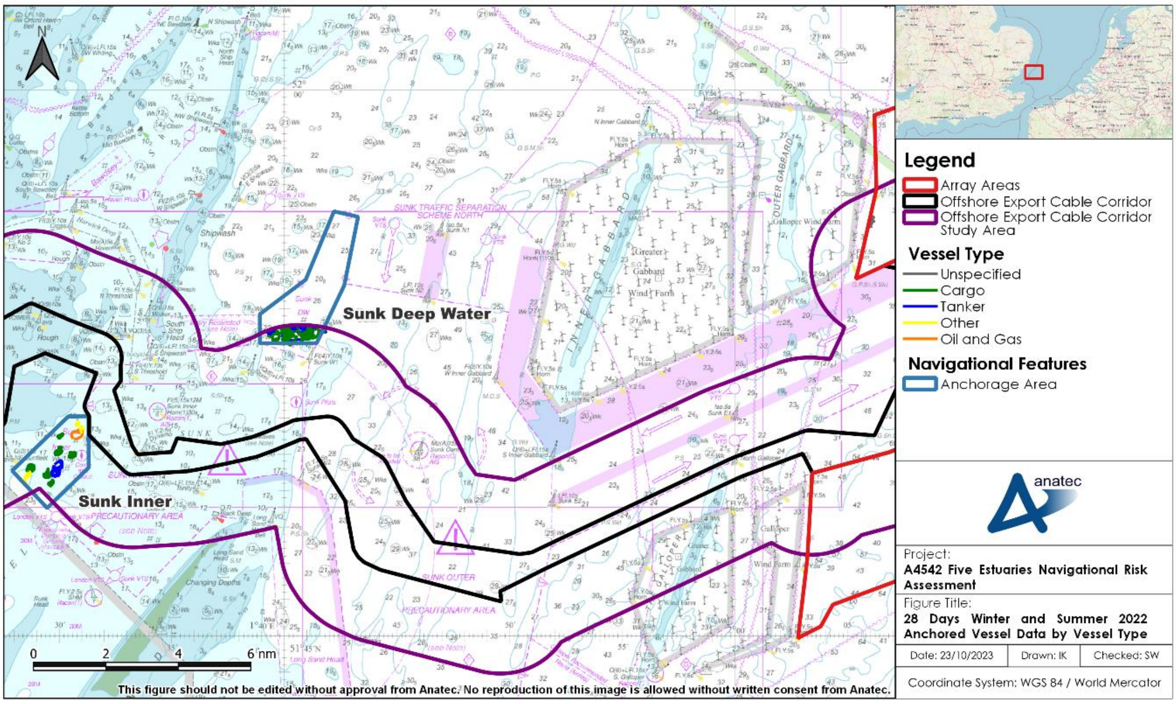

Figure 10.37 28 Days Winter and Summer Anchored Vessel Data by Vessel Type (Offshore ECC)

272. Almost all vessels deemed to be at anchor within the offshore ECC study area during the survey periods were cargo vessels (61%) and tankers (29%). Vessels typically anchored in the two designated anchorages in proximity to the offshore ECC, namely the Sunk DW and Inner Sunk anchorages. Vessels anchoring in the Sunk DW anchorage were typically of greater length (on average 257 m) than those using the Sunk Inner anchorage (112 m).

273. Given the extent of the offshore ECC study area, Figure 10.37 only shows anchored vessels within the Sunk DW anchorage that interact with the offshore ECC study area. However, vessels do anchor within the full extent of this designated anchorage area.

10.2.4 Vessel Size

10.2.4.1 Vessel Length

274. Vessel length was available for more than 99% of vessels recorded throughout the two 14-day survey periods and ranged from 5 m for a sailing vessel to 400 m for a

container vessel. The distribution of vessel lengths recorded within the offshore ECC study area throughout each survey period is presented in Figure 10.38.

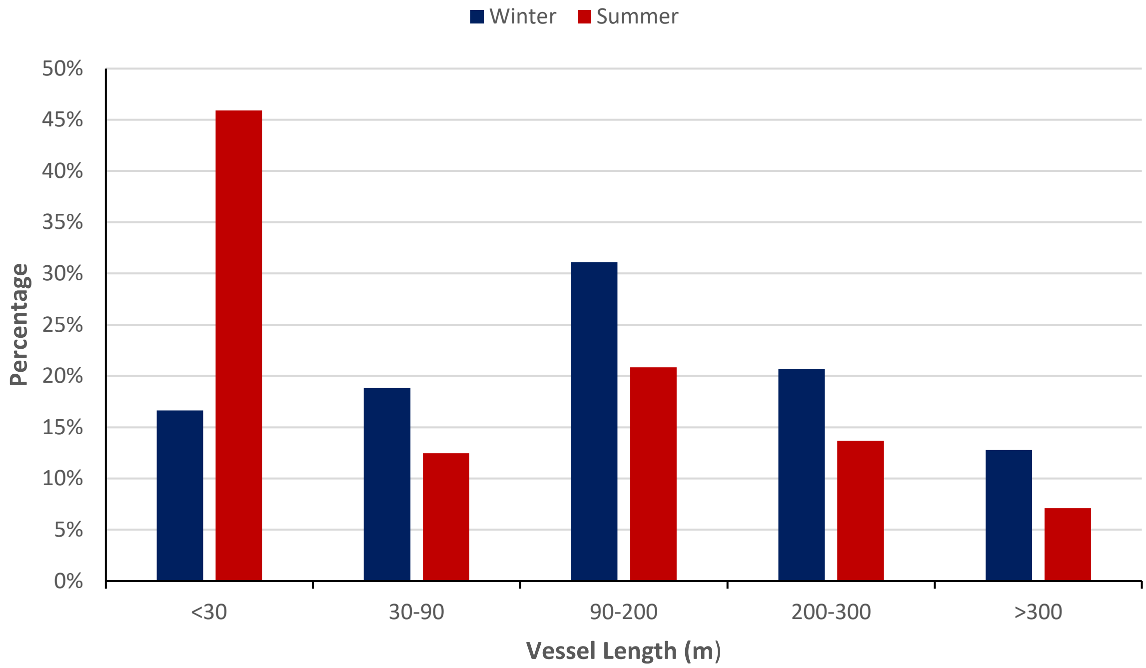

Figure 10.38 Vessel Length Distribution in the Offshore ECC

275. Excluding the proportion of vessels for which length was not available, the average length of vessels within the offshore ECC traffic study area throughout the winter and summer survey periods was 156 and 107 m respectively. The difference in average vessel length between the two survey periods may be attributed to the greater presence of small recreational vessels in the summer period.

276. Figure 10.39 presents a plot of the vessel tracks recorded throughout the survey periods, colour-coded by vessel length.

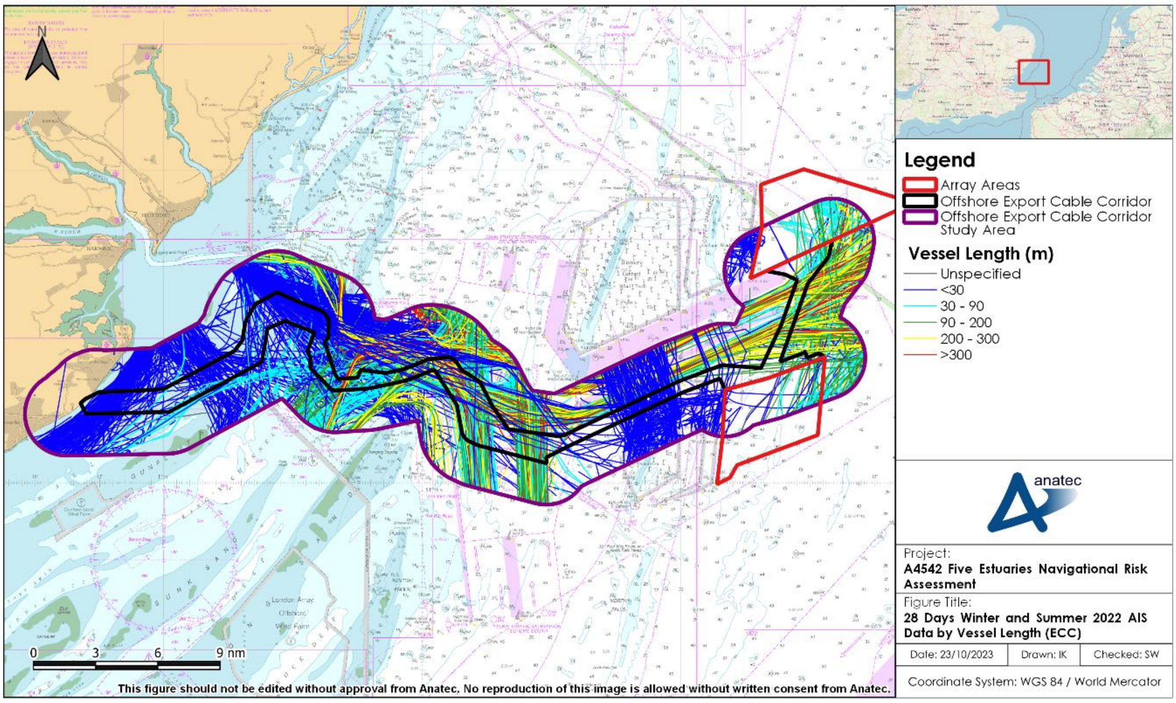

Figure 10.39 28 Days Winter and Summer 2022 AIS Data by Vessel Length (Offshore ECC)

277. Vessels of smaller length were primarily located close to shore, and were largely composed of fishing, pilot, and recreational vessels that steered from the Sunk routeing measure. The larger vessels were recorded utilising the Sunk routeing measure and comprised commercial vessels, with the largest of these being cargo vessels and tankers. Vessels over 300 m in length were typically recorded using the Harwich Deep Water Channel and Sunk deep water route.

10.2.4.2 Vessel Draught

Vessel Traffic Data

278. Vessel draught was available for approximately 82% of vessels recorded throughout the two 14-day survey periods and ranged from 0.9 m for a wind farm support vessel to 15.7 m for two container vessels. The distribution of vessel draughts recorded within the offshore ECC study area throughout each survey period is presented in Figure 10.38.

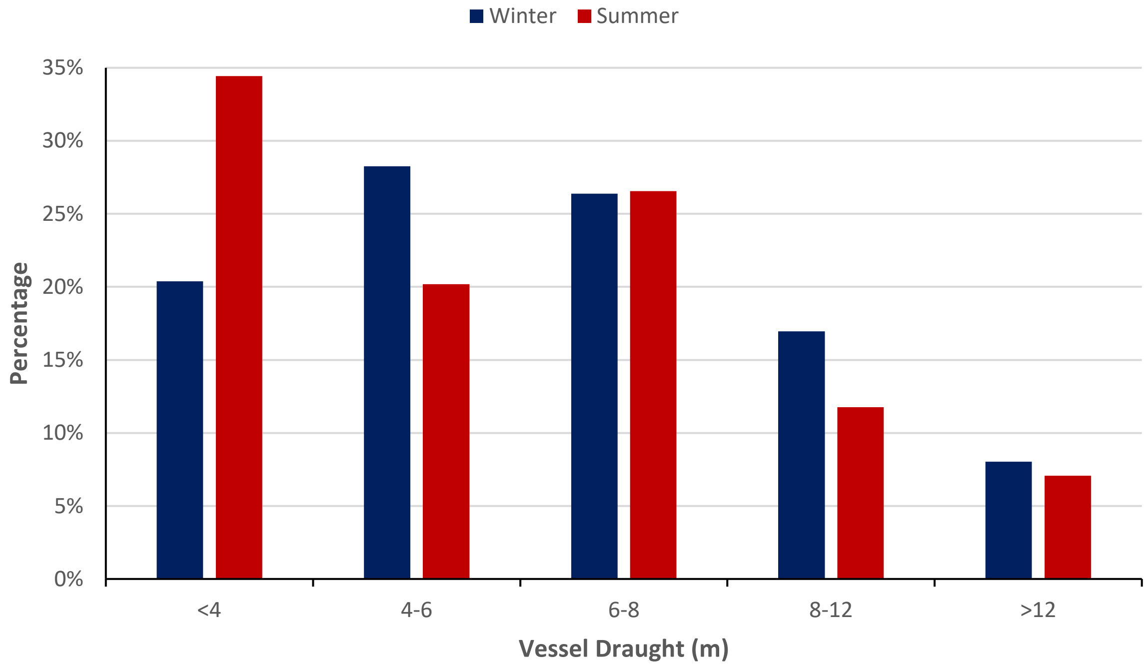

Figure 10.40 Vessel Draught Distribution in the Offshore ECC

279. Excluding the proportion of vessels for which draught was not available, the average draught of vessels within the array traffic study area throughout the winter and summer survey periods was 6.9 and 6.8 m respectively. The difference in average vessel draught between the two survey periods may be attributed to the greater presence of small recreational vessels in the summer period. The greatest vessel draught recorded was 15.7 m, associated with two container vessels utilising the Harwich Deep Water Channel.

280. Figure 10.41 presents a plot of the vessel tracks recorded throughout the survey periods, colour-coded by vessel draught, with this figure zoomed to the deep water routes in the Sunk Inner Precautionary Area in Figure 10.42.

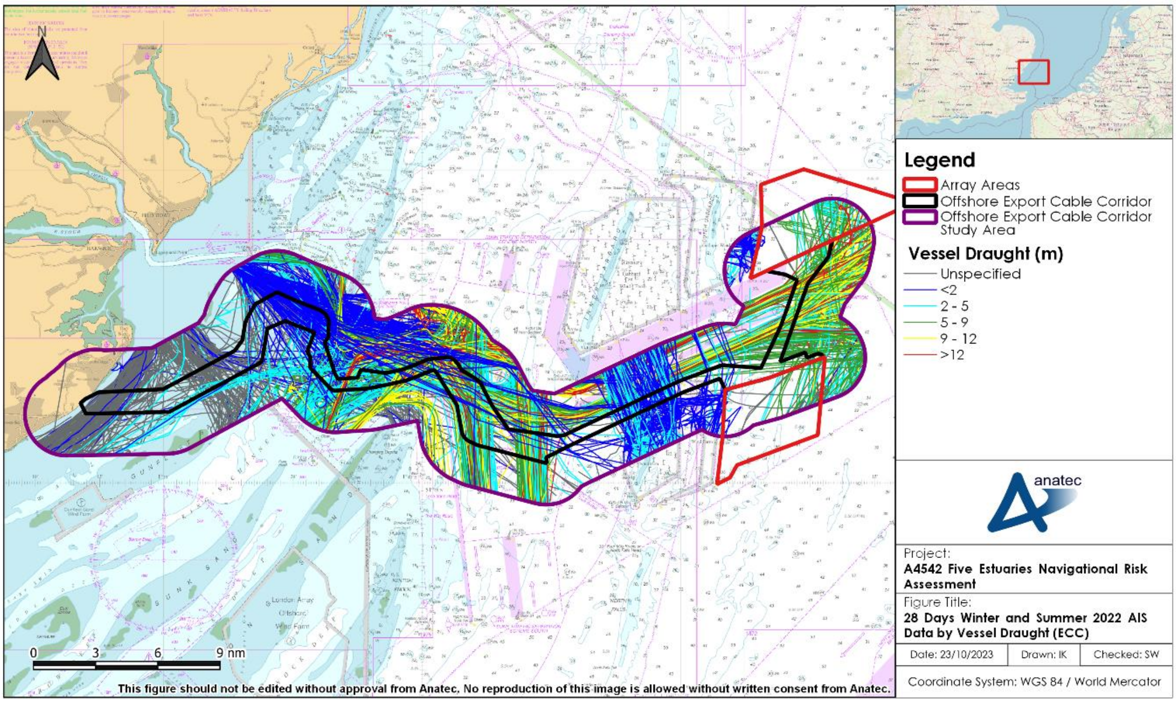

Figure 10.41 28 Days Winter and Summer 2022 AIS Data by Vessel Draught (Offshore ECC)

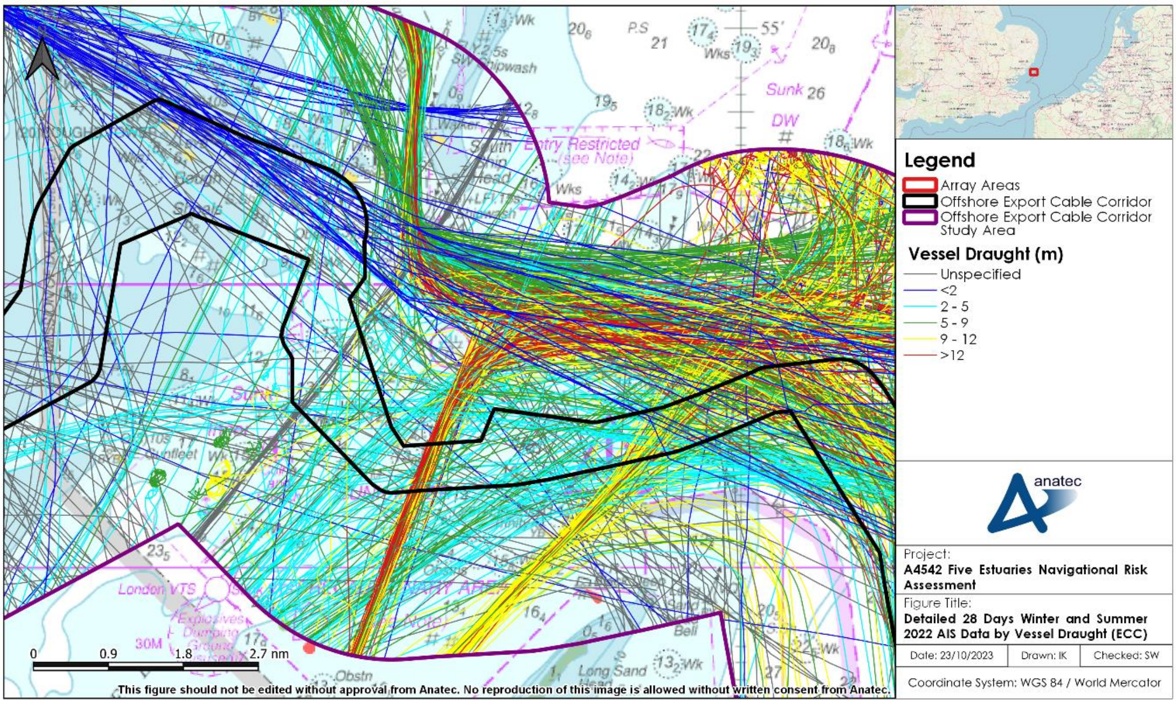

Figure 10.42 Detailed 28 Days Winter and Summer 2022 AIS Data by Vessel Draught (Offshore ECC)

281. As with vessel length, vessels of smaller draught tended to transit closer to shore, with the commercial vessels of larger draughts utilising the deep water routes within the Sunk Inner Precautionary Area.

Long-Term Vessel Traffic Data

282. Following PEIR, long-term vessel traffic data recorded via AIS has been considered within the Sunk Inner and Outer Precautionary Areas, including in relation to vessel draught. Figure 10.43 presents a plot of the vessel tracks recorded within the Sunk offshore ECC study area, colour-coded by vessel draught. Following this, Figure 10.44 presents a plot of the vessel tracks associated with vessels greater than 12 m draught, colour-coded by vessel type.

283. In both Figure 10.43 and Figure 10.44 the DWRs (inclusive of the Harwich DW Channel) are shown for context (see Section 7.3.3).

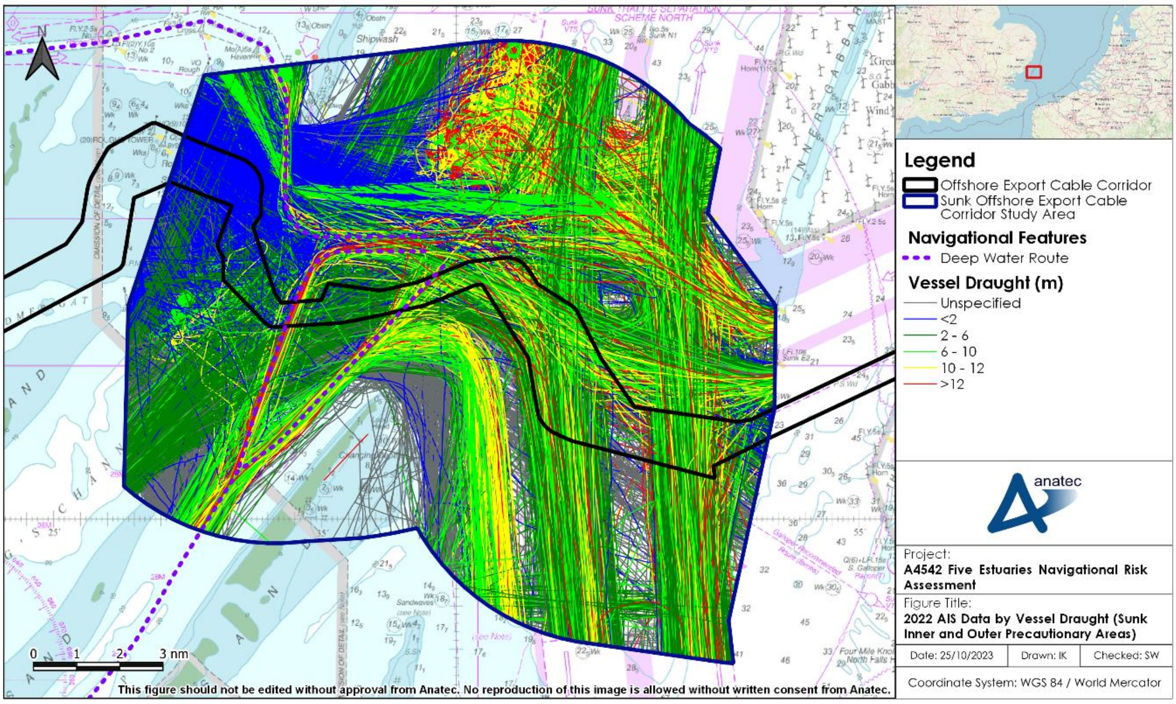

Figure 10.43 2022 AIS Data by Vessel Draught (Sunk Inner and Outer Precautionary Areas)

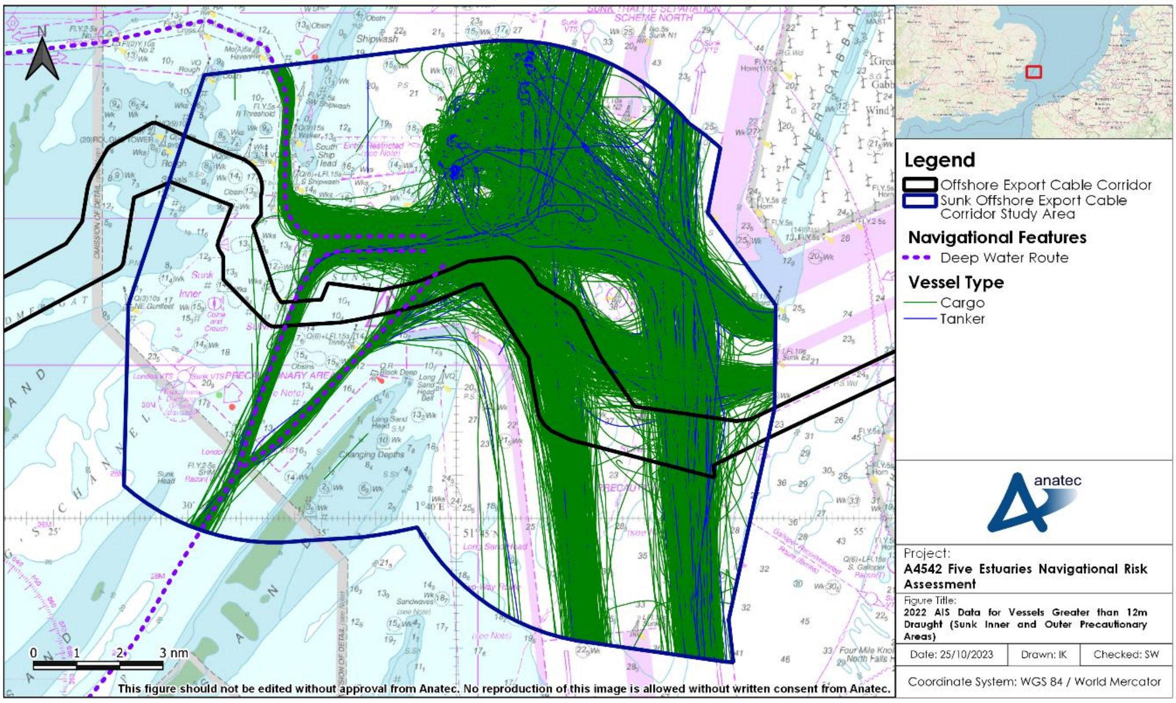

Figure 10.44 2022 AIS Data for Vessels Greater than 12 m Draught (Sunk Inner and Outer Precautionary Areas)

284. The pattern of vessel traffic movements is highly constrained by vessel draught. Within the Sunk Outer Precautionary Area movements by deeper draught vessels conform to the lanes of the surrounding TSSs which a vessel in transit has exited and/or is entering. Within the Sunk Inner Precautionary Area there is clear and regular use of the deep water routes and Harwich Deep Water Channel by commercial vessels, particularly deeper draught vessels (which are primarily container vessels). The Sunk deep water route is used more regularly than the Trinity deep water route, and this has been confirmed by London Gateway during consultation.

285. Given that the offshore ECC crosses the Sunk and Trinity deep water routes, a gate analysis[5] has been undertaken to identify vessel traffic as users of each of these routes. The distribution of vessel draughts for each deep water route is presented in Figure 10.45.

[5] The gate for the Sunk deep water route was positioned at the Dynamo special mark and for the Trinity deep water route was positioned at the Trinity south cardinal mark.

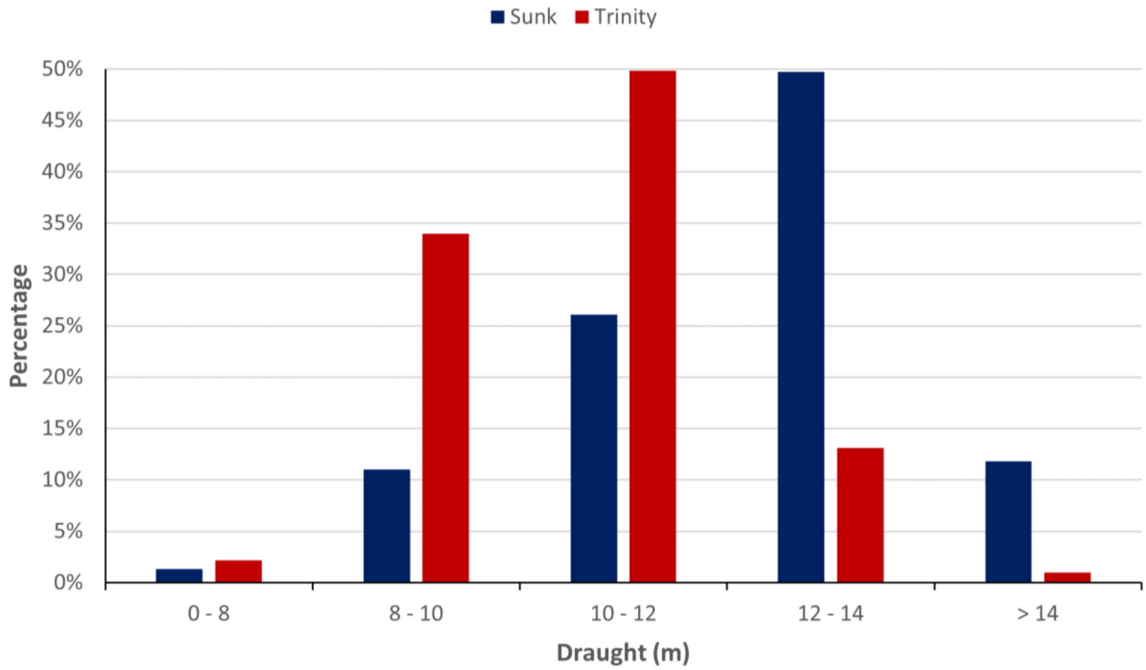

Figure 10.45 Draught Distribution on Vessels through the Sunk and Trinity Gates

286. For users of the Sunk deep water route, the maximum vessel length was 400 m and maximum draught was 16.1 m, although only two vessels broadcast a draught of at least 16 m. The majority of vessels were between 250 and 350 m length and 12 and 14 m draught.

287. For users of the Trinity deep water route, the maximum vessel length was 399 m and maximum draught was 14.4 m, although only 1% vessels broadcast a draught of at least 14 m. The majority of vessels were up to 250 m length and under 12 m draught.

288. From this analysis, it is inferred that the largest vessels generally utilise the Sunk deep water route rather than the Trinity deep water route, and local ports have confirmed this to be the case during consultation in which this data has been presented.

11 Base Case Vessel Routeing

11.1 Definition of a Main Commercial Route

289. Main commercial 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. The route width is then calculated using the 90th percentile rule from the mean line of the potential shipping route as shown in Figure 11.1. Additionally, the outputs of consultation undertaken with local stakeholders has assisted in the identification of the main commercial routes.

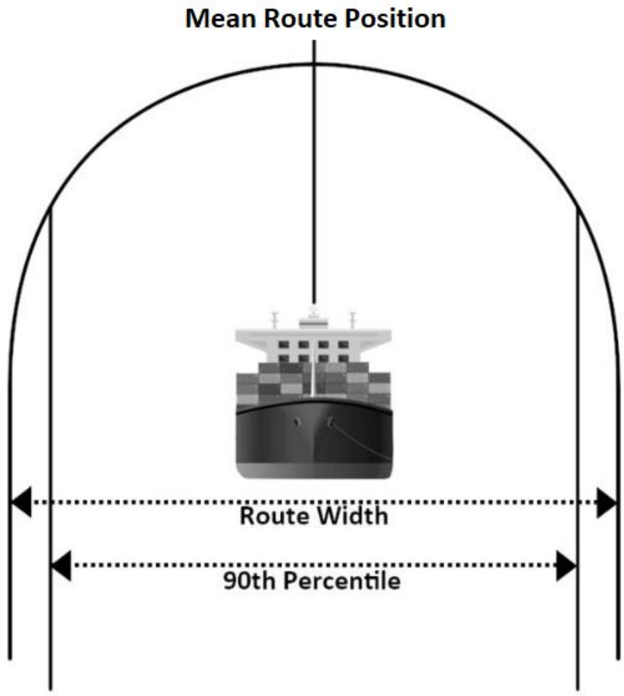

Figure 11.1 Illustration of Main Route Calculation

11.2 Pre Wind Farm Main Commercial Routes

290. A total of 26 main commercial routes were identified within the array routeing study area from the long-term vessel traffic dataset, winter, and summer 2022 vessel traffic survey data, and consultation.

291. For clarity, these routes have been grouped based on traffic volumes, but with the vessel traffic density associated with all routeing included in each case. The high use vessel routes (more than five transits per day) are presented in Figure 11.2 relative to the array routeing study area and described in Table 11.1. The medium use (two to five transits per day) and low use (one to two transits per day) are similarly presented in Figure 11.3 and Figure 11.4, respectively, and described in Table 11.2

and Table 11.3, respectively. The average vessels per day has been rounded to the nearest whole number for each route.

292. Routes with less than one transit per day are not characterised as main routes and have not been included in the following figures. However, they are accounted for in the collision and allision risk modelling (see Section 16) and the safety case for the navigation corridor between VE and East Anglia Two (see Section 17).

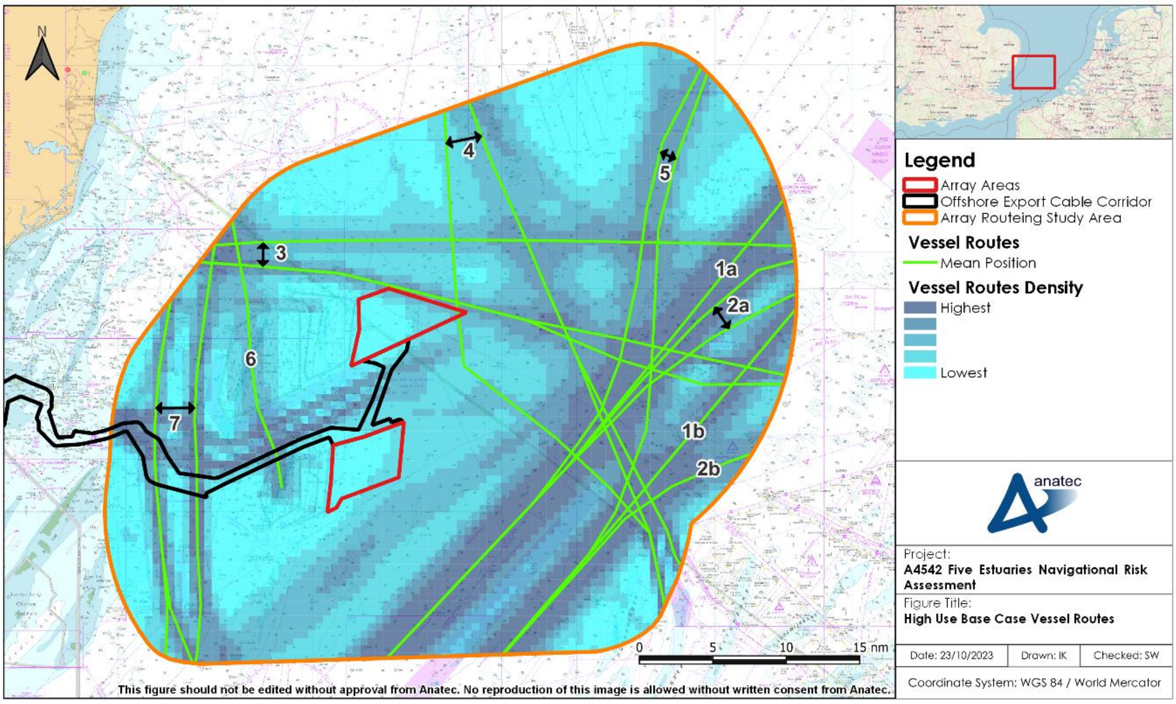

Figure 11.2 High Use Base Case Vessel Routes

Table 11.1 Description of High Use Main Commercial Routes

Route Number	Average Vessels per Day	Description
1	30	**Port of Amsterdam (Netherlands) – Dover Strait**. Generally used by cargo vessels (74%). Route 1a is eastbound only and Route 1b is westbound only.
2	22	**Dover Strait – Port of Rotterdam (Netherlands).** Used by cargo vessels (59%) and tankers (38%). Route 2a is westbound only and Route 2b is eastbound only, with the latter passing north and south of the NHR buoy.
3	11	**Harwich Haven (UK) – Port of Rotterdam (Netherlands).** Generally used by cargo vessels (77%) including DFDS Seaways and Stena Line operated Ro-Ro services between the Port of Felixstowe and the Port of Rotterdam, and between Harwich Haven and the Port of Rotterdam respectively. This route also includes a Stena Line-operated Ro-Pax service between Harwich Haven and the Port of Rotterdam. The eastbound variant passes parallel to the northern array area whereas the westbound variant passes further north.

Route Number	Average Vessels per Day	Description
4	9	**Port of Hull (UK) – Port of Zeebrugge (Belgium).** Used by cargo vessels (50%) and passenger vessels (43%), including a CLdN-operated Ro-Ro services between Killingholme Port and the Port of Zeebrugge, and P&O Ferries-operated Ro-Ro services between the Port of Tilbury and Port of Zeebrugge, and between Teesport and the Port of Zeebrugge. Route 4a is north and southbound whereas Route 4b is southbound only.
5	7	**Dover Strait – North Europe Ports.** Used by cargo vessels (44%) and tankers (53%).
6	7	**Port of Lowestoft (UK) – Greater Gabbard OWF.** Only used by wind farm vessels (100%).
7	6	**Dover Strait – Humber Ports (UK).** Generally used by cargo vessels (68%).

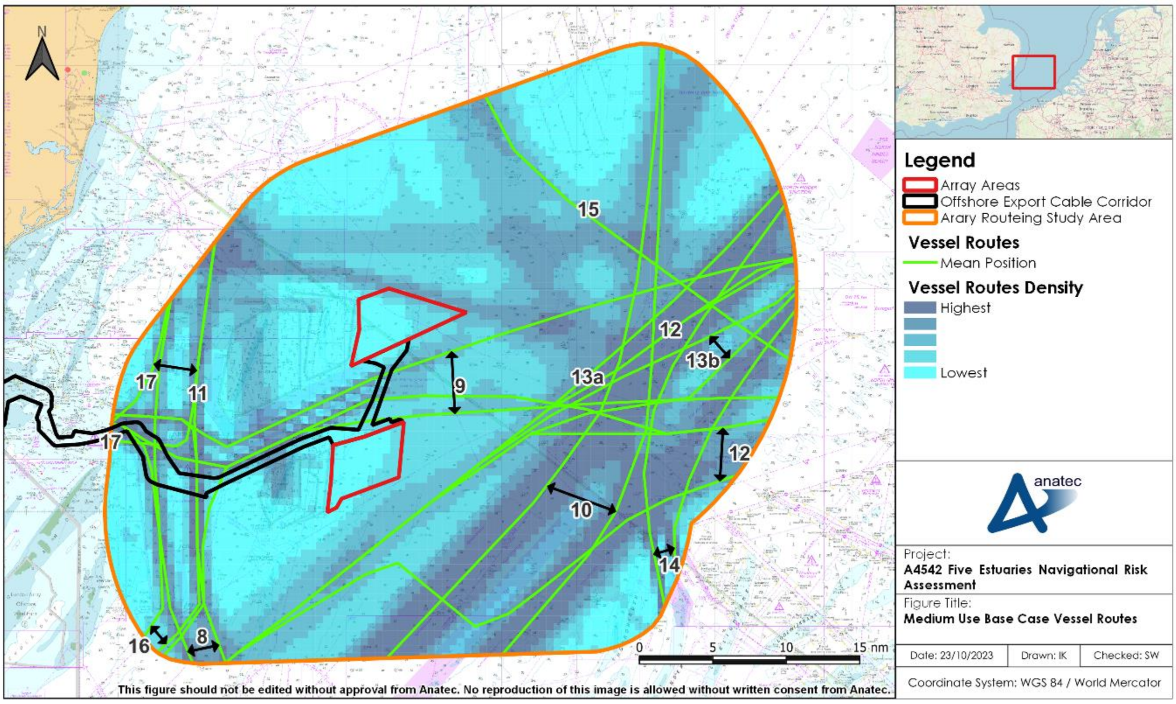

Figure 11.3 Medium Use Base Case Vessel Routes

Table 11.2 Description of Medium Use Main Commercial Routes

Route Number	Average Vessels per Day	Description
8	5	**Port of Antwerp (Belgium) – London Gateway (UK).** Generally used by cargo vessels (92%).

Route Number	Average Vessels per Day	Description
9	5	**Port of Rotterdam (Netherlands) – Sunk TSS.** Generally used by cargo vessels (86%) including CLdN and DFDS Seaways-operated Ro-Ro services between the Port of Felixstowe and Vlissingen East, and between Dagenham Dock and Vlissingen East, respectively. This route also includes a Stena Line-operated Ro-Pax service between Harwich Haven and the Port of Rotterdam.
10	4	**Dover Strait – Port of Immingham (UK).** Used by tankers (51%) and cargo vessels (37%).
11	3	**Port of Antwerp (Belgium) – Humber Ports (UK).** Generally used by cargo vessels (70%).
12	3	**Port of Rotterdam (Netherlands) – Thames/Medway Ports (UK).** Generally used by cargo vessels (72%).
13	3	**German Ports – Thames/Medway Ports (UK).** Generally used by cargo vessels (84%). Route 13a is westbound only and Route 13b is eastbound only and includes transits both north and south of the Euro West spherical buoy.
14	3	**Port of Bremerhaven (Germany) – Port of Zeebrugge (Belgium).** Generally used by cargo vessels (85%).
15	2-3	**Port of Ghent (Belgium) – Port of Immingham (UK).** Used by cargo vessels (63%) and tankers (30%).
16	2	**Humber Ports (UK) – Thames/Medway Ports (UK).** Used by wind farm vessels (50%) and cargo vessels (34%).
17	1-2	**Humber Ports (UK) – Thames/Medway Ports (UK).** Used by cargo vessels (73%).

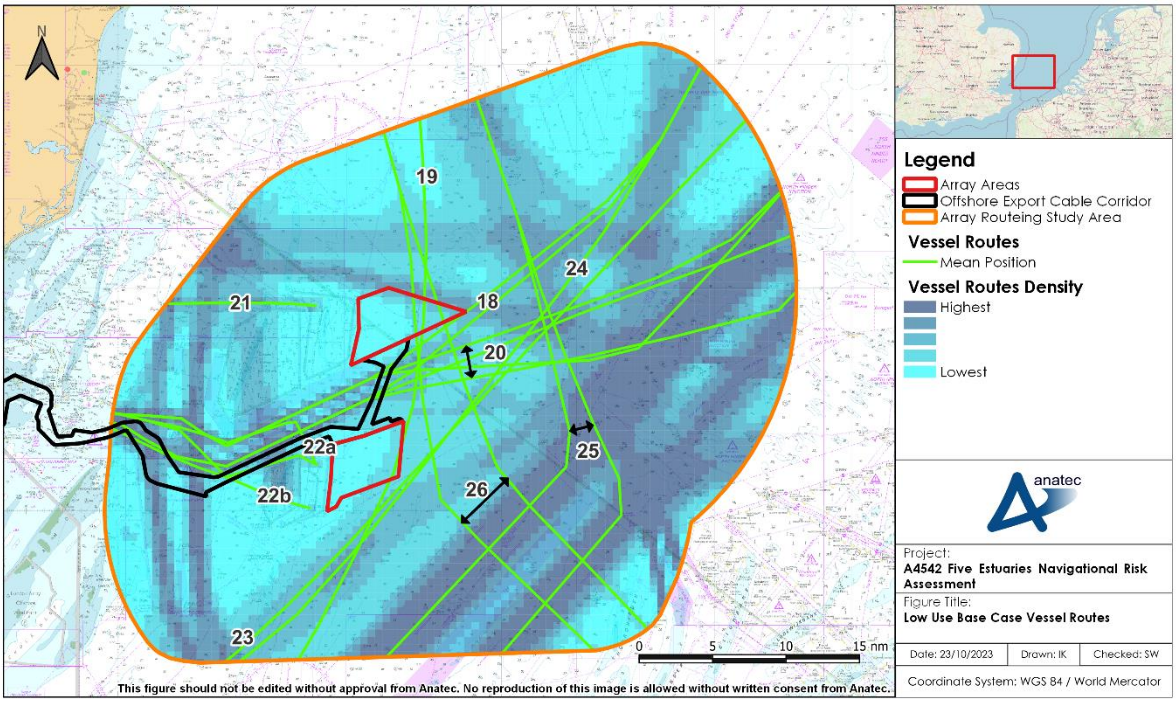

Figure 11.4 Low Use Base Case Vessel Routes

Table 11.3 Description of Low Use Main Commercial Routes

Route Number	Average Vessels per Day	Description
18	1-2	**Port of Bremerhaven (Germany) – Sunk TSS.** Used by cargo vessels (67%) and tankers (29%).
19	1-2	**Dover Strait – Port of Immingham (UK).** Used by cargo vessels (53%) and tankers (33%).
20	1-2	**Port of Hamburg (Germany) – Sunk TSS.** Generally used by cargo vessels (90%).
21	1-2	**Galloper OWF – Harwich Haven (UK).** Only used by wind farm vessels (100%).
22	1-2	**Galloper OWF – Harwich Haven (UK).** Only used by wind farm vessels (100%). Route 22a approaches Galloper via the Sunk TSS East and Route 22b approaches Galloper from the west.
23	1	**Port of Amsterdam (Netherlands) – Thames/Medway Ports (UK).** Generally used by cargo vessels (80%).
24	1	**Baltic Ports – Thames/Medway Ports (UK).** Used by cargo vessels (54%) and tankers (41%).
25	1	**Dover Strait – Port of Immingham (UK).** Used by tankers (62%) and cargo vessels (32%).
26	1	**Port of Grimsby (UK) – Port of Zeebrugge (Belgium).** Generally used by cargo vessels (83%).

12 Adverse Weather Routeing

293. Some vessels and vessel operators currently operate alternative routes infrequently during periods of adverse weather after considering weather forecasts, as part of the passage planning process required by Chapter V of the International Convention for the Safety of Life at Sea (SOLAS) Chapter V (IMO, 1974). This section focuses on vessel movements in adverse weather given the implications if a commercial vessel is unable to make passage or a small craft is unable to access safe havens in adverse weather due to the presence of the development or activities associated with the development.

294. Adverse weather includes wind, wave, and tidal conditions as well as reduced visibility due to fog that can hinder a vessel's standard route, speed of navigation and/or ability to enter the destination port. 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 the actual stability parameters, hull geometry, vessel type, vessel size and speed.

12.1 Identification of Periods of Adverse Weather

295. Historical weather information provided by the Met Office (Met Office, 2019) has been used to identify periods of adverse weather during 2019 (the year covered by the long-term vessel traffic data) when routes in proximity to VE could be considered most likely to be altered or cancelled. The key weather events identified are detailed in Table 12.1.

Table 12.1 Key Weather Events During 2019 Relevant to Five Estuaries (Met Office)

Weather event	Date(s)	Details
Storm Erik	8 to 9 February 2019	Deep Atlantic low-pressure system which brought strong winds to the UK with much of the country recording gusts over 58 kt.
Storm Freya	3 to 4 March 2019	Strong winds and heavy rain in England, Wales, and southern Scotland.
Storm Gareth	10 to 16 March 2019	Turbulent week of very wet and windy weather.
Storm Hannah	26 to 27 April 2019	One of the most significant April storms in the last 50 years with exposed locations in west Wales recording gusts of over 60 kt.
Storm Lorenzo	3 October 2019	Followed a spell of wet weather in late September.

12.2 Commercial Routeing Changes in Adverse Weather Conditions

296. The long-term vessel traffic data has been used to identify potential commercial routeing activity related to adverse weather conditions within and in proximity to VE, with the periods outlined in Table 12.1 studied most closely.

12.2.1 Alternative Routeing

297. Two regularly routeing commercial vessels were observed undertaking alternative routeing characteristic of possible adverse weather routeing, with both vessels navigating between the Port of Grimsby/Port of Hull and the Port of Zeebrugge. Figure 12.1 and Figure 12.2 present plots of the vessel tracks recorded on AIS within the traffic study area throughout the survey period, respectively, colour-coded by possible adverse weather transits.

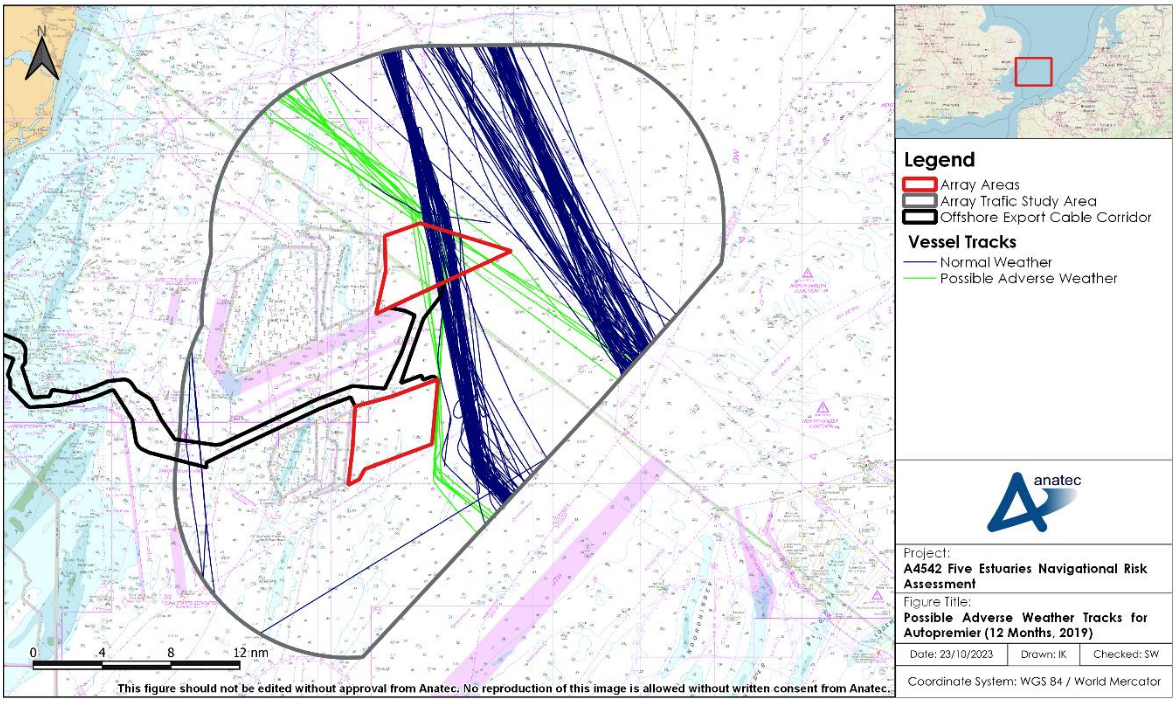

Figure 12.1 Possible Adverse Weather Tracks for *Autopremier* (2019)

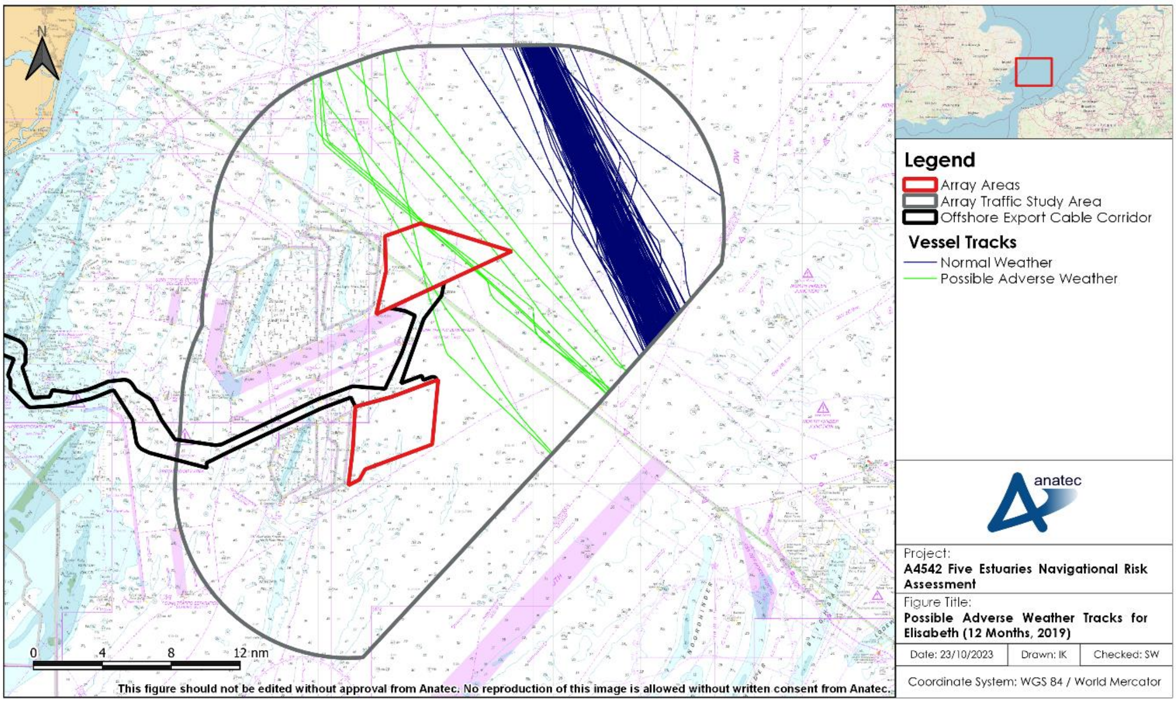

Figure 12.2 Possible Adverse Weather Tracks for *Elisabeth* (2019)

298. Standard routeing for the *Autopremier* and *Elisabeth* typically involves making passage either directly out of the Off North Hinder TSS or by crossing the North Hinder South TSS perpendicularly intersecting the northern array area (*Autopremier* only). However, there are a number of transits which head closer to the UK east coast, despite the destination broadcast on AIS remaining the Port of Grimsby.

299. For the *Autopremier* all such transits were northbound (8% of all transits across standard and adverse weather routeing) and for the *Elisabeth* almost all such transits were southbound (9% of all transits across standard and adverse weather routeing).

300. Comparing against the 28-day vessel traffic survey data (2022), neither of these vessels were detected navigating within the array traffic study area. Research confirms that the *Autopremier* has changed her name twice since the end of 2020 and has primarily operated in the Black Sea and Sea of Marmara during 2022. The *Elisabeth* has primarily operated on the UK South Coast and in the Irish Sea during 2022.

301. Although these vessels are no longer present in the region, they are nevertheless considered characteristic of possible adverse weather routeing in the future. To this end, the operators of both vessels (UECC and Holwerda) were included in the Regular Operator consultation (see Section 4) which included a particular request for information relating to adverse weather routeing (see Appendix C) but neither provided any feedback.

302. During consultation, CLdN noted that it is often the vessel Master's preference to alter routes taken during adverse weather including choosing to potentially 'hug' the coast. The UK Chamber of Shipping and DFDS Seaways confirmed that adverse weather routeing represents a very small proportion of all routeing in the region.

12.2.2 Cancelled Sailings

303. It is known that in extreme adverse weather regular commercial routeing can be cancelled entirely. Examples identified during the long-term vessel traffic data which coincided with periods of adverse weather identified in Table 12.1 include:

- *Pride of Bruges* and *Pride of York* between the Port of Hull and Port of Zeebrugge– 2 to 5 November 2019; and
- *Norstream* between the Port of Tilbury and Port of Zeebrugge – 3 and 4 November 2019.

304. The absence of these vessels suggests that their services were cancelled entirely due to adverse weather. It is noted that both the *Pride of Bruges* and *Pride of York* no longer operate the Port of Hull – Port of Zeebrugge Ro-Pax service provided at the time of the long-term vessel traffic data (BBC, 2020). The operator of all these vessels (P&O Ferries) was included in the Regular Operator consultation (see Section 4) and requested to be included in the circulation of the hazard log but have not provided any feedback to date.

12.3 Small Craft Use of Safe Havens

305. Both the long-term vessel traffic data and the 28-day vessel traffic survey data have been used to identify potential small craft use of safe havens related to adverse weather conditions in proximity to VE, with the periods outlined in Table 12.1 and fishing vessels and recreational vessels studied most closely. Additionally, the Admiralty Sailing Directions (UKHO, 2020) were reviewed for information relating to local safe havens.

306. From the research undertaken, no evidence of safe haven use has been observed and no concerns have been raised during consultation with recreational stakeholders (including the RYA and Cruising Association).

307. The final array layout will not be determined until post consent, but small craft will be able to safely navigate within the array areas in the majority of conditions should they choose to do so. As per SOLAS Chapter V (IMO, 1974), all vessels at sea are required to passage plan and part of the passage planning process requires them to consider forecast weather conditions. It is anticipated that vessels would then take account of these forecasts prior to embarking on a passage in proximity to the array areas.

13 Navigation, Communication, and Position Fixing Equipment

308. This section discusses the potential effects on the use of navigation, communication and position fixing equipment of vessels that may arise due to the infrastructure associated with VE. The following subsections use both desktop and in situ trials to assess the significance of risk.

13.1 Very High Frequency Communications (including Digital Selective Calling)

309. In 2004, trials were undertaken at the North Hoyle Offshore Wind Farm, 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 Digital Selective Calling (DSC)) when operated close to WTGs.

310. The WTGs had no noticeable effect on voice communications within the array 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 WTGs, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

311. During this trial, a number of telephone calls were made from ashore, both within and offshore of the array area. No effects were recorded using any system provider (MCA and QinetiQ, 2004).

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

313. 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, 2014).

314. 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 presence of VE is anticipated to have no significant impact upon VHF communications.

13.2 Very High Frequency Direction Finding

315. During the North Hoyle trials in 2004, the VHF Direction Finding (DF) equipment carried in the trial boats did not function correctly when very close to WTGs (within approximately 50 m). This is deemed to be a relatively small-scale impact due to the

limited use of VHF DF equipment and will not impact operational or SAR activities (MCA and QinetiQ, 2004).

316. Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King 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 array, at a range of approximately 1 nm, the homer system operated as expected with no apparent degradation.

317. Since the trials detailed above, no significant issues with regards to VHF DF have been observed or reported, and therefore the presence of VE is anticipated to have no significant impact upon VHF DF equipment.

13.3 Automatic Identification System

318. No significant issues with interference to AIS transmission from operational OWFs have been observed or reported to date. Such interference was also absent in the trials carried out at North Hoyle (MCA and QinetiQ, 2004).

319. 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 notable impact is anticipated due to the presence of VE.

13.4 Navigational Telex System

320. 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.

321. There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518 kHz 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.

322. The 490 kHz 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.

323. 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 presence of VE.

13.5 Global Positioning System

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

325. 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).

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

13.6 Electromagnetic Interference

327. 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.

328. 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 is important that potential impacts from Electromagnetic Field (EMF) are minimised to ensure continued safe navigation.

329. The vast majority of commercial traffic uses non-magnetic gyrocompasses as the primary means of navigation, which are unaffected by EMF. Therefore, it is considered highly unlikely that any interference from EMF as a result of the presence of VE will have a significant impact on vessel navigation. However, some smaller craft (fishing or leisure) may rely on it as their sole means of navigation.

13.6.1 Subsea Cables

330. The subsea cables for VE will be Alternating Current (AC), with studies indicating that AC does not emit an EMF significant enough to impact marine magnetic compasses (Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR), 2008). Therefore, electromagnetic interference due to cables associated with VE are not considered any further.

13.6.2 Wind Turbine Generators

331. MGN 654 (MCA, 2021) notes that small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to WTGs as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ, 2004). Potential effects are deemed to be within acceptable levels when considered alongside other mitigation such as the mariner being able to make visual observations (not wholly reliant on the magnetic compass), lighting, sound signals and identification marking in line with MGN 654.

13.6.3 Experience at Operational Offshore Wind Farms

332. No issues with respect to magnetic compasses have been reported to date in any of the trials (MCA and QinetiQ, 2004) undertaken (inclusive of SAR helicopters) nor in any published reports from operational OWFs.

13.7 Marine Radar

333. This section summarises the results of 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, WTG technology has advanced significantly, most notably in terms of the size of WTGs available to be installed and utilised. The use of these larger WTGs allows for a greater spacing between WTGs 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.

13.7.1 Trials

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

335. In 2004 trials undertaken at North Hoyle (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 WTGs (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).

336. 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 1.5 nm) 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 13.1.

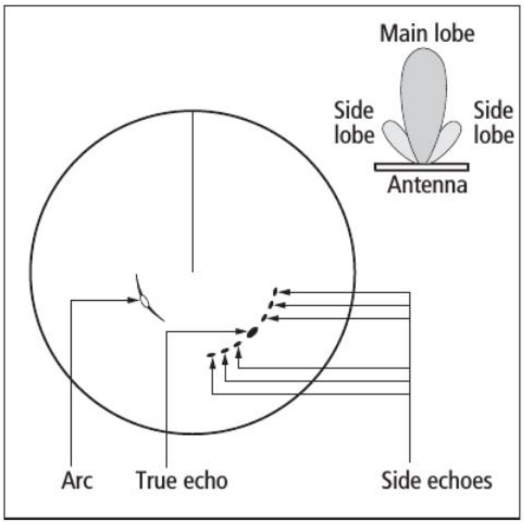

Figure 13.1 Illustration of Side Lobes on Radar Screen

337. 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 13.2.

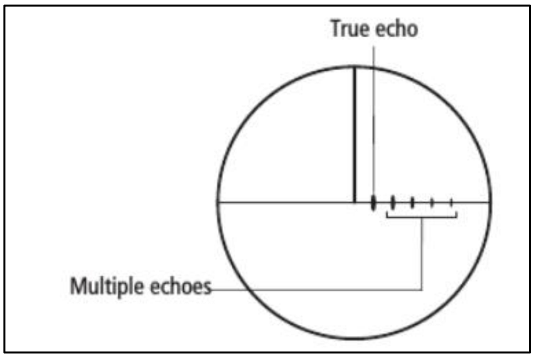

Figure 13.2 Illustration of Multiple Reflected Echoes on Radar Screen

338. Based on 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. However, as experience of effects associated with use of marine Radar in proximity to OWFs grew, the MCA refined their guidance, offering more flexibility within the most recent Shipping Route Template contained within MGN 654 (MCA, 2021).

339. A second set of trials conducted at Kentish Flats Offshore Wind Farm 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.

340. Theoretical modelling of the effects of the development of the proposed Atlantic Array Offshore Wind Farm, which was to be located off the south coast of Wales, on marine Radar systems was undertaken by the Atlantic Array project (Atlantic Array, 2012) and considered a wider spacing of WTGs than that considered within the early trials[6]. 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 WTGs and safe navigation;
- Even in the worst case with Radar operator settings artificially set to be poor, there is significant clear space around each WTG 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 WTGs 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 WTGs 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 (those without AIS installed which are usually fishing and recreational craft). It is noted that this situation would arise with or without WTGs 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.

341. 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

[6] It is acknowledged that other theoretical analysis has been undertaken.

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*".

342. 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 13.1 are based on MGN 654 (MCA, 2021), MGN 371 (MCA, 2008), MGN 543 (MCA, 2016) and MGN 372 (MCA, 2022).

Table 13.1 Distances at which Impacts on Marine Radar Occur

Distance at Which Effect Occurs (nm)	Identified Effects
0.5	▪ Intolerable impacts can be experienced. ▪ X-Band Radar interference is intolerable under 0.25 nm. ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45 nm.
1.5	▪ Under MGN 654, impacts on Radar are considered to be tolerable with mitigation between 0.5 and 3.5 nm. ▪ S-band Radar interference starts at 1.5 nm. ▪ Echoes develop at approximately 1.5 nm, with progressive deterioration in the Radar display as the range closes. Where a main vessel route passes within this range considerable interference may be expected along a line of WTGs. ▪ The WTGs produce strong Radar echoes giving early warning of their presence. ▪ Target size of the WTG echo increases close to the WTG with a consequent degradation on both X and S-Band Radars.

343. As noted in Table 13.1, the onset range from the WTGs of false returns is approximately 1.5 nm, 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 (IMO, 1972/77). 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 VTS or AIS (MCA, 2016).

13.7.2 Experience from Operational Developments

344. The evidence from mariners operating in proximity to existing OWFs is that they quickly learn to adapt to any effects. Figure 13.3 presents the example of the nearby

Greater Gabbard and Galloper, which are located in proximity to the Sunk routeing measure and directly west of the array areas. Despite this proximity to moderately 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 13.3 are as per Table 13.1.

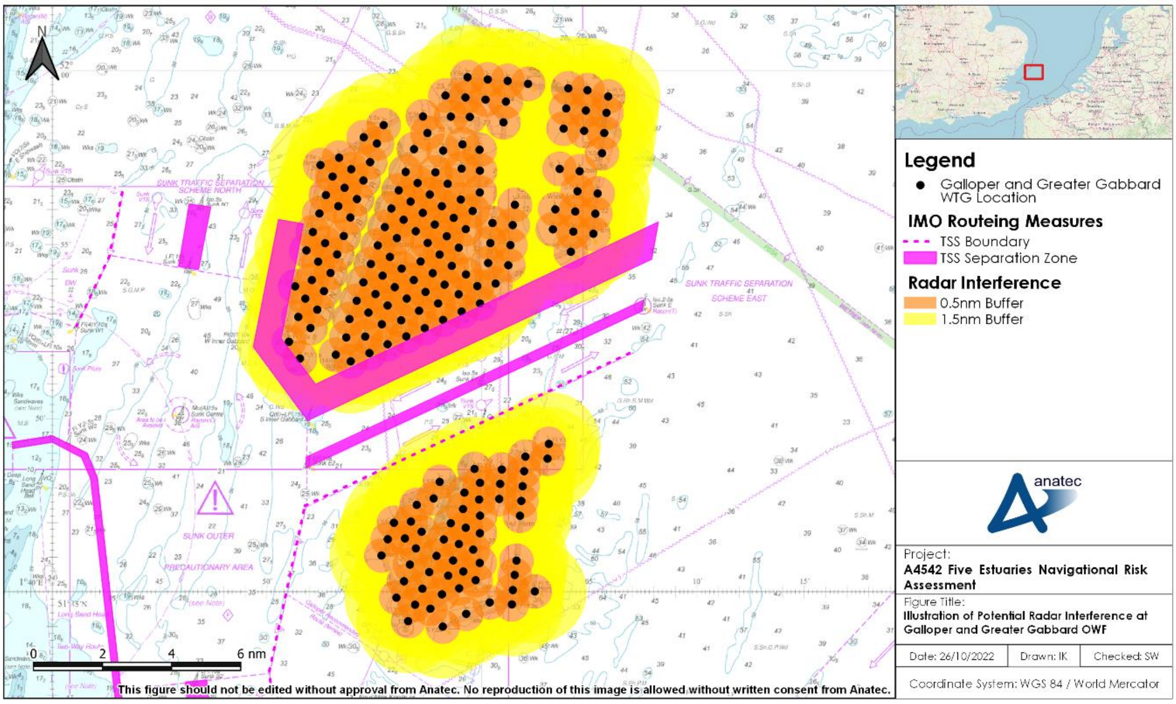

Figure 13.3 Illustration of Potential Radar Interference at Galloper and Greater Gabbard OWFs

345. As indicated by Figure 13.3, vessels utilising these TSS lanes will experience some Radar interference based on the available guidance. Both developments are operational, and the lanes are used by a minimum of eight 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.

346. AIS information can also be used to verify the targets of larger vessels (generally vessels over 15 m LOA – the minimum threshold for fishing vessel AIS carriage requirements). Approximately 2% of the vessel traffic recorded within the array traffic study area was under 15 m LOA, although throughout the vessel traffic surveys approximately 97% of vessel tracks were recorded on AIS, indicating a high level of AIS take-up among vessels for which AIS carriage is not mandatory.

347. 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.

13.7.3 Increased Radar Returns

348. 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.

349. Larger WTGs (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, and at closer distances this five-degree width would be much further limited. Therefore, increased WTG height in the array will not create any effects in addition to those already identified from existing operational wind farms (interfering side lobes, multiple and reflected echoes). Additionally, the level and way Radar returns occur is not expected to differ significantly for different foundation types (i.e., monopiles and jacket foundations).

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

13.7.4 Fixed Radar Antenna Use in Proximity to an Operational Wind Farm

351. 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.

13.7.5 Application to Five Estuaries in Isolation Scenario

352. Upon development of VE, some commercial vessels may pass within 1.5 nm of the wind farm structures 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.

353. Figure 13.4 presents an illustration of potential Radar interference due to VE. The Radar effects have been applied to the indicative array layout introduced in Section 6 and the as built layouts for Greater Gabbard and Galloper.

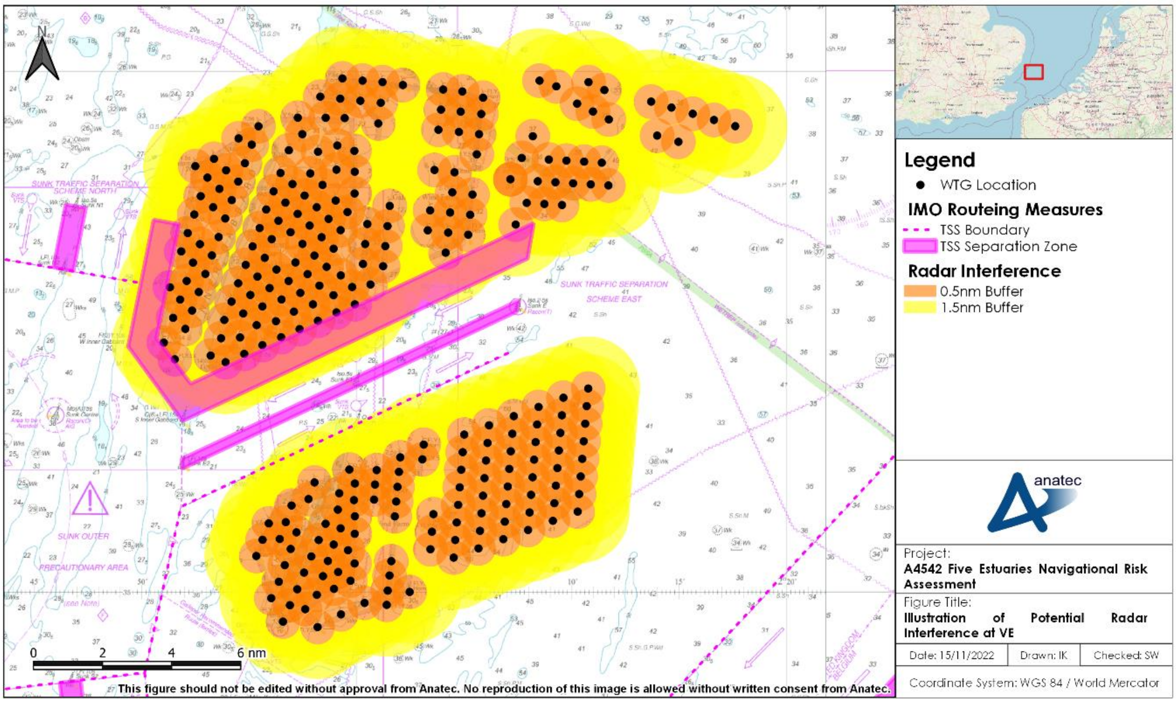

Figure 13.4 Illustration of Potential Radar Interference of VE

354. Vessels passing within the array will be subject to a greater level of interference with impacts becoming more substantial in close proximity to WTGs. This will require additional mitigation by any vessels including consideration of the navigational conditions (visibility) when passage planning and compliance with the COLREGs (IMO, 1972/77) will be essential.

355. Overall, the impact on marine Radar due to VE in isolation (with existing developments) is expected to be low and no further impact upon navigational safety is anticipated outside the parameters which can be mitigated by operational controls.

13.7.6 Application to Cumulative Scenario

356. Figure 13.5 presents an illustration of potential Radar interference due to VE alongside nearby cumulative offshore wind farm developments (North Falls and East Anglia Two). The Radar effects have again been applied to the indicative array layout introduced in Section 6 and as built layouts for Greater Gabbard and Galloper. As a worst case, full build out of nearby cumulative offshore wind farm developments is assumed.

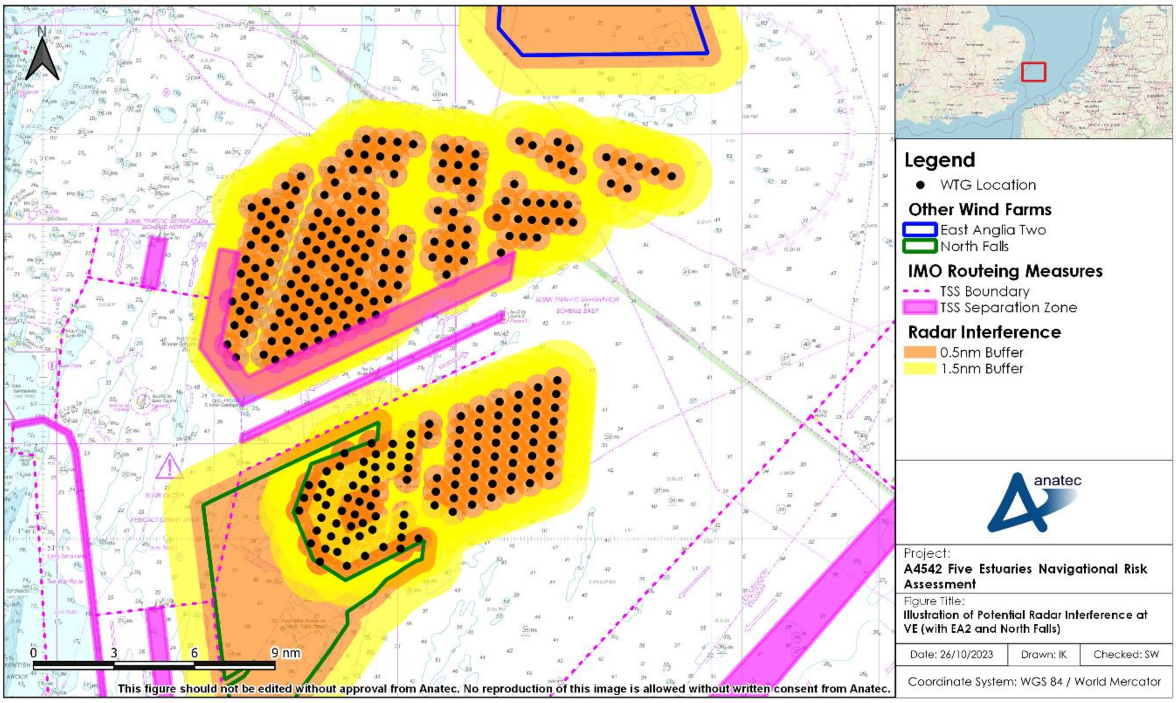

Figure 13.5 Illustration of Potential Radar Interference of VE (with EA2 and North Falls)

357. Vessels passing through the navigation corridor between the northern array area and East Anglia Two will likely be subject to a greater level of interference, although there is no overlap of the 1.5 nm buffer from each array. The additional mitigation outlined in Section 13.7.5 for VE in isolation will again be applicable to corridor users. A safety case for the corridor has been undertaken in Section 17.

358. Similarly, vessels utilising the Sunk TSS East will likely be subject to a greater level of interference, although there is again no overlap of the 1.5 nm buffer from the various arrays, with the closest point occurring between Greater Gabbard and North Falls (i.e., not related to the presence of VE).

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

13.8 Sound Navigation Ranging Systems

360. 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 presence of VE.

13.9 Noise

361. No evidence has been found to date with regard to existing OWFs to suggest that prescribed sound signals are in any way impacted by acoustic noise produced by the wind farm.

13.10 Summary of Potential Effects on Use

362. Based on the detailed technical assessment of the effects due to the presence of VE on navigation, communication, and position fixing equipment in the previous subsections, Table 13.2 summarises the assessment of frequency and consequence and the resulting risk for each component of this hazard.

Table 13.2 Summary of Risk to Navigation, Communication, and Position Fixing Equipment

Topic	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VHF	Negligible	Minor	Broadly Acceptable
VHF DF	Extremely Unlikely	Minor	Broadly Acceptable
AIS	Negligible	Minor	Broadly Acceptable
NAVTEX	Negligible	Minor	Broadly Acceptable
GPS	Negligible	Minor	Broadly Acceptable
EMF	Extremely Unlikely	Negligible	Broadly Acceptable
Marine Radar	Remote	Minor	Broadly Acceptable
SONAR	Negligible	Minor	Broadly Acceptable
Noise	Negligible	Minor	Broadly Acceptable

363. On the basis of these findings, associated risks are screened out of the risk assessment (including cumulative) undertaken from Section 18.

14 Cumulative and Transboundary Overview

364. Cumulative risks have been considered for activities in combination and cumulatively with VE. This section provides an overview of the baseline used to inform the cumulative risk assessment including the pre wind farm vessel routeing and developments and proposed developments screened into the cumulative risk assessment based upon the criteria outlined in Section 3.3. Given the unique nature of shipping and navigation users the bespoke tiering system outlined in Section 3.3 has been applied.

365. The MCA have welcomed the 12 cumulative developments which have been screened in. It is noted that port developments (and specifically the subsequent changes in vessel traffic movements) are considered as part of the future case vessel traffic (see Section 15).

14.1 Screened in Other Developments

14.1.1 Offshore Wind Farms

366. In addition to VE, there are a number of other OWF developments located in the region. Table 14.1 includes details of these OWF developments, whether they are screened into the cumulative risk assessment and the cumulative tier applied (where applicable). The project statuses listed are as of November 2022.

367. As per the cumulative risk assessment methodology, any development greater than 50 nm from the array areas is not considered.

368. Figure 14.1 presents the locations of the OWF developments screened into the cumulative risk assessment alongside baseline developments.

Table 14.1 Cumulative Screening

Development	Development Type	Development Status	Closest Distance (nm)		Data Confidence	Cumulative Risk Assessment Screened In/Out	Cumulative Tier
			Array Areas	Offshore ECC			
Area 2101	Marine aggregate area	Tender area	Location TBC	Location TBC	Low	Screened out – insufficient information available	N/A
Area 2112	Marine aggregate area	Tender area	Location TBC	Location TBC	Low	Screened out – insufficient information available	N/A
Borssele I	OWF	Operational	29	31	High	Screened out – baseline	N/A
Borssele II	OWF	Operational	33	34	High	Screened out – baseline	N/A
Borssele III	OWF	Operational	27	28	High	Screened out – baseline	N/A
Borssele IV	OWF	Operational	22	23	High	Screened out – baseline	N/A
Borssele V	OWF	Operational	30	30	High	Screened out – baseline	N/A
East Anglia One	OWF	Operational	12	16	High	Screened out – baseline	N/A
East Anglia One North	OWF	Consented	19	22	High	**Screened in**	2
East Anglia Three	OWF	Consented	37	41	High	**Screened in**	3
East Anglia Two	OWF	Consented	3	6	High	**Screened in**	1
East Orford Ness 1809	Marine aggregate area	Exploration	4	7	High	**Screened in**	1
Galloper	OWF	Operational	0	1	High	Screened out – baseline	N/A
Goodwin Sands 521	Marine aggregate area	Production	37	35	High	Screened out – baseline	N/A

Development	Development Type	Development Status	Closest Distance (nm)		Data Confidence	Cumulative Risk Assessment Screened In/Out	Cumulative Tier
			Array Areas	Offshore ECC			
Greater Gabbard	OWF	Operational	3	4	High	Screened out – baseline	N/A
Gunfleet Sands Demo	OWF	Operational	32	6	High	Screened out – baseline	N/A
Gunfleet Sands I	OWF	Operational	29	3	High	Screened out – baseline	N/A
Gunfleet Sands II	OWF	Operational	28	3	High	Screened out – baseline	N/A
Hollandse Kust (West)	OWF	Pre scoping or early development	48	52	Low	**Screened in**	3
Hollandse Kust F	OWF	Pre scoping or early development	34	38	Low	**Screened in**	3
Kentish Flats	OWF	Operational	39	20	High	Screened out – baseline	N/A
Kentish Flats Extension	OWF	Operational	38	21	High	Screened out – baseline	N/A
LionLink	Subsea cable	Proposed	Unknown	Unknown	Low	Screened out – insufficient information available	N/A
London Array	OWF	Operational	19	8	High	Screened out – baseline	N/A
Longsand 508	Marine aggregate area	Production	15	3	High	Screened out – baseline	N/A
Longsand 509/1	Marine aggregate area	Production	18	<1	High	Screened out – baseline	N/A
Longsand 509/2	Marine aggregate area	Production	19	1	High	Screened out – baseline	N/A
Longsand 510/2	Marine aggregate area	Production	12	2	High	Screened out – baseline	N/A
Lowestoft 512	Marine aggregate area	Production	28	31	High	Screened out – baseline	N/A
Lowestoft 513/2	Marine aggregate area	Production	30	33	High	Screened out – baseline	N/A

Development	Development Type	Development Status	Closest Distance (nm)		Data Confidence	Cumulative Risk Assessment Screened In/Out	Cumulative Tier
			Array Areas	Offshore ECC			
Mermaid	OWF	Operational	20	21	High	Screened out – baseline	N/A
Nautilus	Subsea cable	Proposed	Unknown	Unknown	Low	Screened out – insufficient information available	N/A
NeuConnect	Subsea cable	Proposed	Unknown	Unknown	Medium	**Screened in**	1
Nobelwind	OWF	Operational	25	26	High	Screened out – baseline	N/A
Norfolk Vanguard East	OWF	Consented	50	53	High	**Screened in**	3
Norfolk Vanguard West	OWF	Consented	49	52	High	**Screened in**	3
North Falls	OWF / subsea cable	Scoped	3	0.3	High	**Screened in**	1
North Falls East 501	Marine aggregate area	Production	6	9	High	Screened out – baseline	N/A
North Inner Gabbard 498	Marine aggregate area	Production	6	8	High	Screened out – baseline	N/A
Norther	OWF	Operational	33	35	High	Screened out – baseline	N/A
Northwester 2	OWF	Operational	21	23	High	Screened out – baseline	N/A
Northwind	OWF	Operational	28	29	High	Screened out – baseline	N/A
Outer OTE 528/2	Marine aggregate area	Exploration	14	8	High	**Screened in**	2
Rentel	OWF	Operational	29	31	High	Screened out – baseline	N/A
Sea Link	Subsea cable	Scoped	Unknown	Unknown	Medium	**Screened in**	1
Seastar	OWF	Operational	26	27	High	Screened out – baseline	N/A

Development	Development Type	Development Status	Closest Distance (nm)		Data Confidence	Cumulative Risk Assessment Screened In/Out	Cumulative Tier
			Array Areas	Offshore ECC			
Shipwash 507/1	Marine aggregate area	Production	13	5	High	Screened out – baseline	N/A
Shipwash 507/2	Marine aggregate area	Production	13	9	High	Screened out – baseline	N/A
Shipwash 507/3	Marine aggregate area	Production	14	7	High	Screened out – baseline	N/A
Shipwash 507/4	Marine aggregate area	Production	11	7	High	Screened out – baseline	N/A
Shipwash 507/5	Marine aggregate area	Production	10	12	High	Screened out – baseline	N/A
Shipwash 507/6	Marine aggregate area	Production	8	9	High	Screened out – baseline	N/A
Southwold East 430	Marine aggregate area	Production	15	19	High	Screened out – baseline	N/A
Thames D 524	Marine aggregate area	Production	1	5	High	Screened out – baseline	N/A
Thanet	OWF	Operational	23	20	High	Screened out – baseline	N/A
Thornton Bank Phase I	OWF	Operational	30	32	High	Screened out – baseline	N/A
Thornton Bank Phase II	OWF	Operational	32	34	High	Screened out – baseline	N/A
Yarmouth 401/2A	Marine aggregate area	Production	28	32	High	Screened out – baseline	N/A

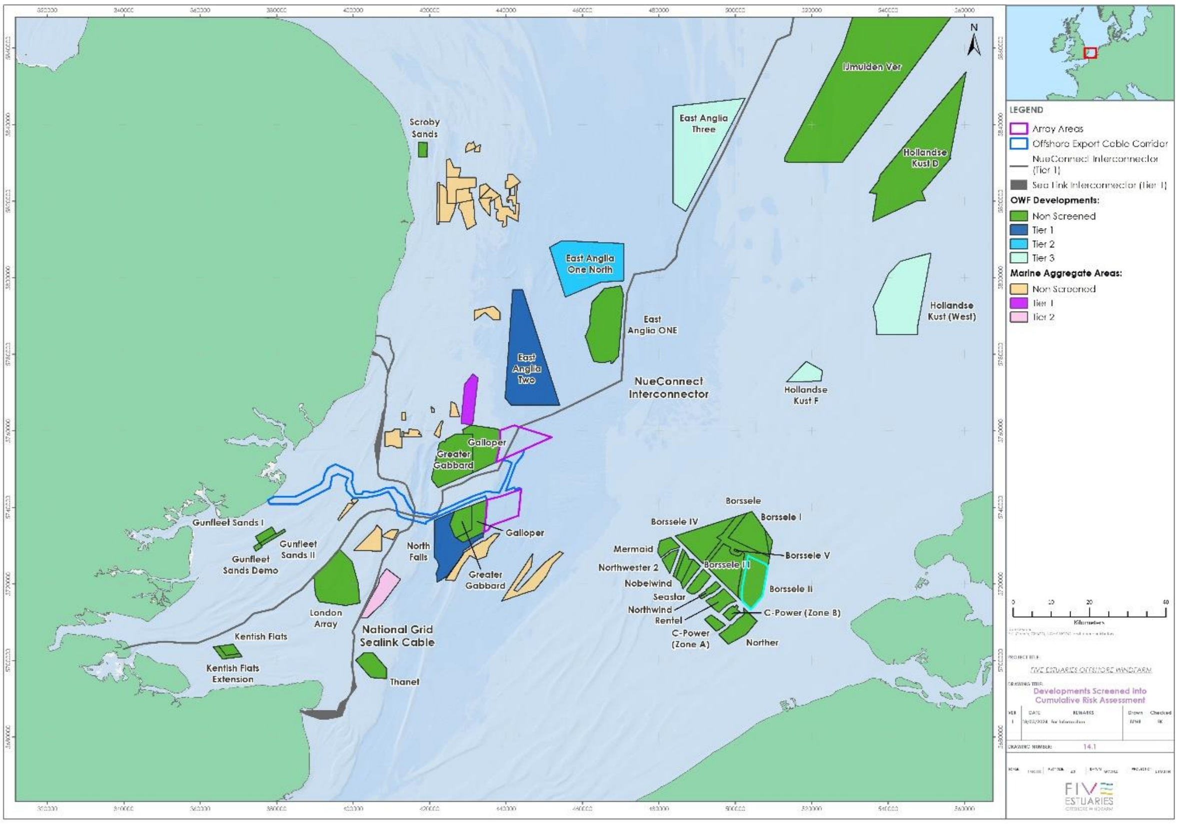

Figure 14.1 Developments Screened into Cumulative Risk Assessment

14.1.2 Marine Aggregate Areas

369. There are a number of marine aggregate areas located in the region. The majority of these are production areas and are therefore considered as part of the baseline assessment (see Section 7). However, there are two exploration areas, and these are included in Figure 14.1. Two further future marine aggregate areas which are included in the 2021/22 marine aggregate tender round – Area 2101 and Area 2112 – are also noted, although geographical information is unavailable.

370. As per the cumulative risk assessment methodology, any marine aggregate area greater than 30 nm from the array areas and 5 nm from the offshore ECC is not considered.

371. Figure 14.1 presents the locations of the marine aggregate areas screened into the cumulative risk assessment alongside baseline developments.

14.1.3 Subsea Cables

372. There are a number of future subsea cable developments located in the region, including the export cable for North Falls, Sea Link, NeuConnect, Nautilus, and EuroLink. As Sea Link and NeuConnect are screened into the cumulative risk

assessment (Table 14.1) they have been included in Figure 14.1. North Falls export cable, Sea Link and NeuConnect are expected to have close proximity with the offshore ECC. Those subsea cables already operational are considered as part of the baseline assessment (see Section 7.6).

373. As per the cumulative risk assessment methodology, any subsea cable greater than 2 nm from the array areas and offshore ECC is not considered.

14.1.4 Other Developments and Infrastructure

374. There is no oil and gas infrastructure in this region of the southern North Sea. The nearest oil and gas surface structure is the P11-b De Ruyter platform located approximately 45 nm north-east of the array areas.

375. There are no other future developments and infrastructure screened into the cumulative risk assessment.

14.2 Pre Wind Farm Routeing Interaction with Screened in Developments

376. The route deviations are summarised in Table 14.2. As per the methodology for re-routeing due to VE in isolation (see Section 15.9), it is assumed that any main commercial route within 1 nm of a surface piercing installation will require a deviation.

Table 14.2 Anticipated Main Commercial Route Interaction with Cumulative Developments

Route Number	Average Vessels per Day	Main Ports	Interaction with Cumulative Developments			
			North Falls	East Anglia Two	East Orford Ness 1809	Norfolk Vanguard West
3	11*	Harwich Haven (UK) – Port of Rotterdam (Netherlands)		✓	✓	
4	9*	Port of Hull (UK) – Port of Zeebrugge (Belgium)		✓		
6	7*	Dover Strait – North Europe Ports	✓			
7	6*	London Gateway (UK) – Port of Antwerp (Belgium)	✓			
10	4	Dover Strait – Port of Immingham (UK)				✓
11	3*	Port of Antwerp (Belgium) – Humber Ports (UK)	✓			
12	3*	Port of Rotterdam (Netherlands) – Thames/Medway Ports (UK)	✓			

Route Number	Average Vessels per Day	Main Ports	Interaction with Cumulative Developments			
			North Falls	East Anglia Two	East Orford Ness 1809	Norfolk Vanguard West
16	2*	Humber Ports (UK) – Thames/Medway Ports (UK)	✓			
17	1-2*	Humber Ports (UK) – Thames/Medway Ports (UK)	✓			
19	1-2	Dover Strait – Port of Immingham (UK)		✓		
21	1-2	Harwich Haven (UK) – Galloper OWF	✓			
22	1-2*	Harwich Haven (UK) – Galloper OWF	✓			
26	1	Port of Grimsby (UK) – Port of Zeebrugge (Belgium)		✓		

*These routes are not expected to deviate in directions (e.g., inbound and outbound), so the average vessel numbers per day affected will be lower than presented.

377. In summary, 12 main commercial routes are anticipated to be permanently displaced by the additional presence of North Falls and East Anglia Two (Tier 1). Two routes are anticipated to experience short-term displacement due to activities associated with the additional presence of East Orford Ness 1809 (Tier 1).

378. One main commercial route is anticipated to be permanently displaced by the additional presence of Norfolk Vanguard West (Tier 3), although this is considered only qualitatively in the cumulative risk assessment.

379. Subsea cables screened into the cumulative risk assessment have been incorporated into Figure 14.1.

15 Future Case Vessel Traffic

380. The characterisation of vessel traffic established in the baseline (see Section 10 and Section 11) is used as input to the risk assessment (see Section 18). However, it is also necessary to consider potential future case vessel traffic, in terms of general volume[7] and size changes, port developments which may influence movements, and changes to movements associated with the presence of VE (the post wind farm scenario).

15.1 Consultation Feedback

381. Consultation feedback to date (including at the Hazard Workshop) has highlighted the importance of the future case, with representatives for ports in the region indicating that there is potential for substantial vessel traffic growth. Table 15.1 highlights the key points raised relating to future case vessel volumes and sizes (with all consultation feedback relating to shipping and navigation summarised in Section 4.3). It is noted that at the time of these key points being raised, future case scenarios featuring 10% and 20% increases in all vessel movements were under consideration (as per the PEIR NRA).

Table 15.1 Summary of Key Points Raised during Consultation Relating to Future Case Vessel Traffic

Stakeholder	Point Raised
Vessel Volume	
HHA	Vessel traffic increases could vary, including greater than 20%, although an accurate forecast is difficult given market conditions.
	A 20% increase is low for the lifetime of VE. Felixstowe could be redeveloped and Bathside Bay could be developed. A third future case traffic band of 50% increase is suggested.
	The increased depth of the Harwich Deep Water Channel and new deeper berths at Felixstowe is expected to attract more shipping lines to use Felixstowe.
	The worldwide maritime industry trend for less vessel movements but larger vessels carrying equivalent tonnage is set to continue.
London Gateway	London Gateway is only 50% constructed and therefore port capacity could double over the next 10 years. Increases of 50% vessel traffic associated with London Gateway would be a suitable future case.
	Organic growth of port related traffic is not appropriate due to ongoing developments including additional berths at London Gateway and Tilbury.
Felixstowe	Application of a higher future case band to specific route options rather than increasing traffic on all routes will be a more accurate approach.
	Felixstowe has nine berths currently but plans are in place for the addition of smaller berths.

[7] Throughout the NRA the term 'vessel volume' refers to the number of vessels and not vessel capacity.

Stakeholder	Point Raised
UK Chamber of Shipping	The expansion of major ports in the area, in combination with the proximity of several other new offshore wind farm projects in the area, leads to the suggestion that a 20% increase may be too low. An additional scenario of 30% in overall vessel numbers is suggested.
DFDS Seaways	Increases of 20% are reasonable.
MCA	The 30% increase in commercial vessel movements is fair.
Vessel Size	
HHA	The worldwide maritime industry trend for less vessel movements but larger vessels carrying equivalent tonnage looks set to continue. Over the last 15 years vessel size changes have primarily related to air draught and draught with limited changes to length/width given berth limitations.
	In recent years vessel draughts out of Rotterdam have increased from 12 to 17 m but it is difficult to forecast how this may change in the future. A theoretical maximum draught of 22 m may be possible in the future noting the existence of Chinamax vessels.
	Accounting for vessel draughts and future dredging, a maximum draught of 20 m plus 10% under keel clearance should be considered, i.e., minimum depth required of 22 m below CD.
	There are no current plans to further deepen the Harwich Deep Water Channel.
London Gateway	To account for potential of vessel draughts of 20 m and additional under keel clearance of 10%, a 22 m channel should be considered during the lifetime of VE.
	Should draught-beam calculations change in the future then the Suez Canal as a wider constraint may change.
UK Chamber of Shipping	Historically the Suez Canal has been dredged deeper and so this could happen again.
Felixstowe	Vessel size increases should be considered with draught and air draught also increasing.
MCA	No further comments given ports/terminals are content with the proposed assumptions [23 m draught as maximum future worst case].

15.2 Vessel Trends

15.2.1 Lloyds Database

382. Based on the Lloyds Database, PierNext has analysed data for container vessels since 1964 to gain insight into trends for vessel draught relative to capacity. Figure 15.1 indicates there is an approximate ceiling for draughts, with very few container vessels exceeding 16 m draught, irrespective of the capacity. Indeed, draught is relatively stable for capacities over 12,000 twenty-foot equivalent unit (TEU).

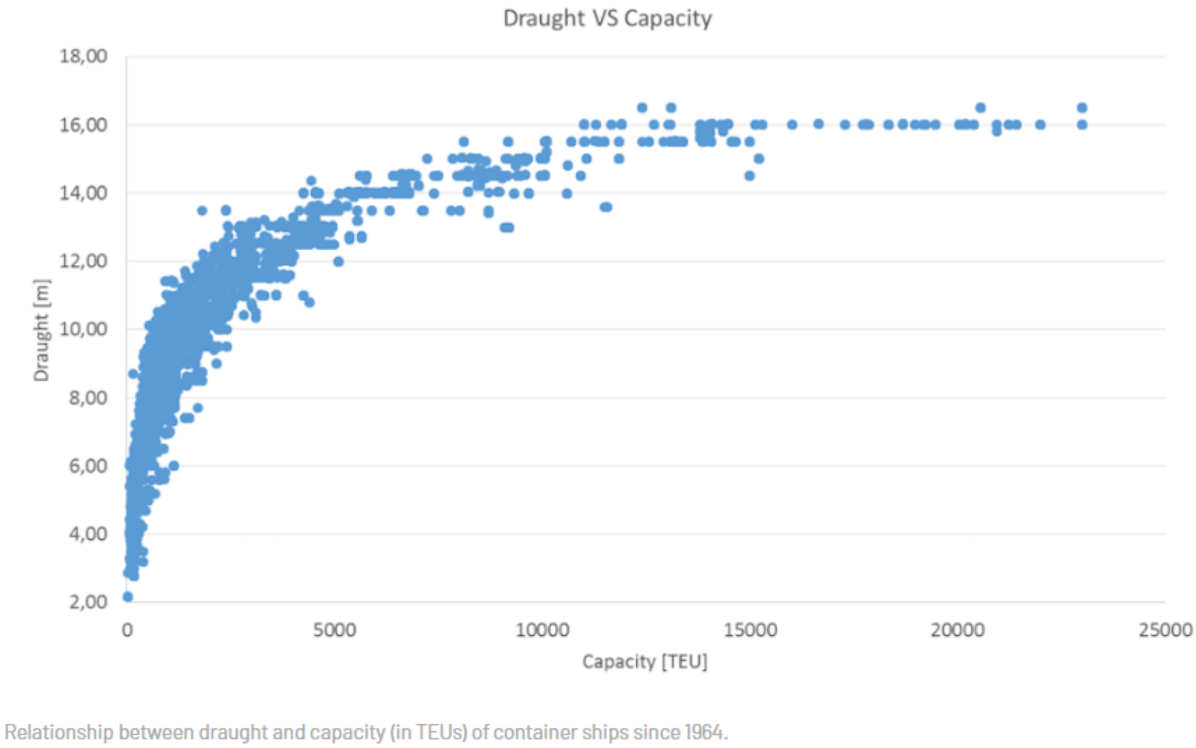

Figure 15.1 Relationship Between Vessel Draught and Capacity (1964 to 2019) (PierNext, 2019)

15.2.2 Clarksons World Fleet Register

383. During consultation, the UK Chamber of Shipping shared overarching data for the global fleet since 2005. Figure 15.2 indicates that the number of vessels in the global fleet has increased substantially, with a 56% increase in volumes from 2005 to 2023. However, the rate of increase year-on-year is slowing, with a maximum year-on-year increase of 1.8% over the last six years, compared with 3.1% in the previous six-year period.

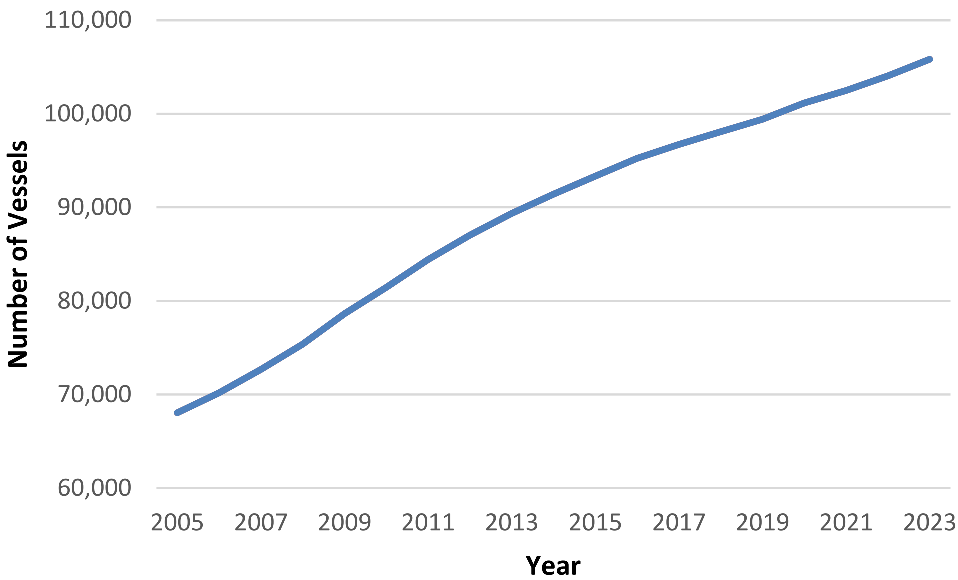

Figure 15.2 Number of Vessels in Global Fleet by Year (2005 to 2023)

15.3 Suez Canal

384. The Suez Canal offers a key navigational route, connecting the Mediterranean (and by extension the North Sea) and Red Seas. The Suez Canal drastically reduces transit times and fuel consumption for vessels since the alternative option is to make passage around the Cape of Good Hope and north-south through the Atlantic Ocean. Therefore, vessel draught on an international level is highly reliant upon the Suez Canal since alternative routeing options are generally not economical. This is demonstrated by the effects of the Suez Canal's blockage due to the grounding of the Ever Given in March 2021, with "*some estimates that it cost the global economy around $10 billion per day*" (SAFETY4SEA, 2023).

385. Moreover, the economic importance of the Suez Canal was emphasised by vessel movements during the COVID-19 pandemic; although internationally vessel movements declined markedly during 2020, the Suez Canal Authority reported a decline of just 0.27% in transits for the full year of 2020 (Maritime Executive, 2021).

386. The Rules of Navigation for the Suez Canal (Suez Canal Authority, 2020) gives maximum authorised draught values for various values of beam for a loaded vessel, with an overall maximum of 66 feet (ft) (22.1 m) associated with a vessel of 20.12 m beam. It is therefore reasonable to expect a maximum draught of 22 m in the future case scenario is feasible headed in/ out of ports local to VE, noting that currently draughts reach up to around 16 m (see Section 10.2.4.2). This 22 m value is within the parameters suggested by London Gateway and the HHA.

387. However, there is also potential for the Suez Canal to be dredged in the future to increase depths and subsequently allow larger draught vessels, as acknowledged by the UK Chamber of Shipping during consultation. Figure 15.3 presents the maximum

vessel draught permitted within the Suez Canal historically since it was nationalised in 1956.

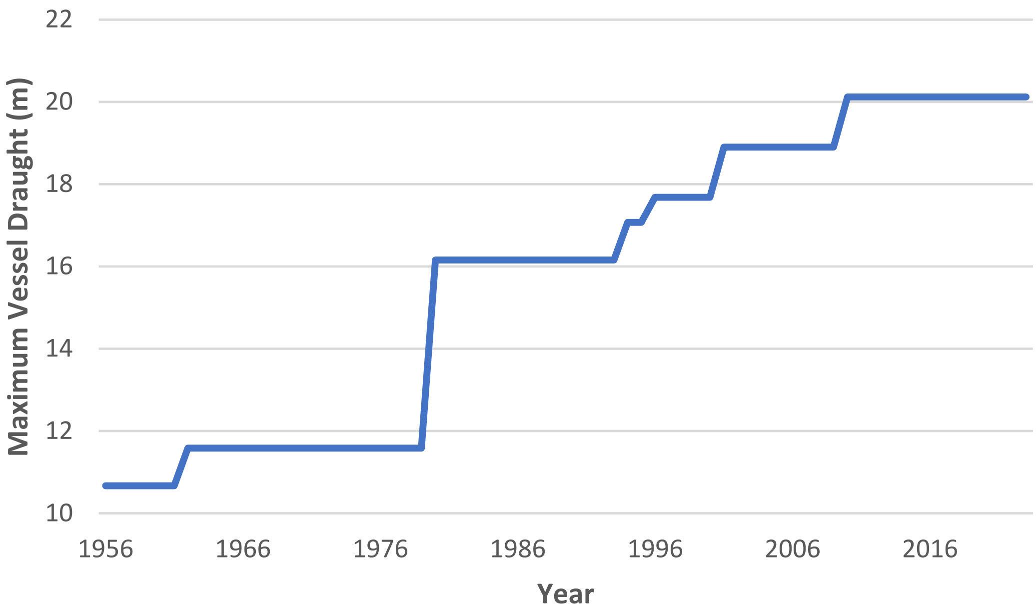

Figure 15.3 Maximum Vessel Draught by Year for the Suez Canal (1956 to 2023) (Suez Canal Authority, 2023)

388. The maximum vessel draught permitted within the Suez Canal has increased substantially through the decades at various stages of development. However, only once (in 1980) has the maximum permitted draught increased monumentally and there has been only one increase since 2001 (in 2010). Therefore, further monumental increases in the maximum vessel draught permitted are considered unlikely and from research there are no current plans for increases in the future.

389. There are vessels which would benefit from a further deepening of the Suez Canal, namely Chinamax vessels. With a maximum draught of 24 m, these have been acknowledged by the HHA during consultation but are not currently able to navigate the Suez Canal. Subsequently, noting the economic implications of alternative routeing options and based on Anatec's experience of vessel traffic analysis in the region, Chinamax vessels do not currently navigate regularly within the North Sea.

390. The following subsections provide a high level future case scenario which has been used to inform the risk assessment at the PEIR stage and will be updated for the ES with the outputs of the detailed methodology noted above.

15.4 Under Keel Clearance Calculations

391. A vessel's safe manoeuvrability depends on the vessel's draught in relation to the available under keel clearance. This subsection aims to establish indicative under keel clearance values for future case vessel sizes. In particular, the 20 m and 23 m

draughts being considered for the realistic and worst case assessment, respectively. For the purposes of this subsection, the follow definitions are used:

- **Static draught** – the draught when a vessel is not making way or subject to sea and swell influences, i.e., the maximum draught the vessel is loaded to.
- **Dynamic draught** – the draught when a vessel is making way and subject to squat, swell, and heel when turning.
- **Percentage under keel clearance** – percentage of a vessel's draught required as under keel clearance.
- **Published minimum under keel clearance** – the minimum clearance required by a port or berth operator irrespective of static or dynamic draught.

392. Table 15.2 provides the percentage and published minimum under keel clearance values associated with relevant port and berth operators (where available).

Table 15.2 Percentage and Published Minimum Under Keel Clearance Associated with Local Ports, Berths, and Terminals

Port/ Berth/ Terminal	Source	Percentage Under Keel Clearance (%)	Published Minimum Under Keel Clearance (m)
PLA	Navigational Assessment Working Group (PLA, 2013)	–	0.9 m on flood tide 1.4 m on ebb tide
HHA	Percentage under keel clearance provided during consultation	10	–
London Gateway	London Gateway Information Guide for Shipmasters (DP World, 2023)	10	1.4

393. The calculation of dynamic draught is vessel specific; therefore this assessment considers a general rule of thumb for calculating the percentage under keel clearance. For the restricted waters and port approaches considered in this NRA, the percentage under keel clearance is calculated as 10% of the static draught. Given this is in excess of the published minimum under keel clearance, this is considered a conservative value which accounts for both static and dynamic draughts (with respect to the 20 m and 23 m draughts being considered for the realistic and worst case assessment).

394. Table 15.3 shows the water depth required for the realistic and worst case draughts used in this assessment, with the current maximum draught also included for context.

Table 15.3 Water Depth Required for Various Vessel Draughts

Vessel Draught	Published Minimum Under Keel Clearance	Water Depth Required Based on Published Minimum Under Keel Clearance	Percentage Under Keel Clearance Required	Water Depth Required Based on Percentage Under Keel Clearance
16 m (current maximum)	1.4 m	17.4 m	1.6%	17.6 m
20 m (realistic future worst case)	1.4 m	21.4 m	2.0%	22.0 m
23 m (maximum future worst case)	1.4 m	24.4 m	2.3%	25.3 m

395. Based on the water depths required, current charted values within the offshore ECC, and location of deeper draught vessels, the areas within which further consideration of the depth of cable burial is required are shown in Figure 15.4.

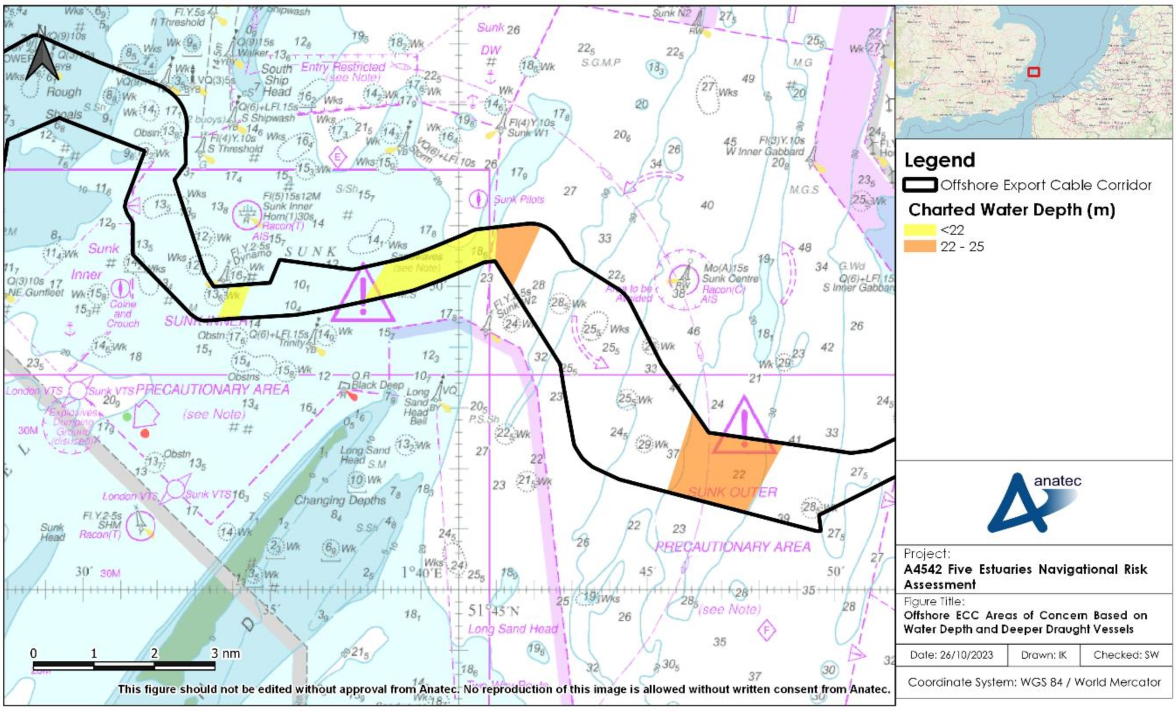

Figure 15.4 Offshore ECC Areas of Concern Based on Water Depth and Deeper Draught Vessels

15.4.1 Assessment of Current Maximum

396. Consideration of the current maximum draught recorded across the offshore ECC related AIS datasets used in this NRA shows that both the required minimum and assumed maximum water depths required (17.4 and 17.6 m, respectively) for existing largest vessels operating in the area are achievable but are tidally constrained.

15.4.2 Assessment of Realistic Future Worst Case

397. Table 15.3 shows that the required minimum and maximum water depths (21.4 and 22.0 m) are not achievable within the areas shaded yellow in Figure 15.4. Should vessels achieve a draught of 20 m within the lifetime of VE additional dredging over the installed cables would be required and therefore consideration of this and agreement on values would be required as part of the cable burial risk assessment. It is noted that these depths would require dredging along the existing deep-water routes, within turning areas and berths at the relevant ports. Additionally, burial depths should account for tidal constraints associated with larger vessel movements within the areas of concern including at flood tides.

398. Assuming the minimum 0.9 m under keel clearance value this would result in the required water depth would decrease to 20.5 m. Accounting for the limited spatial extent and the potential for the final export cable route to be installed through the deeper areas, this realistic future worst case is considered feasible with the embedded mitigation measures in place.

15.4.3 Maximum Future Worst Case

399. Table 15.3 show that the required minimum and maximum water depths (24.4 and 25.3 m) are not achievable within the area shaded yellow and orange in Figure 15.4. Unlike the realistic future worst case scenario, the likelihood of these values being required is considered extremely unlikely. The following list details the reasoning behind this assertion and why its consideration is not necessary in the lifetime of VE.

- Historical vessel trends suggests that there is limited appetite for container vessels with draughts exceeding 16 m.
- The Suez Canal allows for a maximum draught of 22.1 m and thus would require material dredging works to facilitate use by a vessel with 23 m draught.
- The maximum vessel draught permitted in the Suez Canal has increased only once since 2001 indicating that there is limited international appetite for deeper draught vessels.
- To allow vessel access to local ports would require extensive dredging works within the region and at the time of writing there were no such plans in place for any of the local ports.
- Extensive dredging works would also be required beyond the jurisdiction of the local ports, noting that charted water depths within the Sunk TSS as a whole are

under 24 m in some locations, and such dredged depths would have to be maintained on an ongoing basis.
- Notable berth modifications would also be required including dredging, turning circles, and crane size and capacity.

15.5 Future Case Vessel Volume

15.5.1 Commercial Vessels

400. Defining a suitable growth in commercial vessel volume for the future case is challenging and this has been acknowledged by stakeholders during consultation. There have been various views, but the majority of stakeholders indicated that a 20% increase across all vessels was insufficient.

401. Noting that concerns are specific to commercial vessels and traffic associated with offshore wind farms, the 20% increase in volume is considered a realistic worst case for commercial fishing vessels and recreational vessels.

402. For commercial vessels, three distinct bands of vessel traffic growth are considered in the risk assessment: 10%, 20%, and 30% increases in volume. This reflects the UK Chamber of Shipping's recommendation and strikes a balance between the recommendations of other stakeholders including London Gateway, HHA, and DFDS Seaways, as well accounting for current vessel trends and constraints.

403. This increase applies across commercial vessels as a whole and it is recognised that the increase will vary for different routes, areas, and types of commercial vessel. In particular, the increase may be greater than 30% for container vessels utilising the deep water routes within the Sunk Inner Precautionary Area given further port development at London Gateway and Felixstowe. The level of increase will also be influenced by changes to navigable water depths, with the potential for port access constraints to be reduced should these be increased.

15.5.2 Commercial Fishing Vessels and Recreational Vessels

404. For commercial fishing vessel and recreational vessel transits there is similar uncertainty associated with long-term predictions of growth given the limited reliable information on future trends upon which any firm assumption can be made. There are no known major developments which would increase commercial fishing or recreational vessel activity in the region.

405. Therefore, a conservative potential growth in commercial fishing vessel and recreational vessel movements of 10% and 20% has been estimated throughout the lifetime of VE. Changes in fishing activity are considered further in **Volume 6, Part 2, Chapter 8: Commercial Fisheries**.

15.6 Future Case Vessel Size

15.6.1 Commercial Vessels

406. Similarly to vessel volumes, defining a suitable growth in commercial vessel size for the future case is challenging and this has been acknowledged by stakeholders during consultation. Again, there have been various views shared with the focus of discussions (and subsequent desktop review) relating to vessel draught.

407. For commercial vessels, a worst case maximum draught of 23 m is considered, with a realistic maximum draught of 20 m. This reflects feedback from HHA and London Gateway recommending use of a 22 m and 20 m draught, respectively, whilst also allowing for some modest future increases noting the uncertainty with future values.

408. It is noted that the likelihood of a 23 m draught vessel accessing local ports during the lifetime of VE is considered low due to various factors:

- Historical vessel trends suggests that there is limited appetite for container vessels with draughts exceeding 16 m.
- The Suez Canal allows for a maximum draught of 22.1 m and thus would require material dredging works to facilitate use by a vessel with 23 m draught.
- The maximum vessel draught permitted in the Suez Canal has increased only once since 2001 indicating that there is limited international appetite for deeper draught vessels.
- Charted water depths and bathymetric data collected by VE in the area surrounding the offshore ECC indicates that large scale and extensive dredging would be required to allow a 23 m draught vessel to access local ports with such works extending beyond the jurisdiction of the local ports, noting that charted water depths within the Sunk TSS are under 24 m in some locations.

15.6.2 Commercial Fishing Vessels and Recreational Vessels

409. No material changes in the size of commercial fishing vessels and recreational vessels is anticipated nor have any changes been raised by stakeholders during consultation.

15.7 Increases in Traffic Associated with VE Operations

410. During the construction phase up to 4,311 annual round trips to port will be made by vessels involved in the installation of VE (see Section 6.4). During the O&M phase, up to 1,776 annual round trips to port will be made by vessels involved in the O&M of VE (see Section 6.5).

15.8 Changes in Marine Aggregate Dredging Activities

411. As indicated in Section 7, there are numerous marine aggregate dredging areas in the region, the majority of which are active. In the future production associated with these areas may be discontinued, thus reducing the volume of marine aggregate

dredger movements. Likewise, new marine aggregate dredging areas may be designated, with two exploration areas screened into the cumulative risk assessment (see Section 14.1.2).

412. At this time, it is unclear how frequent marine aggregate dredging activities may be at new sites and therefore no specific changes are considered in the future baseline, noting that marine aggregate dredgers are included in the 10%, 20%, and 30% growth of commercial vessel movements described in Section 15.5.

15.9 Commercial Traffic Routeing (VE in Isolation)

15.9.1 Methodology

413. It is not possible to consider all potential alternative routeing options for commercial traffic and therefore worst-case alternatives have been considered where possible in consultation with operators. Assumptions for re-routeing include:

- All alternative routes maintain a minimum mean distance of 1 nm from offshore installations and existing OWF boundaries in line with industry experience. This distance is considered for shipping and navigation from a safety perspective as explained below; and
- All mean routes take into account sandbanks, aids to navigation and known routeing preferences.

414. Annex 1 of MGN 654 defines a methodology for assessing passing distance from OWF boundaries (the Shipping Route Template) but states that it is "*not a prescriptive tool but needs intelligent application*".

415. To date, internal and external studies undertaken by Anatec on behalf of the UK Government and offshore wind farm developers show that vessels do pass consistently and safely within 1 nm of established OWFs (including between distinct developments) 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 1 nm off established developments. Evidence also demonstrates that commercial vessels do not transit through arrays.

416. The NRA also aims to establish the MDS based on navigational safety parameters, and when considering this the most conservative realistic scenario for vessel routeing is considered to be when main commercial routes pass 1 nm off developments. Evidence collected during numerous assessments at an industry level confirms that it is a safe and reasonable distance for vessels to pass; however, it is likely that a large number of vessels would instead choose to pass at a greater distance depending upon their own passage plan and the current conditions.

15.9.2 Main Commercial Route Deviations

417. An illustration of the anticipated worst case shift in the mean positions of the main commercial routes that are likely to deviate within the array routeing study area following the development of VE is presented in Figure 15.5, but with the vessel traffic density associated with all routeing included. These deviations are based on Anatec's assessment of the MDS including the indicative array layout presented in Section 6.2.

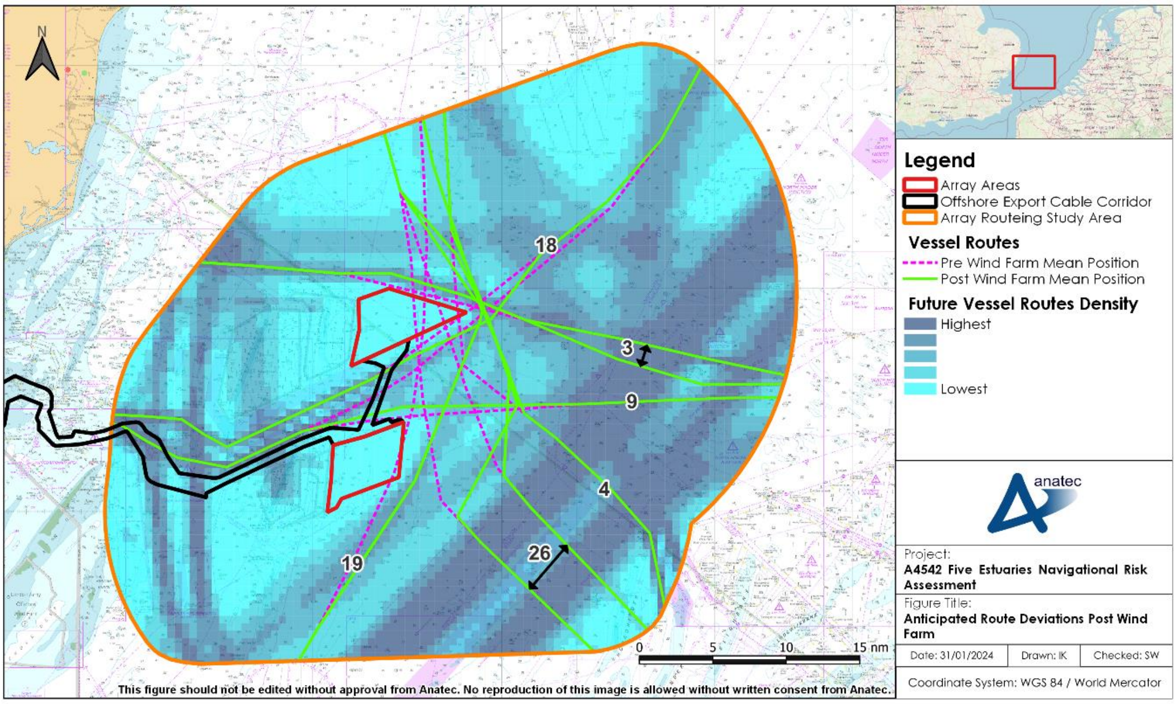

Figure 15.5 Anticipated Route Deviations Post Wind Farm

418. Deviations from the pre wind farm scenario would be required for six out of the 26 main commercial routes identified with the level of deviation varying between a decrease of 1 nm for Route 4 and an increase of 2.7 nm for Route 26, with the latter being a primarily cargo vessel route between the Port of Grimsby (UK) and Port of Zeebrugge (Belgium). For the displaced routes, the increase in distance from the pre wind farm scenario is presented in Table 15.4.

Table 15.4 Summary of Post Wind Farm Main Commercial Deviations within the Array Routeing Study Area

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
3	0.1	0.1	Passing slightly north of the northern array area.

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
4	-1.0	-0.6	Passing slightly east of the northern array area.
9	0.1	0.1	Passing slightly north of the southern array area
18	0.3	0.1	Passing slightly south of the northern array area.
19	2.0	1.0	Passing slightly east of the array areas.
26	2.7	1.4	Passing slightly east of the array areas.

15.10 Commercial Routeing (Cumulative)

419. An illustration of the anticipated worst case shift in the mean positions of the main commercial routes that are likely to deviate within the array routeing study area following the development of VE and Tier 1 and 2 cumulative developments is presented in Figure 15.6, but with the vessel traffic density associated with all routeing (for the cumulative scenario) included. Again, these deviations are based on Anatec’s assessment of the MDS and follow the same methodology outlined for deviations due to VE in isolation (see Section 15.9.1).

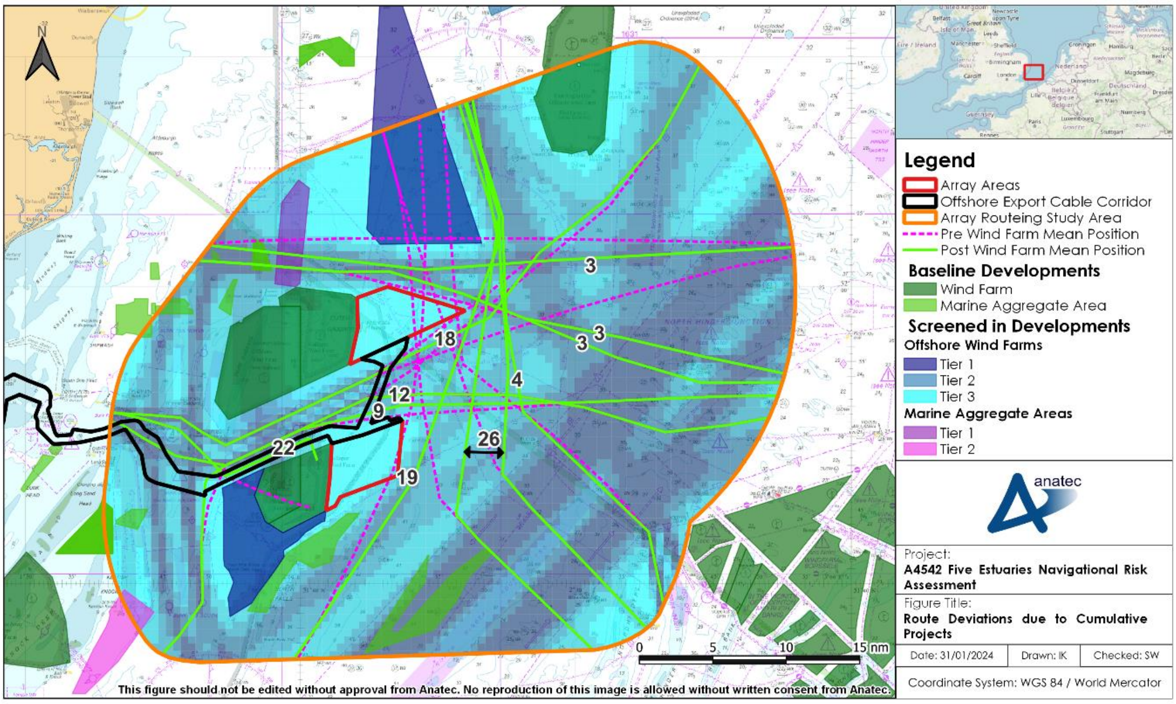

Figure 15.6 Route Deviations due to Cumulative Projects

420. Deviations from the pre wind farm scenario would be required for eight out of the 26 main commercial routes identified with the level of deviation varying between a decrease of 1.3 nm for Route 4 and a 2.3 nm increase for Route 19. For the displaced routes, the increase in distance from the pre wind farm scenario is presented in Table 15.5.

Table 15.5 Summary of Cumulative Main Commercial Deviations within the Array Routeing Study Area

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
3	0.1	0.1	Passing slightly south of East Anglia Two.
4	-1.3	-0.7	Passing slightly east of East Anglia Two.
9	0.1	0.1	Passing slightly north of the southern array area (no additional deviation due cumulative developments).
12	0.4	0.3	Passing slightly west of North Falls.

Route Number	Increase in Route Length (nm)	Percentage Change in Total Route Length (%)	Nature of Deviation
18	0.3	0.1	Passing slightly south of the northern array area (no additional deviation due cumulative developments).
19	2.3	1.1	Passing slightly east of East Anglia Two.
22	1.3	4.1	Passing slightly north of North Falls.
26	1.7	0.9	Passing slightly east of East Anglia Two.

16 Collision and Allision Risk Modelling

421. To inform the risk assessment, a quantitative assessment of collision and allision risk associated with VE has been undertaken using Anatec's COLLRISK modelling suite. The following subsections outline the inputs and methodology used for the collision and allision risk modelling.

16.1 Hazards Under Consideration

422. Hazards considered in the quantitative 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.

423. The pre wind farm assessment has been informed by the vessel traffic survey data (see Section 10) in combination with the outputs of consultation (see Section 4) and other baseline data sources (such as Anatec's ShipRoutes database). Conservative assumptions have been made with regard to route deviations and future shipping growth over the lifetime of VE (see Section 15).

16.2 Scenarios Under Consideration

424. 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, eight distinct scenarios have been modelled:

- Pre wind farm with base case traffic levels;
- Pre wind farm with a 10% increase in future case traffic levels;
- Pre wind farm with a 20% increase in future case traffic levels;
- Pre wind farm with a 30% increase in future case traffic levels;
- Post wind farm with base case traffic levels;
- Post wind farm with a 10% increase in future case traffic levels;
- Post wind farm with a 20% increase in future case traffic levels; and
- Post wind farm with a 30% increase in future case traffic levels.

425. For the 30% increase in future case traffic levels scenario, the fishing vessel to structure allision risk has not been modelled since this scenario is included in response to consultation feedback relating to commercial traffic (see Section 15). Therefore, the results for the 20% increase in future case traffic levels scenario have been applied for the fishing vessel to structure allision risk component of the total risk for the 30% scenario.

426. The results of the base case scenarios are detailed in full in the following subsections with the equivalent results for the future case scenarios provided in Section 16.4.

16.3 Pre Wind Farm Modelling

16.3.1 Vessel to Vessel Encounters

427. An assessment of vessel to vessel encounters has been undertaken by replaying at high speed the vessel traffic survey data. The model defines an encounter as two vessels passing within 1 nm of each other within the same minute. This helps to illustrate where existing shipping congestion is highest and therefore where offshore developments, such as an offshore wind farm, could potentially increase the risk of encounters and collisions. No account of whether encounters are head on or stern to head is given; only close proximity is accounted for.

428. Figure 16.1 presents a density heat map based upon the locations of vessel encounters.

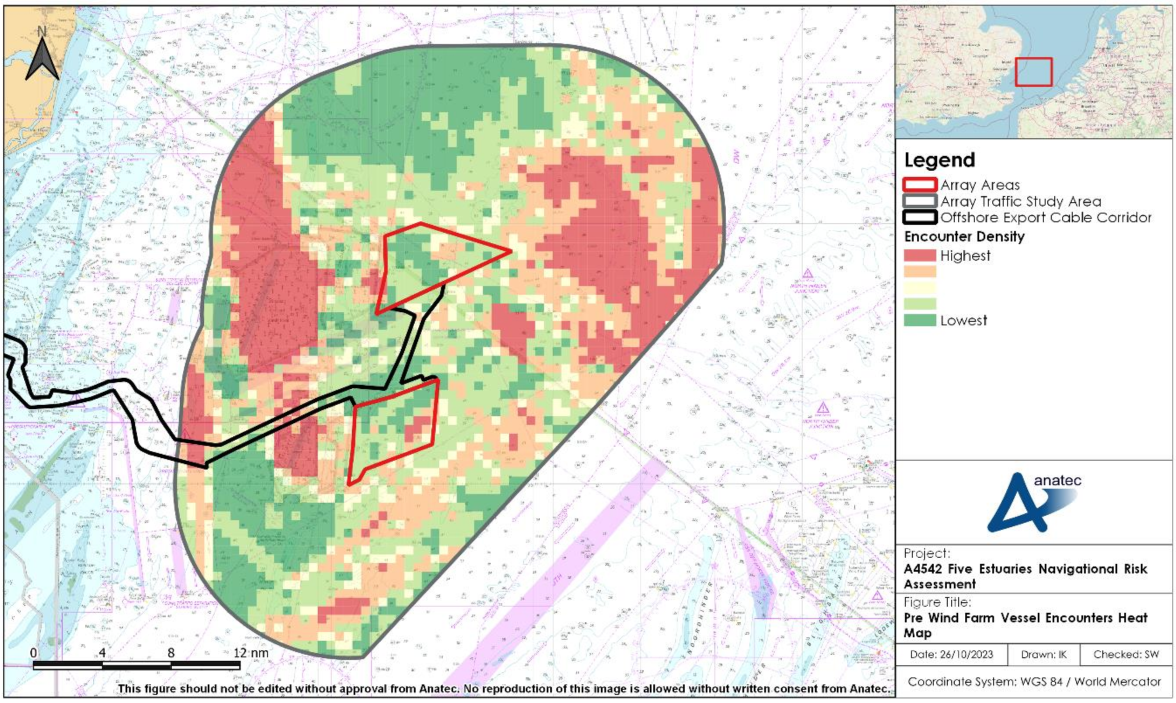

Figure 16.1 Pre Wind Farm Vessel Encounters Heat Map

429. There was an average of 86 encounters per day within the array traffic study area throughout the survey periods, with these most closely associated with wind farm vessel routeing and activities for Greater Gabbard and Galloper. Higher encounters density was also observed east of the northern array area where various main commercial routes meet.

430. The greatest number of encounters recorded on a single day was 220, on 28th June 2022, with these consisting primarily of wind farm vessel routeing and activities for Greater Gabbard and Galloper. The most frequent vessel types involved in

encounters during the survey period were wind farm vessels (51%), cargo vessels (22%) and fishing vessels (13%).

16.3.2 Vessel to Vessel Collision Risk

431. Using the pre wind farm vessel routeing as input, Anatec's COLLRISK model has been run to estimate the existing vessel to vessel collision risk within the array routeing study area. The route positions and widths are based on the vessel traffic survey data and have been validated using the long-term vessel traffic data and consultation with local stakeholders.

432. A heat map based upon the geographical distribution of collision risk within a density grid for the pre wind farm base case is presented in Figure 16.2.

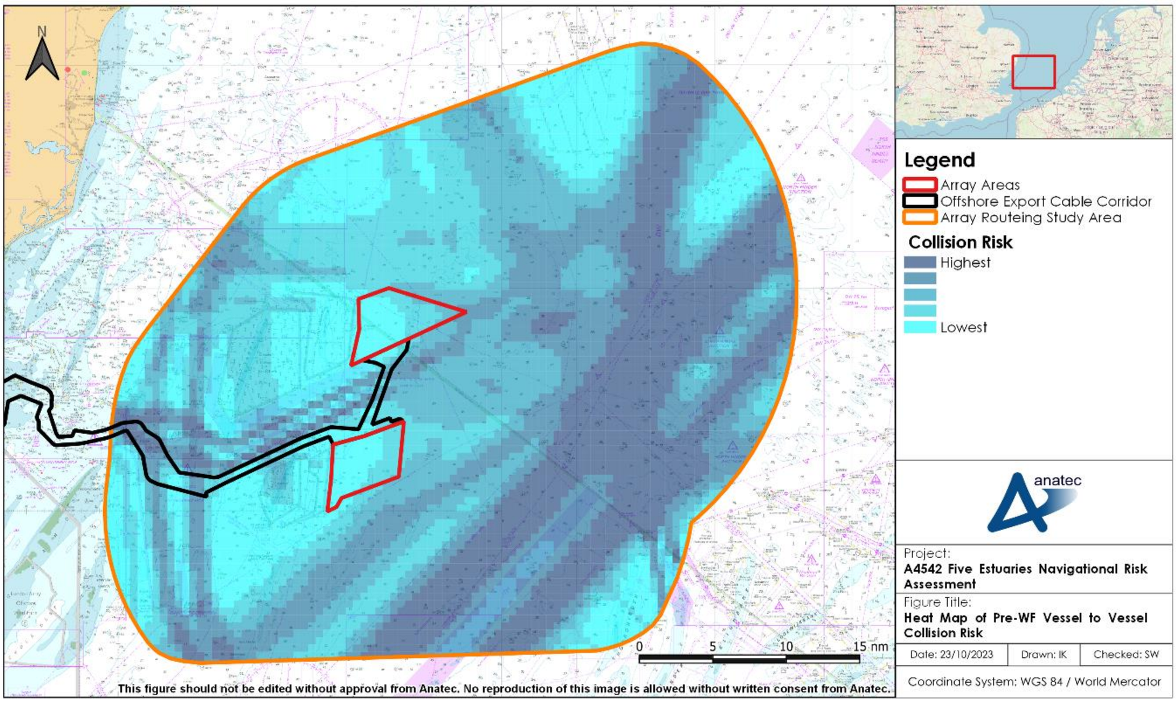

Figure 16.2 Heat Map of Pre-WF Vessel to Vessel Collision Risk

433. Assuming base case vessel traffic levels, the annual collision frequency pre wind farm was calculated to be 1.91×10^{-1}, corresponding to a return period of approximately one in 5.22 years. This is a high return period compared to that estimated in the pre wind farm scenario for most other UK OWF developments and is reflective of the high volume of vessel traffic in the area, particularly within and out of the Sunk and North Hinder TSS. It is noted that the model is calibrated based upon major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor effects. Other incident data, which includes minor incidents, is presented in Section 9.

16.4 Post Wind Farm Routeing

434. The methodology for determining the post wind farm routeing is outlined in Section 15.

16.4.1 Simulated Automatic Identification System

435. Anatec's AIS Simulator software was used to gain an insight into the potential re-routed commercial traffic following the installation of the wind farm structures within the array areas. The AIS Simulator uses the mean positions of the main commercial routes identified within the array routeing study area and the anticipated shift post wind farm, together with the standard deviations and average number of vessels on each main commercial route to simulate tracks.

436. A plot of 28 days of simulated AIS (matching the total duration of the vessel traffic surveys) within the array routeing study area, based on the deviated main commercial routes, is presented in Figure 16.3.

437. It is noted that the simulated AIS represents an MDS based on commercial routes passing at a minimum mean distance of 1 nm from the array areas.

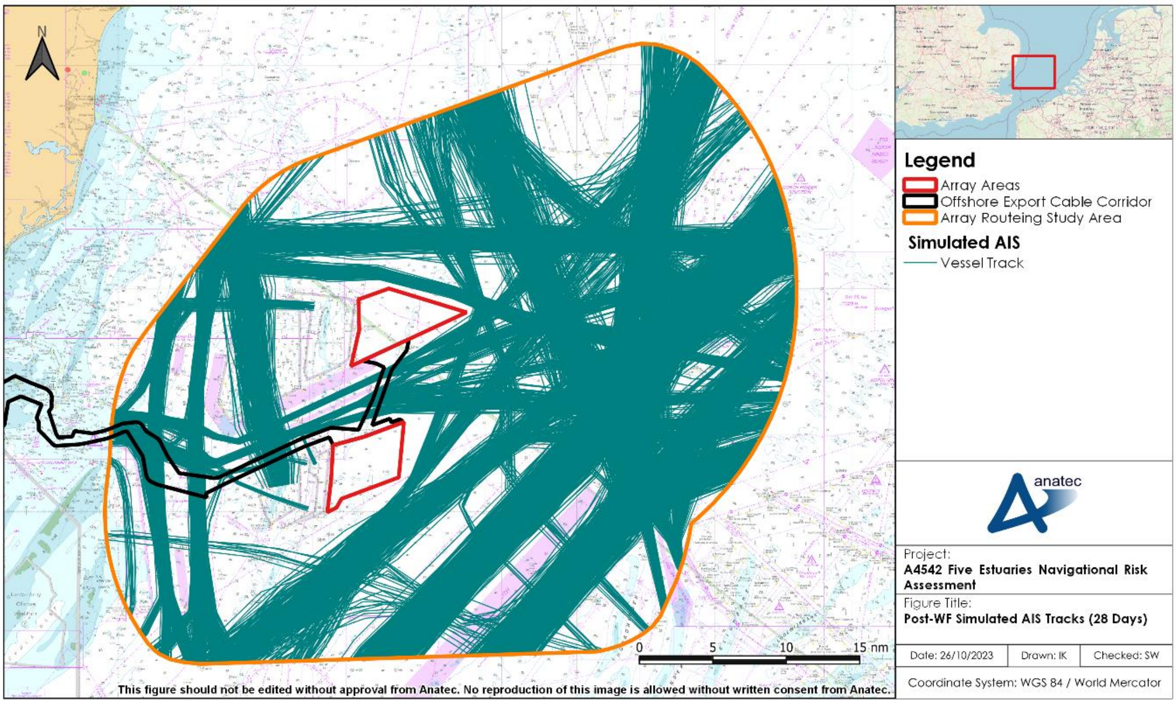

Figure 16.3 Post-WF Simulated AIS Tracks (28 Days)

16.4.2 Vessel to Vessel Collision Risk

438. Using the post wind farm routeing as input, Anatec's COLLRISK model has been run to estimate the anticipated vessel to vessel collision risk within the array routeing study area.

439. A heat map based on the geographical distribution of collision risk within a density grid for post wind farm base case is presented in Figure 16.4.

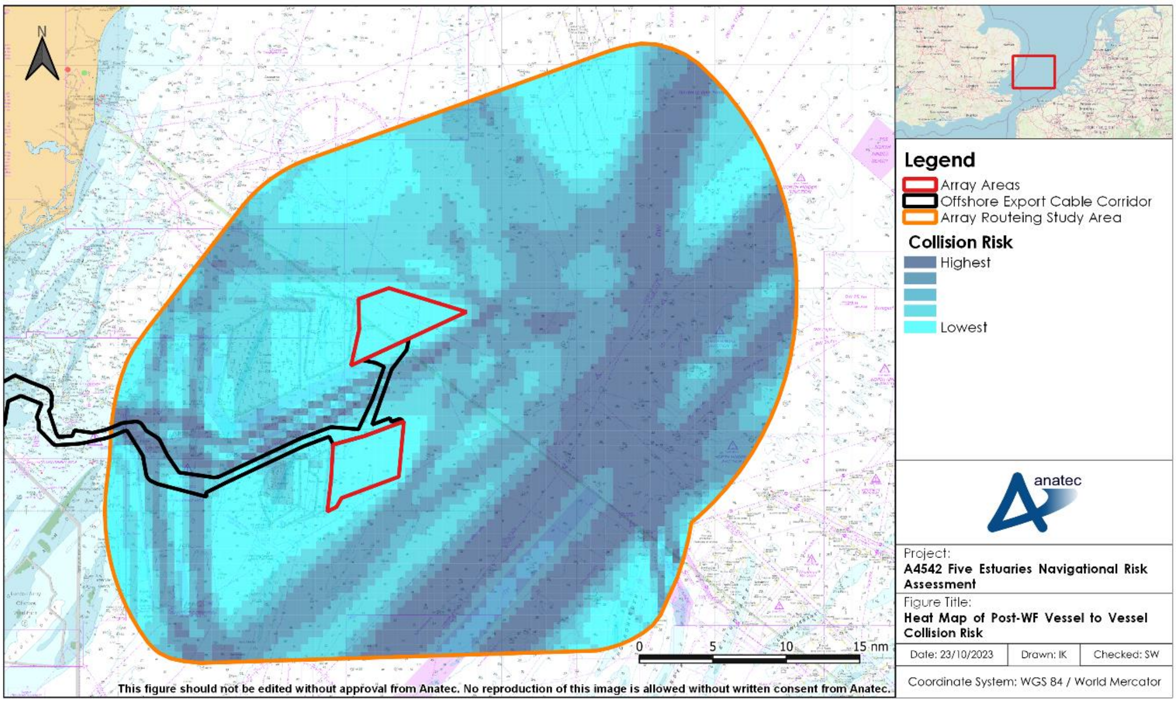

Figure 16.4 Heat Map of Post-WF Vessel to Vessel Collision Risk

440. Assuming base case traffic levels, the annual collision frequency post wind farm was estimated to be 1.92×10^{-1}, corresponding to a return period of approximately one in 5.20 years. This represents a 0.32% increase in collision frequency compared to the pre wind farm base case result.

441. The change in vessel to vessel collision risk between the base case pre wind farm and post wind farm scenarios is presented in a heat map in Figure 16.5. Generally, there is an increase in collision risk where routeing traffic has been displaced to and a decrease in collision risk where routeing traffic has been displaced from.

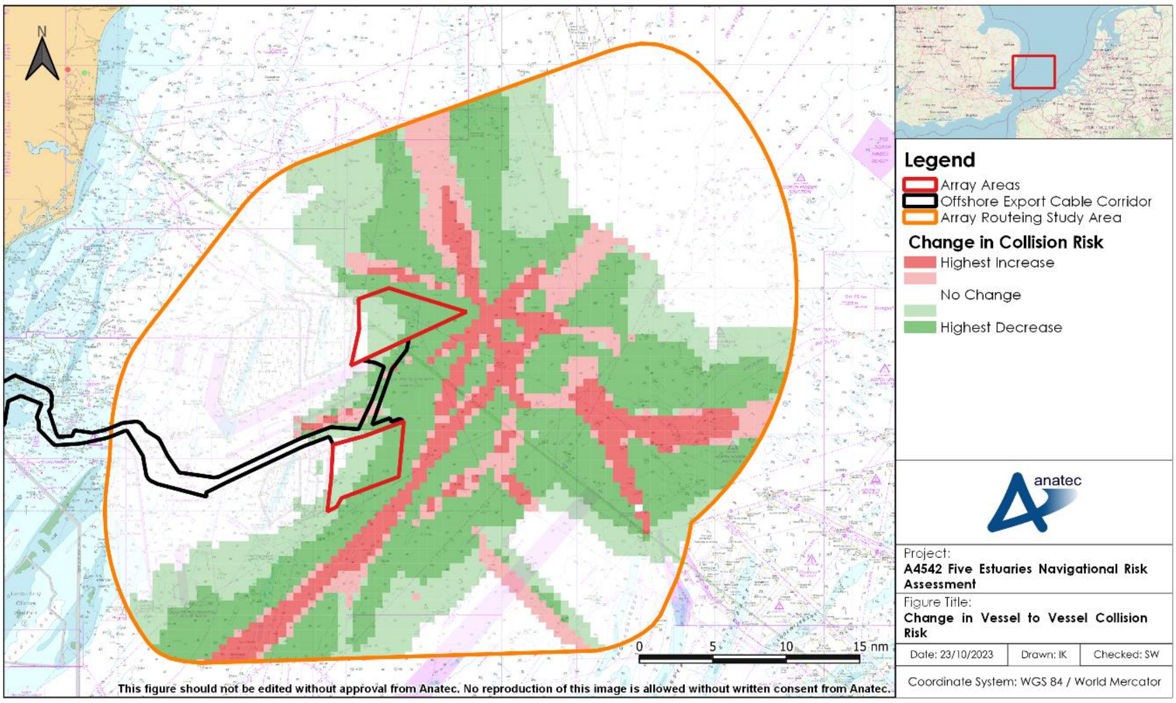

Figure 16.5 Change in Vessel to Vessel Collision Risk

16.4.3 Powered Vessel to Structure Allision Risk

442. Based upon the vessel routeing identified in the array routeing study area, the anticipated re-routeing as a result of the presence of VE, and assumptions that relevant embedded mitigation measures are in place (see Section 21), the frequency of an errant vessel under power deviating from its route to the extent that it came into proximity with a wind farm structure associated with VE is considered to be low.

443. From consultation with the shipping industry, 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 and those present at VE. During the construction and decommissioning phases this will primarily consist of the buoyed construction area whilst during the O&M phase this will primarily consist of the lighting and marking of the wind farm structures.

444. Using the post wind farm routeing as input, together with the worst-case indicative array layout and local meteorological ocean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the wind farm structures within the array areas whilst under power. In order to maintain an MDS, the model did not consider one structure shielding another.

445. A plot of the annual powered allision frequency per structure for the base case is presented in Figure 16.6, with the chart background removed to increase the visibility of those structures with lower allision frequencies.

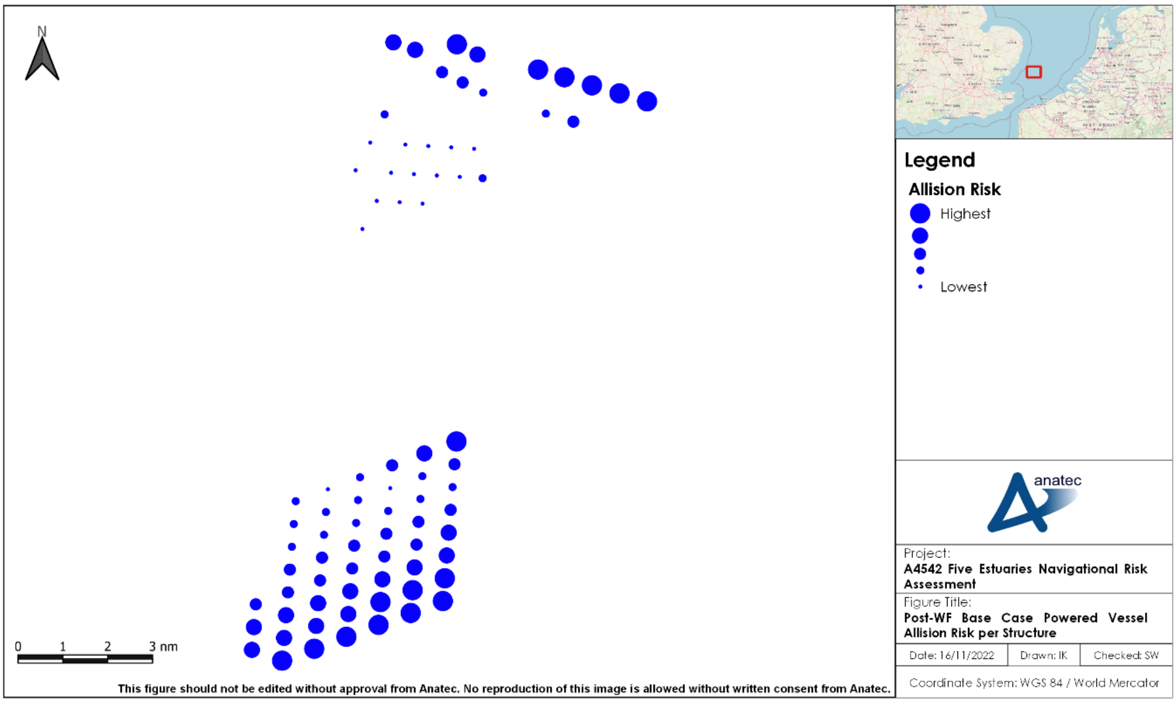

Figure 16.6 Post-OWF Base Case Powered Vessel Allision Risk per Structure

446. Assuming base case vessel traffic levels, the annual powered allision frequency was estimated to be 1.34×10^{-3}, corresponding to a return period of approximately one in 746 years.

447. The greatest powered vessel to structure allision risk was associated with structures at the south-eastern extent of the southern array area where a high volume of traffic from multiple main commercial routes associated with the North Hinder TSS pass, and the northern extent of the northern array area where the main commercial route between Harwich Haven and the Port of Rotterdam passes in close proximity (1 nm). The greatest individual allision risk was associated with the most eastern structure on the northern array area (approximately 4.17×10^{-4} or one in 2,400 years).

16.4.4 Drifting Vessel to Structure Allision Risk

448. Using the post wind farm routeing as input, together with the worst-case indicative array layout and local meteorological ocean data, Anatec's COLLRISK model was run to estimate the likelihood of a commercial vessel alliding with one of the wind farm structures within the array area. 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 errors caused by human actions.

449. The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the array area (up to 10 nm from the array area). These have been estimated based on the vessel traffic levels, speeds, and revised routeing patterns.

The exposure is divided by vessel type and size to ensure that these specific factors, which based upon analysis of historical incident data have been shown to influence incident rates, are taken into account for the modelling.

450. Using this information, the overall rate of mechanical failure in proximity to the array areas was estimated. The probability of a vessel drifting towards a wind farm structure and the drift speed are dependent on the prevailing wind, wave, and tidal conditions at the time of the incident. Therefore, three drift scenarios were modelled, each using the meteorological ocean data provided in Section 8:

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

451. The probability of vessel recovery from drift is estimated based upon the speed of the drift and hence the time available before arriving at a wind farm structure. Vessels which do not recover within this time are assumed to allide. Conservatively, no account is made for another vessel (including a project vessel) rendering assistance.

452. After modelling the three drifting scenarios, it was established that the flood tide dominated scenario produced the worst-case results. A plot of the annual powered allision frequency per structure for the base case is presented in Figure 16.7, with the chart background removed to increase the visibility of those structures with a low allision frequency.

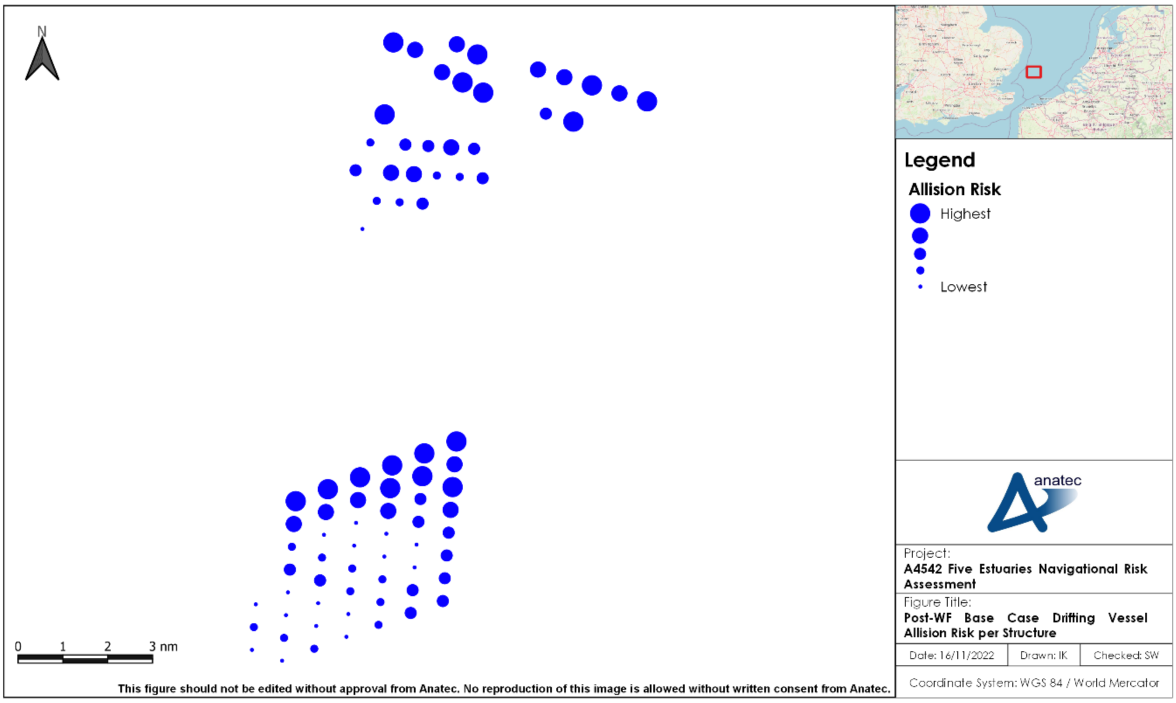

Figure 16.7 Post-OWF Base Case Drifting Vessel Allision Risk per Structure

453. Assuming base case vessel traffic levels, the annual drifting allision frequency was estimated to be 1.71×10^{-3}, corresponding to a return period of approximately one in 584 years.

454. The greatest drifting vessel to structure allision risk was associated with structures in the northern array area and northern perimeter of the southern array area where multiple main commercial routes pass at the minimum mean distance from the array area (1 nm). The greatest individual allision risk was associated with a structure on the northern perimeter of the northern array area (approximately 3.13×10^{-4} or one in 3,197 years).

455. It is noted that historically there have been no reported drifting allision incidents with wind farm structures in the UK. Whilst drifting vessels do occur every year in UK waters, in most cases the vessel has been recovered prior to any allision incident occurring (such as by anchoring, restarting engines, or being taken in tow).

16.4.5 Fishing Vessel to Structure Allision Risk

456. Using the vessel traffic survey data as input, Anatec's COLLRISK model was run to estimate the likelihood of a fishing vessel alliding with one of the wind farm structures within the array areas.

457. A fishing vessel allision is classified separately from other allisions since, unlike in the case of the commercial traffic characterised using the main commercial routes, fishing vessels may be either in transit or actively fishing. Moreover, fishing vessels

could be observed internally within the array in addition to externally. Anatec's COLLRISK model uses vessel numbers, sizes (length and beam), array layout and structure dimensions. The likelihood of a major allision incident has been calibrated against historical maritime incident data and historical AIS vessel traffic data within operational OWF arrays. Given that not all fishing vessels broadcast on AIS, the vessel density observed is scaled up to account for non-AIS fishing vessels, with the scaling factor dependent on the distance of the array offshore.

458. A plot of the annual fishing vessel allision frequency per structure for the base case is presented in Figure 16.8.

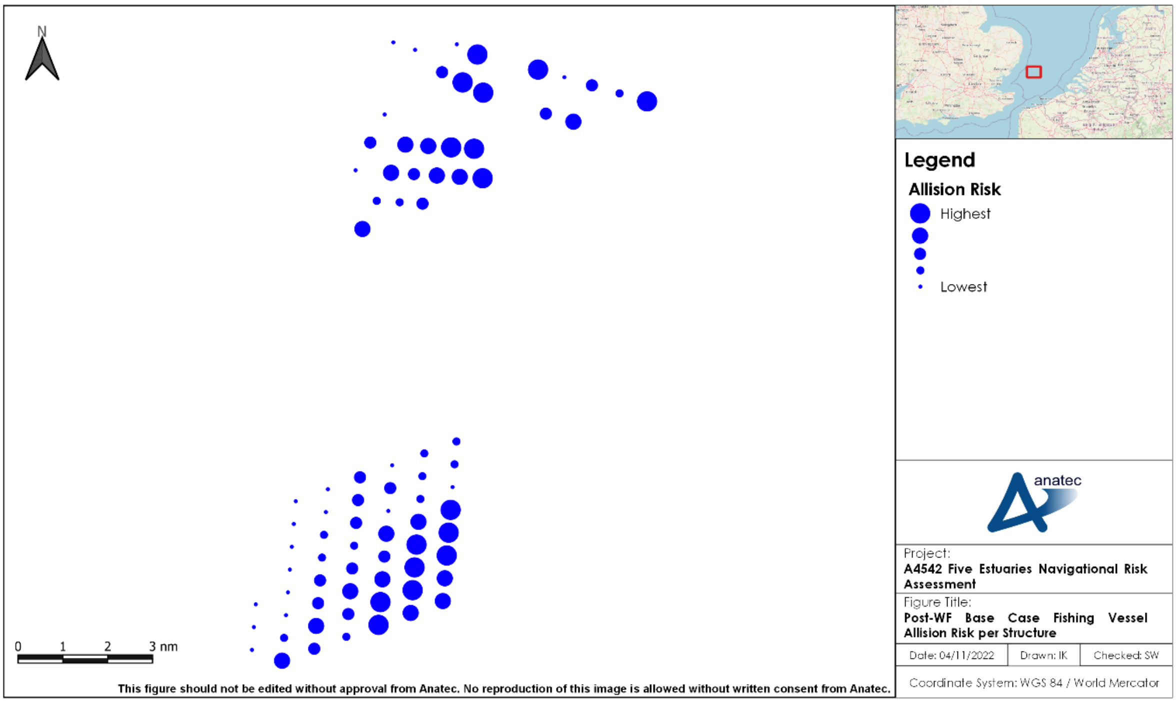

Figure 16.8 Post-WF Base Case Fishing Vessel Allision Risk per Structure

459. Assuming base case vessel traffic levels, the annual fishing vessel to structure allision frequency was estimated to be 2.92×10^{-1}, corresponding to a return period of approximately one in 3.43 years.

460. The majority of structures with greatest fishing vessel to structure allision risk were in the southern array area where active fishing activity was observed. The greatest individual allision risk however was associated with one of the structures in the northern array area (approximately 3.37×10^{-2} or one in 47 years).

16.5 Risk Results Summary

461. The previous sections modelled two scenarios, namely the pre and post wind farm scenarios with base case traffic levels. In order to incorporate the potential for future

traffic growth pre and post wind farm scenarios each with future case traffic levels have also been modelled. Table 16.1 summarises the results of all eight scenarios.

Table 16.1 Risk Results Summary

Risk	Scenario	Annual Frequency		
		Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	Base case	1.92×10^{-1} (1 in 5.22 years)	1.92×10^{-1} (1 in 5.20 years)	6.17×10^{-4} (1 in 1,619 years)
	Future case (10%)	2.33×10^{-1} (1 in 4.29 years)	2.34×10^{-1} (1 in 4.27 years)	7.66×10^{-4} (1 in 1,306 years)
	Future case (20%)	2.77×10^{-1} (1 in 3.61 years)	2.78×10^{-1} (1 in 3.60 years)	9.02×10^{-4} (1 in 1,108 years)
	Future case (30%)	3.24×10^{-1} (1 in 3.09 years)	3.25×10^{-1} (1 in 3.08 years)	1.04×10^{-3} (1 in 958 years)
Powered vessel to structure allision	Base case	N/A	1.34×10^{-3} (1 in 746 years)	1.34×10^{-3} (1 in 746 years)
	Future case (10%)	N/A	1.48×10^{-3} (1 in 676 years)	1.48×10^{-3} (1 in 676 years)
	Future case (20%)	N/A	1.61×10^{-3} (1 in 621 years)	1.61×10^{-3} (1 in 621 years)
	Future case (30%)	N/A	1.74×10^{-3} (1 in 574 years)	1.74×10^{-3} (1 in 574 years)
Drifting vessel to structure allision	Base case	N/A	1.71×10^{-3} (1 in 584 years)	1.71×10^{-3} (1 in 584 years)
	Future case (10%)	N/A	1.89×10^{-3} (1 in 529 years)	1.89×10^{-3} (1 in 529 years)
	Future case (20%)	N/A	2.06×10^{-3} (1 in 486 years)	2.06×10^{-3} (1 in 486 years)
	Future case (30%)	N/A	2.23×10^{-3} (1 in 449 years)	2.23×10^{-3} (1 in 449 years)
Fishing vessel to structure allision	Base case	N/A	2.92×10^{-1} (1 in 3.43 years)	2.92×10^{-1} (1 in 3.43 years)
	Future case (10%)	N/A	3.21×10^{-1} (1 in 3.43 years)	3.21×10^{-1} (1 in 3.43 years)
	Future case (20%)	N/A	3.50×10^{-1} (1 in 2.86 years)	3.50×10^{-1} (1 in 2.86 years)
Total	**Base case**	**1.91×10^{-1} (1 in 5.22 years)**	**4.87×10^{-1} (1 in 2.05 years)**	**1.05×10^{-1} (1 in 9.54 years)**
	Future case (10%)	**2.33×10^{-1} (1 in 4.29 years)**	**5.58×10^{-1} (1 in 1.79 years)**	**3.03×10^{-1} (1 in 3.30 years)**
	Future case (20%)	**2.77×10^{-1} (1 in 3.61 years)**	**6.32×10^{-1} (1 in 1.58 years)**	**3.65×10^{-1} (1 in 2.74 years)**

Risk	Scenario	Annual Frequency		
		Pre Wind Farm	Post Wind Farm	Change
	Future case (30%)	**3.24×10^{-1} (1 in 3.09 years)**	**6.79×10^{-1} (1 in 1.47 years)**	**3.53×10^{-1} (1 in 2.83 years)**

17 Navigation Corridor Safety Case

462. This section considers the navigation corridor between the northern array area and East Anglia Two and, where appropriate, uses available guidance to provide a safety case for the corridor from a navigational perspective.

463. Figure 17.1 presents an overview of the gap between the array areas and East Anglia Two. For the purposes of this subsection, East Anglia Two is represented by the array area boundary published by The Crown Estate (TCE), noting that a final array layout has not been published at the time of writing. Therefore, as a worst case, it is assumed that build out of East Anglia Two could maximise use of the array area.

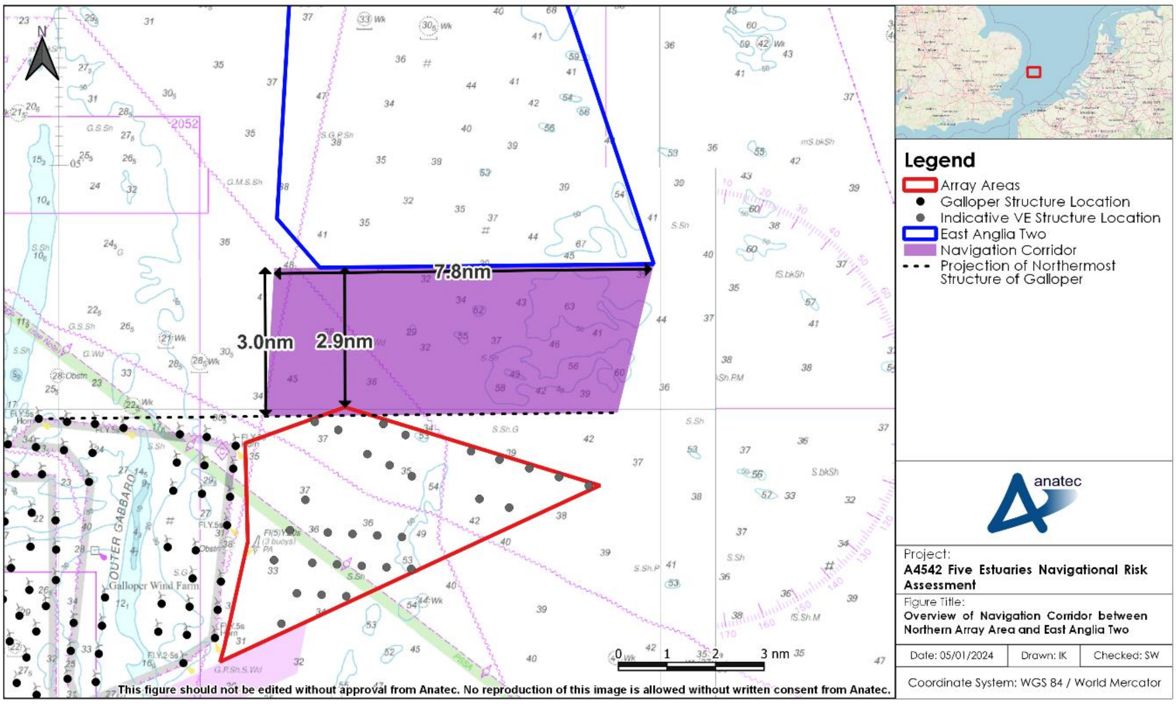

Figure 17.1 Overview of Navigation Corridor between Northern Array Area and East Anglia Two

464. The navigation corridor takes a trapezium shape, with the northern and southern edges parallel. The dotted line on the southern edge has been projected east from the northernmost structure associated with Greater Gabbard and Galloper given that this represents a waypoint vessels currently use for navigating in the area.

465. Measured east-west at the northern extent, the length of the corridor is 7.8 nm. At the narrowest point, the width of the corridor[8] is 3.02 nm, although this width does include a small overlap of the northern array area into the corridor; this overlap amounts to a north-south distance of approximately 315 m (0.16 nm) and so the effective corridor width is approximately 2.86 nm. The consideration of the corridor

[8] Measured from the array area boundary of East Anglia Two.

in alignment with Galloper was welcomed by the UK Chamber of Shipping during consultation (see Section 17.11).

17.1 Existing Navigational Features

466. The charted water depth within the navigation corridor varies between 29 and 62 m below CD. There are no existing surface features within the corridor with the only surface features in proximity the WTGs for Galloper. There are three existing subsea cables within the corridor of which two cross the corridor (Concerto 1 North and Atlantic Crossing 1).

467. The North Inner Gabbard marine aggregate area (Area 498) is located approximately 6.2 nm west of the navigation corridor.

17.2 Future Navigational Features

468. The East Orford Ness marine aggregate area (Area 1809) is located approximately 4.1 nm west of the navigation corridor, immediately east of Area 498. This exploration and option area was awarded as part of TCE's 2018/19 marine aggregate tender round.

17.3 Potential Users

469. From the assessment of cumulative post wind farm routeing (see Section 15), it is anticipated that one main commercial route may use the navigation corridor (Route 3). This route primarily consists of Stena Line and DFDS Seaways operated Ro-Ro and Ro-Pax routes between the Port of Felixstowe/Harwich Haven and the Port of Rotterdam. Across this main commercial route and minor routes (less than one transit per day), there is an average of 11 to 12 transits per day by potential users.

470. Applying a conservative 20% increase in commercial vessel movements for the future case scenario (as outlined in Section 15), an average of 14 transits per day by potential navigation corridor users is considered throughout the rest of this section. This increase does not directly reflect the worst case increase considered in the review of future case vessel traffic (see Section 15) but it is recognised that the largest volume increases anticipated are associated with use of the Sunk routeing measure rather than the sea area associated with the navigation corridor.

471. The average length of potential corridor users was 193 m with a 90th percentile length of 240 m. The 90th percentile length is considered throughout the rest of this section, noting that it is well aligned with the two most prominent vessels deemed potential users (Stena Line operated Ro-Pax ferries). Applying a conservative 10% increase in commercial vessel size for the future case scenario, the applied vessel length is 264 m.

17.3.1 Simulated Automatic Identification System

472. In their Section 42 response, the UK Chamber of Shipping (in a joint position with DFDS Seaways and Stena Line) suggested that stakeholders would benefit from simulated AIS being used to provide an illustration of how potential corridors users may navigate post development of VE and East Anglia Two.

473. A plot of 28 days of simulated AIS (matching the total duration of the vessel traffic surveys) within and in proximity to the navigation corridor is presented in Figure 17.2. This is based on only the cumulatively deviated main commercial routes passing through the corridor and assumes worst case deviations and passing distances. In this future case it is likely that vessels will adapt a less constrained routeing pattern given the sea room available.

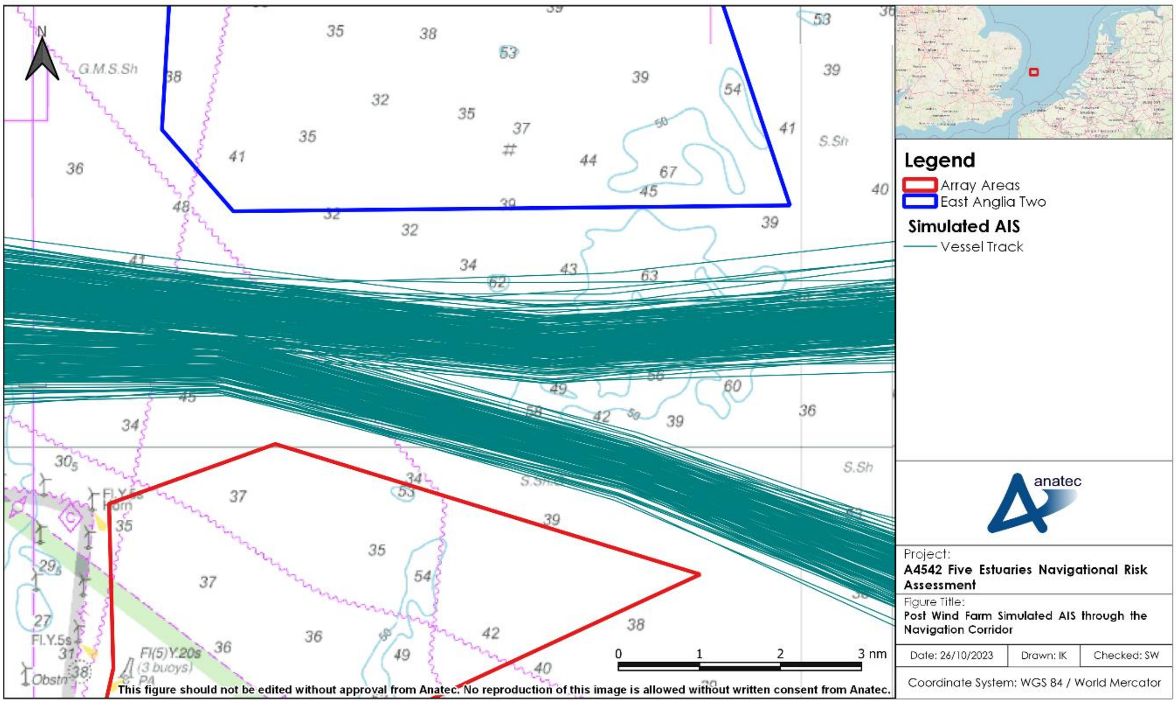

Figure 17.2 Post Wind Farm Simulated AIS through the Navigation Corridor

17.4 Application of Marine Guidance Note 654

474. Whilst Section 17.3 provides a realistic scenario for routeing based on the presence of East Anglia Two (as requested by the UK Chamber of Shipping), this subsection intends to quantify the acceptability of the navigation corridor in line with the several methods outlined in MGN 654. Those methods for calculating the safe width of a navigation corridor are demonstrated in the following subsections.

17.4.1 Vessels Overtaking

475. MGN 654 states that:

476. *The possibility of ships overtaking cannot be excluded and should be taken into consideration. Consequently, the assumption should be that four ships should safely be able to pass each other… Between overtaking and meeting vessels, a distance of two ship's lengths is normally maintained as a minimum passing distance.*

477. Therefore, the overtaking width for the navigation corridor, based on the 90th percentile length, is 0.86 m. To determine the overall corridor width, the suitable distance between the outermost vessels and the array areas is required. The Shipping Route Template indicates that 1 nm is the "*minimum distance to a parallel IMO routeing measure*" and is widely accepted in the industry as a generally safe passing distance from an OWF.

478. Therefore, the minimum overall width for the navigation corridor, based on the 90th percentile length is **2.86 nm**.

17.4.2 Twenty-Degree Rule

479. MGN 654 states that:

480. *Experience also shows that in heavy sea conditions it is much harder to turn the vessel around and [it] may not be possible to achieve a dead stop and deviations from track are common. Therefore 20° or more, are common and must be considered in developing corridors through OREIs.*

481. Applying this 20-degree rule to the navigation corridor length of 7.8 nm gives a corresponding width requirement of **2.84 nm**.

17.4.3 Shipping Route Template

482. MGN 654 includes a Shipping Route Template (Annex 2) which states that a "*minimum separation distance between turbines on opposite sides of a route*" of **3.5 nm** is low risk and broadly acceptable. A distance of between 2 and 3.5 nm (the bracket within which the navigation corridor falls) is also considered low risk but tolerable if ALARP.

17.5 Application of Permanent International Association of Navigation Congresses Guidance

483. The Guidance on the Interaction Between Offshore Wind Farms and Maritime Navigation (World Association for Waterborne Transport Infrastructure (PIANC), 2018) provides a methodology for calculating the width of the corridor required to make a round turn to starboard in the event of a head-on encounter between two vessels. Although this methodology is designed for a TSS running parallel to an OWF, it is considered relevant and useful for corridor design, noting that vessels will have greater flexibility to alter course in the event that collision avoidance is required than would be the case within an IMO routeing measure.

484. As illustrated in Figure 17.3, the calculation assumes an initial deviation of 0.3 nm, turning circle of six vessel lengths diameter and 500 m safety margin.

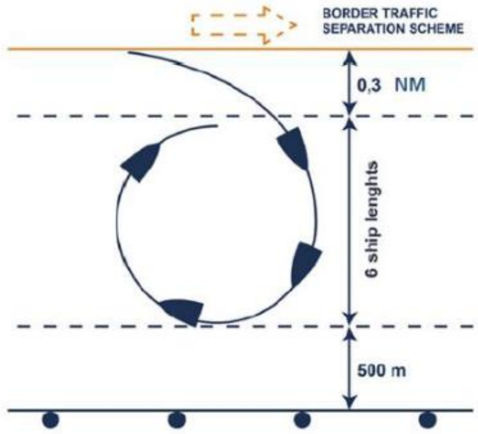

Figure 17.3 Sea Space Required for a Full Round Turn to Starboard (PIANC, 2018)

485. Applying the calculation to the navigation corridor gives a total width requirement of **2.85 nm**, with the breakdown of the distances considered illustrated in Figure 17.4.

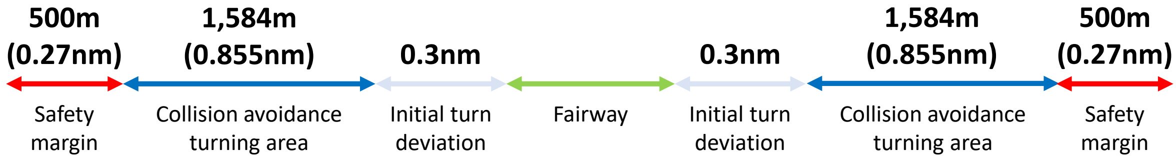

Figure 17.4 Application of PIANC Guidance to Navigation Corridor Between the Northern Array Area and East Anglia Two

17.6 Application of Maritime Institute Netherlands Guidance

486. A study undertaken by the Maritime Institute Netherlands (MARIN) and referenced in both the PIANC guidance and The Shipping Industry and Marine Spatial Planning (MSP) – A Professional Approach (Nautical Institute, 2013) states that the width of a navigation corridor should consider:

1. *Number of vessels: based on AIS study, keeping in mind the future development during the lifespan of the structures;*
2. *Maximum size of vessels: same as point 1 re: future development;*
3. *Number of vessels overtaking:*
    a. *<4,400 vessels per year: 2 vessels side to side.*
    b. *>4,400 vessels and <18,000 vessels: 3 side to side.*
    c. *>18,000 vessels: 4 vessels side to side.*
4. *Room per vessel: 2 ship lengths.*

487. The following example is then provided, noting that a separation of one vessel length between the flank vessels and the array is assumed:

488. *For example: a traffic lane that accommodates 18,000 vessels per year with a maximum size of 400 m should be at least 3,200 m (1.72 nm) wide.*

489. Applying this calculation to the navigation corridor, the number of potential users per day was estimated as 14, which corresponds to approximately 5,100 vessels per year. Under the Maritime Institute Netherlands (MARIN) guidance this leads to an assumption that three vessels should be able to pass side by side through the corridor. Therefore, the overall corridor width (inclusive of the separation between the flank vessels and the array areas) is **0.86 nm**.

490. Applying the more conservative MGN 654 Shipping Route Template value of 1 nm between the flank vessels and the array areas, the overall corridor width is **2.57 nm**.

17.7 Application of International Regulations for Preventing Collisions at Sea

491. The COLREGs are the rules and regulations that help regulate vessel traffic movements throughout the world. It is therefore important that the navigation corridor does not prevent a vessel from being able to comply with these regulations. Although the COLREGs do not make specific provision for a separation between OWFs such as a navigation corridor, they do lay down rules for navigating within a narrow channel which may be somewhat applicable.

492. Rule 9a states:

493. *A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.*

494. However, a vessel should not enter the corridor unless it is confident that it can alter course and manoeuvre as required to comply with the collision regulations and avoid a collision. Course alterations within the corridor should not be required under most circumstances given that vessels will be able to navigate straight through on a generally east-west bearing.

495. Rule 9b states:

496. *A vessel of less than 20 m in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.*

497. Furthermore, Rule 9c states:

498. *A vessel engaged in fishing shall not impede the passage of any other vessel navigation within a narrow channel or fairway.*

499. Although the COLREGs give priority to vessels navigating within a narrow channel it is still prudent for the purpose of minimising the navigational risk to consider any dense activity involving relevant small craft.

500. From analysis of non-commercial vessel traffic (see Section 10 and Appendix D), there is heavy fishing vessel presence, particularly at east of the corridor. Based on track behaviour such vessels are characteristic of active trawling activities. Recreational vessel presence within and in proximity to the corridor is low.

501. The shape of the navigation corridor is favourable for identifying active fishing vessels whilst making passage eastbound through the corridor. Towards the eastern extent, the corridor width gradually increases to approximately 4.7 nm, giving sufficient sea room to allow commercial traffic and active fishing to continue to coexist, noting that such coexistence is already evidenced in the baseline.

17.8 Effect of Crossing Commercial Traffic

502. From analysis of commercial traffic (see Section 10 and Appendix D), there is north-south commercial routeing which may cross those routes utilising the navigation corridor. In particular, there is a heavily trafficked main route that passes east of East Anglia Two (Route 4 in Section 11.2).

503. As seen across the post wind farm routeing scenarios (VE in isolation and cumulatively), the presence of East Anglia Two has limited additional effect on these crossing points, with vessel Masters already very alert given the complexities of navigation in this region.

504. Moreover, the minimum spacing between structures within the northern array area (830 m measured centre-to-centre) and the East Anglia Two array area (consented minimum spacing of 800 m (ScottishPower Renewables, 2019)) will assist with the earlier detection by corridor users of approaching crossing traffic.

17.9 Effect of Non-Transit Users

17.9.1 Fishing Vessels

505. A fishing vessel engaged in fishing activities may be unable to make a manoeuvre in sufficient time to avoid an oncoming commercial vessel making passage through the navigation corridor. However, the shape of the corridor (as discussed at the start of Section 17) will maximise opportunity for the commercial vessel to make a course alteration to avoid an encounter developing into a collision incident or near miss.

506. Additionally, the minimum spacing between structures (as described in Section 6.2.1) will assist with the earlier detection by corridor users of any smaller craft present within or on the other side of the corridor[9].

[9] This point is relevant to recreational vessels and wind farm vessels in addition to fishing vessels.

17.9.2 Marine Aggregate Dredgers

507. From analysis of marine aggregate dredgers (see Section 10 and Appendix D), there is active aggregate dredging located within the North Inner Gabbard marine aggregate area (Area 498). Additionally, although currently an exploration and option area, the East Orford Ness aggregate area (Area 1809) may feature active aggregate dredging in the future.

508. However, given the distance between the navigation corridor and these marine aggregate areas (6.2 and 4.2 nm, respectively), it is anticipated that westbound corridor users will have sufficient time and distance upon exiting the corridor to make a course alteration to avoid an encounter developing into a collision incident or near miss.

509. Additionally, the width of the navigation corridor increases at the western extent towards 4.5 nm, will maximise opportunity for corridor users to alter course as required.

17.9.3 Project Vessels

510. For project vessels, any movements within or in proximity to the navigation corridor will be made in line with the embedded mitigation measures (see Section 21) which include marine coordination and compliance with the COLREGs. A similar mitigation measure is provided in the East Anglia Two NRA (Anatec, 2019) in relation to vessels associated with East Anglia Two works:

511. *Compliance from all vessels associated with the offshore development area with international maritime regulations as adopted by the relevant flag state… marine traffic coordination.*

512. With these mitigation measures in place, it is not anticipated that vessels (either for VE or East Anglia Two) will have any detrimental effect on the ability of navigation corridor users to make passage safely.

17.9.4 Third-Party Wind Farm Vessels

513. From analysis of wind farm vessels (see Section 10 and Appendix D), there is O&M works associated with the Greater Gabbard and Galloper arrays. However, for both developments non-transit activities typically occur at the location of surface infrastructure and therefore is confined to within the array areas. Therefore, use of the navigation corridor is not anticipated to be affected by the presence of third-party wind farm vessels.

17.10 Radar Interference

514. For vessels transiting through the navigation corridor there may be potential for increased exposure to Radar interference. This is considered fully in Section 13 as part of the wider assessment of risks associated with navigation, communication and

position fixing equipment and is not considered to have carry a substantial significant of risk. In particular, it is very unlikely that vessels will navigate within 0.5 nm of a WTG on either side of the corridor (the distance at which intolerable risks can be experienced).

17.11 Consultation

515. The cumulative scenario has been highlighted throughout the EIA Scoping and NRA process for VE. For example, the shipping and navigation section of the Scoping Report included a targeted question for stakeholders in relation to the scope of the cumulative assessment:

516. *Are there any specific cumulative projects that are considered relevant to VE and do they create a specific cumulative risk that requires consideration in the NRA?*

517. This was mirrored in the Regular Operator consultation undertaken (see Appendix C) and the Hazard Workshop (see Section 4.2).

17.11.1 Pre Preliminary Environmental Information Report

518. Limited feedback was received up to the PEIR stage in relation to the navigation corridor. During the Hazard Workshop, the UK Chamber of Shipping noted that the corridor requires consideration as part of the cumulative risk assessment (and limited feedback can be provided until this is undertaken), and MCA added that relevant guidance such as MGN 654 and that published by PIANC should be applied to the assessment. The two main Regular Operators which are potential corridor users – Stena Line and DFDS Seaways – were both present at the Hazard Workshop but raised no concerns.

17.11.2 Post Preliminary Environmental Information Report

519. Following PEIR, the UK Chamber of Shipping raised concerns in a joint position with DFDS Seaways and Stena Line relating to the variable width of the navigation corridor resulting from the refinement of the northern array area. This results in a potential convergence of vessel traffic at the narrowest point, increasing collision and allision risk.

520. The interpretation of the navigation corridor presented in Figure 17.1 (and described in the text that follows) was produced in response to this concern and shared with the UK Chamber of Shipping and DFDS Seaways alongside simulated AIS for the potential users (see Section 16.4.1). Both stakeholders were content with the corridor when considered in alignment with Galloper and this interpretation was also welcomed by MCA and Trinity House.

17.12 Overlap with Northern Array Area

521. As noted at the start of the safety case, there is a small overlap of the northern array area into the navigation corridor covering a north-south distance of approximately 315 m (0.16 nm). This means the effective corridor width is approximately 2.86 nm.

522. The indicative worst case array layout introduced in Section 6.2.1 does not include any surface structures within the overlap area. However, at this time it is not possible for the Applicant to commit to no surface structures being located within this overlap area (inclusive of blade overfly).

523. Relevant guidance applied to the navigation corridor earlier in this safety case has indicated that the width of the corridor when measured to the northern array area is sufficient, i.e., the corridor is compliant with the various width calculations. The additional sea room afforded by excluding the overlap area is relatively low, corresponding to a 5.6% width increase.

524. The width of the corridor was raised as a concern during Section 42 consultation by the UK Chamber of Shipping, DFDS Seaways, and Stena Line, noting that whilst the corridor is compliant with guidance, the northern extent of VE in combination with a full build out of East Anglia Two will lead to a convergence of traffic at the narrowest point. Further consultation was undertaken with these stakeholders post PEIR during which consideration was given to the northern extent of Galloper which already ensures that traffic will align with the northern extent of VE (as illustrated in Figure 17.1). Therefore, when considered on a wider basis this matter was considered acceptable with suitable mitigation to ensure the minimisation of protruding structures and risk of allision. Furthermore, this has been discussed with Trinity House and MCA with agreement that the corridor width is suitable, subject to post consent agreement on specific turbine locations.

525. The simulated AIS (see Section 16.4.1) indicates that there is sufficient sea room for the commercial routeing to continue in the presence of both the array areas and East Anglia Two, with little spatial overlap of the routes. However, there is some limited spatial overlap of the routes towards the western extent where the narrowest point of the corridor occurs. Although this may give rise to increased collision risk compared to the in isolation scenario, the majority of vessels on these routes are operated by just two operators (DFDS Seaways and Stena Line) headed to and from the same ports (Harwich and Rotterdam). Therefore, there is a high level of familiarity with the route and other users which limits the likelihood of an encounter situation developing.

17.13 Embedded Mitigation Measures

526. Embedded mitigation measures for VE as a whole in relation to shipping and navigation are described fully in Section 21. Embedded mitigation measures that

contribute to ensuring the significance of risk associated with the navigation corridor is ALARP include:

- Compliance with MGN 654;
- Lighting and marking;
- Marine coordination for project vessels;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

17.14 Summary and Conclusion

527. This safety case has considered the following in relation to the navigation corridor between the northern array area and East Anglia Two:

- Existing and future navigational features;
- Volume and size of potential corridor users;
- Simulated AIS for potential corridor users;
- Relevant guidance and legislation including MGN 654, PIANC guidance, MARIN guidance, and the COLREGs;
- Non-transit users and activities;
- Radar interference;
- Consultation undertaken with relevant stakeholders including Regular Operators;
- Potential overlap of the corridor with the northern array area; and
- Relevant embedded mitigation measures.

528. Table 17.1 summarises the outcome of the various width calculations undertaken based on relevant guidance, noting that the proposed minimum navigation corridor width is 2.86 nm.

Table 17.1 Summary of Navigation Corridor Width Calculations

Guidance	Minimum Corridor Width Required (nm)	Notes (Where Applicable)
MGN 654 – vessels overtaking	2.86	With application of 1 nm minimum passing distance between flank vessels and each array area (as per MGN 654 Shipping Route Template).
MGN 654 – 20-degree rule	2.84	Based on a corridor width of 7.8 nm.
MGN 654 – Shipping Route Template	2.0	Associated with the tolerable if ALARP parameters of 2 to 3.5 nm being low risk.

Guidance	Minimum Corridor Width Required (nm)	Notes (Where Applicable)
PIANC – collision avoidance	2.85	Assumes a round turn could occur towards either array area since the corridor will allow two-way navigation.
MARIN – vessels overtaking	0.86	With application of one vessel length between flank vessels and each array area (as per MARIN guidance).
	2.57	With application of 1 nm minimum passing distance between flank vessels and each array area (as per MGN 654 Shipping Route Template).

529. The MGN 654 vessels overtaking, MGN 654 20-degree rule and PIANC collision avoidance calculations all result in similar minimum corridor width requirements which are aligned with the proposed minimum navigation corridor width. For the MGN 654 Shipping Route Template, the corridor falls within the parameters of being considered tolerable if ALARP.

530. Therefore, with the relevant embedded mitigation measures in place (thus ensuring the significance of risk is ALARP), the navigation corridor is considered to meet safety of navigation expectations.

18 Introduction to Risk Assessment

531. Section 19 provides a qualitative and quantitative risk assessment (using FSA) for the hazards identified due to VE, based on baseline data, expert opinion, outputs of the Hazard Workshop, stakeholder concerns and lessons learnt from existing offshore developments. The hazards assessed are as follows:

- Vessel displacement and increased collision risk;
- Third-party with project vessel collision risk;
- Reduced access to local ports and harbours and reduction in under keel clearance;
- Creation of allision risk;
- Anchor interaction with subsea cables; and
- Reduction of emergency response capability (including SAR access).

532. The shipping and navigation users considered are as follows:

- Commercial vessels;
- Recreational vessels;
- Commercial fishing vessels in transit;
- Military vessels;
- Anchored vessels;
- Emergency responders; and
- Local ports and services including pilot vessels.

533. For each hazard, the full description of the hazard is provided in *italicised* text. This is followed by assessment of the hazard for the in isolations scenario (VE only) and the cumulative scenario (VE alongside those cumulative developments screened in Section 14.1). The cumulative scenario is considered on a tiered basis to ensure all realistic build out scenarios are accounted for:

- Tier 1 – East Anglia Two, East Orford Ness 1809, NeuConnect, North Falls, and Sea Link;
- Tier 2 – East Anglia One North and Outer OTE 528/2; and
- Tier 3 – East Anglia Three, Hollandse Kust (West), Hollandse Kust F, Norfolk Vanguard East, and Norfolk Vanguard West.

534. Each hazard covers the array areas, offshore ECC, or both, as appropriate with consideration of the MDS.

535. For each hazard, embedded mitigation measures which have been identified as relevant to reducing risk are listed, with full descriptions provided in Section 21.

536. Finally, the potential significance of risk has been determined for each hazard based on the frequency of occurrence and severity of consequence, based on the methodology defined in Section 3.2.

537. The risk control log (see Section 20) summarises the risk assessment and a concluding risk statement is provided (see Section 23.5).

19 Risk Assessment

19.1 Vessel Displacement and Increased Collision Risk (Array Areas)

538. *Construction/ decommissioning activities and the presence of surface structures within the array areas may result in the displacement of vessels from their existing routes and activities. This displacement may result in an increased risk of a collision between third-party vessels.*

19.1.1 In Isolation Scenario – All Users

539. The potential for displacement of vessels due to the presence of the array areas and associated construction activities has been raised by stakeholders during consultation including Stena Line, CLdN, and Intrada Ship Management.

540. The potential for increased collision risk for third-party vessels as a consequence of displacement has also been raised by multiple stakeholders during consultation including the MCA, Trinity House, UK Chamber of Shipping, Stena Line and Intrada Ship Management. The MCA and Trinity House also highlighted the need for consideration of IMO routeing measures and the ability for vessels to abide by the COLREGs when navigating within and in proximity to such routeing measures.

19.1.1.1 Main Commercial Route Displacement

541. During the construction and decommissioning phases, a buoyed construction/ decommissioning area will be deployed around each array area accounting for the presence of the traffic routeing between the two array areas. No restrictions on entry will be enforced for the buoyed construction/ decommissioning areas or the arrays during the O&M phase outside of any statutory safety zones. However, based on experience at previously under construction and existing operational OWFs (including the neighbouring Greater Gabbard and Galloper), it is anticipated that commercial vessels will choose not to navigate internally within the buoyed construction/ decommissioning areas or the operational arrays. These assumptions have been supported during consultation with Regular Operators including Stena Line, A2B-online and Tarmac Marine. Therefore, some displacement of main commercial routes is expected during all phases, with less available sea room for navigation, as highlighted by CLdN and Intrada Ship Management during consultation.

542. Main commercial routes have been identified in line with the principles set out in MGN 654 (MCA, 2021) based primarily on vessel traffic data collected during dedicated surveys (28 days in winter and summer 2022) and from coastal receivers (12 months in 2019) but also Anatec's ShipRoutes database. Further details of the methodology for main commercial route identification is provided in Section 11.1, noting that the vessel traffic data has been agreed as appropriate by the MCA and Trinity House, as well as being discussed within the Hazard Workshop. As part of the

future case considerations, increases of 10%, 20%, and 30% of all commercial traffic is assumed, in line with Section 15.5.1.

543. The full methodology for main commercial route deviations is provided in Section 15.9, with deviations established in line with MGN 654. A deviation may be required for six main commercial routes, as illustrated in Figure 15.5. The level of deviation varies between a decrease of 1 nm for Route 4 and an increase of 2.7 nm for Route 26, with the maximum percentage change in total route length being 1.4% (for Route 26).

544. The size of these deviations is small, particularly when considered relative to the length of the routes overall which range from 104 to 338 nm within the North Sea alone[10]. Effects on vessel approaches to IMO routeing measures in the region (such as the Sunk and North Hinder routeing measures) are therefore considered negligible. In some instances, these small deviations are resultant of the refinement of the array areas undertaken between the Scoping and PEIR stages which minimises the displacement to heavily trafficked commercial ferry routes, i.e., without this refinement the deviations would have been larger. This refinement has been well received by stakeholders including MCA, Trinity House, the UK Chamber of Shipping, Stena Line and DFDS Seaways (two of the key commercial ferry operators in the region).

545. Whilst vessel traffic on the deviated routes is regular the associated deviations are small. This aligns with consultation feedback from the MCA noting that the region features a number of regularly used routes and through traffic to major ports.

546. The most likely consequences of vessel displacement will be increased journey times and distances for affected third-party vessels, as indicated by Stena Line and CLdN during consultation. The hazard will occur over a local spatial extent given that the buoyed construction/ decommissioning areas will be deployed around the maximum extent of the array areas.

547. As a worst case, there could be disruption to schedules, particularly for commercial ferry operators in the region. However, given the anticipated size of the deviations outlined above and the international nature of routeing in the region alongside the ability to passage plan, disruptions to schedule are expected to be minimal.

19.1.1.2 Collision Risk

548. Post wind farm modelling using the main commercial route deviations as input gives an estimated collision return period of one in 5.20 years for base case traffic levels, rising to one in 3.08 years for the highest tier of future case traffic levels (30%). The high level of collision risk is due to the high volume of vessel traffic in the area,

[10] Some main commercial routes in the region extend beyond the North Sea, such as into the English Channel and the Baltic Sea. Such routes have a wide variety of potential destinations, and therefore determining an overall route length (to/from a specific port) beyond the North Sea is not feasible.

particularly within the North Hinder routeing measures. However, the base case collision result represents a 0.32% increase compared to the pre wind farm base case result indicating that the influence of the array areas on the overall collision risk for commercial traffic is very low. This reflects historical incident data which indicates that no collision incidents between third-party vessels have occurred directly as a result of a UK OWF.

549. In poor visibility, third-party vessels may experience limitations regarding visual identification of other third-party vessels, either when passing on another side of the buoyed construction/ decommissioning areas and operational arrays, or when navigating internally within the operational arrays (small craft only). These limitations may increase the potential for an encounter. However, this will be mitigated by the application of the COLREGs (reduced speeds) in adverse weather conditions. Moreover, the minimum spacing between structures (830 m) will be sufficient to ensure any visual hindrance is very short-term in nature.

550. The extension of the Sunk TSS East has been considered as possible additional mitigation for reducing the likelihood of a collision risk. However, given the refinement of the array areas since the Scoping stage, and the subsequent positive effect on hotspots of collision risk (for further details see Section 16.4), the MCA have confirmed that they do not propose to pursue an extension to the Sunk TSS East, with this stance widely supported at the Hazard Workshop. Additionally, Stena Line suggested that the arrays form a natural corridor, thus mitigating any need for an extension to the Sunk TSS East. Only MSC have indicated any preference during consultation for an extension to the Sunk TSS East, although MSC also raised the option of using cardinal buoys to mark the array areas.

551. The most likely consequences in the event of an encounter between two or more third-party vessels is the implementation of avoidance action in line with the COLREGs, with the vessels involved able to resume their respective passages with no long-term consequences.

552. Should an encounter develop into a collision incident, it is most likely to involve minor contact resulting in minor damage to the vessels with no harm to people and no substantial reputational effects. As a worst case with very low frequency of occurrence one of the vessels could receive substantial damage or founder with Potential Loss of Life (PLL) and pollution, with this outcome more likely where one of the vessels is a small craft (e.g., fishing vessel, recreational vessel or CTV).

553. It is acknowledged that vessel traffic monitoring will be undertaken throughout the construction phase to characterise changes to routeing patterns. These will be compared against the anticipated deviations determined in the NRA to allow a comprehensive review of the embedded mitigation measures applied at the time.

19.1.1.3 Adverse Weather Routeing

554. The need to consider commercial routeing in adverse weather conditions was highlighted by the MCA, Hanson Aggregates, and Intrada Ship Management during consultation.

555. From the long-term vessel traffic data, two cases of alternative routeing characteristic of possible adverse weather routeing were observed, featuring navigation between Grimsby/ Hull and Zeebrugge which passes through the northern array area. These cases are analysed further in Section 12.2, noting that neither of the vessels featured remain present in the region. During consultation CLdN acknowledged that the alternative routeing is likely a result of Master preference but may have limited benefits.

556. As with displacement to standard routeing, the refinement of the array areas undertaken between the Scoping and PEIR stages has increased the available sea room for such adverse weather routeing, such that it is anticipated that this routeing may safely continue during all phases.

557. In terms of frequency, during consultation the UK Chamber of Shipping and DFDS Seaways noted that adverse weather routeing represents a very small portion of all routeing in the region.

558. The most likely consequences of displacement of adverse weather routeing are similar to that of displacement of standard weather routeing, i.e., slightly increased journey times and distances for affected third-party vessels with the hazard occurring over a local spatial extent given that the buoyed construction/ decommissioning areas and infrastructure will be deployed around the maximum extent of the array areas.

559. As a worst case, the deviated route may be considered unsafe for navigation in adverse weather conditions resulting in the vessel being unable to make the transit. It is considered highly unlikely that the vessel would proceed on an unsafe transit and therefore the effect on the vessel and/ or crew is negligible due to the frequency of occurrence.

19.1.1.4 Promulgation of Information and Passage Planning

560. All vessels operating in the area are expected to comply with international flag state regulations (including the COLREGs and SOLAS) and will have a raised level of awareness of construction and decommissioning activities given the promulgation of information relating to VE including the charting of the construction/ decommissioning areas on relevant nautical charts and the use of safety zones. The buoyed construction/ decommissioning areas will also serve to maximise awareness. Likewise, during the O&M phase, infrastructure will be appropriately marked on relevant nautical charts and awareness of the operational arrays will be very high and continue to increase with the longevity of VE.

561. All vessels are expected to comply with flag state regulations including Regulation 34 of SOLAS Chapter V – which states that "*the voyage plan shall identify a route which… anticipates all known navigational hazards and adverse weather conditions*" (IMO, 1974) – and IMO Resolution A.893(21) on the Guidelines for Voyage Planning (IMO, 1999). The promulgation of information relating to VE will assist such passage planning.

19.1.1.5 Small Craft Displacement

562. From the vessel traffic survey data (which incorporates Radar and visual observations in addition to AIS) regular transits by commercial fishing vessels and recreational vessels through the northern array area are infrequent (noting that displacement of commercial fishing vessels engaged in fishing activity is assessed in **Volume 6, Part 2, Chapter 8: Commercial Fisheries**). However, sailing vessels participating in the annual RORC North Sea Race do pass through the northern array area. There are more regular transits in a north-east – south-west direction through the southern array area, with the course of the RORC North Sea Race also passing through. It is anticipated that sailing vessels participating in the RORC North Sea Race will be displaced by the array areas, although the RORC have not engaged in consultation.

563. Based on experience at previously under construction OWFs it is anticipated that commercial fishing vessels and recreational vessels will choose not to navigate internally within the buoyed construction/ decommissioning areas. Therefore, some displacement of transits by small craft will be required during the construction and decommissioning phases.

564. For regular transits through the southern array area, there is again sufficient sea room available for deviations to the south-east. The distance between the southern array area and the North Hinder South TSS is approximately 5.4 nm and therefore it is not anticipated that this displacement will result in any substantial increase in interaction between small craft and larger commercial vessels utilising this routeing measure.

565. For the O&M phase, based on experience at existing operational OWFs, it is anticipated that commercial fishing vessels and recreational vessels may choose to navigate internally within the operational arrays, particularly in favourable weather conditions and as awareness of the array increases throughout the O&M phase. However, the Cruising Association indicated during consultation that sailing vessels would likely avoid the array areas. In situations where small craft do navigate internally, the level of displacement is considered negligible.

19.1.1.6 Collision Risk Involving Small Craft

566. From the vessel traffic survey data (which incorporates Radar and visual observations in addition to AIS) regular transits by commercial fishing vessels and recreational vessels through the northern array area are infrequent.

567. Since the changes in highest collision risk areas for commercial vessels are minor there is not anticipated to be a substantial shift in the interaction of small craft with commercial vessels. The annual RORC North Sea Race, which may be displaced east of the northern array area, may be subject to greater exposure, although race participants are familiar navigating in busy areas and information relating to the race itself is highly promulgated.

568. In relation to the Sunk TSS East, Stena Line recommended during consultation that the implementation of a recommended route for small craft to offer segregation from larger commercial vessels would be beneficial. The vessel traffic survey data indicates that small craft movements typically occur directly south of the eastbound lane, resulting in a natural segregation between small craft and commercial vessels. Therefore, it is not considered necessary to implement a recommended route for small craft.

569. In the event of a collision incident involving a small craft with comparatively weaker structural integrity (due to hull materials) compared to a larger commercial vessel, the likelihood of a worst case outcome (the small craft foundering with PLL and pollution) will be greater.

19.1.2 Cumulative Scenario – All Users

19.1.2.1 Tier 1

570. Four of the main commercial routes identified for the in isolation scenario interact with East Anglia Two (and will be permanently displaced) and one with East Orford Ness 1809 (and could be temporarily displaced due to the presence of a marine aggregate dredger). The level of permanent cumulative deviation varies between a decrease of 1.3 nm for Route 4 and an increase of 2.3 nm for Route 19, with the maximum percentage change in total route length being 1.1% (for Route 19). All four routes are also displaced by the array areas.

571. As with the in isolation scenario, the size of these deviations is small, particularly when considered relative to the length of the routes overall. Again, effects on vessel approaches to IMO routeing measures in the region (such as the Sunk and North Hinder routeing measures) are therefore considered negligible. Although the size of the deviations is small, vessel traffic volumes associated with the deviated routes are high, with the busiest route requiring a deviation featuring an average of 11 vessels per day (Route 3).

572. Noting the size of the deviations, additional increases in collision risk due to the presence of East Anglia Two and East Orford Ness 1809 will be limited, i.e., comparable with the in isolation scenario. For routeing through the navigational corridor between VE and East Anglia Two (Route 3), a safety case has been undertaken in Section 17 and includes consideration of vessels overtaking, collision avoidance, crossing commercial traffic, and the effect of non-transit users (including

marine aggregate dredgers associated with East Orford Ness 1809. The safety case concluded that the corridor's design (including width) meets safety of navigation expectations.

19.1.2.2 Tier 2

573. For this hazard there is no direct link between the array areas and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.1.2.3 Tier 3

574. One of the main commercial routes identified for the in isolation scenario interacts with Norfolk Vanguard West and will be permanently displaced (Route 10). However, this route is not displaced by the array areas; the minimum passing distance of this route from the array areas is approximately 7.8 nm which is great enough that the presence of the array areas is not anticipated to have any additional effects in terms of vessel displacement and subsequent collision risk.

19.1.3 Embedded Mitigation Measures

575. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Application for safety zones;
- Buoyed construction areas;
- Charting of infrastructure;
- Compliance with MGN 654;
- Guard vessels as required;
- Lighting and marking;
- NIP;
- Promulgation of information;
- Pollution planning; and
- Vessel traffic monitoring.

19.1.4 Potential Significance of Risk

576. The frequency of occurrence and severity of consequence due to vessel displacement and increased collision risk associated with the array areas for each phase of VE is presented in Table 19.1 alongside the resulting significance of risk.

Table 19.1 Significance of Risk for Vessel Displacement and Increased Collision Risk (Array Areas)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Displacement with effects on schedule and collision incident occurs with vessel damage, PLL, and/ or pollution.	Extremely Unlikely	Moderate	**Broadly Acceptable**
	O&M		Negligible	Moderate	**Broadly Acceptable**
	Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**
Cumulative	Construction		Remote	Moderate	**Tolerable with Mitigation**
	O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**
	Decommissioning		Remote	Moderate	**Tolerable with Mitigation**

577. An additional embedded mitigation measure has been identified relevant to this hazard: Trinity House have indicated during consultation that additional aids to navigation (such as buoys) may be necessary to mitigate effects during the construction phase; this will be discussed as part of lighting and marking discussions for the final array layout post consent.

19.2 Vessel Displacement and Increased Collision Risk (Offshore Export Cable Corridor)

578. *Construction, maintenance, and decommissioning activities associated with the offshore ECC may result in the displacement of vessels from their existing routes and activities. Vessel displacement may subsequently result in an increased risk of a collision between third-party vessels.*

19.2.1 In Isolation Scenario – All Users

579. Once installed the presence of the export cables will not directly result in vessel displacement (noting that hazards associated with port/ harbour access and under keel clearance are assessed separately). Therefore, this hazard is considered only in relation to export cable installation and maintenance activities.

580. Given the complexity of the area in terms of vessel activity and cable installation, this hazard is mitigated by the inclusion of a NIP as a consent requirement secured through the conditions of the transmission deemed marine licence (see **Volume 9, Report 20: Outline Navigation Installation Plan**).

581. The spatial extent of the hazard will be limited to where installation/ removal or maintenance activities are ongoing, with routeing vessels required to make small deviations to pass around installation/ removal or maintenance works. Although the offshore ECC passes through the Sunk routeing measure, the Applicant is committed to working with regulators and interested parties to minimise the displacement of third-party vessels through agreement and dissemination of the NIP.

582. Additionally, mariners navigating in proximity to the offshore ECC will have a raised level of awareness given the complexity of the region in terms of navigational features. This will be heightened further by the promulgation of information relating to VE including the publication of Notifications to Mariners as export cable installation progresses and maintenance activities are required, as well as regular engagement with the Sunk VTS in line with the NIP. Tarmac Marine indicated during consultation that they have a preference to be informed via a Notification to Mariners when installation works commence.

583. The most likely and worst case consequences of vessel displacement due to installation/ removal or maintenance activities for the offshore ECC are generally analogous to those outlined for the array area, although the likelihood of disruption to vessel schedules is likely to be lower than for the array areas given the operation of the Sunk VTS and the agreement and dissemination of the NIP. As a worst case there could be potential for increased encounters and congestion at areas of the offshore ECC with less available sea room (i.e., within the Sunk Inner Precautionary Area) and subsequently a risk of collision with PLL, pollution and vessel damage as outcomes. However, the NIP will include planned protocols and actions in the event of any close encounters.

19.2.2 Cumulative Scenario – All Users

19.2.2.1 Tier 1

584. North Falls (export cables), NeuConnect, and Sea Link are expected to intersect the offshore ECC including crossings. In the unlikely event that simultaneous operations occur during installation/ removal or maintenance activities of VE and subsea cable developments, the NIP will be expanded to include project vessel management procedures and planned protocols to minimise displacement of third-party vessels.

585. Additionally, it is assumed that other developments will suitably promulgate information including via Notifications to Mariners as cable installation progresses and maintenance activities are required. Therefore, mariners may have an even greater level of awareness of ongoing activities than for the in isolation scenario.

19.2.2.2 Tier 2

586. For this hazard there is no direct link between the offshore ECC and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.2.2.3 Tier 3

587. For this hazard there is no direct link between the offshore ECC and any Tier 3 developments and therefore no additional assessment of effects has been undertaken.

19.2.3 Embedded Mitigation Measures

588. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Charting of infrastructure;
- Compliance with MGN 654;
- Guard vessels as required;
- NIP;
- Pollution planning; and
- Promulgation of information.

19.2.4 Potential Significance of Risk

589. The frequency of occurrence and severity of consequence due to vessel displacement and increased collision risk associated with the offshore ECC for each phase of VE is presented in Table 19.2 alongside the resulting significance of risk.

Table 19.2 Significance of Risk for Vessel Displacement and Increased Collision Risk (Offshore ECC)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Displacement with effects on schedule and collision incident occurs with vessel damage, PLL, and/ or pollution	Remote	Moderate	**Tolerable with Mitigation**
	O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**
	Decommissioning		Remote	Moderate	**Tolerable with Mitigation**
Cumulative	Construction		Reasonably Probable	Moderate	**Tolerable with Mitigation**
	O&M		Negligible	Moderate	**Broadly Acceptable**
	Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**

19.3 Third-Party with Project Vessels Collision Risk (Array Areas)

590. *The presence of vessels associated with construction, O&M, and decommissioning activities for the array areas may result in increased risk of a collision between a third-party vessel and a project vessel.*

19.3.1 In Isolation Scenario – All Users

591. The construction phase may last for up to five years and the decommissioning phase up to three years. For both phases, up to 35 construction/ decommissioning vessels may be located on-site simultaneously, in turn making a maximum of 4,311 round trips to port. The O&M phase may last for up to 40 years with up to 27 O&M vessels located on-site simultaneously, in turn making a maximum of 1,776 annual round trips to port. Some project vessels may be RAM and it is anticipated that project vessels will generally undertake construction/ decommissioning or O&M works associated with the array areas within the buoyed construction/ decommissioning areas or operational arrays, both of which third-party vessels are generally expected to avoid.

592. From historical incident data, there has been one instance of a third-party vessel colliding with a project vessel associated with a UK OWF. In this incident, occurring in 2011, moderate vessel damage was reported with no harm to persons. Since then, awareness of OWF developments and the application of the measures outlined below has improved or been refined considerably in the interim, with no further collision incidents reported since. This was reflected in feedback from CLdN during consultation that the presence of project vessels does not represent a notable concern since third-party vessels can comfortably and safely operate around construction activities.

593. Project vessels will be managed by a marine coordination facility which will work in communication with the Sunk VTS. The coordinators will consider the need for entry/ exit points to and from the array areas to account for heavily trafficked areas. Entry/ exit points to and from the array areas will be designated post consent once construction/ decommissioning and O&M ports have been identified. This has been suggested by the UK Chamber of Shipping and Stena Line as suitable mitigation to control interaction with commercial traffic. Project vessels will carry AIS and be compliant with Flag State regulations including the COLREGs.

594. Authorised safety zones around active construction/ decommissioning and major maintenance works will also serve to protect third party and project vessels. These will be particularly effective in the event of smaller craft such as commercial fishing vessels and recreational vessels choosing to navigate internally within the operational arrays, where a project vessel may be undertaking major maintenance at a structure. Details of authorised safety zones will be promulgated alongside details of ongoing activities, thus maximising awareness for all third-party users, including in both day and night conditions.

595. In poor visibility, third-party vessels may experience limitations regarding visual identification of project vessels entering and exiting the buoyed construction/ decommissioning areas and operational arrays. However, this will be mitigated by the application of the COLREGs (reduced speeds) in adverse weather conditions and project vessel compulsory AIS carriage.

596. The most likely consequences (during any phase) in the event of an encounter between a third-party and project vessel is the implementation of avoidance action in line with the COLREGs, with the vessels involved able to resume their respective passages with no long-term consequences.

597. Should an encounter develop into a collision incident, it is most likely to involve minor contact resulting in minor damage to the vessels with no harm to people (as noted in incidents occurred to date) and no substantial reputational effects. As a worst case, one of the vessels could founder with PLL and pollution, with this outcome more likely where one of the vessels is a small craft (e.g., fishing vessel, recreational vessel, or CTV) with comparatively weaker structural integrity given the hull materials.

19.3.2 Cumulative Scenario – All Users

19.3.2.1 Tier 1

598. NeuConnect is expected to intersect the northern array area. Should installation/ removal or maintenance activities for VE and NeuConnect occur simultaneously then there is potential for additional project vessels associated with both developments to be located within or in proximity to the array areas, as noted by the UK Chamber of Shipping during consultation. However, this is considered highly unlikely.

599. In the unlikely event that there is simultaneous installation/ removal or maintenance activities, the likelihood of an encounter between a third-party vessel and a project vessel will be greater.

600. On-site project vessel activities associated with North Falls and East Anglia Two are not expected to create a cumulative effect with VE. However, at the time of writing, the base ports for VE and these developments (for construction/ decommissioning and O&M) are not known. If the developments have a common base port, there may be an increased collision risk when vessels are entering/ exiting the port and enroute to/ from the arrays. However, the marine coordination facility will take account of this, and it is assumed that a similar facility will be in place for East Anglia Two and North Falls.

19.3.2.2 Tier 2

601. Again, on-site activities associated with East Anglia One North are not expected to create a cumulative effect with VE. However, at the time of writing, the base ports for VE and East Anglia One North (for construction/ decommissioning and O&M) are

not known and therefore the same points raised for Tier 1 developments are again applicable.

19.3.2.3 Tier 3

602. Again, on-site activities associated with East Anglia Three, Norfolk Vanguard East, and Norfolk Vanguard West are not expected to create a cumulative effect with VE. However, at the time of writing, the base ports for VE and these developments (for construction/ decommissioning and O&M) are not known and therefore the same points raised for Tier 1 developments are again applicable.

19.3.3 Embedded Mitigation Measures

603. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Application for safety zones;
- Buoyed construction areas;
- Guard vessels as required;
- Marine coordination for project vessels;
- Pollution planning;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

19.3.4 Potential Significance of Risk

604. The frequency of occurrence and severity of consequence due to third-party with project vessel collision risk associated with the array areas for each phase of VE is presented in Table 19.3 alongside the resulting significance of risk.

Table 19.3 Significance of Risk for Third-Party with Project Vessel Collision Risk (Array Areas)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Collision incident occurs with vessel damage, PLL, and/ or pollution.	Extremely Unlikely	Moderate	**Broadly Acceptable**
	O&M		Negligible	Moderate	**Broadly Acceptable**
	Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**
Cumulative	Construction		Reasonably Probable	Moderate	**Tolerable with Mitigation**
	O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
	Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**

19.4 Third-Party with Project Vessels Collision Risk (Offshore Export Cable Corridor)

605. *The presence of vessels associated with construction, maintenance, and decommissioning activities for the offshore ECC may result in increased risk of a collision between a third-party vessel and a project vessel.*

19.4.1 In Isolation Scenario – All Users

606. Once installed the presence of the export cables will not directly result in third-party with project vessel collision risk. Therefore, this hazard is considered only in relation to export cable installation/ removal and maintenance activities.

607. Given the complexity of the area in terms of vessel activity and cable installation, this hazard is mitigated by the inclusion of a NIP as a consent requirement (see **Volume 9, Report 20: Outline Navigation Installation Plan**).

608. The level of exposure to this hazard for third-party vessels will depend upon the location of export cable installation/ removal or maintenance at any given time, with the PLA confirming during consultation that there are 'pinch points' along the offshore ECC where effective traffic management will be critical. An area of interest reflecting this will be identified in the NIP.

609. The most likely and worst case consequences of third party to project vessel collision risk will be due to installation/ removal and maintenance activities for the offshore ECC are generally analogous to those outlined for the array area, although the presence of larger commercial vessels accessing local ports via the Sunk routeing measure is noted, with these vessels likely to have limited manoeuvrability to take collision avoidance action in the event of an encounter. This will be mitigated by implementation of the NIP which includes planned protocols and actions in the event of any close encounters.

19.4.2 Cumulative Scenario – All Users

19.4.2.1 Tier 1

610. North Falls OWF, NeuConnect, and Sea Link are expected to intersect the offshore ECC including crossings. In the unlikely event that simultaneous operations occur during installation/ removal or maintenance activities of VE and these subsea cable

developments, the NIP will be expanded to include project vessel management procedures and planned protocols to minimise collision risk between third-party vessels and project vessels.

611. Additionally – and as highlighted by the Sunk VTS during consultation – project vessels associated with North Falls may cross the Sunk TSS East, adding to existing crossing project vessel traffic from Greater Gabbard and Galloper and future crossing project vessel traffic from VE. Where installation/ removal or maintenance activities are ongoing for the export cables this additional crossing traffic may further exacerbate collision risk, although it is assumed that marine coordination for project vessels associated with North Falls will be in place, including consideration of crossing the Sunk TSS East.

19.4.2.2 Tier 2

612. For this hazard there is no direct link between the offshore ECC and any Tier 2 developments and therefore no additional assessment of effect has been undertaken.

19.4.2.3 Tier 3

613. For this hazard there is no direct link between the offshore ECC and any Tier 3 developments and therefore no additional assessment of effect has been undertaken.

19.4.3 Embedded Mitigation Measures

614. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Guard vessels as required;
- Marine coordination for project vessels;
- NIP;
- Pollution planning;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

19.4.4 Potential Significance of Risk

615. The frequency of occurrence and severity of consequence due to third-party with project vessel collision risk associated with the offshore ECC for each phase of VE is presented in Table 19.4 alongside the resulting significance of risk.

Table 19.4 Significance of Risk for Third-Party with Project Vessel Collision Risk Offshore ECC

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Collision incident occurs with vessel damage, PLL, and/ or pollution.	Negligible	Moderate	**Broadly Acceptable**
	O&M		Negligible	Moderate	**Broadly Acceptable**
	Decommissioning		Negligible	Moderate	**Broadly Acceptable**
Cumulative	Construction		Extremely Unlikely	Moderate	**Broadly Acceptable**
	O&M		Negligible	Moderate	**Broadly Acceptable**
	Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**

19.5 Reduced Access to Local Ports and Harbours and Reduction in Under Keel Clearance (Array Areas)

616. *Construction/ decommissioning activities and the presence of surface structures within the array areas may result in reduced access to local ports and harbours for vessels. The presence of cable protection associated with the array cables may result in reductions to water depth and the creation of an under keel clearance risk for vessels, again limiting access to ports, harbours, terminals, and marinas.*

617. These two hazards (reduced access to local ports and harbours/ reduction in under keel clearance) are considered together given the links between reduced under keel clearance and access to local ports, etc.

19.5.1 In Isolation Scenario – All Users

618. There are numerous ports and harbours located west of the array areas, on the UK east coast. However, given the distance of the array areas offshore, the presence of the buoyed construction/ decommissioning areas and operational arrays is not anticipated to directly interfere with mariners from their preferred approach to local ports and harbours. Furthermore, given that the size of main commercial route deviations due to the presence of the buoyed construction/ decommissioning areas and operational arrays (as outlined for the vessel displacement hazard) are small, the effects on any port/ pilot arrivals times are expected to be limited and therefore schedules will not be impacted.

619. The construction phase for the array area may last for up to five years and the decommissioning phase up to three years. For both phases, up to 35 construction/ decommissioning vessels may be located on-site simultaneously, in turn making a maximum of 1,776 round trips to port. The O&M phase may last for up to 40 years with up to 27 O&M vessels located on-site simultaneously, in turn making a maximum of 1,776 annual round trips to port. Some project vessels may be RAM and it is anticipated that project vessels will generally undertake construction/ decommissioning or O&M works associated with the array areas within the buoyed construction/ decommissioning areas or operational arrays, both of which third-party vessels are generally expected to avoid. Given that the volume of project vessel movements will be substantially lower during the O&M phase than the construction/ decommissioning phases, the likelihood of disruption is lower for the O&M phase.

620. Project vessels will also be managed by a marine coordination facility which may include traffic management procedures such as defined routes to and from construction/ decommissioning and O&M ports. Project vessels will also carry AIS and be compliant with all Flag State regulations including the COLREGs. Given the presence of Greater Gabbard and Galloper OWF, whose O&M vessels are operated out of Harwich Haven and Port of Lowestoft, respectively, there is relevant experience of managing project vessel movements in and out of local ports which will be drawn upon.

621. Up to 108 nm of array cables will be located within the array areas including up to 26 crossings. Where available, the primary means of cable protection will be by seabed burial, with no material effect on under keel clearance. Indicatively, up to 20% of array cables may require alternative cable protection with a height of 1.0 m, or 1.4 m for crossings. This will be fully determined by the Cable Burial Risk Assessment, noting that deep-draughted commercial vessels are not expected to navigate internally within the arrays.

622. In relation to under keel clearance the Applicant intends to follow the guidance contained in MGN 654 in relation to cable protection, namely that cable protection will not change the charted water depth by more than 5%. This was reaffirmed by the MCA during consultation.

623. This aligns with the RYA's recommendation that the "*minimum safe under keel clearance over submerged structures and associated infrastructure should be determined in accordance with the methodology set out in MGN 543 [since superseded by MGN 654]*" (RYA, 2019). Noting that water depths within the array areas vary between 31 and 57 m below CD, this should be achievable throughout and therefore the likelihood of an underwater allision incident is very low.

624. The most likely consequences of reduced port access in relation to the array areas will be limited effects on port schedules. As a worst case, there could be disruption to port schedules, but with no safety issues.

625. Should a vessel navigate over an area of reduced under keel clearance within the array area the most likely consequence is that no contact occurs and the vessel's passage is able to continue unaffected. As a highly unlikely worst case, the vessel could ground on the cable protection with pollution and vessel damage as potential outcomes.

19.5.2 Cumulative Scenario – All Users

19.5.2.1 Tier 1

626. The presence of East Anglia Two in addition to VE may interfere with mariners planning their preferred approach to local ports and harbours. The northern array area and East Anglia Two span a north-south extent of approximately 24 nm, and therefore together may affect port schedules for commercial vessels headed to/ from the numerous ports and harbours on the UK east coast. Only one main commercial route (Route 3) is expected to be affected, although features high vessel traffic volumes.

627. However, a navigational corridor with minimum width of 2.86 nm separates the two arrays and provides a means of access to the aforementioned ports and harbours. As previously noted, a safety case has been undertaken in Section 17 for the navigational corridor and concluded that the corridor's design (including width) meets safety of navigation expectations. Therefore, this corridor will minimise the cumulative effect for vessels heading to/ from ports on the UK east coast, including on Route 3.

19.5.2.2 Tier 2

628. For this hazard there is no direct link between the array areas and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.5.2.3 Tier 3

629. For this hazard there is no direct link between the array areas and any Tier 3 developments and therefore no additional assessment of effects has been undertaken.

19.5.3 Embedded Mitigation Measures

630. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Cable Burial Risk Assessment;
- Compliance with MGN 654;
- Marine coordination for project vessels;
- Pollution planning;
- Project vessel compliance with international marine regulations;

- Promulgation of information; and
- Vessel traffic monitoring.

19.5.4 Potential Significance of Risk

631. The frequency of occurrence and severity of consequence due to reduced port and harbour access and reduction in under keel clearance associated with the array areas for each phase of VE is presented in Table 19.5 alongside the resulting significance of risk.

Table 19.5 Significance of Risk for Reduced Access to Local Ports and Harbours and Reduction in Under Keel Clearance (Array Areas)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Disruption to port schedules and vessel grounding on cable protection with vessel damage and/ or pollution.	Remote	Minor	**Broadly Acceptable**
	O&M		Remote	Moderate	**Tolerable with Mitigation**
	Decommissioning		Remote	Minor	**Broadly Acceptable**
Cumulative	Construction		Remote	Minor	**Broadly Acceptable**
	O&M		Remote	Moderate	**Tolerable with Mitigation**
	Decommissioning		Remote	Minor	**Broadly Acceptable**

19.6 Reduced Access to Local Ports and Harbours and Reduction in Under Keel Clearance (Offshore Export Cable Corridor)

632. *Construction, maintenance, and decommissioning activities associated with the offshore ECC could result in reduced access to local ports and harbours for vessels without effective mitigation.*

633. These two hazards (reduced access to local ports and harbours/ reduction in under keel clearance) are again considered together given the links between reduced under keel clearance and access to local ports, etc. The hazard does not consider the presence of cable protection reducing under keel clearance within sensitive areas since the Applicant has committed to burial of export cables, or use of low profile protection material, to maintain suitable under keel clearance within such areas.

19.6.1 In Isolation Scenario – All Users

634. The offshore ECC crosses the exit of the Sunk TSS East, passes alongside the eastbound lane of the Sunk TSS East and crosses the Sunk Outer and Inner Precautionary Areas before making landfall east of Holland-on-Sea (see Figure 6.3). At the Hazard Workshop, stakeholders generally agreed that the final section of the offshore ECC inshore of the Rough Sands did not raise any concerns for shipping and navigation users, noting that from the vessel traffic survey data, crossing vessels in this area were primarily recreational vessels with shallower draughts.

635. The other sections of the offshore ECC have been the subject of detailed consultation throughout the Scoping, PEIR, and ES stages given that deep draught vessels do cross the offshore ECC, particularly when accessing local ports through the Sunk Inner Precautionary Area. For smaller craft hazards on water depth are not as substantial, as indicated by the Cruising Association during consultation.

636. The offshore ECC crosses the Trinity and Sunk deep water routes and passes in proximity to the Harwich Deep Water Channel. These are key navigational routes for vessels accessing ports in the region, including at Harwich Haven, the Port of Felixstowe, and Thames and Medway ports. These routes are required to give deep water access for the current maximum draught (up to 17.5 m) and realistic future worst case draught (up to 20 m) so that they can avoid shallower areas within the Sunk Inner Precautionary Area and provide reassurance as to depth maintained channels. There is no alternative approach available for these larger vessels to access such ports.

637. A Cable Specification and Installation Plan (CSIP) (which will include a Cable Burial Risk Assessment – see **Volume 9, Report 12: Cable Specification and Installation** Plan and **Volume 9, Report 9: Cable Burial Risk Assessment**) will set out the proposed burial depths and cable protection (where necessary and permitted), taking into account areas where deep draught vessels transit and therefore areas where water depth cannot be compromised by more than 5%. Alongside the CSIP, the NIP will be developed (see **Volume 9, Report 20: Navigation Installation Plan**) to ensure that installation and maintenance methodologies (further considered in Section 19.6.1.1) do not compromise safe vessel access to local ports. Furthermore, where appropriate, export cables will be buried or protected sufficiently to ensure there is no interaction with any foreseeable future spot dredging associated with London Gateway operations around the Sunk and Trinity deep water routes. The CSIP and NIP will be conditioned in the deemed Marine Licence.

19.6.1.1 Installation and Maintenance Activities

638. The offshore ECC may interact with mariners' preferred approach to local ports and harbours during periods of installation and maintenance. This element of the hazard will apply when export cable installation/ removal activities are ongoing.

639. In terms of reduced port access for vessels in relation to the offshore ECC the most likely consequences will be limited effects on port schedules. As a worst case, there could be disruption to port schedules, with congestion caused and subsequent potential for safety issues including collision and grounding (influenced by tidal streams). However, the implementation of the NIP is anticipated to reduce the likelihood of these consequences to tolerable levels. Further details pertaining to the NIP are provided in Section 21.4.

19.6.1.2 Pilotage Operations

640. A key element of port access in the region is pilotage services and therefore any disruption to pilotage operations may reduce access to local ports.

641. From the vessel traffic survey data, all pilot vessels operating in the Sunk Inner Precautionary Area do so out of Harwich Haven, with this confirmed by HHA during consultation. Only a small section of the offshore ECC is crossed enroute to the Sunk pilot boarding station, which is the primary boarding location for pilots.

642. Pilot vessels are small and have greater flexibility than large commercial vessels. This is evidenced in the vessel traffic survey data which indicates that pilot vessels are not as constrained by the navigational features in the region such as the Harwich Deep Water Channel. Therefore, the presence of installation/ removal and maintenance activities associated with the offshore ECC are unlikely to create a substantial access constraint for pilot vessels but could result in minor disruption to pilot boarding operations due to the temporary location of project vessels. This issue will be specifically considered in the NIP, noting that the content of the NIP will be agreed with HHA, PLA, Sunk VTS, and any other relevant parties to ensure that pilot boarding remains safe and commercially viable.

19.6.1.3 Sunk Vessel Traffic Service

643. The MCA requested during consultation that effects upon operation of the Sunk VTS are considered, i.e., man power. This will also require consideration in relation to pilot boarding operations conducted by HHA. Given the rate of export cable installation, the short-term duration of the works are unlikely to have any substantial effect upon the operation of the Sunk VTS.

644. The movements of project vessels to/ from construction ports (if located within the Sunk VTS area) is another potential cause of hazarding Sunk VTS resources. However, project vessels will be managed by a marine coordination facility which may include traffic management procedures and defined routes to and from construction ports. Additionally, the NIP will be implemented within a defined area of interest. Such procedures will ensure effects on the operation of the Sunk VTS is minimised.

19.6.1.4 Existing Aids to Navigation

645. The offshore ECC avoids most aids to navigation but does overlap with the North Galloper north cardinal mark and Dynamo special mark. The Sunk Inner Light vessel is not impacted directly although HHA noted during consultation that it may nevertheless need to be moved.

646. For those overlapping aids to navigation there is potential that their movement may be required. Trinity House have indicated a preference during consultation to avoid moving existing aids to navigation but acknowledged that during installation there may be opportunities to do so. Any movements during export cable installation/ removal and maintenance works would be of short-term duration given the nature of the works and have limited effect on a vessel's ability to safely navigate to/ from port, especially when a pilot with local knowledge is on board.

19.6.2 Cumulative Scenario – All Users

19.6.2.1 Tier 1

647. This hazard has been highlighted by stakeholders during consultation, with MCA, Trinity House, HHA, and PLA raising concerns relating to the cumulative presence of activities for VE and other subsea cable developments.

648. North Falls (export cables), NeuConnect, and Sea Link are expected to intersect the offshore ECC including crossings. Should installation/ removal or maintenance activities for VE and these subsea cable developments occur simultaneously then the spatial extent of the hazard will be increased, although the likelihood of this is very low.

649. In the highly unlikely event of simultaneous operations this will be managed through cooperation within the parameters of the NIP.

650. Since the CSIP and maximum indicative cable protection height of 1.4 m for VE is also applicable to crossings, the reduction in under keel clearance associated with VE together with the subsea cable developments is analogous to that assessed for the in isolation scenario.

19.6.2.2 Tier 2

651. For this hazard there is no direct link between the offshore ECC and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.6.2.3 Tier 3

652. For this hazard there is no direct link between the offshore ECC and any Tier 3 developments and therefore no additional assessment of effects has been undertaken.

19.6.3 Embedded Mitigation Measures

653. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Cable Burial Risk Assessment;
- Compliance with MGN 654;
- Marine coordination for project vessels;
- NIP;
- Pollution planning;
- Promulgation of information; and
- Vessel traffic monitoring.

19.6.4 Potential Significance of Risk

654. The frequency of occurrence and severity of consequence due to reduced access to local ports and harbours and reduction in under keel clearance associated with the offshore ECC for each phase of VE is presented in Table 19.6 alongside the resulting significance of risk.

Table 19.6 Significance of Risk for Reduced Access to Local Ports and Harbours and Reduction in Under Keel Clearance (Offshore ECC)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	Construction	Disruption to port schedules and vessel grounding on cable protection with vessel damage and/ or pollution.	Reasonably Probable	Moderate	**Tolerable with Mitigation**
	O&M		Reasonably Probable	Moderate	**Tolerable with Mitigation**
	Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**
Cumulative	Construction		Reasonably Probable	Moderate	**Tolerable with Mitigation**
	O&M		Reasonably Probable	Moderate	**Tolerable with Mitigation**
	Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**

19.7 Creation of Allision Risk (Array Areas)

655. *The presence of surface structures within the array areas may result in the creation of a risk of allision for vessels.*

656. This hazard is considered only in relation to the array areas since there are no surface structures associated with the offshore ECC (underwater allision risk due to reduction in under keel clearance is considered in a separate hazard).

19.7.1 In Isolation Scenario – All Users

657. The main commercial route deviations and future case considerations described for the vessel displacement hazard have also been assumed for this hazard, noting that a full build out of the array areas is assumed and internal navigation by commercial vessels is not anticipated. However, commercial fishing vessels and recreational vessels may choose to navigate internally within the arrays, particularly in favourable weather conditions.

658. Vessels operating in the region will be familiar with navigating in proximity to OWFs, including Greater Gabbard, Galloper, East Anglia One, and various developments within Belgian waters. However, the presence of new surface structures does introduce new allision risk which can be considered across three forms, all of which are localised in nature given that a vessel must be in close proximity to a structure for an allision incident to occur:

- Powered allision risk;
- Drifting allision risk; and
- Internal allision risk.

19.7.1.1 Powered Allision Risk

659. Post wind farm modelling using the main commercial route deviations as input gives an estimated powered allision return period of one in 746 years for base case traffic levels, rising to one in 574 years for future case traffic levels (30%). This is a low to moderate return period compared to that estimated for other UK OWF developments and is reflective of the shape of the array areas (following site refinement) being sympathetic to the most heavily trafficked routes as well as the comparatively low number of surface structures. The greatest allision risk was associated with:

- Structures at the south-eastern extent of the southern array area where a high volume of traffic from multiple main commercial routes associated with the North Hinder TSS pass; and
- Structures at the northern extent of the northern array area where a heavily trafficked commercial ferry route between Harwich and Rotterdam passes in close proximity (1 nm), noting that this includes an indicative OSP location.

660. From historical incident data, there have been three instances of a third-party vessel alliding with an operational wind farm structure in the UK. These incidents all involved a fishing vessel, with a RNLI lifeboat attending on each occasion and a helicopter deployed in one case. Given the navigational measures present in the

region (including the Sunk TSS East) and subsequent heightened mariner alertness, it is unlikely that such an incident will occur at VE.

661. Additionally, vessels are expected to comply with international flag state regulations (including the COLREGs and SOLAS) and will be able to effectively passage plan a route which minimises effects given the promulgation of information relating to VE including the charting of infrastructure on relevant nautical charts and the use of safety zones (for major maintenance). On approach, the operational lighting and marking of the arrays will also assist in maximising marine awareness and project vessels will as required alert a vessel on a closing approach with a structure.

662. Should a powered allision incident occur, the consequences will depend on multiple factors including the energy of the contact, structural integrity of the vessel involved, type of structure contacted, and the sea state at the time of the contact. Small craft including commercial fishing vessels and recreational vessels are considered most vulnerable to the hazard given the potential for a non-steel construction.

663. With consideration of lessons learned the most likely consequences are minor damage with the vessel involved able to resume passage and undertake a full inspection at the next port of call. As a worst case, the vessel could allide with an OSP, resulting in foundering with PLL and pollution.

19.7.1.2 Drifting Allision Risk

664. A vessel adrift may only develop into an allision situation where the vessel is in proximity to a structure and the direction of the wind and/ or tide is such as to direct the vessel towards the structure. In the case of VE – and accounting for local metocean conditions – the direction of the peak flood tide is highlighted as potentially sensitive given that:

- Heavily trafficked east-west routeing north of the northern array could be set on an allision course with structures on the northern edge of the northern array area; and
- Moderately trafficked east-west routeing through the Sunk TSS East could be set on an allision course with structures on the northern edge of the southern array area.

665. Post wind farm modelling using the main commercial route deviations as input gives an estimated drifting allision return period of one in 584 years for base case traffic levels, rising to one in 449 years for future case traffic levels (30%). This is a moderate to high return period compared to that estimated for other UK OWF developments and is reflective of the high volume of vessel traffic in the region and the unsympathetic direction of drift (described above) relative to the shape of the array areas.

666. From historical incident data, there have been no instances of a third-party vessel alliding with an operational wind farm structure in the UK whilst Not Under

Command (NUC). However, there is some potential for a vessel to run adrift in this region; this is reflected in the number of machinery failure incidents[11] reported locally to the MAIB (22% of all reported incidents within the array traffic study area).

667. In circumstances where a vessel drifts towards a structure, there are actions which may be taken to prevent the incident developing into an allision situation. For a powered vessel, the ideal and likely solution would be regaining power prior to reaching the arrays (by rectifying any fault). Failing this, the vessel's emergency response procedures would be implemented – this may include an emergency anchoring event following a check of the relevant nautical charts to ensure the deployment of the anchor will not lead to other effects (such as anchor snagging on a subsea cable).

668. Where the deployment of the anchor is not possible (such as for small craft) then project vessels on-site may be able to render assistance including under SOLAS obligations (IMO, 1974) and this response will be managed via marine coordination and depends on the type and capability of vessels on site. This would be particularly relevant for sailing vessels whose propulsion is dictated solely by the metocean conditions, although if the vessel becomes adrift in proximity to a structure there may be limited time to render assistance.

669. Should a drifting allision incident occur, the consequences will be similar to those outlined for a powered allision incident, including the determining factors. However, the speed at which the contact occurs will likely be lower than for a powered allision, resulting in the contact energy being lower.

670. It is acknowledged that as per the assessment of powered allision risk, an allision with an OSP is likely to create higher consequence given the size of the structure. This is particularly relevant given the peak flood tide scenario outlined above since both of the highest exposure portions of the arrays include an OSP.

19.7.1.3 Internal Allision Risk

671. As described for the vessel displacement hazard, commercial vessels are not anticipated to navigate internally within the arrays and therefore the likelihood of an internal allision risk for such vessels is negligible.

672. Post wind farm modelling using the vessel traffic survey data as input gives an estimated commercial fishing allision return period of one in 3.43 years for base case traffic levels, rising to one in 2.86 years for future case traffic levels (20%)[12]. This is a high return period compared to that estimated for other UK OWF developments and

[11] An incident reported as a 'machinery failure' may not be so severe as to result in the vessel losing power and becoming NUC.

[12] These results are highly conservative since the model cannot account in detail for how fishing vessels will adapt to the presence of the arrays.

is reflective of the high volume of fishing vessel activity in the region, noting that this is largely characteristic of fishing vessels engaged in fishing rather than in transit.

673. The minimum spacing between structures (830 m) is sufficient for safe internal navigation and is greater than that associated with many other UK OWF, some of which are navigated by commercial fishing vessels in favourable conditions. The minimum spacing between structures is also similar to that present at the neighbouring Greater Gabbard and Galloper. The final array layout will be agreed with the MCA and Trinity House post consent but will be compliant with the requirements of MGN 654 (MCA, 2021), including the completion of a safety justification for a SLoO layout should this be taken forward.

674. As with any passage, a vessel navigating internally within the arrays is expected to passage plan in accordance with SOLAS Chapter V (IMO, 1974). The lighting and marking of the arrays as required by Trinity House, MCA, and Civil Aviation Authority (CAA) and MGN 654 compliant unique identification marking of structures in an easily identifiable pattern will assist with minimising the likelihood of a mariner becoming disoriented whilst navigating internally within the arrays.

675. For recreational vessels under sail navigating internally within the arrays, there is also potential for effects such as wind shear, masking, and turbulence to occur. From previous studies of offshore wind developments, it has been concluded that WTGs do reduce wind velocity downwind of a WTG (MCA, 2022) but that no negative effects on recreational craft have been reported on the basis of the limited spatial extent of the effect and its similarity to that experienced when passing a large vessel or close to other large structures (such as bridges) or the coastline. In addition, no practical issues have been raised by recreational users to date when operating in proximity to existing offshore wind developments.

676. An additional allision risk associated with the WTG blades applies for recreational vessels with a mast when navigating internally within the arrays. However, the minimum air gap will be 28 m above MHWS which is greater than the minimum clearance the RYA recommend for localised allision risk (RYA, 2019) and which is also noted in MGN 654.

677. Should an internal allision incident occur, the consequences will be similar to those outlined for a powered allision incident, including the determining factors. However, as with a drifting allision incident, the speed at which the contact occurs will likely be lower than for an external allision, resulting in the contact energy being lower.

19.7.2 Cumulative Scenario – All Users

19.7.2.1 Tier 1

678. Although allision risk is localised in nature, there remains a cumulative effect associated with routeing through the navigation corridor between VE and East Anglia Two (Route 3) which has a minimum width of 2.86 nm. A safety case has been

undertaken in Section 17 and includes consideration of the suitable width for the corridor based on various guidance including the MGN 654 Shipping Route Template. The safety case concluded that the corridor's design (including width) meets safety of navigation expectations.

679. Nevertheless, it is recognised that there is a clear narrowest point of the navigation corridor which may increase allision exposure for a WTG located at or close to the northern tip of the northern array area. However, the corridor may be viewed as a trapezium allowing for a straight east-west transit – this is illustrated in Figure 17.1. This form of the corridor, which incorporates alignment with Galloper, provided comfort to the UK Chamber of Shipping and DFDS Seaways during consultation.

680. There remains the possibility that a WTG may be located at or close to the northern tip of the northern array area, thus encroaching upon the alignment with Galloper. Should this occur, this WTG would be subject to greater allision risk exposure from navigation corridor users. Trinity House have identified during consultation that enhanced marking could be implemented for this WTG if considered necessary. Both MCA and Trinity House have confirmed that this issue can be resolved (if required) as part of discussions relating to the final array layout undertaken post consent.

19.7.2.2 Tier 2

681. For this hazard there is no direct link between the array areas and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.7.2.3 Tier 3

682. For this hazard there is no direct link between the array areas and any Tier 3 developments and therefore no additional assessment of effects has been undertaken.

19.7.3 Embedded Mitigation Measures

683. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Application for safety zones (major maintenance only);
- Charting of infrastructure;
- Compliance with MGN 654;
- Lighting and marking;
- Marine coordination for project vessels;
- Minimum blade tip clearance;
- Pollution planning;
- Project vessel compliance with international marine regulations; and
- Promulgation of information.

19.7.4 Potential Significance of Risk

684. The frequency of occurrence and severity of consequence due to creation of allision risk associated with the array areas for the O&M phase of VE is presented in Table 19.7 alongside the resulting significance of risk.

Table 19.7 Significance of Risk for Creation of Allision Risk (Array Areas)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	O&M	Allision incident occurs with an OSP with the vessel foundering, PLL, and/ or pollution.	Negligible	Major	**Tolerable with Mitigation**
Cumulative	O&M		Extremely Unlikely	Major	**Tolerable with Mitigation**

19.8 Anchor Interaction with Subsea Cables (Array Areas)

685. *The presence of array cables may result in the creation of a risk of a vessel anchor making contact with an array cable.*

19.8.1 In Isolation Scenario – All Users

686. Up to 108 nm of array cables will be located within the array areas. Where available, the primary means of cable protection will be by seabed burial, with a target burial depth of 0.5 m. Indicatively, up to 20% of array cables may require alternative cable protection with a height of 1.0 m, or 1.4 m for crossings. The burial depth will be informed by the Cable Burial Risk Assessment.

687. There are three anchoring scenarios which are considered for this hazard:

- Planned anchoring – most likely as vessel awaits a berth to enter port but may also result from adverse weather conditions, machinery failure, or subsea operations;
- Unplanned anchoring – generally resulting from an emergency situation where the vessels has experienced steering failure; and
- Anchor dragging – caused by anchor failure.

688. Since the array cables will be fully contained within the array areas, it is considered unlikely that a vessel will choose to anchor in close proximity to an array cable. Moreover, from the vessel traffic data, anchoring activity within and in proximity to the array areas is limited, with vessels instead choosing to use designated anchorage areas in the region.

689. In any anchoring scenario, an interaction risk exists only where the anchoring occurs in proximity to an array cable and it is anticipated that the charting of infrastructure

including the array cables will inform the decision to anchor, as per Regulation 34 of SOLAS (IMO, 1974). Feedback from Mariners indicated that this will also occur in an emergency situation, even where time for decision-making is limited – a key priority for Bridge crew whilst the anchor is being readied would be to check charts.

690. The most likely consequences in the event of a vessel anchoring over an array cable is that no interaction occurs given the protection applied to the cable (by burial or other means). Should an interaction occur, historical incident data suggests that the consequences would be negligible, with no damage caused to the vessel or cable. As a worst case, a snagging incident could occur to a commercial fishing vessel with damage caused to the anchor and/ or the cable, compromising the stability of the vessel.

19.8.2 Cumulative Scenario – All Users

19.8.2.1 Tier 1

691. NeuConnect is expected to intersect the northern array area. Should a vessel anchor within the northern array area the likelihood of a snagging incident will be greater given the wider spatial extent compared to the in isolation scenario. However, the hazard remains localised in nature and the likelihood of a vessel anchoring within the array areas is low, as discussed for the in isolation scenario.

692. It is assumed that, as with the export cables, NeuConnect will be subject to a Cable Burial Risk Assessment and will be shown on relevant nautical charts.

19.8.2.2 Tier 2

693. For this hazard there is no direct link between the array areas and any Tier 2 developments and therefore no additional assessment of effects has been undertaken.

19.8.2.3 Tier 3

694. For this hazard there is no direct link between the array areas and any Tier 3 developments and therefore no additional assessment of effects has been undertaken.

19.8.3 Embedded Mitigation Measures

695. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Cable Burial Risk Assessment;
- Charting of infrastructure;
- Guard vessels as required; and
- Promulgation of information.

19.8.4 Potential Significance of Risk

696. The frequency of occurrence and severity of consequence due to anchor interaction with subsea cables associated with the array areas for the O&M phase of VE is presented in Table 19.8 alongside the resulting significance of risk.

Table 19.8 Significance of Risk for Anchor Interaction with Subsea Cables (Array Areas)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	O&M	Anchor snagging incident occurs with anchor and/ or cable damage and compromised vessel stability.	Extremely Unlikely	Minor	**Broadly Acceptable**
Cumulative	O&M		Negligible	Moderate	**Broadly Acceptable**

19.9 Anchor Interaction with Subsea Cables (Offshore Export Cable Corridor)

697. *The presence of export cables may result in the creation of a risk of a vessel anchor making contact with an export cable.*

19.9.1 In Isolation Scenario – All Users

698. The cable protection methodology for array cables is again applicable, although the indicative cable protection height (excluding crossings) is 1.1 m. The burial depth will be informed by the Cable Burial Risk Assessment.

699. There is general agreement among stakeholders that the burial depth for export cables will be important, particularly in higher risk areas and with consideration of potential vessel traffic growth in the future case scenario. HHA have indicated during consultation that a burial depth of 0.5 m would likely be insufficient in some areas, and may need to be substantially more. As noted, the Cable Burial Risk Assessment will inform the cable burial depth, with particular consideration given to the types and numbers of vessels crossing the offshore ECC at the higher risk locations and the maintenance and monitoring of the burial depth deployed. This latter point was raised as an important consideration by London Gateway during consultation. In the event of an export cable exposure a guard vessel may need to be deployed (depending upon a dynamic risk assessment) as a precaution whilst awaiting the reburial works alongside a Notification to Mariners.

700. The most likely and worst case consequences are analogous to those outlined for the array areas, although further assessment is provided below in relation to the three

anchoring scenarios outlined for the array cables which are again applicable for the export cables.

19.9.1.1 Planned Anchoring

701. Following consultation the offshore ECC avoids and does not overlap with any designated anchorage areas. The Sunk Inner anchorage is located directly south of the offshore ECC and the Sunk DW anchorage is located approximately 1.5 nm north of the offshore ECC (see Figure 10.37 which shows these designated anchorage areas alongside anchored vessels within the offshore ECC study area). Both of these designated anchorage areas were noted by the UK Chamber of Shipping during consultation and HHA indicated that deeper burial will be required where there is an increased interaction risk from anchorage areas. From the vessel traffic data, anchoring activity in proximity to the offshore ECC is substantial but limited to these two anchorage areas. Therefore, planned anchoring within the offshore ECC is considered unlikely, particularly given that the offshore ECC passes through the Sunk VTS area.

19.9.1.2 Unplanned Anchoring

702. The location of unplanned anchoring cannot be pinpointed to any specific locations within the offshore ECC given the nature of this activity. This element of this hazard was a key topic of discussion during the Hazard Workshop, with specific locations noted as higher risk including the Sunk Inner Precautionary Area (given the shifting seabed) and where the offshore ECC crosses the Sunk Outer Precautionary Area. For the latter, Stena Line indicated that the burial depth would need to be greater than where the offshore ECC follows the Sunk TSS East. Any unplanned anchoring is highly likely to be undertaken in consultation with Sunk VTS.

19.9.1.3 Anchor Dragging

703. With suitable metocean conditions, an anchor dragging event could cause an interaction incident, particularly out of the Sunk Inner anchorage given its proximity. To investigate this further, a dedicated anchor dragging risk assessment was undertaken for the preferred option presented at the PEIR stage. This involved application of Anatec's anchor dragging model based on long-term AIS data, metocean data, and holding ground conditions.

704. The total annual frequency of vessels dragging anchor over the export cables, assuming that they are unburied (worst case) and based upon the preferred option presented at the PEIR stage, was estimated to be 5.5×10^{-3}, corresponding to a return period of approximately one in 180 years.

705. The risk was greatest for sections of the preferred option close to the charted anchorages, and in particular the Sunk Inner anchorage (87% of the anchor dragging risk). The majority of the risk was associated with cargo vessels and tankers between

1,000 and 30,000 Dead Weight Tonnage (DWT), which again relate to the Sunk Inner anchorage.

19.9.2 Cumulative Scenario – All Users

19.9.2.1 Tier 1

706. This hazard has been highlighted by stakeholders during consultation, with HHA, PLA, London Gateway, and Stena Line raising concerns relating to the cumulative presence of activities for VE and other subsea cable developments.

707. North Falls (export cables), NeuConnect, and Sea Link are expected to intersect the offshore ECC including crossings. Should a vessel anchor in a location where VE and other subsea cable developments are in close proximity, the level of exposure to anchor snagging will be greater.

708. However, the application of good seamanship is anticipated, with mariners checking the relevant nautical charts prior to making the decision to drop the anchor. Dropping the anchor over a subsea cable would only occur as a last resort to prevent an incident with potentially greater consequences such as a collision or allision, especially given the increased difficulty which would be presented to the mariner in recovering a snagged anchor. Additionally, the likelihood of a vessel requiring to drop anchor at a location where the export cables and other subsea cable developments are in close proximity is very low, with the assessment of vessel traffic data provided for the in isolation scenario again applicable.

709. It is assumed that, as with the export cables, North Falls, NeuConnect, and Sea Link will be subject to a Cable Burial Risk Assessment and will be shown on relevant nautical charts.

19.9.2.2 Tier 2

710. For this hazard there is no direct link between the offshore ECC and any Tier 2 developments and therefore no additional assessment of effect has been undertaken.

19.9.2.3 Tier 3

711. For this hazard there is no direct link between the offshore ECC and any Tier 3 developments and therefore no additional assessment of effect has been undertaken.

19.9.3 Embedded Mitigation Measures

712. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Cable Burial Risk Assessment;

- Charting of infrastructure;
- Guard vessels as required; and
- Promulgation of information.

19.9.4 Potential Significance of Risk

713. The frequency of occurrence and severity of consequence due to anchor interaction with subsea cables associated with the offshore ECC for the O&M phase of VE is presented in Table 19.9 alongside the resulting significance of risk.

Table 19.9 Significance of Risk for Anchor Interaction with Subsea Cables (Offshore ECC)

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	O&M	Anchor snagging incident occurs with anchor and/ or cable damage and compromised vessel stability.	Remote	Minor	**Broadly Acceptable**
Cumulative	O&M		Remote	Moderate	**Tolerable with Mitigation**

19.10 Reduction of Emergency Response Capability (Array Areas and Offshore Export Cable Corridor)

714. *The presence of surface structures within the array areas and O&M activities associated with the array areas and offshore ECC may result in an increased likelihood of an incident occurring which requires an emergency response and may reduce access for surface and air responders, including SAR assets.*

715. The MCA have noted during consultation that particular consideration is needed of the implications due to the presence of VE on SAR resources, with a SAR Checklist requiring completion post consent in consultation with the MCA.

716. The array areas and offshore ECC are considered collectively for this hazard since the assessment undertaken is considered relevant to VE as a whole.

19.10.1 In Isolation Scenario – All Users

19.10.1.1 Emergency Response Resources

717. The O&M phase may last for up to 40 years with up to 27 O&M vessels located on-site simultaneously, and making up to 1,776 annual round trips. With a full build out of the array areas, these vessels will increase the likelihood of an incident requiring an emergency response and subsequently increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability.

718. There are various emergency response resources serving the region, including RNLI stations (closest at Aldeburgh approximately 21 nm to the north-west) and SAR helicopter bases (closest at Lydd approximately 63 nm to the south-west). Given the distances which would be travelled in the event of an emergency response incident in proximity to VE, this hazard covers a regional spatial extent.

719. From historical incident data, there is a moderate rate of incidents in the region, although the likelihood of an incident relating to VE occurring at the same time is low. Additionally, based on the number of collision and allision incidents[13] associated with UK OWF reported to date, there is an average of one incident per 1,680 operational WTG years (as of November 2023). Therefore, VE itself is not expected to result in a marked increase in the frequency of incidents requiring an emergency response.

720. Additionally, should an incident occur in proximity to the array areas, it is likely that a project vessel would be well equipped to assist under SOLAS obligations (IMO, 1974) and in liaison with the MCA, potentially as the first responder. This is reflected in past experience, with 12 known instances of a vessel (or persons on a vessel) being assisted by an industry vessel for a nearby UK OWF.

721. The most likely consequences in the event of an incident in the region requiring an emergency response is that emergency responders are able to assist without any limitations on capability. As a worst case, there could be a delay to a response request due to a simultaneous incident associated with VE leading to PLL, pollution, and vessel damage. However, this worst case scenario is highly unlikely.

19.10.1.2 Search and Rescue Access

722. With a full build out of the array areas, its physical presence may restrict access for SAR responders, either due to the incident in question occurring within the arrays or the arrays obstructing the most effective path to each an incident (likely further offshore). This is more likely to be an issue in adverse weather conditions. The Applicant is committed to working within the parameters of MGN 654 to minimise hazards.

723. From recent SAR helicopter taskings data, the frequency of UK SAR operations in proximity to the array areas is relatively low. Those incidents reported primarily occurred inshore of the array areas, with only one incident occurring east of the array areas.

724. The total area covered by the array areas is approximately 37 nm^2, which represents a low to moderate area to search compared to other OWF. It is unlikely that a SAR operation will require both array areas to be searched; it is much more likely that a

[13] Although other types of incidents are acknowledged, collision and allision incidents have the potential to be among the most serious and give a reasonable indication of the rate of incidents requiring an emergency response.

search could be restricted to the northern array area or southern array area exclusively depending upon the information available regarding the casualty location (inclusive of any assumptions on the drift of the casualty).

725. The minimum spacing between all structures (including OSPs) is 830 m which is greater than that associated with many other UK OWFs and similar to that present at the neighbouring Greater Gabbard and Galloper. The northern array area includes a SLoO but given the size of the array area this is not expected to compromise the effectiveness of a SAR operation noting that the longest SAR access lane for the indicative array layout is less than 5 nm length. As per MGN 654 requirements, a setback of at least 1 nm (measured tip-to-tip) will be maintained from the neighbouring Galloper for both array areas, assuming the array layouts do not align. This will allow a SAR asset to safely exit one array without entering the other. If the layout does align with Galloper a smaller setback may be applied.

726. The final array layout will be agreed with the MCA and Trinity House post consent but will be compliant with the requirements of MGN 654 (MCA, 2021), including:

- Completion of a safety justification for a SLoO layout should this be taken forward;
- Completion of a SAR Checklist;
- Completion of an Emergency Response Cooperation Plan (ERCoP); and
- Application of unique identification marking of structures in an easily identifiable pattern.

727. The SAR Checklist and ERCoP will remain live documents throughout the O&M phase.

728. The most likely consequences in the event of a SAR operation is that SAR assets are able to fulfil their objectives without any limitations on capability. As a worst case, it may not be possible to undertake an effective search. However, given compliance with MGN 654 for the final array layout, this is considered highly unlikely.

19.10.2 Cumulative scenario – All Users

19.10.2.1 Tier 1

729. Activities associated with East Anglia Two, North Falls, NeuConnect, and Sea Link will further increase the likelihood of an incident requiring an emergency response and could subsequently increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability.

730. However, as with VE, it is assumed that these developments will have suitable embedded mitigation measures in place to reduce the likelihood of a reduction in emergency response capability including marine coordination for project vessels and ERCoPs. Furthermore, SOLAS obligations (IMO, 1974) are applicable to all developments and may have a positive effect on a cumulative level, e.g., a project vessel for East Anglia Two may be able to assist with an incident associated with VE.

731. Given that the array areas are not immediately adjacent to East Anglia Two (minimum separation of 2.86 nm), there is not considered to be any cumulative effect associated with SAR access, noting that this separation distance exceeds the 1 nm distance required by MGN 654.

19.10.2.2 Tier 2

732. Activities associated with East Anglia One North will further increase the likelihood of an incident requiring an emergency response and subsequently could increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability.

733. Again, it is assumed that East Anglia One North will have suitable embedded mitigation measures in place to reduce the likelihood of a reduction in emergency response capability. However, given the distance from VE (minimum 18 nm), it is unlikely that SOLAS obligations would be as relevant for project vessels associated with East Anglia One North in the event of an incident associated with VE (compared with Tier 1 developments).

19.10.2.3 Tier 3

734. Activities associated with East Anglia Three, Norfolk Vanguard East, Norfolk Vanguard West, Hollandse Kust (West), and Hollandse Kust F will further increase the likelihood of an incident requiring an emergency response and subsequently could increase the likelihood of multiple incidents occurring simultaneously, diminishing emergency response capability.

735. Again, it is assumed that these developments will have suitable embedded mitigation measures in place to reduce the likelihood of a reduction in emergency response capability. However, given the distance from VE (minimum 35 nm for East Anglia Three), it is unlikely that SOLAS obligations would be as relevant for project vessels associated with these developments in the event of an incident associated with VE.

736. Moreover, it is likely that differing emergency response resources may respond to an incident associated with these developments compared to VE, including Dutch resources (for Hollandse Kust (West) and Hollandse Kust F) and the Humber Maritime Rescue Coordination Centre (MRCC) (for Norfolk Vanguard East and Norfolk Vanguard West). Therefore, the likelihood of this hazard arising is not substantially higher than with the Tier 2 developments in situ.

19.10.3 Embedded Mitigation Measures

737. Embedded mitigation measures identified as relevant to reducing the significance of risk are as follows:

- Compliance with MGN 654;
- Lighting and marking;

- Marine coordination for project vessels;
- Pollution planning; and
- Project vessel compliance with international marine regulations.

19.10.4 Potential Significance of Risk

738. The frequency of occurrence and severity of consequence due to reduction of emergency response capability for the O&M phase of VE is presented in Table 19.10 alongside the resulting significance of risk.

Table 19.10 Significance of Risk for Reduction of Emergency Response Capability

Scenario	Phase	Worst Case Consequences	Frequency of Occurrence	Severity of Consequence	Significance of Risk
VE in isolation	O&M	Delay to a response request and inability to undertake an effective search leading to vessel damage, PLL, and pollution.	Negligible	Serious	**Broadly Acceptable**
Cumulative	O&M		Extremely Unlikely	Serious	**Tolerable with Mitigation**

20 Risk Control Log

Table 20.1 presents a summary of the risk assessment of shipping and navigation hazards. This includes (per hazard) the proposed embedded mitigation measures, frequency of occurrence, severity of consequence, and resulting significance of risk.

Any additional mitigation measures proposed are then listed per hazard alongside the residual risk.

Table 20.1 Risk Control Log

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
Vessel displacement and increased collision risk (array areas)	VE in isolation	Construction	▪ Application for safety zones; ▪ Buoyed construction areas; ▪ Charting of infrastructure; ▪ Compliance with MGN 654; ▪ Guard vessels as required; ▪ Lighting and marking; ▪ Pollution planning; ▪ Promulgation of information; and ▪ Vessel traffic monitoring.	Extremely Unlikely	Moderate	**Broadly Acceptable**	Potential additional aids to navigation during construction phase to be discussed as part of lighting and marking for the final array layout post consent.	**Broadly Acceptable**
		O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
	Cumulative	Construction		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
Vessel displacement and increased collision risk (offshore ECC)	VE in isolation	Construction	▪ Charting of infrastructure; ▪ Compliance with MGN 654; ▪ Guard vessels as required;	Remote	Moderate	**Tolerable with Mitigation**	None identified	**Tolerable with Mitigation**
		O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
	Cumulative	Construction	▪ NIP; ▪ Pollution planning; and ▪ Promulgation of information.	Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
Third-party with project vessel collision risk (array areas)	VE in isolation	Construction	▪ Application for safety zones; ▪ Buoyed construction areas; ▪ Guard vessels as required; ▪ Marine coordination for project vessels; ▪ Pollution planning; ▪ Project vessel compliance with international marine regulations; and ▪ Promulgation of information.	Extremely Unlikely	Moderate	**Broadly Acceptable**	None identified	**Broadly Acceptable**
		O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
	Cumulative	Construction		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		O&M		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
Third-party with project vessel collision risk	VE in isolation	Construction	▪ Guard vessels as required; ▪ Marine coordination for project vessels;	Negligible	Moderate	**Broadly Acceptable**	None identified	**Broadly Acceptable**
		O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
(offshore ECC)		Decommissioning	▪ NIP; ▪ Pollution planning; ▪ Project vessel compliance with international marine regulations; and ▪ Promulgation of information.	Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
	Cumulative	Construction		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
		Decommissioning		Extremely Unlikely	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
Reduced access to local ports and harbours and reduction in under keel clearance (array areas)	VE in isolation	Construction	▪ Cable Burial Risk Assessment; ▪ Compliance with MGN 654; ▪ Marine coordination for project vessels; ▪ Pollution planning; ▪ Project vessel compliance with international marine regulations; ▪ Promulgation of information; and ▪ Vessel traffic monitoring.	Remote	Minor	**Broadly Acceptable**	None identified	**Broadly Acceptable**
		O&M		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		Decommissioning		Remote	Minor	**Broadly Acceptable**		**Broadly Acceptable**
	Cumulative	Construction		Remote	Minor	**Broadly Acceptable**		**Broadly Acceptable**
		O&M		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		Decommissioning		Remote	Minor	**Broadly Acceptable**		**Broadly Acceptable**

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
Reduced access to local ports and harbours and reduction in under keel clearance (offshore ECC)	VE in isolation	Construction	▪ Cable Burial Risk Assessment; ▪ Marine coordination for project vessels; ▪ Pollution planning; ▪ Compliance with MGN 654; ▪ NIP; ▪ Promulgation of information; and ▪ Vessel traffic monitoring.	Reasonably Probable	Moderate	**Tolerable with Mitigation**	None identified	**Tolerable with Mitigation**
		O&M		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
	Cumulative	Construction		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		O&M		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
		Decommissioning		Reasonably Probable	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**
Creation of allision risk (array areas)	VE in isolation	O&M	▪ Application for safety zones (major maintenance only); ▪ Charting of infrastructure; ▪ Compliance with MGN 654; ▪ Lighting and marking;	Negligible	Major	**Tolerable with Mitigation**	None identified	**Tolerable with Mitigation**

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
	Cumulative	O&M	▪ Marine coordination for project vessels; ▪ Minimum blade tip clearance; ▪ Pollution planning; ▪ Project vessel compliance with international marine regulations; and ▪ Promulgation of information.	Extremely Unlikely	Major	**Tolerable with Mitigation**		**Tolerable with Mitigation**
Anchor interaction with subsea cables (array areas)	VE in isolation	O&M	▪ Cable Burial Risk Assessment; ▪ Charting of infrastructure; ▪ Guard vessels as required; and ▪ Promulgation of information.	Extremely Unlikely	Minor	**Broadly Acceptable**	None identified	**Broadly Acceptable**
	Cumulative	O&M		Negligible	Moderate	**Broadly Acceptable**		**Broadly Acceptable**
Anchor interaction with subsea cables (offshore ECC)	VE in isolation	O&M	▪ Cable Burial Risk Assessment; ▪ Charting of infrastructure; ▪ Guard vessels as required; and	Remote	Minor	**Broadly Acceptable**	None identified	**Broadly Acceptable**
	Cumulative	O&M		Remote	Moderate	**Tolerable with Mitigation**		**Tolerable with Mitigation**

Hazard	Scenario	Phase	Embedded Mitigation Measures	Frequency of Occurrence	Severity of Consequence	Significance of Risk	Additional Mitigation Measures	Residual Risk
			▪ Promulgation of information.					
Reduction of emergency response capability	VE in isolation	O&M	▪ Compliance with MGN 654; ▪ Lighting and marking; ▪ Marine coordination for project vessels; ▪ Pollution planning; and ▪ Project vessel compliance with international marine regulations	Negligible	Serious	**Broadly Acceptable**	None identified	**Broadly Acceptable**
	Cumulative	O&M		Extremely Unlikely	Serious	**Tolerable with Mitigation**		**Tolerable with Mitigation**

21 Mitigation Measures

21.1 Embedded Mitigation Measures

739. As part of the design process for VE, a number of embedded mitigation measures have been adopted to reduce the risk of hazards identified, including those relevant to shipping and navigation. These measures include project design measures, compliance with elements of good practice and use of standard protocols. They will continue to evolve over the development process as the EIA progresses and in response to consultation.

740. These measures typically include those that have been identified as good or standard practice and include actions that will be undertaken to meet existing legislation requirements. As there is a commitment to implementing these measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of VE.

741. The embedded mitigation measures within the design relevant to shipping and navigation are outlined in Table 21.1.

Table 21.1 Embedded Mitigation Measures Relevant to Shipping and Navigation

Embedded Mitigation Measure	Details
Application for Safety Zones	An application will be made for safety zones post consent including up to 500 m around ongoing activities during construction, major maintenance and decommissioning and up to 50 m for installed structures pre commissioning.
Buoyed construction/ decommissioning area	The array construction/decommissioning area will be marked by buoyage as required by Trinity House.
Cable Burial Risk Assessment	Cables will typically be buried at a target burial depth to be determined by a Cable Burial Risk Assessment which is provided in **Volume 9, Report 9: Cable Burial Risk Assessment**. Where cable burial is not possible, cable protection will be applied, noting that in sensitive areas the export cables will be buried or low profile protection used to ensure there is no reduction in water depth.
CSIP	Development of, and adherence to, a CSIP post consent. The CSIP will set out appropriate cable burial depth in accordance with industry good practice, minimising the risk of cable exposure. The CSIP will also ensure that cable crossings are appropriately designed to mitigate environmental effects, these crossings will be agreed with relevant parties in advance of CSIP submission. The CSIP will include a detailed Cable Burial Risk Assessment to enable informed judgements regarding burial depth to maximise the chance of cables remaining buried whilst limiting the amount of sediment disturbance to that which is necessary. The CSIP will be conditioned in the deemed Marine Licence and is provided in **Volume 9: Report 12: Cable Specification and Installation Plan**.
Charting of infrastructure	All infrastructure associated with VE (including subsea cables) will be shown on appropriately scaled UHKO Admiralty charts.

Embedded Mitigation Measure	Details
Compliance with MGN 654	VE will be compliant with MGN 654 and its annexes including in relation to reductions of no more than 5% in under keel clearance and the SAR Checklist.
Guard vessel(s)	A guard vessel(s) will be deployed where deemed appropriate by risk assessment.
Lighting and marking	Lights, marks, sounds, signals and other aids to navigation will be exhibited as required by Trinity House, MCA and CAA.
Marine coordination for project vessels	Marine coordination will be implemented to manage project vessels, including in communication with cumulative project marine coordinators as required. The Applicant also commits to use of entry/ exit points and defined routes to and from construction/ decommissioning and O&M ports to mitigate interaction between third-party and project vessels.
Minimum blade clearance	There will be a minimum blade tip clearance of at least 28 m above MHWS.
Navigation Installation Plan (NIP)	A NIP will be developed to manage interactions between project vessels associated with export cable installation/ maintenance/ repair and third-party vessels in a defined area of interest considered navigationally sensitive. Additional detail is provided in Section 21.4 and the outline NIP is provided in **Volume 9, Report 20: Outline Navigation Installation Plan**.
Pollution planning	An MPCP will be developed outlining procedures to protect personnel working and to safeguard the marine environment in the event of a pollution event.
Project vessel compliance with international marine regulations	Project vessels will comply with international marine regulations as adopted by the Flag State, including COLREGs and SOLAS.
Promulgation of information	Local Notifications to Mariners and Kingfisher Bulletins will be updated and reissued at weekly intervals during construction and at least five days prior to planned maintenance works.
Traffic monitoring	Monitoring of vessel traffic will be undertaken for the duration of the construction phase.

21.2 Additional Mitigation Measures

742. The following additional mitigation measure has been identified relevant to shipping and navigation within the risk assessment undertaken in Section 19:

- Trinity House have indicated during consultation that additional aids to navigation (such as buoys) may be necessary to mitigate risks during the construction phase; this will be discussed as part of lighting and marking discussions for the final array layout post consent.

21.3 Marine Aids to Navigation

743. Throughout all phases, aids to navigation will be provided in accordance with Trinity House and MCA requirements, with consideration being given to IALA Recommendation O-139 and G1162 (IALA, 2021) and MGN 654 (MCA, 2021).

21.3.1 Construction and Decommissioning Phases

744. During the construction and decommissioning phases, buoyed construction and decommissioning areas will be established and marked, where required, in accordance with Trinity House requirements based on the IALA Maritime Buoyage System.

21.3.2 Operations and Maintenance Phase

745. Marking during the O&M phase will be agreed in consultation with Trinity House once the final array layout has been selected post consent; however, the following subsections summarise likely requirements.

21.3.2.1 Marking of Individual Array Structures

746. As per IALA Guideline G1162, each surface structure within the array area will be painted yellow from the level of Highest Astronomical Tide (HAT) to at least 15 m above HAT. Each structure will also be clearly marked with a unique alphanumeric identifier which will be clearly visible from all directions. The MCA will advise post consent on the specific requirements for the identifiers, but a logical pattern with potential for additional visual marks may be considered by statutory stakeholders. Each identifier will be illuminated by a low-intensity light such that the sign is available from a vessel thus enabling the structure to be identified at a suitable distance to avoid an allision incident.

747. The identifiers will be situated such that under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer (with the naked eye), stationed 3 m above sea level and at a distance of at least 150 m from the WTG. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigational marks.

21.3.2.2 Marking of Array as a Whole

748. The marking of the array as a whole will be agreed with Trinity House once the final array layout has been selected and will be in line with IALA Recommendation O-139 and G1162. As per the IALA guidance, and in consultation with Trinity House, it will be ensured that:

- All corner structures will be marked as a Significant Peripheral Structure (SPS) and where necessary, to satisfy the spacing requirements between SPSs, additional periphery structures may also be marked as SPSs;

- Structures designated as an SPS will exhibit a flashing yellow five second (flash yellow every five seconds) light of at least 5 nm nominal range and omnidirectional fog signals as appropriate and where prescribed by Trinity House, and will be sounded at least when the visibility is 2 nm or less;
- Further periphery structures may be marked as Intermediate Peripheral Structures (IPS) including a flashing yellow light with a distinctly different flash character from those displayed on the SPSs and at least 2 nm nominal range;
- All lights will be visible to shipping through 360˚ and if more than one lantern is required on a structure to meet the all-round visibility requirement, then all the lanterns on that structure will be synchronised;
- All lights will be exhibited at the same height at least 6 m above HAT and below the arc of the lowest WTG blades;
- Remote monitoring sensors using Supervisory Control and Data Acquisition (SCADA) will be included as part of the lighting and marking scope to ensure a high level of availability for all aids to navigation;
- Aviation lighting will be as per CAA requirements; however, will likely be synchronised Morse “W” at the request of Trinity House; and
- All lighting will be considered cumulatively with existing aids to navigation (including that associated with Galloper) to avoid the potential for light confusion to passing traffic.

749. Consideration will also be given to the use of marking via AIS, or other electronic means (such as Radar Beacons (Racon)) to assist safe navigation particularly in reduced visibility. AIS transmitters or virtual buoys could also be considered internally to assist with safe navigation within the array areas.

750. Additionally, consideration will be given to the cumulative lighting and marking of VE alongside Greater Gabbard and Galloper, again in consultation with Trinity House.

21.3.2.3 Marking of Export Cables

751. No lighting or physical marking will be required during the O&M phase for the export cables.

21.4 Navigation Installation Plan

752. During consultation relating to the NRA, it was agreed with HHA, PLA, and Sunk VTS that a mechanism is required for managing interactions between project vessels associated with export cable installation/ maintenance/ repair and third-party vessels in navigationally sensitive areas.

753. The NIP serves as such a mechanism and is considered an embedded mitigation for minimising the significance of effect associated with shipping and navigation impacts, including vessel displacement and increased collision risk, third-party with project vessel collision risk, reduced access to local ports and harbours including pilotage operations, and reduction in under keel clearance.

754. The NIP does not consider general vessel management associated with VE, e.g., entry and exit points for project vessels to/ from the array areas, since this will be managed by VE's marine coordination which is included as a separate embedded mitigation measure in Section 21.1.

755. The NIP is a live document which will continue to be updated in consultation with relevant parties following the submission of the consent application. Indicatively, matters for which protocols will be agreed with relevant parties include:

- Notification of planned activities;
- Navigational status;
- Restricted operations;
- HAZOP Workshop;
- Additional mitigation measures;
- Weather constraints and data;
- Contingency plans; and
- Stakeholder resource requirements.

756. The outline NIP is provided in **Volume 9, Report 20: Outline Navigation Installation Plan**.

21.5 Design Specifications Noted in Marine Guidance Note 654

757. The individual WTGs and other structures will have functions and procedures in place for generator shut down in emergency situations, as per MGN 654 (MCA, 2021).

22 Through Life Safety Management

22.1 Quality, Health, Safety and Environment

758. Quality, Health, Safety and Environment (QHSE) documentation including a Safety Management System (SMS) will be in place for VE and will be continually updated throughout the development process. The following subsections provide an overview of this documentation and how it will be maintained and reviewed with reference, where required, to specific marine documentation.

759. Monitoring, reviewing, and auditing will be carried out on all procedures and activities and feedback actively sought. Any designated person (identified in QHSE documentation), managers, and supervisors are to maintain continuous monitoring of all marine operations and determine if all required procedures and processes are being correctly implemented.

22.2 Incident Reporting

760. After any incidents, including near misses, an incident report form will be completed in line with VE QHSE documentation. This will then be assessed for relevant outcomes and reviewed for possible changes required to operations.

761. The Applicant will maintain records of investigation and analyse incidents in order to:

- Determine underlying deficiencies and other factors that may be causing or contributing to the occurrence of incidents;
- Identify the need for corrective action;
- Identify opportunities for preventative action;
- Identify opportunities for continual improvement; and
- Communicate the results of such investigations.

762. All investigations shall be performed in a timely manner.

763. A database (lessons learnt) of all marine incidents will be developed. It will include the outcomes of investigations and any resulting actions. The Applicant will promote awareness of their potential occurrence and provide information to assist monitoring, inspection and auditing of documentation.

764. When appropriate, the designated person (noted within the ERCoP) should inform the MCA of any exercise or incidents including any implications on emergency response. If required, the MCA should be invited to take part in incident debriefs.

22.3 Review of Documentation

765. The Applicant will be responsible for reviewing and updating all documentation including the risk assessments, ERCoP, SMS and, if required, will convene a review panel of stakeholders to quantify risk.

766. Reviews of the risk register should be made after any of the following occurrences:

- Changes to the development, conditions of operation and prior to decommissioning;
- Planned reviews; and
- Following an incident or exercise.

767. A review of potential risks should be carried out annually. A review of the response charts should be undertaken annually to ensure that response procedures are up to date and should include any amendments from audits, incident reports and identified deficiencies.

22.4 Inspection of Resources

768. All vessels, facilities, and equipment necessary for marine operations are to be subject to appropriate inspection and testing to determine fitness for purpose and availability in relation to their performance standards. This will include monitoring and inspection of all aids to navigation to determine compliance with the performance standards specified by Trinity House.

22.5 Audit Performance

769. Auditing and performance review are the final steps in QHSE management systems. The feedback loop enables an organisation to reinforce, maintain and develop its ability to reduce risks to the fullest extent, and to ensure the continued effectiveness of the system. The Applicant will carry out audits and periodically evaluate the efficiency of the marine safety documentation.

770. The audits and possible corrective actions should be undertaken in accordance with standard procedures and results of the audits and reviews should be brought to the attention of all personnel having responsibility in the area involved.

22.6 Safety Management System

771. The Applicant will manage the risk associated with the activities undertaken at VE. An integrated SMS, which ensures that the safety and environmental risks of those activities are ALARP, will be established. This includes the use of remote monitoring and switching for aids to navigation to ensure that if a light is faulty a quick fix can be instigated, which will allow IALA availability requirements to be met.

22.7 Cable Monitoring

772. The subsea cable routes will be subject to periodic inspection post-construction to monitor the cable protection, including burial depths. Maintenance of the protection will be undertaken as necessary.

773. If exposed cables or ineffective protection measures are identified during post-construction monitoring, these would be promulgated to relevant sea users including via Notice to Mariners and Kingfisher Bulletins. Where immediate risk was observed, the Applicant would also employ additional temporary measures (such as a guard vessel or temporary buoyage) until such time as the risk was permanently mitigated.

774. Details will be included in full within the assessment of cable burial and protection document, to be produced post-consent.

22.8 Hydrographic Surveys

775. As required by Annex 4 of MGN 654, detailed and accurate hydrographic surveys will be undertaken periodically at intervals agreed with the MCA.

22.9 Decommissioning Plan

776. A Decommissioning Plan will be developed prior to the start of decommissioning works. With regards to hazards to shipping and navigation, this will also include consideration of the scenario where upon decommissioning and completion of removal operations, an obstruction is left on-site (attributable to VE) which is considered to be a danger to navigation and which it has not proved possible to remove. Such an obstruction may require marking 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 Applicant.

23 Summary

777. Using baseline data, expert opinion, outputs of the Hazard Workshop, stakeholder concerns, and lessons learnt from existing offshore developments, hazards relating to shipping and navigation have been identified due to the presence of VE for all phases of the development (construction, O&M, and decommissioning). This has been fed into the risk assessment – which follows the FSA approach – undertaken from Section 18.

23.1 Consultation

778. Consultation has been undertaken throughout the NRA process with key shipping and navigation stakeholders, including dedicated meetings with:

- MCA;
- Trinity House;
- UK Chamber of Shipping;
- Cruising Association;
- Sunk VTS;
- HHA;
- PLA;
- London Gateway;
- Port of Felixstowe;
- Brightlingsea Harbour Commissioners;
- Stena Line;
- DFDS Seaways;
- CLdN; and
- Hanson Aggregates Marine.

23.2 Baseline Characterisation

23.2.1 Navigational Features

779. The Galloper and Greater Gabbard developments (both operational) are located directly west of the array areas. Other nearby OWF developments in the region include North Falls (scoped), East Anglia Two (consented), East Anglia One (operational), and East Anglia One North (consented).

780. The Sunk routeing measure is located directly west and between the array areas, including the Sunk TSS East. The North Hinder South TSS is located approximately 5.5 nm to the south-east of the array areas at the closest point and connects to the North Hinder Junction. The offshore ECC passes through the Sunk routeing measure, including passing directly south of the Sunk TSS East and crossing the Sunk Outer and Inner Precautionary Areas.

781. The Port of Felixstowe is the closest port or harbour to the array areas, with Harwich Haven located also in proximity. Both ports are to the west on the Suffolk coast. The Sunk VTS – operated from Harwich Operations Centre – operates in the region.

782. There are two pilot boarding stations within or in proximity to the offshore ECC – the Rivers Colne and Crouch pilot station and Sunk pilot station. Three DWR are located within the Sunk Inner Precautionary Area; the offshore ECC crosses both the Trinity

and Sunk DWR. The offshore ECC also passes in proximity to the Harwich Deep Water Channel.

783. There are two designated anchorage areas in proximity to the offshore ECC – the Sunk Inner and Sunk DW anchorages.

23.2.2 Maritime Incidents

784. From RNLI incident data recorded between 2013 and 2022 within the array traffic study area, there was an average of three unique incidents per year with machinery failure (60%) the most frequently recorded incident type. One incident was recorded within the array areas.

785. Within the offshore ECC study area there was an average of 19 unique RNLI incidents per year with machinery failure (44%) the most frequently recorded incident type. A total of 20 unique incidents were recorded within the offshore ECC itself.

786. From MAIB incident data recorded between 2012 and 2021 within the array traffic study area, there was an average of one unique incident per year with accident to person (42%) and machinery failure (25%) the most frequently recorded incident types. No incidents were recorded within the array areas.

787. Within the offshore ECC study area there was an average of two to three unique MAIB incidents per year with machinery failure (31%), accident to person (15%), and hazardous incident (15%) the most frequently recorded incident types. A total of three unique incidents were recorded within the offshore ECC itself.

23.2.3 Vessel Traffic Movements

788. From 14 days of vessel traffic survey data recorded in January 2022 (winter) within the array traffic study area, there was average of 102 unique vessels per day with an average of 7-8 unique vessels per day within the array areas. Throughout the winter period, the main vessel types recorded within the array traffic study area were cargo vessels (57%), tankers (23%), and fishing vessels (9%).

789. From 14 days of vessel traffic survey data recorded in July 2022 (summer) within the array traffic study area, there was an average of 116 unique vessels per day with an average of 12 unique vessels per day within the array areas. Throughout the summer period, the main vessel types recorded within the array traffic study area were cargo vessels (49%), tankers (18%), and wind farm vessels (14%).

790. From 14 days of vessel traffic data recorded in January 2022 (winter) within the offshore ECC study area, there was average of 46 unique vessels per day with an average of 38 unique vessels per day within the offshore ECC. Throughout the winter period, the main vessel types recorded within the offshore ECC study area were cargo vessels (63%), tankers (12%), dredgers (5%), and wind farm vessels (5%).

791. From 14 days of vessel traffic data recorded in July 2022 (summer) within the offshore ECC study area, there was an average of 75 unique vessels per day with an average of 63 unique vessels per day within the offshore ECC. Throughout the summer period, the main vessel types recorded within the offshore ECC study area were cargo vessels (37%), recreational vessels (30%), and wind farm vessels (8%).

792. A total of 26 main commercial routes were identified within the array routeing study area from the vessel traffic survey data. The most heavily trafficked main commercial route – with an average of 30 unique vessels per day – was between the Port of Amsterdam and the Dover Strait, utilising the North Hinder South TSS.

23.3 Future Case Vessel Traffic

23.3.1 Vessel Volume

793. Three distinct bands of vessel traffic growth have been considered for the future case scenario as a realistic worst case: 10%, 20%, and 30% increases in volume. This strikes a balance between the recommendations of various stakeholders during consultation and accounts for current vessel trends and constraints. The increase has been applied across commercial vessels as a whole, although for commercial fishing vessels and recreational vessels the 20% band is considered a realistic worst case.

794. Vessel traffic associated with VE operations are also considered, and marine aggregate dredgers are included in the bands outlined above, noting that there is uncertainty associated with the future scenario for marine aggregate dredging areas (new and discontinued sites).

23.3.2 Vessel Size

795. For commercial vessels, a worst case maximum draught of 23 m is considered, with a realistic maximum draught of 20 m. This reflects feedback from stakeholders, with the worst case maximum draught deemed to be of low likelihood due to various factors which are discussed further in Section 15.6.1. No material changes in the size of commercial fishing vessels and recreational vessels are anticipated.

23.3.3 Commercial Routeing

796. Deviations due to the presence of the arrays would be required for six out of the 26 main commercial routes identified with the level of deviation varying between a decrease of 1 nm for a route between the Port of Hull and Port of Zeebrugge, and an increase of 2.7 nm four a route between the Port of Grimsby and Port of Zeebrugge.

797. On a cumulative level, and based on a cumulative screening of other developments into distinct tiers, deviations due to the presence of the arrays alongside cumulative developments would be required for 12 out of the 26 main commercial routes identified with the level of deviation varying between a decrease of 1.3 nm for a

route between the Port of Hull and Port of Zeebrugge, and an increase of 2.3 nm for a route between the Dover Strait and Port of Immingham.

23.4 Collision and Allision Risk Modelling

798. Assuming base case traffic levels, the annual collision frequency post wind farm was estimated to be 1.92×10^{-1}, corresponding to a return period of approximately one in 5.20 years. This represents a 0.32% increase in collision frequency compared to the pre wind farm base case result.

799. Assuming base case traffic levels, the annual powered allision frequency was estimated to be 1.34×10^{-3}, corresponding to a return period of approximately one in 746 years.

800. After modelling three drift scenarios it was established that the flood tide dominated scenario produced the worst case results. Assuming base case traffic levels, the annual drifting allision frequency was estimated to be 1.71×10^{-3}, corresponding to a return period of approximately one in 584 years.

801. Assuming base case traffic levels, the annual fishing allision frequency was estimated to be 2.92×10^{-1}, corresponding to a return period of approximately one in 3.4 years.

23.5 Risk Statement

802. Using the baseline data, expert opinion, outputs of the Hazard Workshop, stakeholder concerns and lessons learnt from existing offshore developments, shipping and navigation hazards have been risk assessed in line with the FSA methodology. The full risk control log including details of hazards, embedded mitigation measures and significance of risk is presented in Section 20.

803. The significance of risk has been determined as either **Broadly Acceptable** or **Tolerable with Mitigation** for all shipping and navigation hazards assessed. With additional mitigation measures applied, the residual risk is **Broadly Acceptable** or **Tolerable with Mitigation** for all shipping and navigation hazards.

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Appendix A Marine Guidance Note 654 Checklist

804. The MGN 654 Checklist can be divided into two distinct checklists, one considering the main MGN 654 guidance document and one considering the Methodology for Assessing Marine Navigational Safety and Emergency Response Risks of OREIs (MCA, 2021) which serves as Annex 1 to MGN 654.

805. The checklist for the main MGN 654 guidance document is presented in Table A.1. Following this, the checklist for the MCA's methodology annex is presented in Table A.2. For both checklists, references to where the relevant information and/or assessment is provided in the NRA is given.

Table A.1 MGN 654 Checklist for Main Document

Issue	Compliance	Comments
Site and Installation Coordinates. Developers are responsible for ensuring that formally agreed coordinates 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 (European Terrestrial Reference System 1989 (ETRS89)) datum.		
Traffic Survey. Includes:		
All vessel types.	✓	**Section 10: Vessel Traffic Movements** All vessel types are considered with specific breakdowns by vessel type given for the array areas and offshore ECC.
At least 28 days duration, within either 12 or 24 months prior to submission of the ES.	✓	**Section 5: Data Sources** A total of 28 full days of vessel traffic survey data from January and July 2022 has been assessed within the respective study areas for the array areas and offshore ECC.
Multiple data sources.	✓	**Section 5: Data Sources** The vessel traffic survey data includes AIS, visual observations and Radar for the summer and winter periods to ensure maximal coverage of vessels not broadcasting on AIS.
Seasonal variations.	✓	**Section 5: Data Sources** A total of 28 full days of vessel traffic survey data from January and July 2022 has been assessed within the respective study areas for the array areas and offshore ECC.
MCA consultation.	✓	**Section 4: Consultation** The MCA have been consulted as part of the NRA process including through the Hazard Workshop.
General Lighthouse Authority (GLA) consultation.	✓	**Section 4: Consultation** Trinity House have been consulted as part of the NRA process.

Issue	Compliance	Comments
UK Chamber of Shipping consultation.	✓	**Section 4: Consultation** The UK Chamber of Shipping have been consulted as part of the NRA process including through the Hazard Workshop.
Recreational and fishing vessel organisations consultation.	✓	**Section 4: Consultation** The Cruising Association have been consulted as part of the NRA process including through the Hazard Workshop. The RYA have been included in consultation outreach and consultation with fisheries organisations is being undertaken as part of **Volume 6, Part 2, Chapter 8: Commercial Fisheries**.
Port and navigation authorities consultation, as appropriate.	✓	**Section 4: Consultation** HHA, the PLA, London Gateway, the Port of Felixstowe, and Brightlingsea Harbour Commissioners have been consulted as part of the NRA process including through 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 10: Vessel Traffic Movements** Vessel traffic data in proximity to VE has been analysed. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase including for all relevant users and on a cumulative basis with other offshore developments in the region.
ii. Numbers, types and sizes of vessels presently using such areas.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to VE has been analysed and includes breakdowns of daily vessel count, vessel type and vessel size.
iii. Non-transit uses of the areas, e.g., fishing, day cruising of leisure craft, racing, aggregate dredging, personal watercraft, etc.	✓	**Section 7: Navigational Features** Non-transit uses of the areas in proximity to VE have been identified, including marine aggregate dredging, pilotage, and anchoring. **Section 10: Vessel Traffic Movements** Non-transit users were identified in the vessel traffic survey data and included fishing vessels engaged in fishing activities and dredgers undertaking maintenance works.
iv. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✓	**Section 10: Vessel Traffic Movements** Main commercial routes have been identified using the principles set out in MGN 654 in proximity to the array areas, with these routes accounting for coastal, deep draught and internationally scheduled vessels.
v. Alignment and proximity of the site relative to adjacent shipping lanes.	✓	**Section 7: Navigational Features** IMO routeing measures in proximity to VE have been identified.
vi. Whether the nearby area contains prescribed routeing schemes or precautionary areas.	✓	**Section 7: Navigational Features** IMO routeing measures in proximity to VE have been identified and precautionary areas such as restricted areas, military areas and spoil grounds have been identified.

Issue	Compliance	Comments
vii. Proximity of the site to areas used for anchorage (charted or uncharted), safe haven, port approaches and pilot boarding or landing areas.	✓	**Section 7: Navigational Features** Designated anchorage areas in proximity to VE have been identified.
viii. Whether the site lies within the jurisdiction of a port and/or navigation authority.	✓	**Section 7: Navigational Features** Ports and port authorities in proximity to VE have been identified.
ix. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓	**Section 10: Vessel Traffic Movements** Commercial fishing vessel movements are considered within the respective study areas for the array areas and offshore ECC.
x. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓	**Section 7: Navigational Features** Military areas and explosives dumping grounds in proximity to VE have been identified.
xi. Proximity of the site to existing or proposed submarine cables or pipelines, offshore oil/gas platforms, marine aggregate dredging, marine archaeological sites or wrecks, Marine Protected Areas or other exploration/exploitation sites.	✓	**Section 7: Navigational Features** Subsea cables, marine aggregate dredging, charted wrecks, and obstructions, and MEHRAs in proximity to VE have been identified.
xii. Proximity of the site to existing or proposed OREI developments, in cooperation with other relevant developers, within each round of lease awards.	✓	**Section 7: Navigational Features** Other OWF developments in proximity to VE have been identified.
xiii. Proximity of the site relative to any designated areas for the disposal of dredging spoil or other dumping ground.	✓	**Section 7: Navigational Features** Spoil grounds and other dumping grounds in proximity to VE have been identified.
xiv. Proximity of the site to aids to navigation and/or VTS in or adjacent to the area and any impact thereon.	✓	**Section 7: Navigational Features** Key aids to navigation and VTS in proximity to VE has been identified.

Issue	Compliance	Comments
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the array areas.
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 9: Emergency Response and Incident Overview** Historical vessel incident data published by the MAIB, RNLI and DfT in proximity to VE has been considered alongside historical OWF incident data throughout the UK.
xvii. Proximity of the site to areas used for recreation which depend on specific features of the area.	✓	**Section 10: Vessel Traffic Movements** Recreational vessel movements are considered within the respective study areas for the array areas and offshore ECC.
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 15: Future Case Vessel Traffic** A methodology for post wind farm routeing is outlined and includes a minimum distance of 1 nm from offshore installations and existing OWF boundaries.
b. The width of a corridor between sites or OREIs to allow safe passage of shipping.	✓	**Section 17: Navigation Corridor Safety Case** A justification is provided for the navigation corridor between the array areas and East Anglia Two.
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has been undertaken for the array areas. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of anchoring and emergency response.

Issue	Compliance	Comments
b. Clearances of fixed or floating WTG blades above the sea surface are not less than 22 m (above Mean High Water Springs (MHWS) for fixed). Floating turbines allow for degrees of motion.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including a minimum blade tip clearance of at least 28 m above MHWS.
c. Underwater devices: i. Changes to charted depth; ii. Maximum height above seabed; and iii. Under keel clearance.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** Array and export cable specifications relevant to the MDS for shipping and navigation are provided.
d. Whether structures block or hinder the view of other vessels or other navigational features.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the use of existing aids to navigation are considered. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of visual hindrance to navigation.
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 6: Project Description Relevant to Shipping and Navigation** The range of water depths within the array areas and offshore ECC are provided. **Section 8: Meteorological Ocean Data** Various states of the tide local to VE are provided. **Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to VE has been analysed. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has accounted for tidal conditions.
b. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓	**Section 8: Meteorological Ocean Data** Various states of the tide local to VE are provided. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has accounted for 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.	✓	

Issue	Compliance	Comments
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 8: Meteorological Ocean Data** Various states of the tide local to VE are provided and hazards are not anticipated at high or low water only. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has accounted for 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 8: Meteorological Ocean Data** No risks 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 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of reduction in under keel clearance.
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 8: Meteorological Ocean Data** Weather and visibility data local to VE is provided. **Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to VE has been analysed including recreational vessels. **Section 12: Adverse Weather Routeing** Alternative routeing used during periods of adverse weather has been identified. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of adverse weather routeing.
i. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓	**Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of vessels under sail.
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling has accounted for weather and tidal conditions and assesses whether machinery failure could cause vessels to be set into danger.
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:		

Issue	Compliance	Comments
i. For all vessels.	✓	**Section 4: Consultation** Regular Operators have been consulted as part of the NRA process including through the Hazard Workshop. **Section 12: Adverse Weather Routeing** Alternative routeing used during periods of adverse weather has been identified. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling includes use of post wind farm routeing and accounts for weather and tidal conditions. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of internal navigation.
ii. For specified vessel types, operations and/or sizes.		
iii. In all directions or areas.		
iv. In specified directions or areas.		
v. In specified tidal, weather or other conditions.		
b. Navigation in and/or near the site should be prohibited or restricted:		
i. For specified vessel types, operations and/or sizes.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the use of navigation, communication, and position fixing devices used in and around OWFs are assessed. **Section 16: Collision and Allision Risk Modelling** Collision and allision risk modelling includes use of post wind farm routeing which assumes that commercial vessel traffic avoids the arrays. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of internal navigation. **Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including an application for safety zones.
ii. In respect of specific activities.	✓	
iii. In all areas or directions.	✓	
iv. In specified areas or directions.	✓	
v. In specified tidal or weather conditions.	✓	
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 16: Collision and Allision Risk Modelling** Collision and allision risk modelling includes use of post wind farm routeing which assumes that commercial vessel traffic avoids the arrays. **Section 19: Risk Assessment** The hazards due to VE have been assessed for each phase and include consideration of emergency response capability.

Issue	Compliance	Comments
d. Guidance on the calculation of safe distance of OREI boundaries from shipping routes has been considered.	✓	**Section 15: Future Case Vessel Traffic** A methodology for post wind farm routeing is outlined and includes consideration of the Shipping Route Template.
SAR, maritime assistance service, counter pollution and salvage incident response.		
The MCA, through HM Coastguard, is required to provide SAR and emergency response within the sea area occupied by all OREIs 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 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires the creation of an ERCoP.
b. The MCA's guidance document *Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response* (MCA, 2021) for the design, equipment and operation requirements will be followed.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires 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 Annex 5 (to be agreed with MCA).	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires the completion of the SAR checklist.
6. 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 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires the specified hydrographic surveys to be completed.
ii. On a pre-established periodicity during the life of the development.	✓	
iii. Post construction: Cable route(s).	✓	
iv. Post decommissioning of all or part of the development: the installed generating assets area and cable route.	✓	

Issue	Compliance	Comments
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:		
i. Vessels operating at a safe navigational distance.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the use of navigation, communication, and position fixing devices used in and around OWFs are assessed.
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.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the use of navigation, communication, and position fixing devices used in and around OWFs are assessed.
ii. Vessel to shore.	✓	
iii. VTS Radar to vessel.	✓	
iv. Racon to/from vessel.	✓	
c. The structures and generators might produce SONAR interference affecting fishing, industrial or military systems used in the area.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the risk of SONAR interference due to VE are assessed.
d. The site might produce acoustic noise which could mask prescribed sound signals.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the risk of noise due to VE are assessed.
e. Generators and the seabed cabling within the site and onshore might produce EMFs affecting compasses and other navigation systems.	✓	**Section 13: Navigation, Communication, and Position Fixing Equipment** Hazards relating to the risk of electromagnetic interference due to VE are assessed.
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 EIA. The specific measures to be employed will be selected in consultation with the MCA and will be listed in the developer's ES. These will be consistent with international standards contained in, for example, SOLAS Chapter V (IMO, 1974), and could include any or all of the following:		

Issue	Compliance	Comments
i. Promulgation of information and warnings through notices to mariners and other appropriate MSI dissemination methods.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including the promulgation of information.
ii. Continuous watch by multi-channel VHF, including DSC.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including marine coordination for project vessels.
iii. Safety zones of appropriate configuration, extent and application to specified vessels[14].	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including an application for safety zones.
iv. Designation of the site as an Area to be Avoided (ATBA).	✓	**Section 6: Project Description Relevant to Shipping and Navigation** It is not planned to designate the array areas as ATBA.
v. Provision of aids to navigation as determined by the GLA.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including lighting and marking as required by Trinity House, MCA, and CAA.
vi. Implementation of routeing measures within or near to the development.	✓	**Section 19: Risk Assessment** It is not planned to implement or amend routeing measures in proximity to VE, including any potential extension to the Sunk TSS East.
vii. Monitoring by Radar, AIS, Closed Circuit Television (CCTV) or other agreed means.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires discussions with the MCA regarding monitoring as part of the SAR checklist.
viii. Appropriate means for OREI operators to notify, and provide evidence of, the infringement of Safety Zones.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including an application for safety zones. The means for notifying and providing evidence of the infringement of safety zones will be provided in the safety zone application, submitted post consent.

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

Issue	Compliance	Comments
ix. Creation of an ERCoP with the MCA's SAR Branch for the construction phase onwards.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including compliance with MGN 654, which requires the creation of an ERCoP.
x. Use of guard vessels, where appropriate.	✓	**Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including the use of guard vessels.
xi. Update NRAs every two years, e.g., at testing sites.	✓	Not applicable to VE.
xii. Device-specific or array-specific NRAs.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** All offshore elements of VE are considered in this HRA including the array areas and offshore ECC infrastructure. **Section 21: Mitigation Measures** Embedded mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined including a Cable Burial Risk Assessment which will serve as additional assessment relating to shipping and navigation.
xiii. Design of OREI structures to minimise risk to contacting vessels or craft.	✓	There is no additional risk posed to craft compared to previous OWFs and so no additional measures are identified.
xiv. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓	**Section 21: Mitigation Measures** Additional mitigation measures to be implemented to reduce the significance of risk associated with shipping and navigation hazards are outlined and have been informed by consultation.

Table A.2 MGN 654 Annex 1 Checklist

Item	Compliance	Comments
A risk claim is included that is supported by a reasoned argument and evidence.	✓	**Section 18: Introduction to Risk Assessment** The risk assessment provides a risk claim for a range of hazards based on a number of inputs including baseline data, expert opinion, outputs of the Hazard Workshop, stakeholder concerns and lessons learnt from existing offshore developments.
Description of the marine environment.	✓	**Section 7: Navigational Features** Navigational features in proximity to VE have been described including (but not limited to) other OWF developments, IMO routeing measures, ports, harbours and related facilities, designated anchorage areas, marine aggregate dredging

Item	Compliance	Comments
		areas, subsea cables, key aids to navigation, and charted wrecks. **Section 14: Cumulative and Transboundary Overview** Potential future offshore developments have been screened into the cumulative risk assessment where a cumulative or in combination activity has been identified based upon the location and distance from VE. Developments screened include other OWFs, marine aggregate areas, and subsea cables.
SAR overview and assessment.	✓	**Section 9: Emergency Response and Incident Overview** Existing SAR resources in proximity to VE are summarised including the UK SAR operations contract, RNLI stations, and HMCG stations. **Section 19: Risk Assessment** The risk assessment includes consideration of how activities associated with VE may restrict emergency response capability.
Description of the OREI development and how it changes the marine environment.	✓	**Section 6: Project Description Relevant to Shipping and Navigation** The maximum extent of VE for which any shipping and navigation hazards are assessed is provided including a description of the array areas and offshore ECC, associated infrastructure, construction phase programme, and indicative vessel and helicopter numbers during the construction and O&M phases.
Analysis of the vessel traffic, including base case and future traffic densities and types.	✓	**Section 10: Vessel Traffic Movements** Vessel traffic data in proximity to VE has been analysed and includes vessel density and breakdowns of vessel type. **Section 15: Future Case Vessel Traffic** Future vessel traffic levels have been considered, with consideration of increases in commercial vessel activity, commercial fishing vessel and recreational vessel activity, traffic associated with VE operations, and changes in marine aggregate dredging activities. Additionally, worst case alternative routeing for commercial traffic has been considered.
Status of the hazard log: ▪ Hazard identification; ▪ Risk assessment; ▪ Influences on level of risk; ▪ Tolerability of risk; and ▪ Risk matrix.	✓	**Section 3: Navigational Risk Assessment Methodology** A tolerability matrix has been defined to determine the tolerability (significance) of risks. **Appendix B: Hazard Log** The complete hazard log is presented and includes a description of the hazards considered, possible causes, consequences (most likely and worst case) and relevant embedded mitigation measures. Using this information, each hazard is then ranked in terms of frequency of occurrence and

Item	Compliance	Comments
		severity of consequence to give a tolerability (significance) level.
NRA: ▪ Appropriate risk assessment; ▪ MCA acceptance for assessment techniques and tools; ▪ Demonstration of results; and ▪ Limitations.	✓	**Section 2: Guidance and Legislation** MGN 654 and the IMOs FSA guidelines are the primary guidance documents used for the assessment. **Section 16: Collision and Allision Risk Modelling** Provides quantification of collision and allision risk resulting from the future case vessel traffic including deviated main commercial routes. Numerical and graphical results are provided, where appropriate.
Risk control log	✓	**Section 20: Risk Control Log** Provides the risk control log which summarises the assessment of shipping and navigation hazards scoped into the risk assessment. This includes the embedded mitigation measures, frequency of occurrence, severity of consequence, and significance of risk, per hazard.

Appendix B Hazard Log

806. The complete hazard log, produced following the Hazard Workshop held in London on 20 October 2022 and updated following feedback received from attendees, is presented in Table B.1. The Hazard Workshop methodology, including the approach to the hazard log, is provided in Section 3.2.1.

807. It should be noted that the hazard log reflects VE at the time of the Hazard Workshop being undertaken; in particular the future case scenario referred to in the additional comments has been defined in detail at the ES stage.

Table B.1 Hazard Log

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required and Additional Comments
Displacement from Standard/Adverse Weather Routeing with Potential for Collision																						
Commercial vessels	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic monitoring	▪ Presence of buoyed construction/ decommissioning area ▪ Adverse weather ▪ Construction/ decommissioning vessels which are RAM	Displacement with effects on schedule but no safety risks	4	1	1	1	2	1.3	**Broadly Acceptable**	Displacement with effects on schedule and collision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	**Broadly Acceptable**	UK Chamber of Shipping have identified these hazards as Tolerable; however VE is confident that the changes to the array areas do mitigate the effects of displacement associated with the array areas. No other comments were returned increasing the level of consequence including from the Regular Operators
			O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures ▪ Adverse weather ▪ Maintenance vessels which are RAM		3	1	1	1	2	1.3	**Broadly Acceptable**	Displacement with effects on schedule and collision event occurs involving vessel damage, injury to person and/or pollution	1	3	3	4	4	3.5	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences								Worst Case Consequences	Realistic Worst Case Consequences								Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk			Frequency	Consequences					Risk		
								People	Environment	Property	Business	Average Consequence					People	Environment	Property	Business	Average Consequence			
		Offshore export cable corridor	C/D	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel	Displacement with effects on schedule but no safety risks	4	1	1	1	1	1.0	**Broadly Acceptable**		Displacement with effects on schedule, causing congestion and subsequently collision event occurs involving vessel damage, injury to person and/or pollution	3	2	4	3	5	3.5	**Tolerable with Mitigation**		Traffic management strategy will be deployed by VE and will be discussed as required with local ports and VTS
			O		▪ Maintenance vessel which is RAM blocking access channel		3	1	1	1	1	1.0	**Broadly Acceptable**			2	2	4	3	5	3.5	**Broadly Acceptable**		
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic monitoring	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Adverse weather ▪ Construction vessels which are RAM	Displacement with effects on schedule but no safety risks	5	1	1	1	2	1.3	**Tolerable with Mitigation**		Displacement with effects on schedule and collision event occurs involving vessel damage, injury to person and/or pollution	3	3	3	4	4	3.5	**Tolerable with Mitigation**		UK Chamber of Shipping awaiting sight of NRA to respond in relation to the navigation corridor between VE and East Anglia Two.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
			O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures for VE, North Falls and East Anglia Two ▪ Maintenance vessels which are RAM		3	1	1	1	2	1.3	**Broadly Acceptable**	Displacement with effects on schedule and collision event occurs involving vessel damage, injury to person and/or pollution	2	4	4	5	4	4.3	**Tolerable with Mitigation**	The cumulative operational array area worst case consequences have been increased to Tolerable at UK Chamber of Shipping request due to their industry wide concerns about cumulative impacts on commercial routeing. UK Chamber of Shipping awaiting sight of NRA to respond in relation to the navigation corridor between VE and East Anglia Two.
		Offshore export cable corridor	C/D	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Displacement with effects on schedule but no safety risks	5	1	1	1	5	2.0	**Tolerable with Mitigation**	Displacement with effects on schedule, causing congestion and subsequently collision event occurs involving vessel damage, injury to person and/or pollution	5	2	3	2	4	2.8	**Tolerable with Mitigation**	If the worst case scenario is feasible from an engineering perspective and considered viable (VE, North Falls and Sea Link

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk		Frequency	Consequences					Risk	
								People	Environment	Property	Business	Average Consequence				People	Environment	Property	Business	Average Consequence		
			O		▪ Maintenance vessel which is RAM blocking access channel ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		3	1	1	1	1	1.0	**Broadly Acceptable**		1	2	4	3	5	3.5	**Broadly Acceptable**	installing simultaneously) then VE commits to opening discussions on a cumulative traffic management strategy which will be discussed with local ports and VTS. A cumulative traffic management strategy would reduce the worst case risk to tolerable levels noting that VE, North Falls and Sea Link will not be installed at the same time with the same vicinity i.e., outer sunk area.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
Commercial fishing vessels in transit	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic monitoring	▪ Presence of buoyed construction/ decommissioning area ▪ Adverse weather ▪ Construction/ decommissioning vessels which are RAM	Displacement with effects on routine but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	None
		Offshore export cable corridor	O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures ▪ Adverse weather ▪ Maintenance vessels which are RAM		1	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	None
		Array areas	C/D	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel	Displacement with effects on routine but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine, causing congestion and subsequently collision event occurs involving vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	Traffic management strategy to be discussed with local ports and VTS
		Offshore export cable corridor	O		▪ Maintenance vessel which is RAM blocking access channel		1	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk		Frequency	Consequences					Risk	
								People	Environment	Property	Business	Average Consequence				People	Environment	Property	Business	Average Consequence		
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic monitoring	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Adverse weather ▪ Construction vessels which are RAM	Displacement with effects on routine but no safety risks	3	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and collision event occurs involving vessel damage, injury to person and/or pollution	2	4	2	3	2	2.8	**Broadly Acceptable**	None
		Offshore export cable corridor	O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures for VE, North Falls and East Anglia Two ▪ Maintenance vessels which are RAM		2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	
		Array areas	C/D	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Displacement with effects on routine but no safety risks	4	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine, causing congestion and subsequently collision event occurs involving vessel damage, injury to person and/or pollution	3	4	2	3	2	2.8	**Broadly Acceptable**	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
		Offshore export cable corridor	O		▪ Maintenance vessel which is RAM blocking access channel ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		3	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	
Recreational vessels (2.5 to 24 m length)	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic Monitoring	▪ Presence of buoyed construction/ decommissioning area ▪ Adverse weather ▪ Construction/ decommissioning vessels which are RAM	Displacement with effects on routine but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and planned races and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	**Broadly Acceptable**	None
			O	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures ▪ Adverse weather ▪ Maintenance vessels which are RAM		1	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine and planned races and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	**Broadly Acceptable**	
		Offshore export cable corridor	C/D	▪ Charting of infrastructure	▪ Installation vessel which is RAM blocking access channel	Displacement with effects on routine but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine, causing congestion and subsequently	1	4	1	2	2	2.3	**Broadly Acceptable**	Traffic management strategy to be discussed with

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk		Frequency	Consequences					Risk	
								People	Environment	Property	Business	Average Consequence				People	Environment	Property	Business	Average Consequence		
			O	▪ Compliance with MGN 654 Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Maintenance vessel which is RAM blocking access channel		1	1	1	1	1	1.0	Broadly Acceptable	collision event occurs involving vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	Broadly Acceptable	local ports and VTS
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information ▪ Traffic Monitoring	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Adverse weather ▪ Construction vessels which are RAM	Displacement with effects on routine but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	Displacement with effects on routine and planned races and collision event occurs involving vessel damage, injury to person and/or pollution	2	4	1	2	2	2.3	Broadly Acceptable	None
			O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Presence of surface structures for VE, North Falls and East Anglia Two ▪ Maintenance vessels which are RAM		2	1	1	1	1	1.0	Broadly Acceptable	Displacement with effects on routine and planned races and collision event occurs involving vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	Broadly Acceptable	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
		Offshore export cable corridor	C/D	▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Guard vessels ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Displacement with effects on routine but no safety risks	3	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on routine, causing congestion and subsequently collision event occurs involving vessel damage, injury to person and/or pollution	2	4	1	2	2	2.3	**Broadly Acceptable**	If the worst case scenario is feasible from an engineering perspective and considered viable (VE, North Falls and Sea Link installing simultaneously) then VE commits to opening discussions on a cumulative traffic management strategy which will be discussed with local ports and VTS.
			O		▪ Maintenance vessel which is RAM blocking access channel ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		2	1	1	1	1	1.0	**Broadly Acceptable**		1	4	1	2	2	2.3	**Broadly Acceptable**	
Collision Risk (Third-Party with Project Vessel in Transit)																						
Commercial vessels	Isolation	Array areas	C/D			Increased encounters resulting in increased	5	1	1	1	1	1.0	**Tolerable**	Collision event occurs involving	2	3	3	4	4	3.5	**Broadly Acceptable**	Traffic management

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required and Additional Comments
		Offshore export cable corridor	O	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	alertness but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	vessel damage, injury to person and/or pollution	1	3	3	4	4	3.5	**Broadly Acceptable**	strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits. Given that the frequency of occurrence is high but the consequences are low the most likely consequences risk level is tolerable. Likely to happen but with no notable impacts on people, environment, property or business.
		Array areas	C/D			Increased encounters resulting in increased	2	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving	2	3	3	4	4	3.5	**Broadly Acceptable**	Traffic management

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
		Offshore export cable corridor	O	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	alertness but no safety risks	1	1	1	1	1	1.0	**Broadly Acceptable**	vessel damage, injury to person and/or pollution	1	3	3	4	4	3.5	**Broadly Acceptable**	strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Increased encounters resulting in increased alertness but no safety risks	5	1	1	1	1	1.0	**Tolerable with Mitigation**	Collision event occurs involving vessel damage, injury to person and/or pollution	4	3	3	4	4	3.5	**Tolerable with Mitigation**	Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE, North Falls and East Anglia Two rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		3	1	1	1	1	1.0	**Broadly Acceptable**		2	3	3	4	4	3.5	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences								Worst Case Consequences	Realistic Worst Case Consequences								Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk		Frequency	Consequences					Risk	
								People	Environment	Property	Business	Average Consequence				People	Environment	Property	Business	Average Consequence		
		Array areas	C/D	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Increased encounters resulting in increased alertness but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving vessel damage, injury to person and/or pollution	2	3	3	4	4	3.5	**Broadly Acceptable**	Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE and North Falls rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		1	1	1	1	1	1.0	**Broadly Acceptable**		1	3	3	4	4	3.5	**Broadly Acceptable**	
Commercial fishing vessels in transit	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	2	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	Traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O				1	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	
		Array areas	C/D			Increased encounters resulting in increased	2	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving	1	4	2	3	2	2.8	**Broadly Acceptable**	Traffic management

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
		Offshore export cable corridor	O	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	alertness but no safety risks	1	1	1	1	1	1.0	**Broadly Acceptable**	vessel damage, injury to person and/or pollution	1	4	2	3	2	2.8	**Broadly Acceptable**	strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits.
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link from same or similar ports	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	2	3	2	2.8	**Broadly Acceptable**	Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE, North Falls and East Anglia Two rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous operation of VE, North Falls and Sea Link from same or similar ports		2	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences								Worst Case Consequences	Realistic Worst Case Consequences								Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk			Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		
		Array areas	C/D	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Increased encounters resulting in increased alertness but no safety risks	4	1	1	1	1	1.0	Broadly Acceptable		Collision event occurs involving vessel damage, injury to person and/or pollution	3	4	2	3	2	2.8	Broadly Acceptable		Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE and North Falls rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		3	1	1	1	1	1.0	Broadly Acceptable			1	4	2	3	2	2.8	Broadly Acceptable		
Recreational vessels (2.5 to 24 m length)	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	Increased encounters resulting in increased alertness but no safety risks	2	1	1	1	1	1.0	Broadly Acceptable		Collision event occurs involving vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	Broadly Acceptable		Traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O				1	1	1	1	1	1.0	Broadly Acceptable			1	4	1	2	2	2.3	Broadly Acceptable		
		Array areas	C/D			Increased encounters resulting in increased	2	1	1	1	1	1.0	Broadly Acceptable		Collision event occurs involving	1	4	1	2	2	2.3	Broadly Acceptable		Traffic management

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences					Risk		Frequency	Consequences					Risk	
								People	Environment	Property	Business	Average Consequence				People	Environment	Property	Business	Average Consequence		
		Offshore export cable corridor	O	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness	alertness but no safety risks	1	1	1	1	1	1.0	**Broadly Acceptable**	vessel damage, injury to person and/or pollution	1	4	1	2	2	2.3	**Broadly Acceptable**	strategy to mitigate impact of construction vessel movements. CTV strategy assumed rather than SOV strategy which would result in fewer project vessel transits.
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link from same or similar ports	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	**Broadly Acceptable**	Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	1	2	2	2.3	**Broadly Acceptable**	Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE, North Falls and East Anglia Two rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous operation of VE, North Falls and Sea Link from same or similar ports		2	1	1	1	1	1.0	**Broadly Acceptable**		1	4	1	2	2	2.3	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences								Worst Case Consequences	Realistic Worst Case Consequences								Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk			Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
		Array areas	C/D	▪ Charting of infrastructure ▪ Guard vessels ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (COLREGs) ▪ Promulgation of information	▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Increased encounters resulting in increased alertness but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable		Collision event occurs involving vessel damage, injury to person and/or pollution	2	4	1	2	2	2.3	Broadly Acceptable	Cumulative traffic management strategy to mitigate impact of construction vessel movements. CTV strategy assumed for VE and North Falls rather than SOV strategy which would result in fewer project vessel transits.
		Offshore export cable corridor	O		▪ Project vessels in transit ▪ Lack of third-party awareness ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		2	1	1	1	1	1.0	Broadly Acceptable			1	4	1	2	2	2.3	Broadly Acceptable	
Restrictions in Port Access																							
Commercial vessels	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information ▪ Traffic monitoring	▪ Presence of buoyed construction/ decommissioning area ▪ Adverse weather ▪ Construction/ decommissioning vessels which are RAM	Displacement with limited effects on port schedule	3	1	1	1	1	1.0	Broadly Acceptable		Displacement with effects on port schedule	3	1	1	1	5	2.0	Broadly Acceptable	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
			O	▪ Application for safety zones (major maintenance only) ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information	▪ Presence of surface structures ▪ Adverse weather ▪ Maintenance vessels which are RAM		2	1	1	1	1	1.0	Broadly Acceptable		2	1	1	1	5	2.0	Broadly Acceptable	
		Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel	Displacement with limited effects on port schedule	5	1	1	1	1	1.0	Tolerable with Mitigation	Displacement with effects on port schedule causing congestion and potential for subsequent safety risks	4	2	4	3	5	3.5	Tolerable with Mitigation	Traffic management strategy to be discussed with local ports.
			O		▪ Maintenance vessel which is RAM blocking access channel		4	1	1	1	1	1.0	Broadly Acceptable		3	2	4	3	5	3.5	Tolerable with Mitigation	A traffic management strategy would reduce the worst case risk to broadly acceptable levels.
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information ▪ Traffic monitoring	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Adverse weather ▪ Construction vessels which are RAM	Displacement with limited effects on port schedule	5	1	1	1	2	1.3	Tolerable with Mitigation	Displacement with effects on port schedule	3	1	1	1	5	2.0	Broadly Acceptable	Given that the frequency of occurrence is high but the consequences are low the most likely consequences risk level is tolerable. Likely to happen but with no notable impacts on

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
			O	▪ Application for safety zones (major maintenance only) ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information	▪ Presence of surface structures for VE, North Falls and East Anglia Two ▪ Maintenance vessels which are RAM		3	1	1	1	2	1.3	**Broadly Acceptable**		2	1	1	1	5	2.0	**Broadly Acceptable**	people, environment, property or business.
		Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Displacement with limited effects on port schedule	5	1	1	1	5	2.0	**Tolerable with Mitigation**	Displacement with effects on port schedule causing congestion and potential for subsequent safety risks	4	2	4	3	5	3.5	**Tolerable with Mitigation**	If the worst case scenario is feasible from an engineering perspective and considered viable (VE, North Falls and Sea Link installing simultaneously) then VE commits to opening discussions on a cumulative traffic management strategy which will be discussed with local ports and VTS.
			O		▪ Maintenance vessel which is RAM blocking access channel ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		4	1	1	1	3	1.5	**Broadly Acceptable**		3	2	4	3	5	3.5	**Tolerable with Mitigation**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
Commercial fishing vessels in transit	Isolation	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information ▪ Traffic monitoring	▪ Presence of buoyed construction/ decommissioning area ▪ Adverse weather ▪ Construction/ decommissioning vessels which are RAM	Displacement with limited effects on port schedule	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on port schedule	1	4	2	3	2	2.8	**Broadly Acceptable**	None
			O	▪ Application for safety zones (major maintenance only) ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information	▪ Presence of surface structures ▪ Adverse weather ▪ Maintenance vessels which are RAM		1	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	
		Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Pollution planning ▪ Promulgation of information	▪ Installation vessel which is RAM blocking access channel	Displacement with limited effects on port schedule	2	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on port schedule causing congestion and potential for subsequent safety risks	1	4	2	3	2	2.8	**Broadly Acceptable**	None
			O		▪ Maintenance vessel which is RAM blocking access channel		1	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
								Consequences					Risk			Consequences					Risk	
							Frequency	People	Environment	Property	Business	Average Consequence			Frequency	People	Environment	Property	Business	Average Consequence		
	Cumulative	Array areas	C/D	▪ Application for safety zones ▪ Buoyed construction/ decommissioning area ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information ▪ Traffic monitoring	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Adverse weather ▪ Construction vessels which are RAM	Displacement with limited effects on port schedule	3	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on port schedule	2	4	2	3	2	2.8	**Broadly Acceptable**	None
			O	▪ Application for safety zones (major maintenance only) ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Promulgation of information	▪ Presence of surface structures for VE, North Falls and East Anglia Two ▪ Maintenance vessels which are RAM		2	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	
		Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Compliance with MGN 654 ▪ Charting of infrastructure ▪ Pollution planning	▪ Installation vessel which is RAM blocking access channel ▪ Simultaneous installation of VE, North Falls and Sea Link is not likely in the same location	Displacement with limited effects on port schedule	4	1	1	1	1	1.0	**Broadly Acceptable**	Displacement with effects on port schedule causing congestion and potential for subsequent safety risks	3	4	2	3	2	2.8	**Broadly Acceptable**	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
			O	▪ Promulgation of information	▪ Maintenance vessel which is RAM blocking access channel ▪ Simultaneous maintenance of VE, North Falls and Sea Link is not likely in the same location		3	1	1	1	1	1.0	**Broadly Acceptable**		1	4	2	3	2	2.8	**Broadly Acceptable**	
Allision Risk (Powered, Drifting or Internal)																						
Commercial vessels	Isolation	Array areas	O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Lighting and marking	▪ Presence of surface structures ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	4	1	1	1	1	1.0	**Broadly Acceptable**	Allision event occurs with a substation on the array perimeter involving vessel damage, injury to person and/or pollution	1	5	5	5	5	5.0	**Tolerable with Mitigation**	The tolerability of this hazard assumes that the array layout will be discussed as part of the ongoing process to

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
	Cumulative			▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS) ▪ Promulgation of information	▪ Presence of surface structures associated with VE, North Falls and East Anglia Two ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure		5	1	1	1	1	1.0	**Tolerable with Mitigation**		2	5	5	5	5	5.0	**Tolerable with Mitigation**	identify suitable locations for OSPs. Assumed internal navigation by commercial vessels is highly unlikely. UK Chamber of Shipping awaiting sight of NRA to respond in relation to the navigation corridor between VE and East Anglia Two.
Commercial fishing vessels in transit	Isolation	Array areas	O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Lighting and marking	▪ Presence of surface structures ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	2	1	1	1	1	1.0	**Broadly Acceptable**	Allision event occurs with a substation on the array perimeter involving vessel damage, injury to person and/or pollution	3	5	3	3	3	3.5	**Tolerable with Mitigation**	Assumed internal navigation by commercial fishing vessels is likely.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
	Cumulative			▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS) ▪ Promulgation of information	▪ Presence of surface structures associated with VE, North Falls and East Anglia Two ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure		3	1	1	1	1	1.0	**Broadly Acceptable**		4	5	3	3	3	3.5	**Tolerable with Mitigation**	
Recreational vessels (2.5 to 24 m length)	Isolation	Array areas	O	▪ Application for safety zones (major maintenance only) ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Lighting and marking ▪ Marine coordination for Project vessels ▪ Minimum blade tip clearance ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS) ▪ Promulgation of information	▪ Presence of surface structures ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure	Vessel passes at an unsafe distance resulting in a need to make a late adjustment to course/speed	1	1	1	1	1	1.0	**Broadly Acceptable**	Allision event occurs with a substation on the array perimeter involving vessel damage, injury to person and/or pollution	2	5	2	3	3	3.3	**Broadly Acceptable**	Assumed internal navigation by recreational vessels is likely.
	Cumulative				▪ Presence of surface structures associated with VE, North Falls and East Anglia Two ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather ▪ Aid to navigation failure		2	1	1	1	1	1.0	**Broadly Acceptable**		3	5	2	3	3	3.3	**Tolerable with Mitigation**	

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required and Additional Comments
Anchor Interaction with Subsea Cables																						
Commercial vessels	Isolation	Array areas (inter array cables)	O	▪ Cable Burial Risk Assessment ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Promulgation of information	▪ Presence of subsea cables ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather	Vessel anchors on or drags anchor over a cable/protection but no interaction occurs	2	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on or drags anchor over a cable/protection resulting in damage to the cable/protection and/or anchor	2	1	1	2	2	1.5	Broadly Acceptable	None
		Offshore export cable corridor					3	1	1	1	1	1.0	Broadly Acceptable		2	1	1	2	2	1.5	Broadly Acceptable	
	Cumulative	Array areas (inter array cables)	O	▪ Cable Burial Risk Assessment ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Promulgation of information	▪ Presence of subsea cables associated with VE, North Falls and Sea Link ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather	Vessel is unable to anchor due to the presence of cables but no safety risks	1	1	1	1	1	1.0	Broadly Acceptable	Vessel is unable to anchor due to presence of cables resulting in allision due to vessel malfunction	1	2	4	3	5	3.5	Broadly Acceptable	This hazard is tolerable on the basis that the Cable Burial Risk Assessment identifies safe burial depths which are then successfully implemented.
		Offshore export cable corridor					5	1	1	3	1.5		Tolerable with Mitigation		3	2	4	3	5	3.5	Tolerable with Mitigation	
Commercial fishing vessels in transit	Isolation	Array areas (inter array cables)	O	▪ Cable Burial Risk Assessment ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Promulgation of information	▪ Presence of subsea cables ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather	Vessel anchors on or drags anchor over a cable/protection but no interaction occurs	3	1	1	1	1	1.0	Broadly Acceptable	Vessel anchors on or drags anchor over a cable/protection resulting in damage to the cable/protection and/or anchor	3	4	2	3	2	2.8	Broadly Acceptable	None
		Offshore export cable corridor					4	1	1	1	1	1.0	Broadly Acceptable		3	4	2	3	2	2.8	Broadly Acceptable	
	Cumulative	Array areas (inter array cables)	O			Vessel is unable to anchor due to the	1	1	1	1	1	1.0	Broadly Acceptable	Vessel is unable to anchor due to	1	4	2	3	2	2.8	Broadly Acceptable	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk		Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	
		Offshore export cable corridor		▪ Cable Burial Risk Assessment ▪ Charting of infrastructure ▪ Compliance with MGN 654 ▪ Promulgation of information	▪ Presence of subsea cables associated with VE, North Falls and Sea Link ▪ Human/navigation error ▪ Mechanical/technical failure ▪ Adverse weather	presence of cables but no safety risks	3	1	1	1	3	1.5	**Broadly Acceptable**	presence of cables resulting in allision due to vessel malfunction	4	4	2	3	2	2.8	**Tolerable with Mitigation**	
Interference with Marine Navigation, Communication and Position Fixing Equipment																						
All vessels	Isolation	Array areas	O	▪ Cable Burial Risk Assessment	▪ Human error relating to adjustment of Radar controls ▪ Presence of surface structures	Structures have no material effect upon the Radar, communications and navigation equipment on a vessel	4	1	1	1	1	1.0	**Broadly Acceptable**	Minor level of Radar interference due to the structures	3	1	1	1	1	1.0	**Broadly Acceptable**	Cumulative risk not considered given localised nature and lack of concerns raised for existing cumulative developments.
All vessels	Isolation	Offshore export cable corridor	O	▪ Cable Burial Risk Assessment	▪ EMF from cables	Cables have no material effect upon the Radar, communications and navigation equipment on a vessel	4	1	1	1	1	1.0	**Broadly Acceptable**	Minor level of EMF interference due to the wind farm infrastructure	3	1	1	1	1	1.0	**Broadly Acceptable**	
Reduction in Under Keel Clearance																						
All vessels	Isolation	Array areas	O	▪ Cable Burial Risk Assessment ▪ Guard vessels ▪ Pollution planning	▪ Reduced depth due to cable protection	Vessel transits over an area of reduced under keel clearance but no contact occurs	3	1	1	1	1	1.0	**Broadly Acceptable**	Grounding on cable protection resulting in vessel damage, pollution and/or prevention of future	3	3	3	4	4	3.5	**Tolerable with Mitigation**	Worst case relates to a large commercial vessel.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Consequences: Environment	Consequences: Property	Consequences: Business	Consequences: Average Consequence	Risk	Further Mitigation Required and Additional Comments
		Offshore export cable corridor					4	1	1	1	3	1.5	**Broadly Acceptable**	access for deeper draught vessels	4	3	3	4	5	3.8	**Tolerable with Mitigation**	Worst case relates to a large commercial vessel. Assumed that relevant future case vessel traffic levels is not adequately resolved. UK Chamber of Shipping suggested business and property worst case consequences should be ranked as major, resulting in an overall risk of significance of **Unacceptable**.
	Cumulative	Array areas	O	▪ Cable Burial Risk Assessment ▪ Guard vessels ▪ Pollution planning	▪ Reduced depth due to cable protection	Vessel transits over an area of reduced under keel clearance but no contact occurs	4	1	1	1	1	1.0	**Broadly Acceptable**	Grounding on cable protection resulting in vessel damage, pollution and/or prevention of future	3	3	3	4	4	3.5	**Tolerable with Mitigation**	Worst case relates to a large commercial vessel.

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences: Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	Worst Case Consequences	Realistic Worst Case Consequences: Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	Further Mitigation Required and Additional Comments
		Offshore export cable corridor					5	1	1	1	3	1.5	**Tolerable with Mitigation**	access for deeper draught vessels	4	3	3	4	5	3.8	**Tolerable with Mitigation**	Worst case relates to a large commercial vessel. Assumed that relevant future case vessel traffic levels is not adequately resolved. UK Chamber of Shipping suggested business and property worst case consequences should be ranked as major, resulting in an overall risk of significance of **Unacceptable**.
Prevention of Use of Existing Aids to Navigation																						
All vessels	Isolation	Array areas	C/D	▪ Lighting and marking ▪ Pollution planning ▪ Promulgation of information	▪ Visual presence of surface structures ▪ Lighting and marking confusion	Short-term inability to effectively use an aid to navigation but no safety risks	3	1	1	1	1	1.0	**Broadly Acceptable**	Short-term inability to effectively use an aid to navigation resulting in an allision or grounding incident with vessel damage, injury to person and/or pollution	2	1	1	1	1	1.0	**Broadly Acceptable**	None
All vessels	Isolation	Offshore export cable corridor	O				2	1	1	1	1	1.0	**Broadly Acceptable**		1	3	3	3	3	3.0	**Broadly Acceptable**	None
All vessels	Cumulative	Array areas	C/D			Short-term inability to effectively use an aid	4	1	1	1	1	1.0	**Broadly Acceptable**	Short-term inability to effectively use an	3	1	1	1	1	1.0	**Broadly Acceptable**	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences							Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
		Offshore export cable corridor	O	▪ Lighting and marking ▪ Pollution planning ▪ Promulgation of information	▪ Visual presence of surface structures ▪ Lighting and marking confusion	to navigation but no safety risks	3	1	1	1	1	1.0	Broadly Acceptable	aid to navigation resulting in an allision or grounding incident with vessel damage, injury to person and/or pollution	2	3	3	3	3	3.0	Broadly Acceptable	
Reduction in Emergency Response Capability																						
Emergency responders	Isolation	Array areas	C/D	▪ Compliance with MGN 654 ▪ Lighting and marking ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS)	▪ Under construction array does not facilitate responder access ▪ Limited resource capability ▪ Adverse weather	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury to person or loss of life	1	4	5	5	5	4.8	Tolerable with Mitigation	None
Emergency responders	Isolation	Array areas	O		▪ Array does not facilitate responder access ▪ Limited resource capability ▪ Adverse weather	Delay to emergency response request	2	1	1	1	2	1.3	Broadly Acceptable	Delay to response request leading to injury to person or loss of life	1	4	5	5	5	4.8	Tolerable with Mitigation	None
Emergency responders	Isolation	Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS)	▪ Limited resource capability	Delay to emergency response request but project vessel assistance rendered	1	1	1	1	1	1.0	Broadly Acceptable	Delay to response request leading to injury	1	3	3	3	3	3.0	Broadly Acceptable	None

User	Isolation / Cumulative	Project Component(s)	Phase (C/O/D)	Embedded Mitigation Measures (Full Descriptions Provided in Section 21)	Possible Causes	Most Likely Consequences	Realistic Most Likely Consequences								Worst Case Consequences	Realistic Worst Case Consequences							Further Mitigation Required and Additional Comments
							Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk		Frequency	Consequences: People	Environment	Property	Business	Average Consequence	Risk	
	Cumulative	Array areas	C/D	▪ Compliance with MGN 654 ▪ Lighting and marking ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS)	▪ Simultaneous buoyed construction/ decommissioning areas for VE, North Falls and East Anglia Two ▪ Under construction array does not facilitate responder access ▪ Limited resource capability ▪ Adverse weather	Delay to response request	3	1	1	1	3	1.5	**Broadly Acceptable**	Delay to response request leading to injury or loss of life	2	4	5	5	5	4.8	**Tolerable with Mitigation**	None
			O		▪ Simultaneous operation for VE, North Falls and East Anglia Two ▪ Array does not facilitate responder access ▪ Limited resource capability ▪ Adverse weather	Delay to response request	3	1	1	1	3	1.5	**Broadly Acceptable**		2	4	5	5	5	4.8	**Tolerable with Mitigation**	
		Offshore export cable corridor	C/D	▪ Cable Burial Risk Assessment ▪ Marine coordination for Project vessels ▪ Pollution planning ▪ Project vessel compliance with international marine regulations (SOLAS)	▪ Limited resource capability	Delay to emergency response request but project vessel assistance rendered	2	1	1	1	3	1.5	**Broadly Acceptable**	Delay to response request leading to injury	1	3	3	3	3	3.0	**Broadly Acceptable**	None

Appendix C Regular Operator Consultation

808. As part of the consultation process for VE, Regular Operators identified (from the vessel traffic surveys and long-term vessel traffic data) that would be required to deviate their routes due to the presence of the array areas were consulted via email. Two rounds of Regular Operator consultation have been undertaken: the first with the most frequent Ro-Ro and Ro-Pax vessel operators identified in the array traffic study area and the second with all Regular Operators identified in the array traffic study area.

809. An example of the correspondence sent for the first Regular Operator consultation round is presented below (noting that the extent of the array areas and offshore ECC was refined after this time), followed by an example of the correspondence sent for the second Regular Operator consultation round.

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Email: aberdeen@anatec.com
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Date: 2nd December 2021

Opportunity to Participate in Consultation Relating to Shipping and Navigation for the Proposed Five Estuaries Offshore Wind Farm

Dear [redacted]

As you may be aware, Five Estuaries Offshore Wind Farm Limited is the developer of the Five Estuaries Offshore Wind Farm ('VE'), an extension to the existing Galloper Offshore Wind Farm which has been operational since 2018.

Following a Scoping Report for VE submitted to the Planning Inspectorate in October 2021 (see here), Five Estuaries Offshore Wind Farm Limited are approaching the next phase of the project, namely the completion of the Preliminary Environmental Information Report (PEIR) including the Navigational Risk Assessment (NRA). The outputs of this process will feed into the subsequent Environmental Statement (ES) with the NRA updated as required.

An overview of the draft Order Limits for VE at the scoping stage is provided in Figure 1. The array area is located approximately 20 nautical miles (nm) off the Suffolk coast immediately east of Galloper. The array area is split into two – north and south of the Sunk Traffic Separation Scheme (TSS) East – although both areas are considered collectively as part of the draft Order Limits and cover approximately 43 square nautical miles (nm^2). The export cable corridor covers an area of approximately 48nm^2 and passes through the Sunk routeing measure before making landfall between Holland-on-Sea and Frinton-on-Sea.

Further information about the project can be found here.

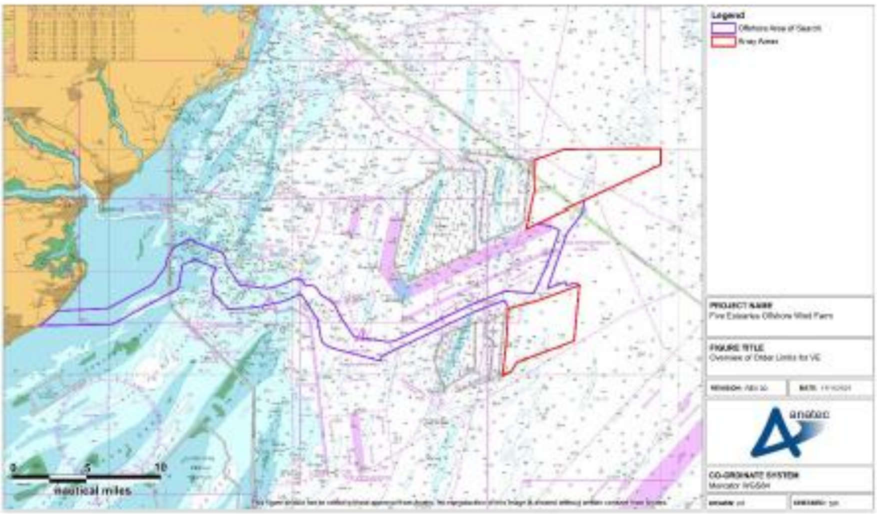

Figure 1 Overview of the Draft Order Limits for VE

Key navigational features in proximity to the array areas include the various IMO routeing measures and other offshore wind farm developments (operational or otherwise) as illustrated in Figure 2. These include the East Anglia TWO Offshore Windfarm located approximately 2.9nm north of the array areas.

Figure 2 Overview of IMO Routeing Measures and Other Offshore Wind Farm Projects

Anatec has been contracted by Five Estuaries Offshore Wind Farm Limited to provide technical support on shipping and navigation during the consenting process, and to coordinate consultation with relevant stakeholders. As part of the consultation process, Anatec has undertaken an assessment of 12 months of Automatic Identification System (AIS) data (2019) to identify regular commercial operators. This exercise has identified Stena Line as a regular operator within or in proximity to the array area, as illustrated in Figure 3.

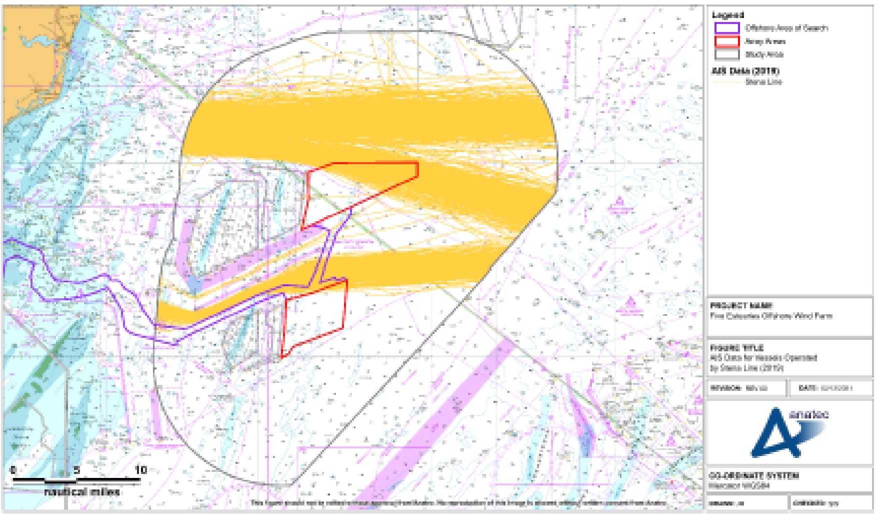

Figure 3 AIS Data for Vessels Operated by Stena Line (2019)

We therefore invite your feedback on the project, including any impact it may have upon the navigation of vessels. Whilst we welcome all feedback we are particularly interested in any comments or feedback on the following:

- Whether VE is likely to impact the routeing of any specific vessels and/or routes, including the nature of any change in regular passage and use of the IMO routeing measures in the area.
- Whether VE poses any safety concern to the routing of your vessels, including any adverse weather routeing.
- Whether the cumulative scenario, including the presence of the offshore wind farm projects shown in Figure 2, affects your responses to the previous questions.
- Whether you would choose to make passage internally through the array area of structures.
- Whether you are aware of any changes to routeing since the 2019 vessel traffic data shown in Figure 3 was recorded or future changes to routeing which may be relevant to VE and should be consider within the NRA.

Additionally, we would like to invite you to attend an Expert Topic Group (ETG) meeting for shipping and navigation on 9th December 2021, as well as further consultation to be undertaken as part of the NRA process in 2022, including the Hazard Workshop.

We would appreciate any responses are provided via email to [redacted] by Friday 7th January 2022, as well as an indication of whether you are available and interested in attending the ETG meeting noted above.

Yours sincerely,

[redacted]
Lead Risk Analyst
Anatec Ltd.

FIVE ESTUARIES OFFSHORE WIND FARM

Our Ref: A4542-VE-LET-01
Name: [redacted]
Telephone: [redacted]
Email: [redacted]

Aberdeen, 23rd August 2022

Project: Five Estuaries Offshore Wind Farm
Reference: Opportunity to Participate in Consultation Relating to Shipping and Navigation for the Proposed Five Estuaries Offshore Wind Farm

Dear Sir/Madam

As you may be aware, Five Estuaries Offshore Wind Farm Limited is the developer of the Five Estuaries Offshore Wind Farm ('VE'), an extension to the existing Galloper Offshore Wind Farm which has been operational since 2018.

Following a Scoping Report for VE submitted to the Planning Inspectorate in October 2021 (see here), Five Estuaries Offshore Wind Farm Limited are undertaking the Preliminary Environmental Information Report (PEIR) including the Navigational Risk Assessment (NRA). The outputs of this process will feed into the subsequent Environmental Statement (ES) with the NRA updated as required.

An overview of the draft Order Limits for VE at the scoping stage is provided in Figure 1. The array area is located approximately 20 nautical miles (nm) off the Suffolk coast immediately east of Galloper. The array area is split into two – north and south of the Sunk Traffic Separation Scheme (TSS) East – although both areas are considered collectively as part of the draft Order Limits and cover approximately 37 square nautical miles (nm^2). The export cable corridor covers an area of approximately 48nm^2 and passes through the Sunk routeing measure before making landfall between Holland-on-Sea and Frinton-on-Sea.

Further information about the project can be found here.

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Windmill Hill Business Park
Whitehill Way, Swindon, Wiltshire, SN5 6PB
COMPANY NO: Registered in England and Wales
company number 12292474

FIVE ESTUARIES
OFFSHORE WIND FARM

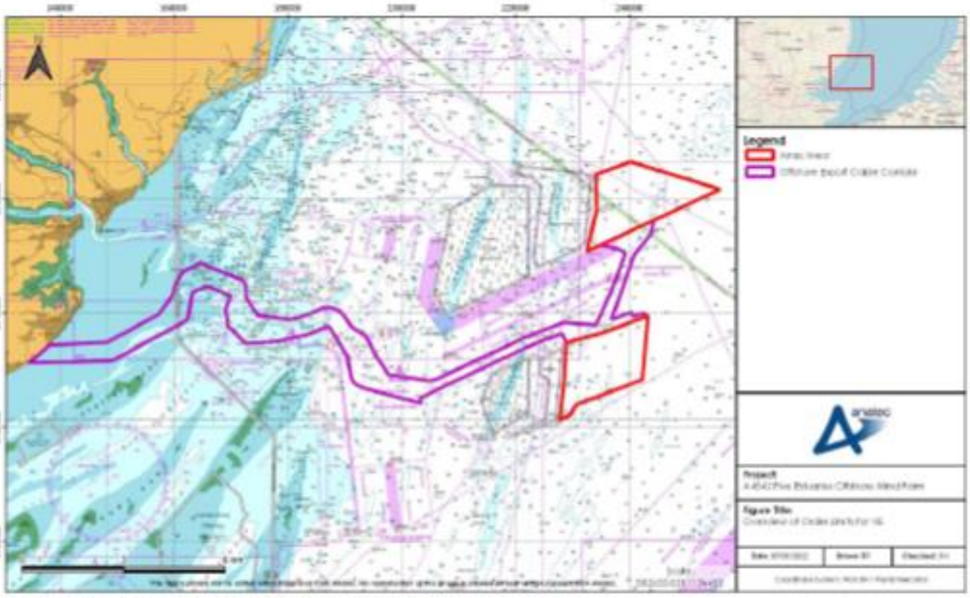

Figure 1 Overview of the Draft Order Limits for VE

Key navigational features in proximity to the array areas include the various IMO routeing measures and other offshore wind farm developments (operational or otherwise) as illustrated in **Error! Reference source not found.**. These include the consented East Anglia TWO Offshore Windfarm located approximately 2.9nm north of the array areas.

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FIVE ESTUARIES
OFFSHORE WIND FARM

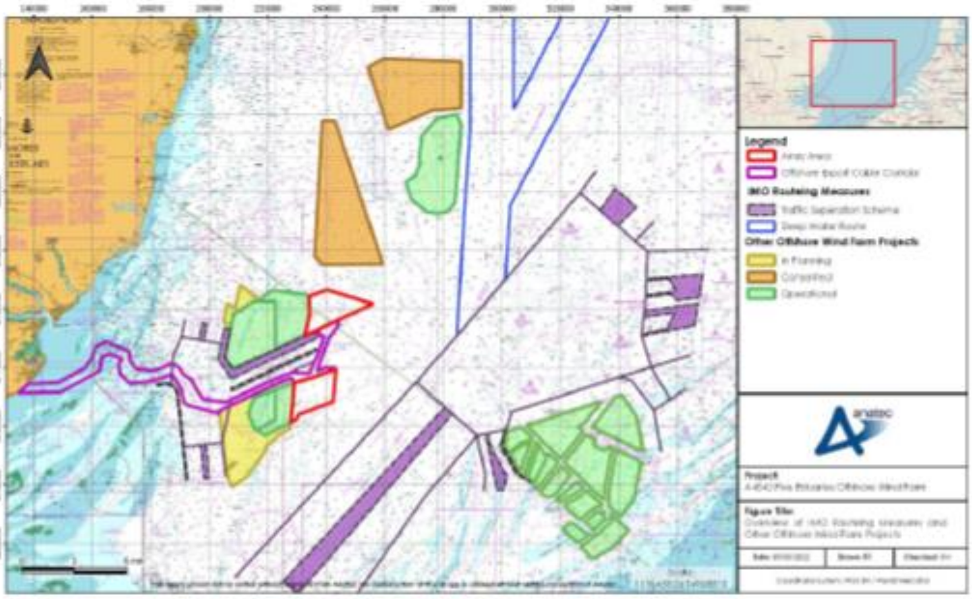

Figure 2 Overview of IMO Routeing Measures and Other Offshore Wind Farm Projects

Anatec has been contracted by Five Estuaries Offshore Wind Farm Limited to provide technical support on shipping and navigation during the consenting process, and to coordinate consultation with relevant stakeholders. As part of the consultation process, Anatec has undertaken an assessment of 28 days of Automatic Identification System (AIS), Radar and visual observations data (14 days winter and 14 days summer 2022) as well as 12 months of AIS data (2019) to identify regular commercial operators. This exercise has identified your organisation as a regular operator within or in proximity to the array area. We therefore invite your feedback on the project, including any impact it may have upon the navigation of vessels. Whilst we welcome all feedback we are particularly interested in any comments or feedback on the following:

1. Whether VE is likely to impact the routeing of any specific vessels and/or routes, including the nature of any change in regular passage and use of the IMO routeing measures in the area.
2. Whether VE poses any safety concern to the routeing of your vessels, including any adverse weather routeing.

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FIVE ESTUARIES OFFSHORE WIND FARM

3. Whether the cumulative scenario, including the presence of the offshore wind farm projects shown in Figure 2, affects your responses to the previous questions.
4. Whether you would choose to make passage internally through the array area of structures.

Additionally, we would like to invite you to attend a Hazard Workshop scheduled to take place in London between 11th and 13th October 2022. The workshop is expected to run for two to three hours.

We would appreciate any responses are provided via email to rebecca@anatec.com by 16th September 2022, as well as an indication of whether you are available and interested in attending the Hazard Workshop noted above.

Yours sincerely,

[redacted]
Risk Analyst
Anatec Ltd. on behalf of Five Estuaries Offshore Wind Farm Limited

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Appendix D Long-Term Vessel Traffic Movements

D.1 Introduction

810. This annex assesses additional long-term vessel traffic data for VE. As required under MGN 654 (MCA, 2021), the NRA and **Volume 6, Part 2, Chapter 9: Shipping and Navigation** consider 28 days of AIS, Radar and visual observation data as the primary vessel traffic data source. However, it should be considered that studying a 28-day period in isolation may exclude certain activities or periods of pertinence to shipping and navigation. Therefore, in line with good practice assessment procedures, this NRA has also considered a longer-term dataset covering all of 2019 to ensure a comprehensive characterisation of vessel traffic movements can be established, including the capture of any season variation.

D.2 Aims and Objectives

811. The key aims and objectives of this appendix are as follows:

- Identify seasonal variations in vessel traffic via assessment of the long-term vessel traffic data;
- Determine which variations are not reflected within the short-term vessel traffic survey data (and therefore should be fed into the NRA baseline); and
- Assess which dataset (long-term, survey, or a combination of both) should be utilised for each key NRA element that requires vessel traffic data input.

D.3 Methodology

D.3.1 Study Area

812. This appendix has assessed the long-term vessel traffic data within the array traffic study area introduced in Section 5.

D.3.2 Data Period and Temporary Vessel Traffic

813. The long-term vessel traffic data was collected from coastal AIS receivers for the entirety of 2019 (1 January to 31 December). Approximately 7% downtime was observed throughout the data period, although this was primarily concentrated in January (46.66% downtime) and November (26.78% downtime).

814. As per the vessel traffic surveys, a number of vessel tracks recorded during the data period were classified as temporary (non-routine) and have been excluded from the characterisation of the vessel traffic baseline, including vessels guarding the under-construction East Anglia One OWF and vessels carrying out survey operations to the north-west of the array traffic study area between April and July.

D.3.3 AIS Carriage

815. General limitations associated with the use of AIS data (for example, carriage requirements) are discussed in full within Section 5.4.1.

D.4 Long-Term Vessel Traffic Movements

816. A plot of the vessel tracks recorded within the array traffic study area during the data period, colour-coded by vessel type and excluding temporary traffic, is presented in Figure D.1. Following this, the same data presented as a heat map of vessel density, is presented in Figure D.2.

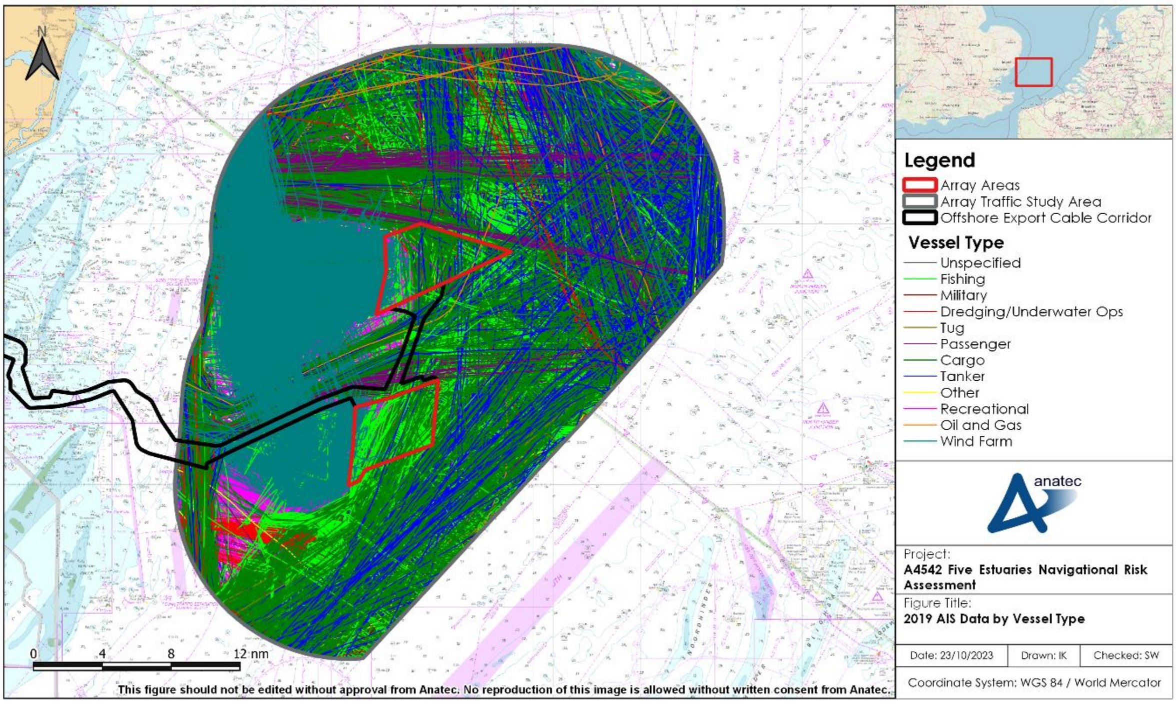

Figure D.1 2019 AIS Data by Vessel Type

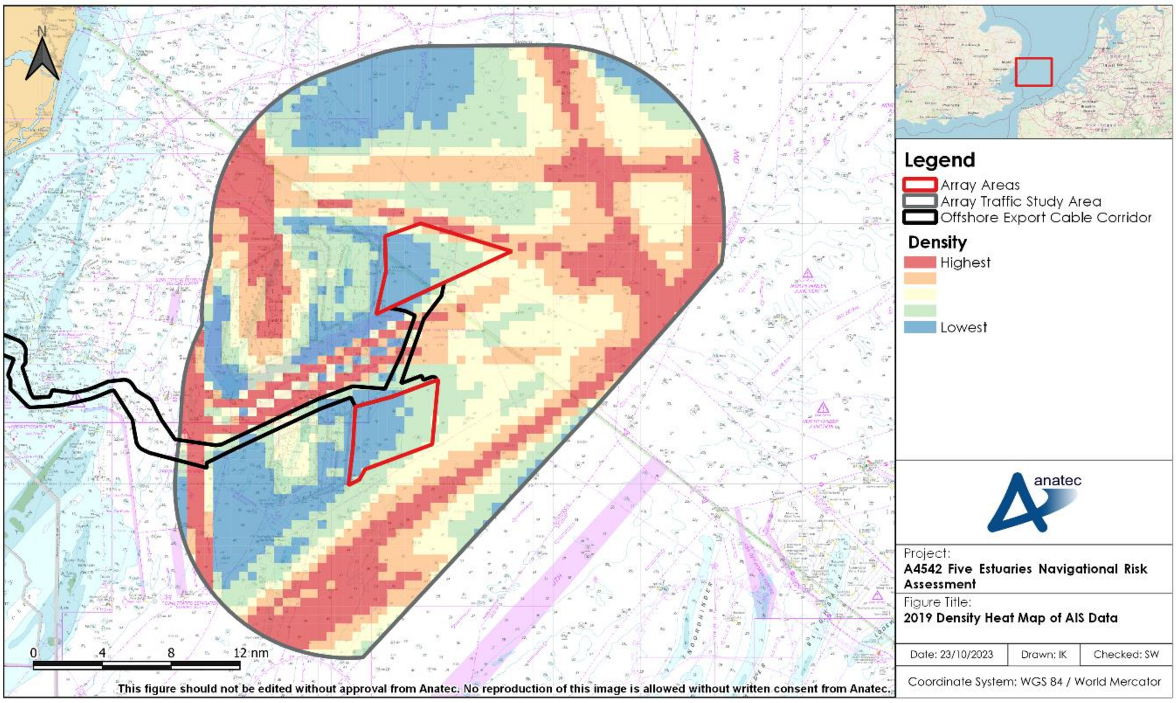

Figure D.2 2019 Density Heat Map of AIS Data

D.4.2 Vessel Count

817. The average daily number of vessels within the array traffic study area and array areas are presented in Figure D.3. The downtime in each given month was accounted for when calculating the average daily vessels.

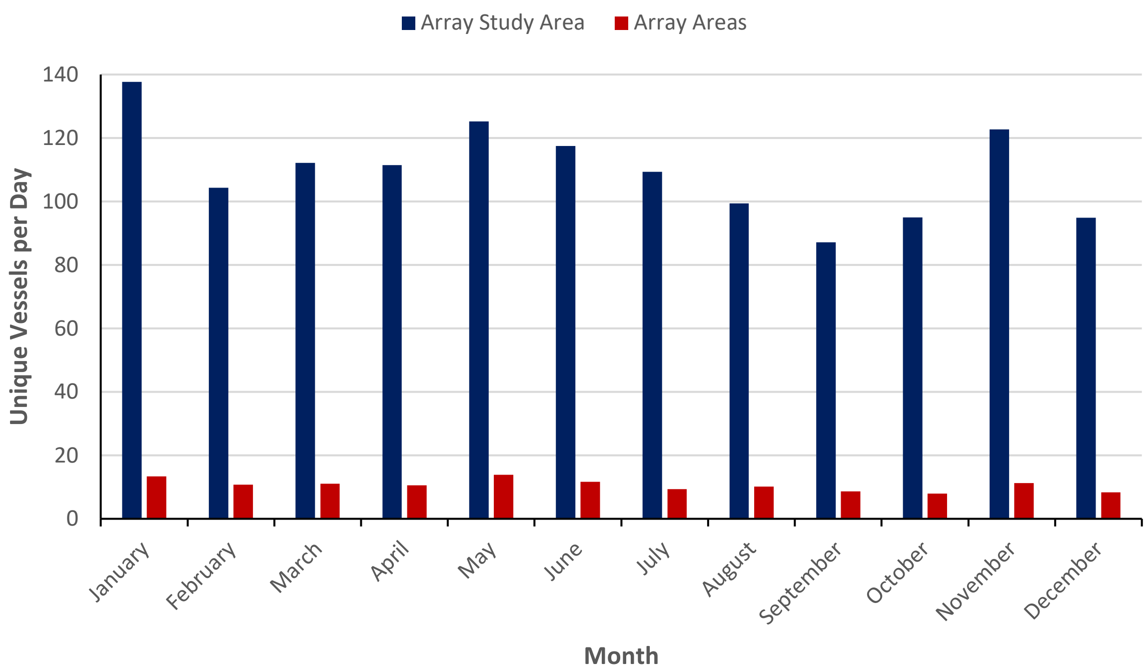

Figure D.3 Long-Term Daily Vessel Counts by Month

818. The busiest month recorded within the array traffic study area was January with 138 unique vessels recorded per day, while the quietest month was September with approximately 87 vessels per day (factored for downtime).

D.4.3 Vessel Type

819. The distribution of the main vessel types recorded during the data period are presented in Figure D.4.

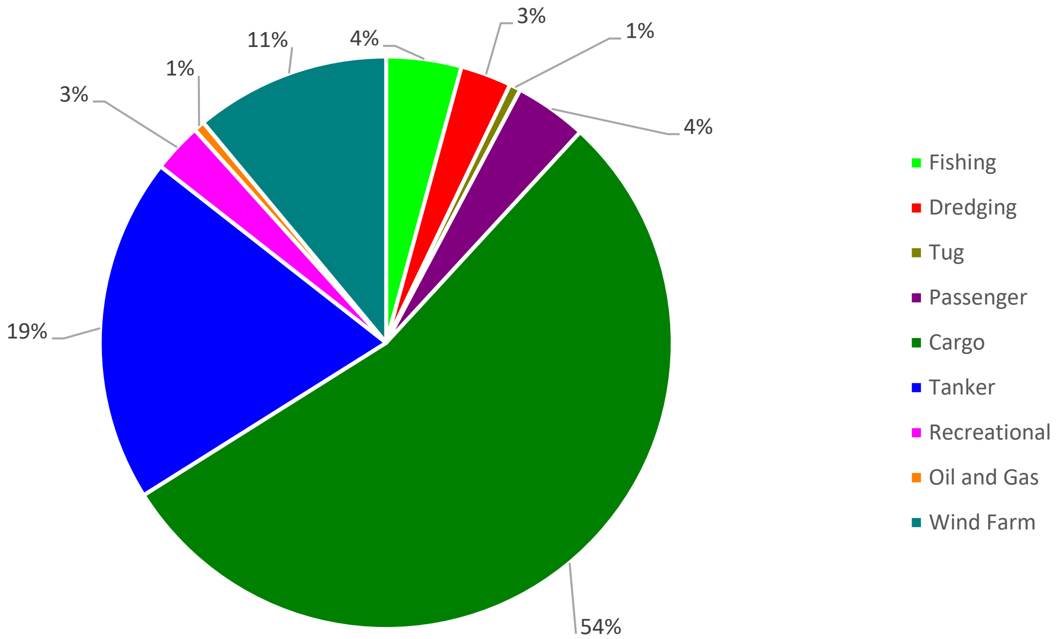

Figure D.4 Long-Term Main Vessel Type Distribution

820. The most common vessel type recorded was cargo vessels, accounting for approximately 54% of all traffic recorded. Other common vessel types included tankers (19%) and wind farm vessels (11%).

D.4.3.2 Commercial Vessels

821. The commercial vessels recorded via AIS within the array traffic study area during the long-term survey period are colour-coded by vessel type and presented in Figure D.5. Following this the same data, converted to a heat map of vessel density, is presented in Figure D.6.

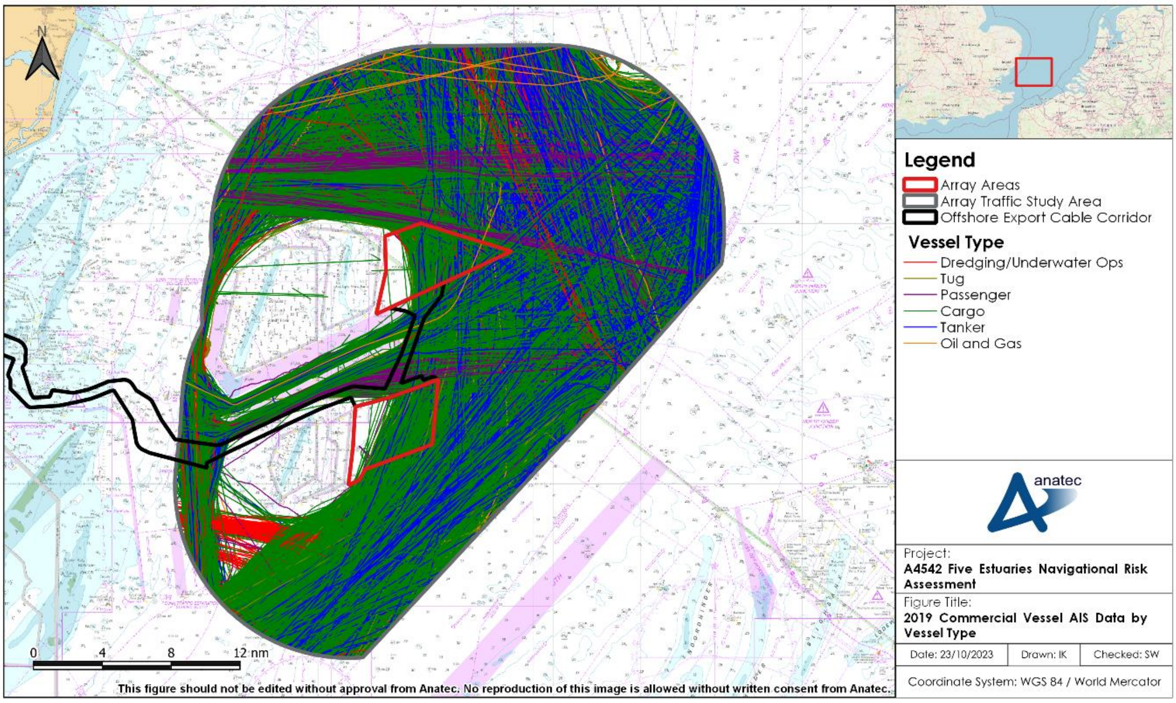

Figure D.5 2019 Commercial Vessel AIS Data by Vessel Type

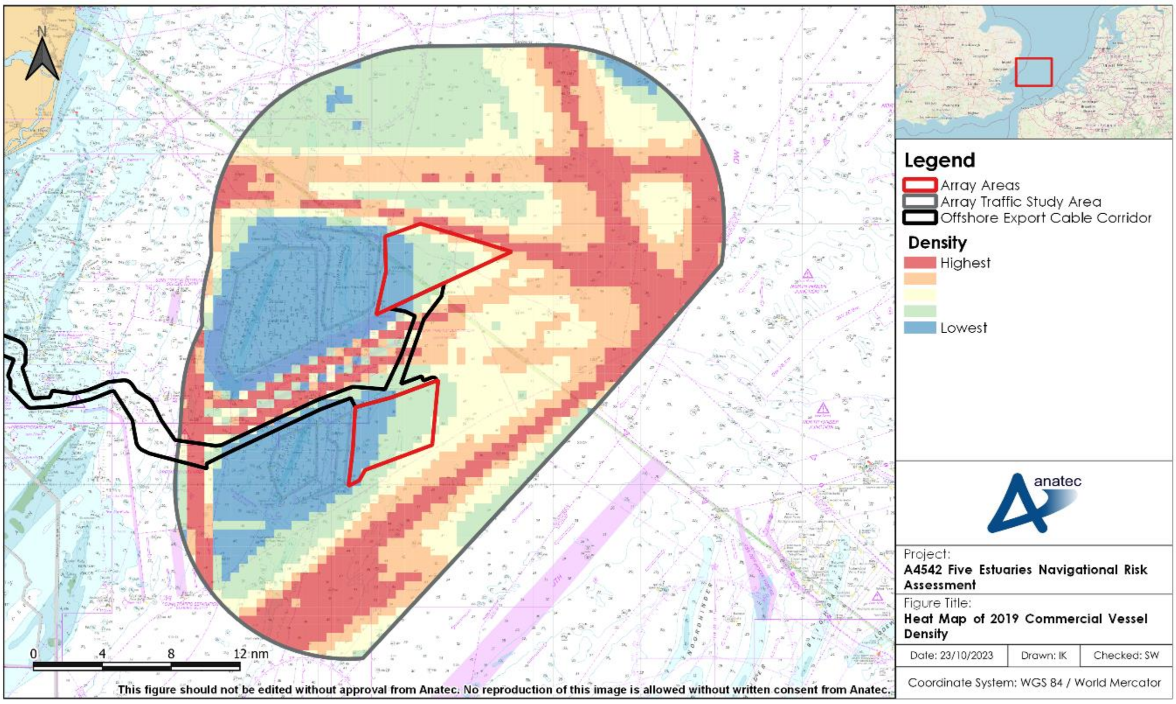

Figure D.6 Heat Map of 2019 Commercial Vessel Density

822. A high density of commercial traffic was noted, as it accounts for over 75% of the total vessel activity within the array traffic study area. The majority of the commercial traffic is on well-defined routes.

823. The average number of unique commercial vessels for each vessel type per month within the array traffic study area during the long-term survey period is presented in Figure D.7, factored to account for downtime.

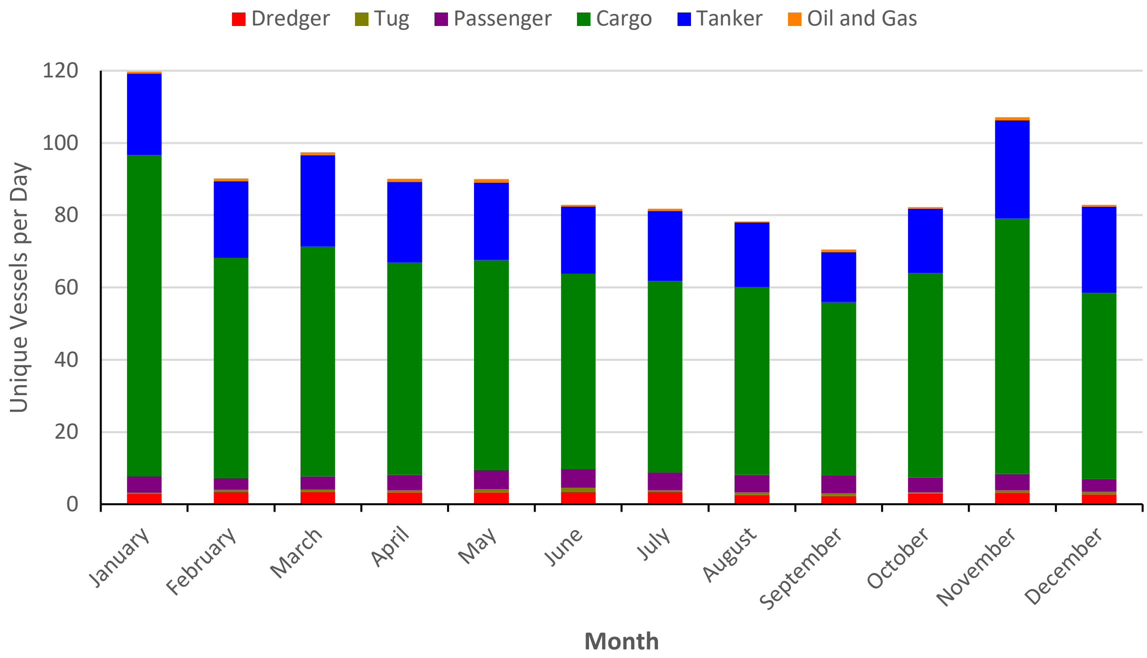

Figure D.7 Average Number of Daily Commercial Vessels per Month

Table D.1 Quietist, Busiest, and Average Daily Unique Vessel Counts

Vessel Type	Quietest Month (Unique vessels per day)	Busiest Month (Unique vessels per day)	Average (Unique vessels per day)
Cargo vessels	48	89	60
Tankers	18	27	21
Passenger vessels	3	5	4
Marine aggregate dredgers	2-3	3-4	3
Tugs	0-1	1	0-1
Oil and gas vessels	0-1	1	0-1

824. In summary, the most common type of commercial vessel recorded within the array traffic study area was cargo vessels. All commercial vessel types showed little seasonal variation.

D.4.3.3 Fishing Vessels

825. The tracks of fishing vessels recorded via AIS within the array traffic study area during the long-term survey period are converted to a heat map of density and presented in Figure D.8.

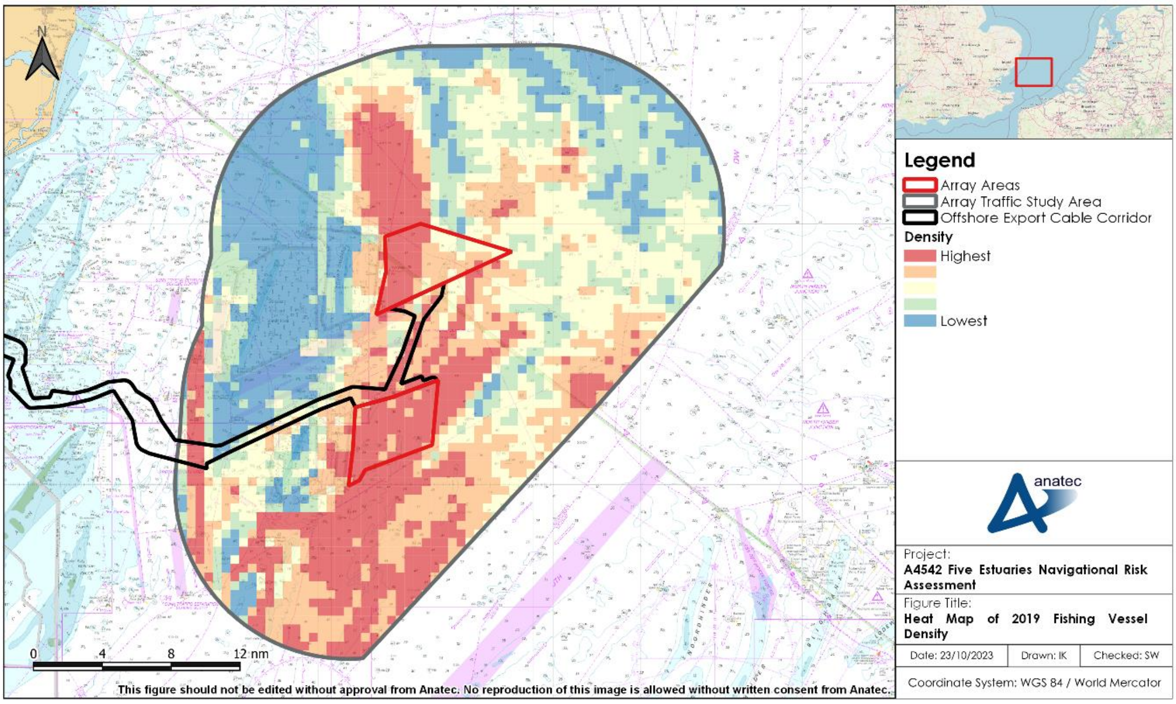

Figure D.8 Heat Map of 2019 Fishing Vessel Density

826. The distribution of daily unique fishing vessels recorded per month within the array traffic study area is presented in Figure D.9

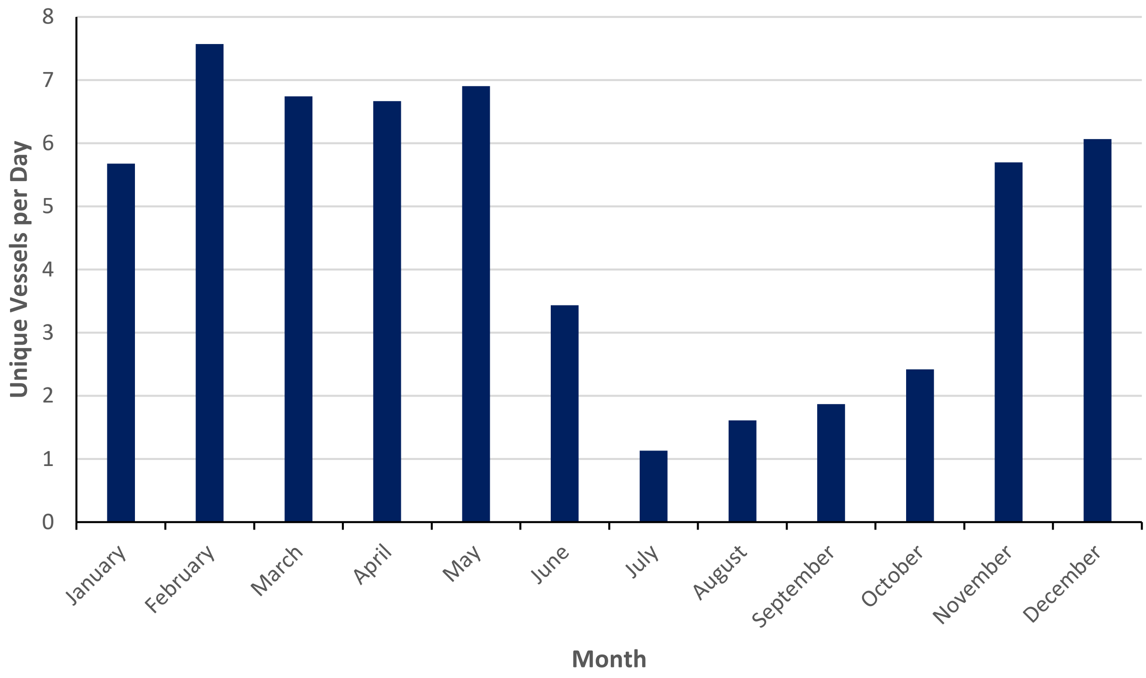

Figure D.9 Average Daily Unique Fishing Vessel Count per Month

D.4.3.4 Wind Farm Vessels

827. The wind farm vessels recorded via AIS within the array traffic study area during the long-term survey period are presented in Figure D.10.

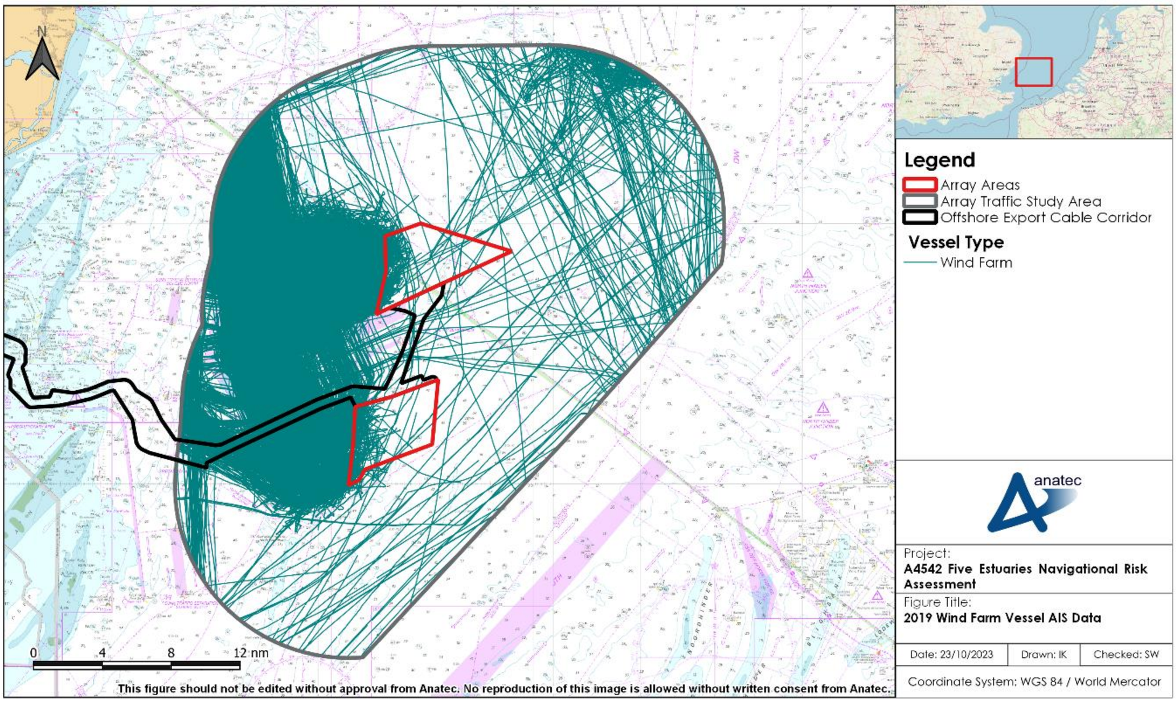

Figure D.10 2019 Wind Farm Vessel AIS Data

828. The distribution of daily unique wind farm vessels recorded per month within the array traffic study area is presented in Figure D.11. Wind farm vessels were recorded involved in operations in the Gabbard and East Anglia One OWFs out of the Port of Lowestoft; and Greater Galloper out of Harwich Haven.

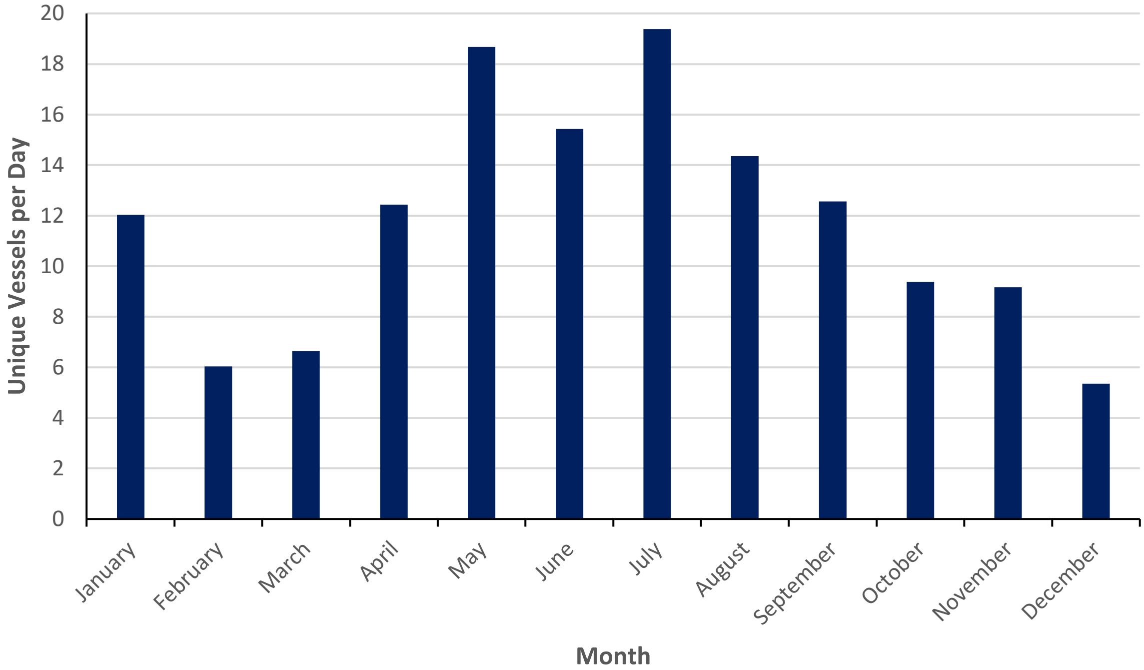

Figure D.11 Average Daily Unique Wind Farm Vessel Count per Month

D.4.3.5 Recreational Vessels

829. The tracks of recreational vessels recorded via AIS within the array traffic study area during the long-term survey period are converted to a heat map of density and presented in Figure D.12.

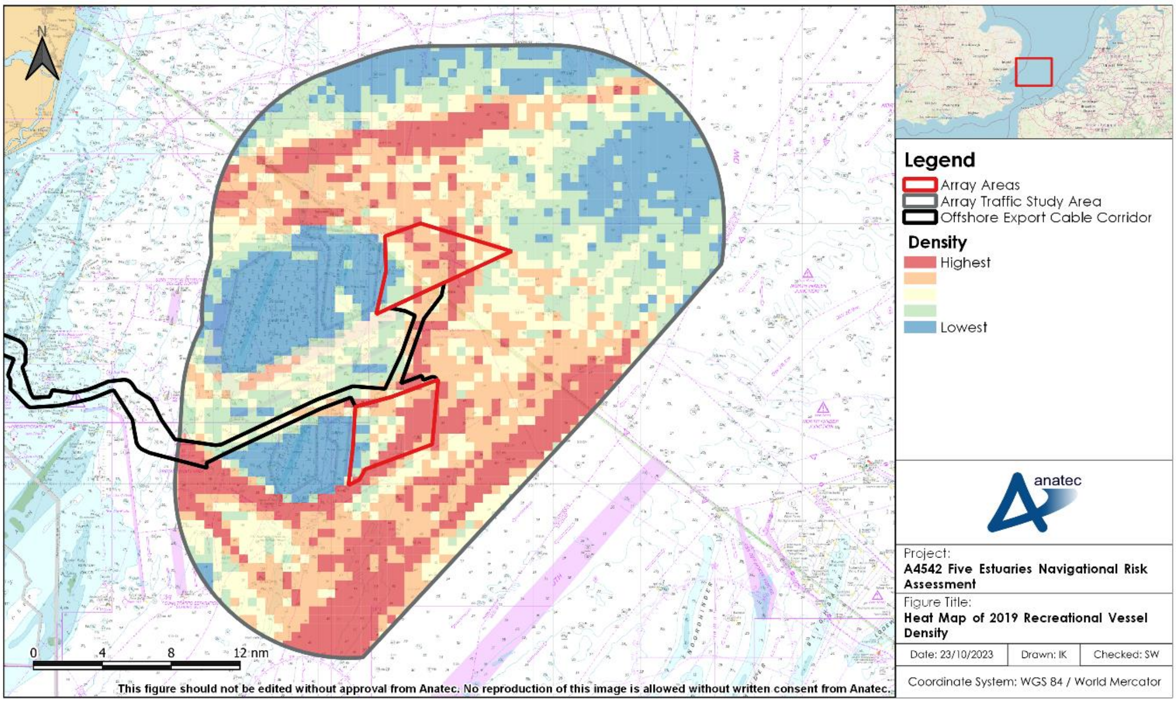

Figure D.12 Heat Map of 2019 Recreational Vessel Density

830. The distribution of daily unique recreational vessels recorded per month within the array traffic study area is presented in Figure D.13.

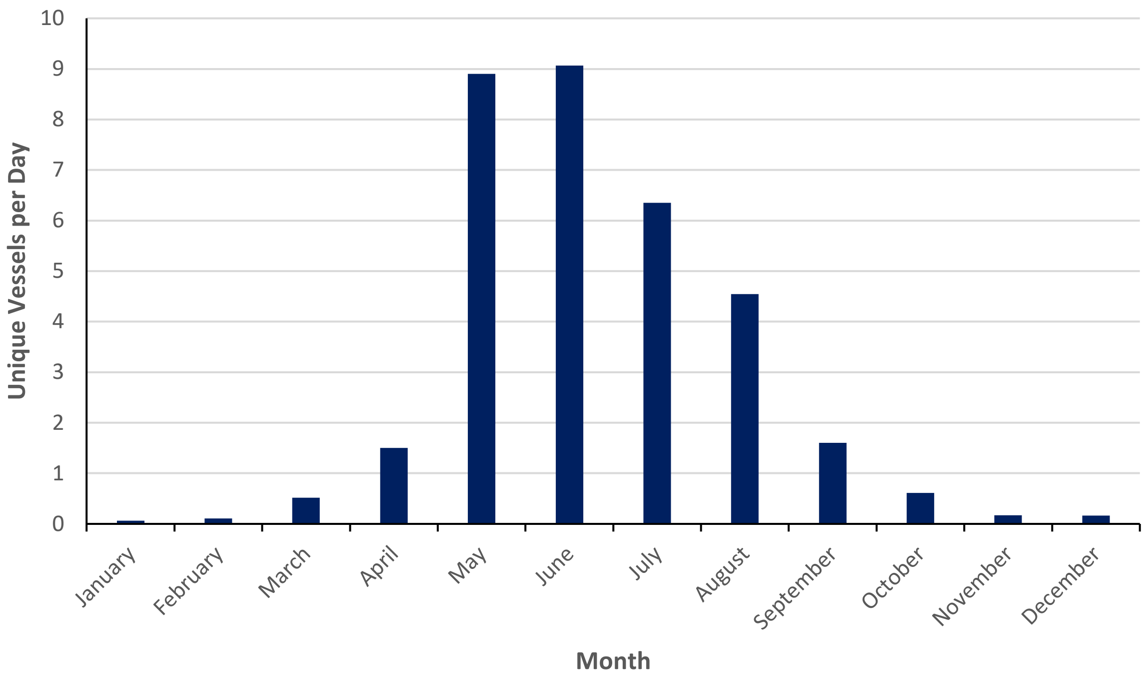

Figure D.13 Average Daily Unique Recreational Count per Month

D.5 Site Specific Analysis

831. The vessel tracks intersecting the array areas during the long-term survey period are presented in Figure D.14.

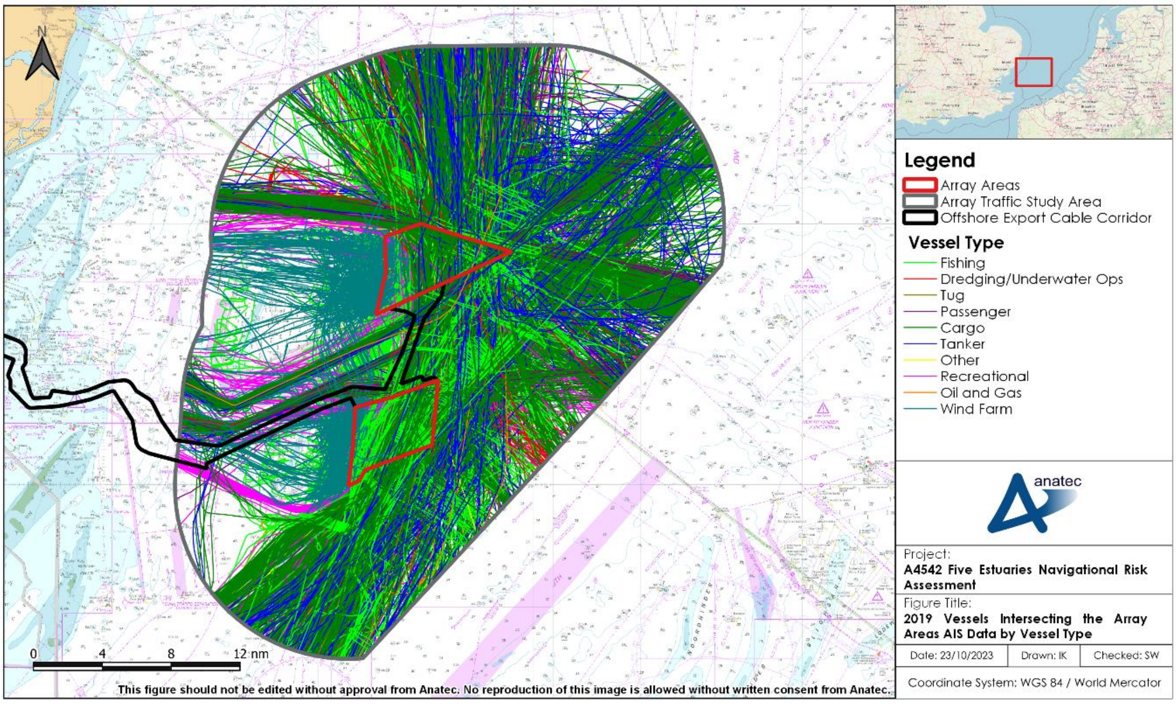

Figure D.14 2019 Vessels Intersecting the Array Areas AIS Data by Vessel Type

832. On average, five to six unique vessels per day were recorded intersecting the array areas during 2019. The busiest day was the 31 of May, on which 82 unique vessels were recorded intersecting the array areas. This traffic was largely recreational and coincided with the RORC North Sea Race. These vessels are presented in Figure D.15.

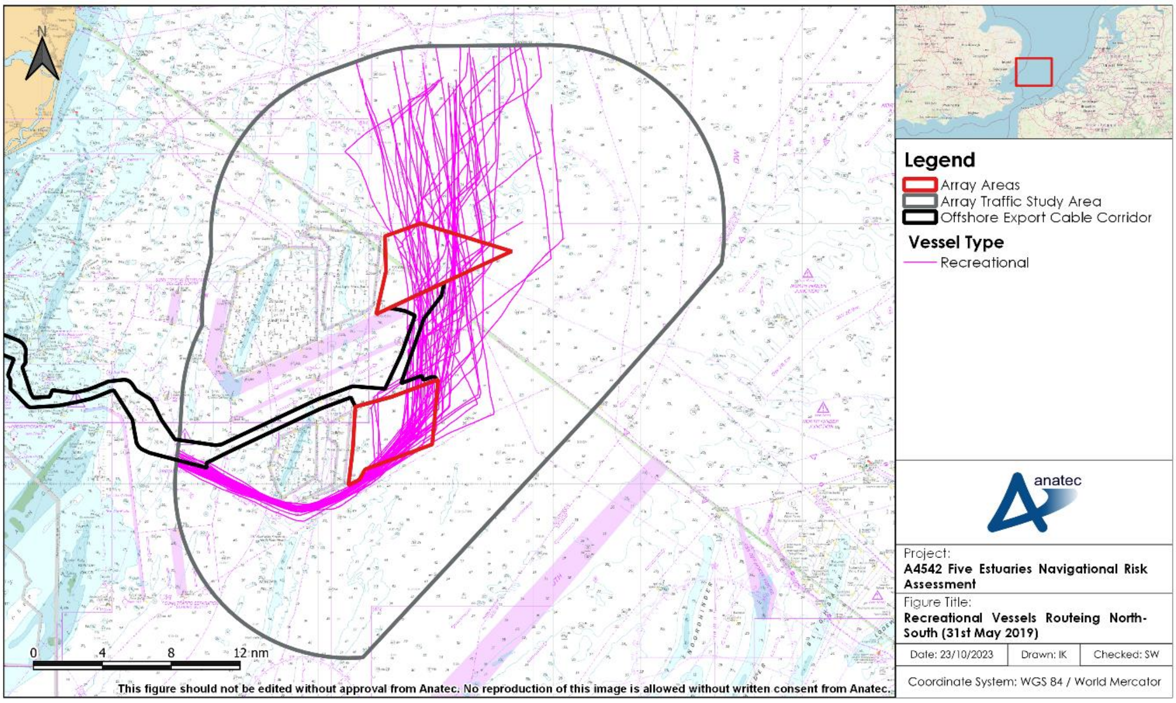

Figure D.15 Recreational Vessels Routeing North-South (31 May 2019)

833. A breakdown of the daily unique vessel count intersecting the array areas is presented in Figure D.16 by vessel type.

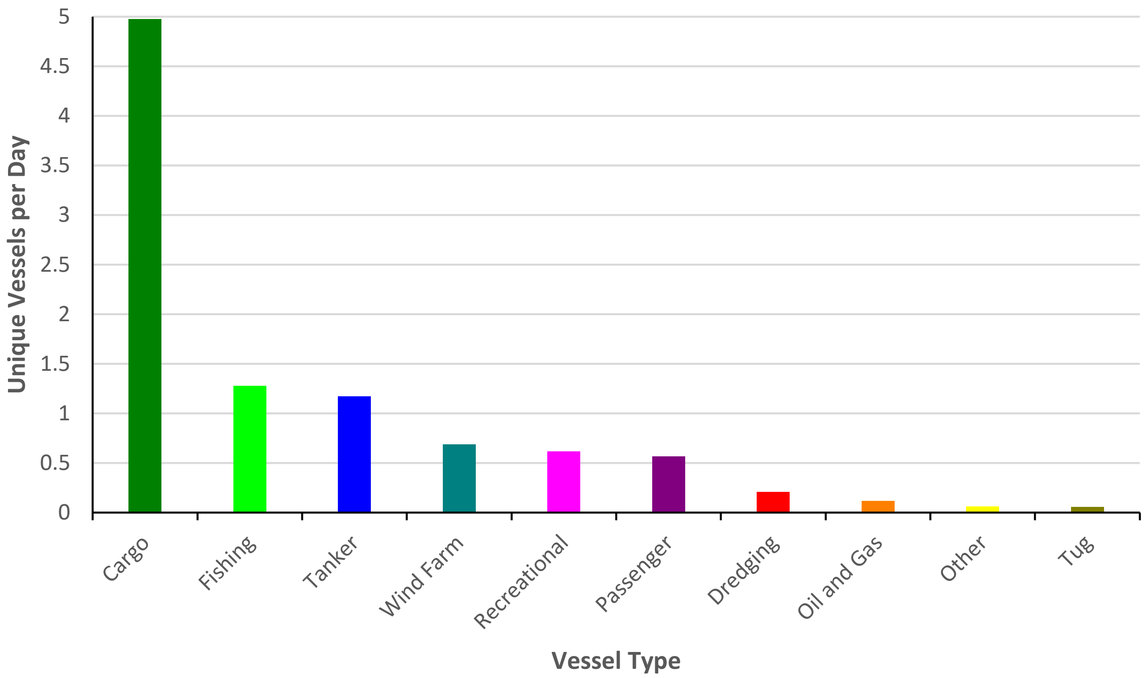

Figure D.16 Distribution of Vessels Intersecting the Array Areas by Vessel Type

D.6 Survey Data Comparison

Table D.2 Average Daily Vessel Counts by Type for Survey and Long-Term Data

Vessel Type	Long-term 2019 AIS Data (Vessels per Day)			Winter Survey (January 2022)	Summer Survey (July 2022)
	Quietest Month	Busiest Month	Average Vessels per Day	Average Vessels per Day	Average Vessels per Day
Cargo vessels	48	89	54	55	56
Tankers	18	27	20	23	21
Wind farm vessels	5	19	11	6	16
Fishing vessels	1	7-8	4	8	4
Passenger vessels	3	5	4	1-2	3
Recreational vessels	<1	9	3	0	7-8
Marine aggregate dredgers	2-3	3-4	3	2	4
Tugs	0-1	1	0-1	0-1	0-1
Oil and gas vessels	0-1	1	0-1	0-1	0-1

D.7 Conclusion

834. A year of AIS data during 2019 has been analysed to validate the winter and summer 2022 vessel traffic survey data recorded within the array traffic study area.

835. The main type of vessels detected within the array traffic study area during 2019 were cargo vessels (54%), followed by tankers (19%) and wind farm vessels (11%). Similarly, main vessel types detected during the winter 2022 period were cargo vessels (57%), tankers (23%), and fishing vessels (9%), with wind farm vessels also common (7%). During summer 2022, the most common vessel types were cargo vessels (49%), tankers (23%), and wind farm vessels (14%). Overall, the vessel types detected within the array traffic study area were similar between the vessel traffic survey data and long-term data.

Appendix E Consequences Assessment

836. This appendix presents an assessment of the consequences of collision and allision incidents, in terms of people and the environment, due to the presence of VE.

837. The significance of the impact due to the presence of VE is also assessed based on risk evaluation criteria and comparison with historical incident data in UK waters[15].

E.1 Risk Evaluation Criteria

E.1.1 Risk to People

838. Regarding the assessment of risk to people two measures are considered, namely:

- Individual risk; and
- Societal risk.

E.1.1.1 Individual Risk

839. Individual risk considers whether the risk from an incident to a particular individual changes significantly due to the presence of VE. Individual risk considers not only the frequency of the incident and the consequences (e.g., 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.

840. The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of VE are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of VE relative to the UK background individual risk levels.

841. Annual risk levels to crew (the annual risk to an average crew member) for different vessel types are presented in Figure E.1, which also includes the upper and lower bounds for risk acceptance criteria as suggested in IMO Maritime Safety Committee 72/16 (IMO, 2001). The annual individual risk level to crew falls within the ALARP region for each of the vessel types presented.

[15] For the purposes of this assessment, UK waters is defined as the UK EEZ and UK territorial waters refers to the 12 nm limit from the British Isles, excluding the Republic of Ireland.

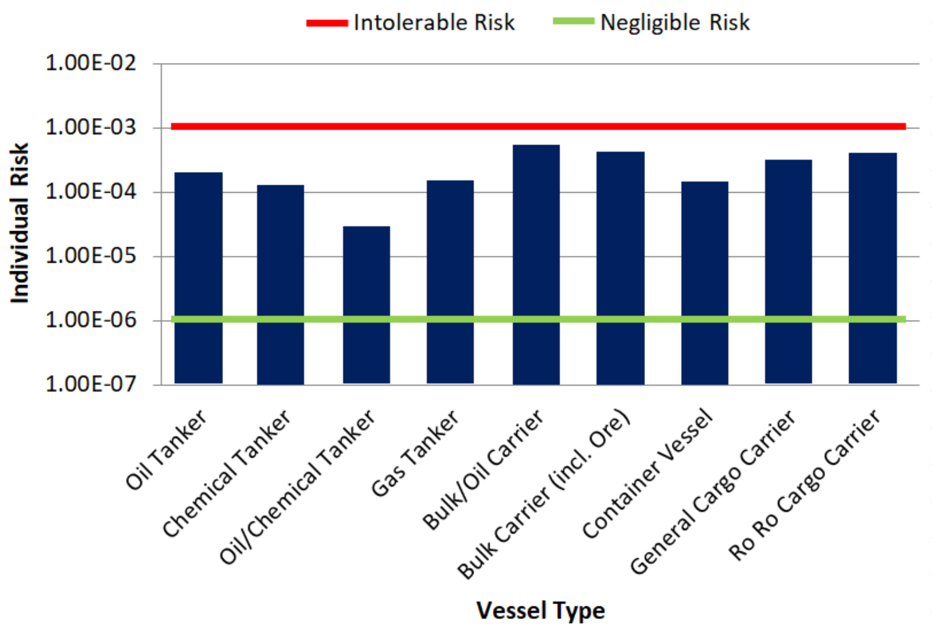

Figure E.1 Individual Risk Levels and Acceptance Criteria per Vessel Type

842. The typical bounds defining the ALARP regions for decision making within shipping are presented in Table E.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 E.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

843. 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 E.2, noting that in the period since HSE may have improved (rendering this a conservative review).

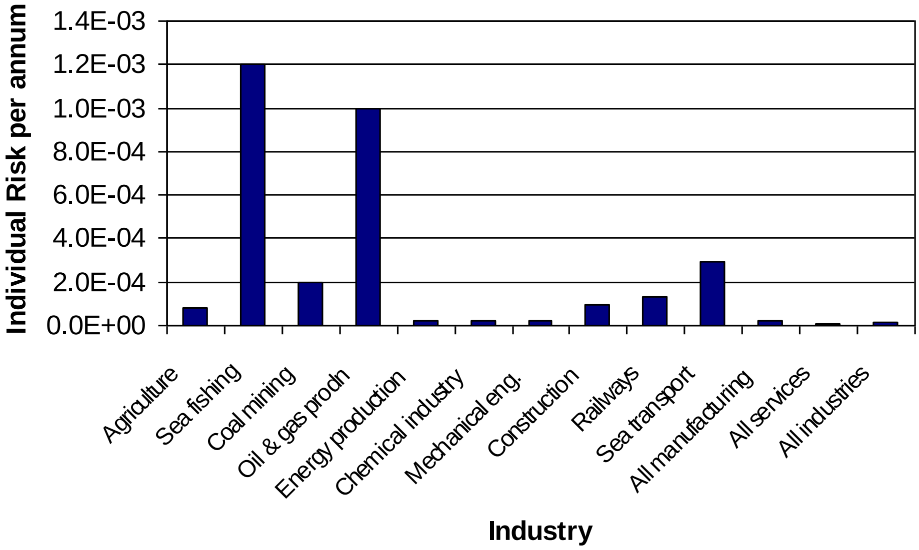

Table E.2 Individual Risk per Year for Various UK Industries

844. The individual risk for sea transport of 2.9×10^{-4} per year is consistent with the worldwide data presented in Figure 2.1, whilst the individual risk for sea fishing of 1.2×10^{-3} per year is the highest across all of the industries included.

E.1.1.2 Societal Risk

845. Societal risk is used to estimate risks of incidents affecting many persons (catastrophes) and acknowledging risk adverse 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.

846. Within this assessment, societal (navigation based) risk can be assessed for VE, giving account to the change in risk associated with each incident scenario caused by the introduction of the wind farm structures. 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.

847. 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 the UK background risk levels.

E.1.2 Risk to Environment

848. For risk to the environment the key criteria considered in terms of the risk due to VE is the potential quantity of oil spilled from a vessel involved in an incident.

849. It is recognised that 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 VE compared to UK background pollution risk levels.

E.2 Marine Accident Investigation Branch Incident Data

E.2.1 All Incidents in UK Waters

850. 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 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.

851. The MCA, harbour authorities and inland waterway authorities also have a duty to report incidents to the MAIB. Therefore, whilst there may be a degree of underreporting of incidents with minor consequences, those resulting in more serious consequences, such as fatalities, are likely to be reported.

852. 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 VE.

853. Accounting for these criteria, a total of 11,773 accidents, injuries and hazardous incidents were reported to the MAIB in the 20-year period between 2002 and 2021 involving 13,415 vessels (some incidents, such as collisions, involved more than one vessel).

854. The location of all incidents in proximity to the UK are presented in Figure E.2, colour-coded by incident type. The majority of incidents occur in coastal waters.

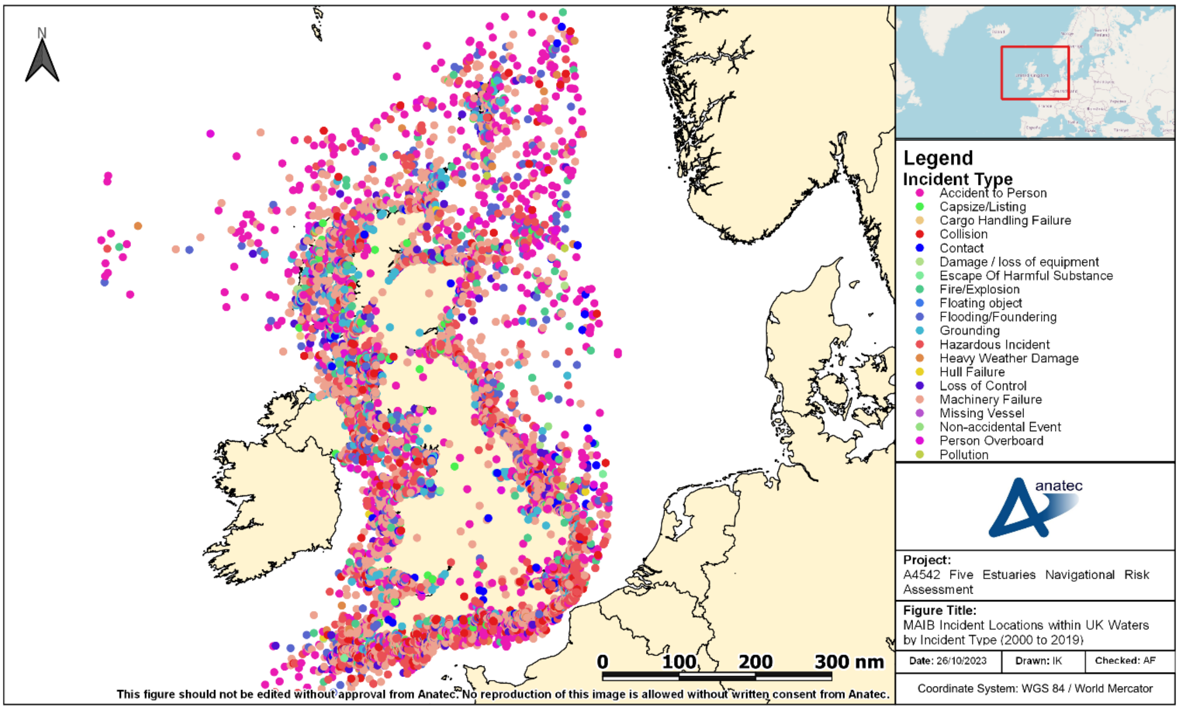

Figure E.2 MAIB Incident Locations by Incident Type within UK Waters (2002 to 2021)

855. The distribution of incidents by year in UK waters is presented in Figure E.3.

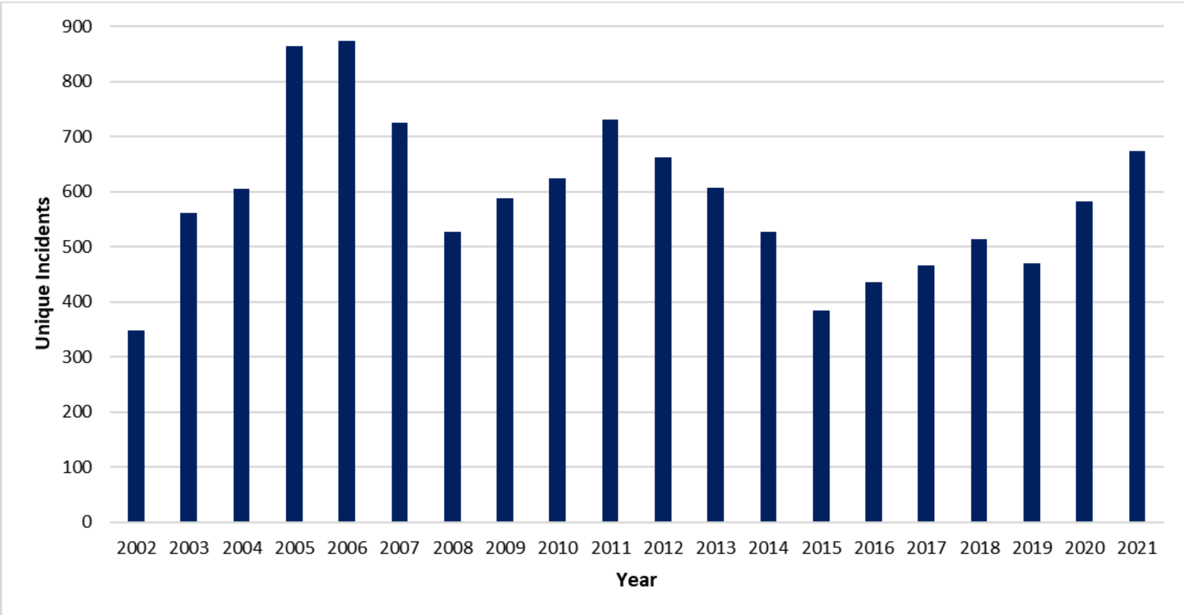

Figure E.3 MAIB Unique Incidents per Year within UK Waters (2002 to 2021)

856. The average number of unique incidents per year was 589. There has generally been a fluctuating trend in incidents over the 20-year period.

857. The distribution of incidents in UK waters by incident type is presented in Figure E.4.

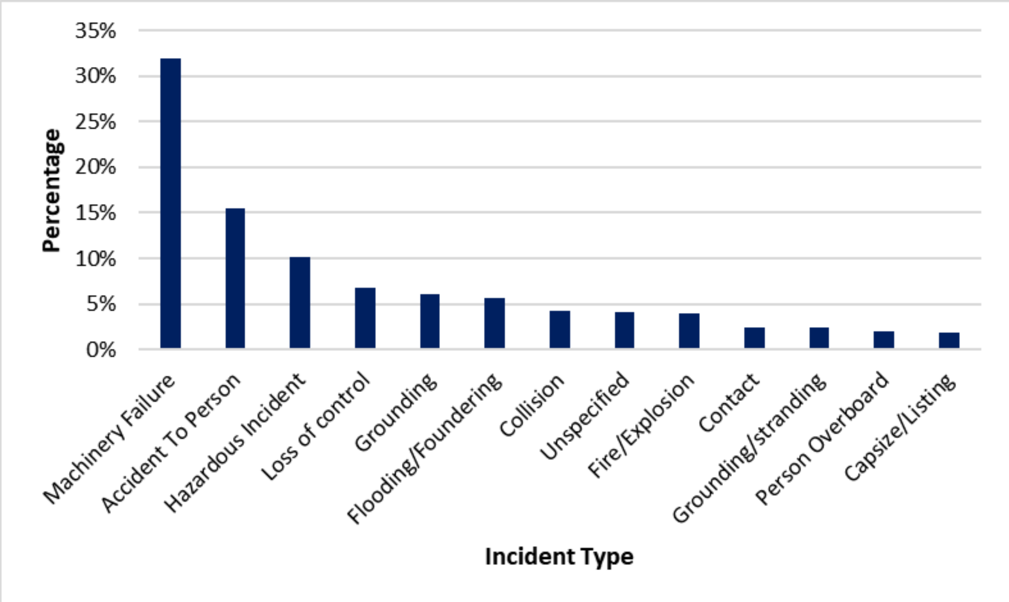

Figure E.4 MAIB Incident Type Breakdown within UK Waters (2002 to 2021)

858. The most frequent incident types were machinery failure (32%), accident to person (16%), and hazardous incident (10%). Collision and contact incidents represented 4% and 2% of total incidents, respectively.

859. The distribution of incidents in UK waters by vessel type is presented in Figure E.5.

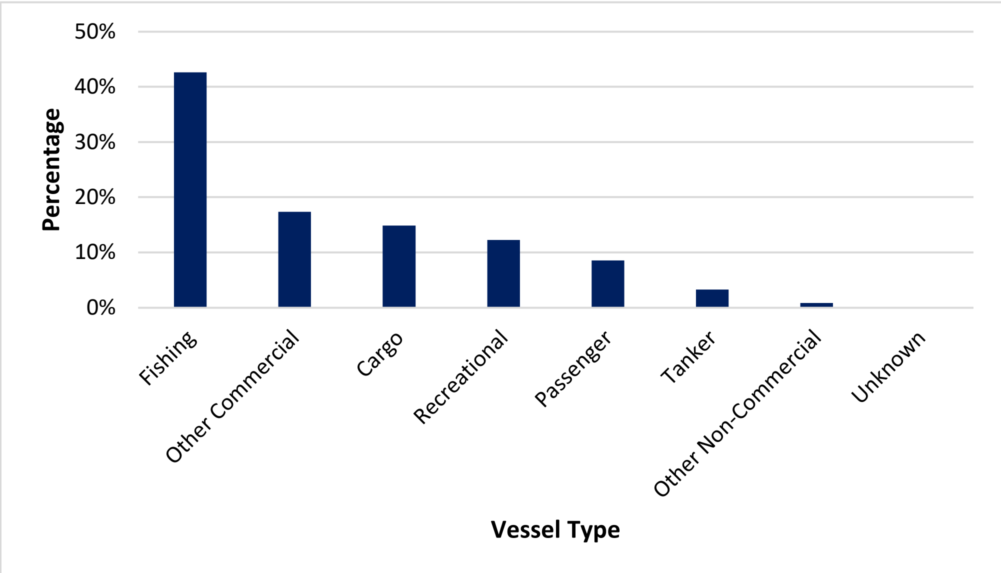

Figure E.5 MAIB Vessel Type Breakdown within UK Waters (2002 to 2021)

860. The most frequent vessel types involved in incidents were fishing vessels (43%), other commercial vessels (17%) (including offshore industry vessels, tugs, workboats and pilot vessels) and cargo vessels (15%).

861. A total of 414 fatalities were reported in the MAIB incidents within UK waters between 2002 and 2021, corresponding to an average of 21 fatalities per year.

862. The distribution of fatalities in UK waters by vessel type and person category (crew, passenger and other) is presented in Figure E.6.

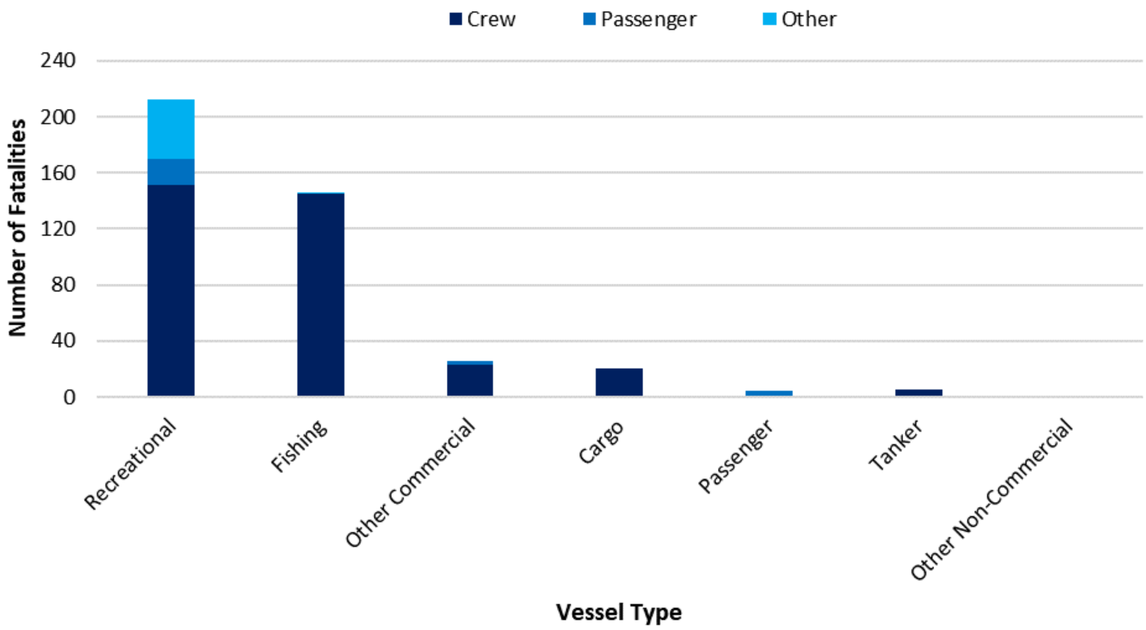

Figure E.6 MAIB Fatalities by Vessel Type within UK Waters (2002 to 2021)

863. The majority of fatalities occurred to recreational vessels (51%) and fishing vessels (35%), with crew members the main people involved (83%).

E.2.2 Collision Incidents

864. 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).

865. A total of 504 collision incidents were reported to the MAIB in UK waters between 2002 and 2021 involving 1,068 vessels (in a small number of cases the other vessel involved was not logged).

866. The locations of collision incidents reported in proximity to the UK are presented in Figure E.7.

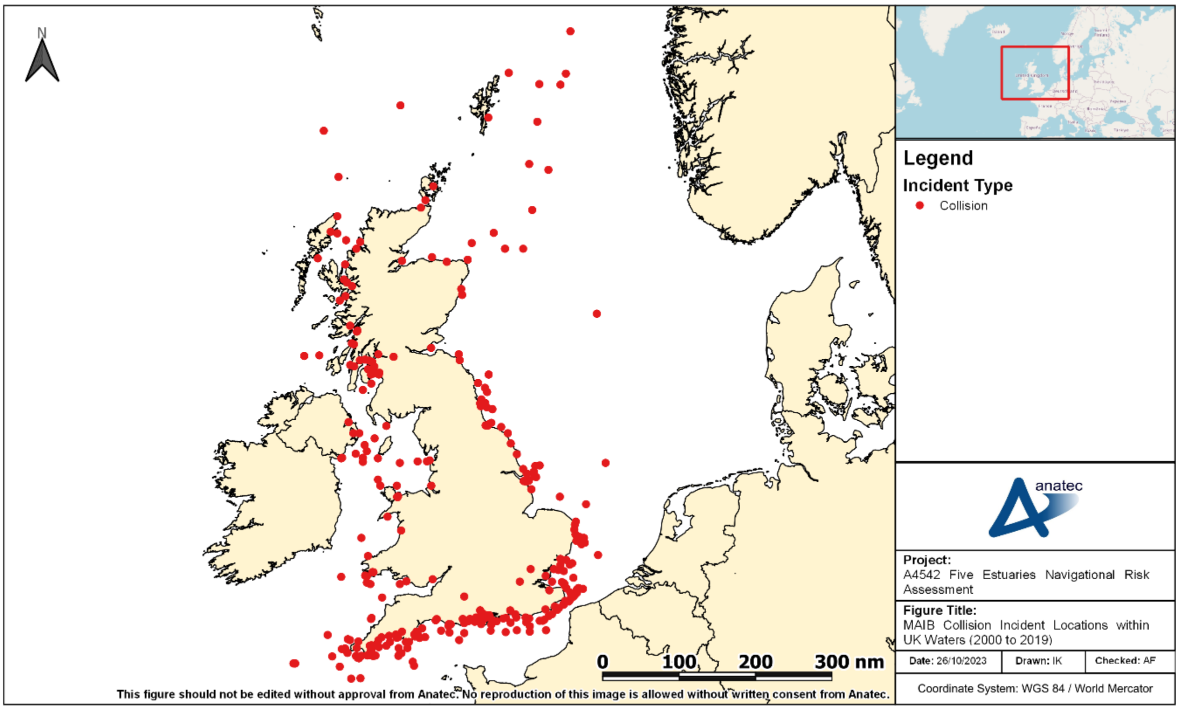

Figure E.7 MAIB Collision Incident Locations within UK Waters (2002 to 2021)

867. The distribution of collision incidents per year is presented in Figure E.8.

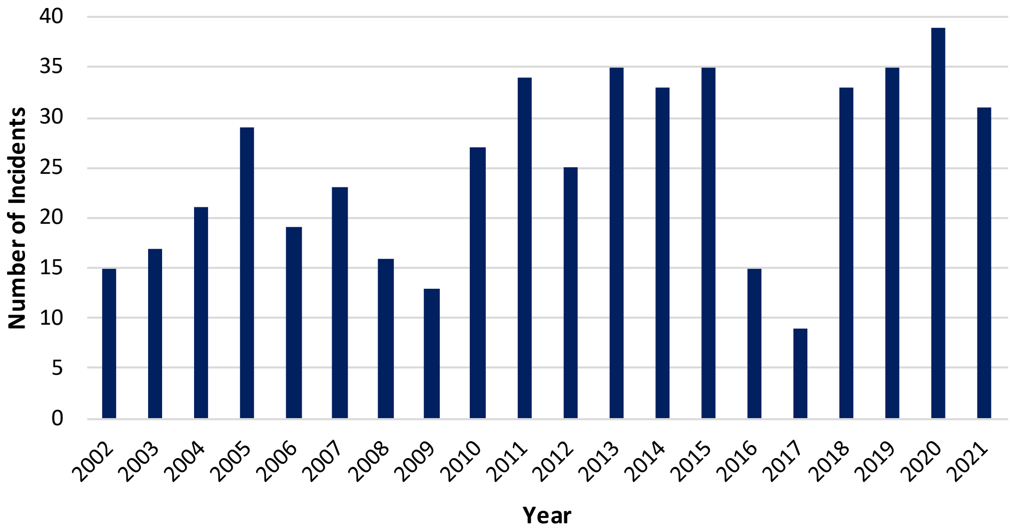

Figure E.8 MAIB Annual Collision Incidents within UK Waters (2002 to 2021)

868. The average number of collision incidents per year was 25. There has been an overall slight increasing trend in collision incidents over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

869. The distribution of vessel types involved in collision incidents is presented in Figure E.9.

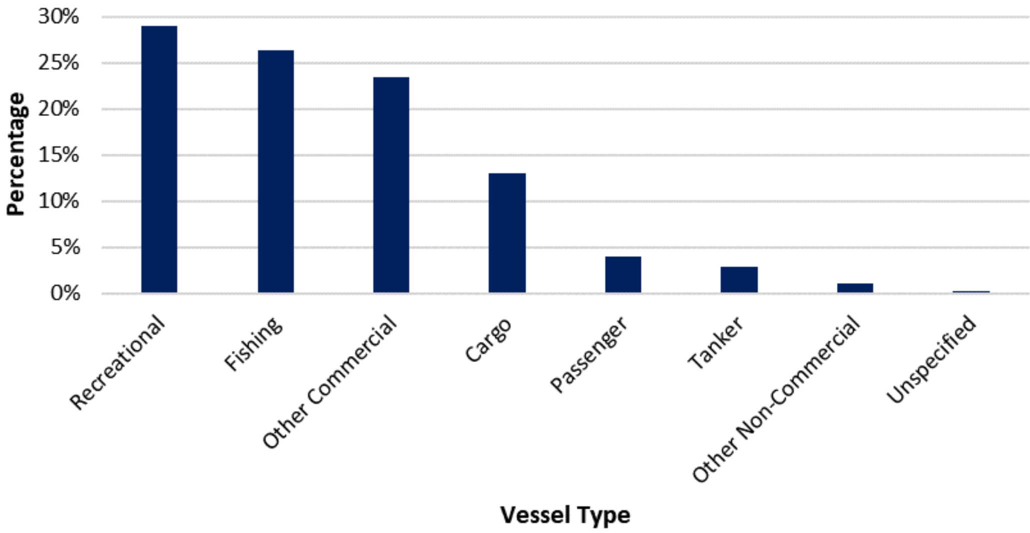

Figure E.9 MAIB Collision Fatalities by Vessel Type within UK Waters (2002 to 2021)

870. The most frequent vessel types involved in collision incidents were recreational vessels (29%), fishing vessels (26%), other commercial vessels (24%) and cargo vessels (13%).

871. A total of five fatalities were reported in MAIB collision incidents within UK waters between 2002 and 2021. Details of each of these fatal incidents reported by the MAIB are presented in Table E.3.

Table E.3 Description of Fatal MAIB Collision Incidents (2002 to 2021)

Date	Description	Fatalities
July 2005	Collision between two powerboats at night. Both vessels were unlit and both helmsmen had consumed alcohol. One of the helmsmen died.	1
October 2007	Collision between fishing vessel and coastal general cargo vessel following failure to keep an effective lookout. Fishing vessel sank with three of the four crew members abandoning ship into a life raft, but the fourth crew member was not recovered.	1
August 2010	Collision between passenger ferry and fishing vessel. Fishing vessel sank with one of the two crew members recovered from the sea but the other member was not recovered despite an extensive search.	1
June 2015	Collision between Rigid-hulled Inflatable Boat (RIB) and yacht. Believed that around a dozen persons were onboard the motorboat with the majority taken ashore by lifeboat. One person seriously injured and airlifted to hospital before being pronounced dead later.	1
June 2018	Collision between power boats during a race. One of the vessels overturned with the pilot pronounced dead at the scene.	1

E.2.3 Allision Incidents

872. 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). In line with the NRA as a whole, an allision is considered to involve a moving object and a stationary object at sea, with port infrastructure excluded from consideration; the MAIB contact incidents have been individually inspected and filtered in line with the NRA definition.

873. A total of 119 allision incidents were reported to the MAIB within UK waters between 2002 and 2021 involving 119 vessels.

874. The locations of allision incidents reported in proximity to the UK are presented in Figure E.10.

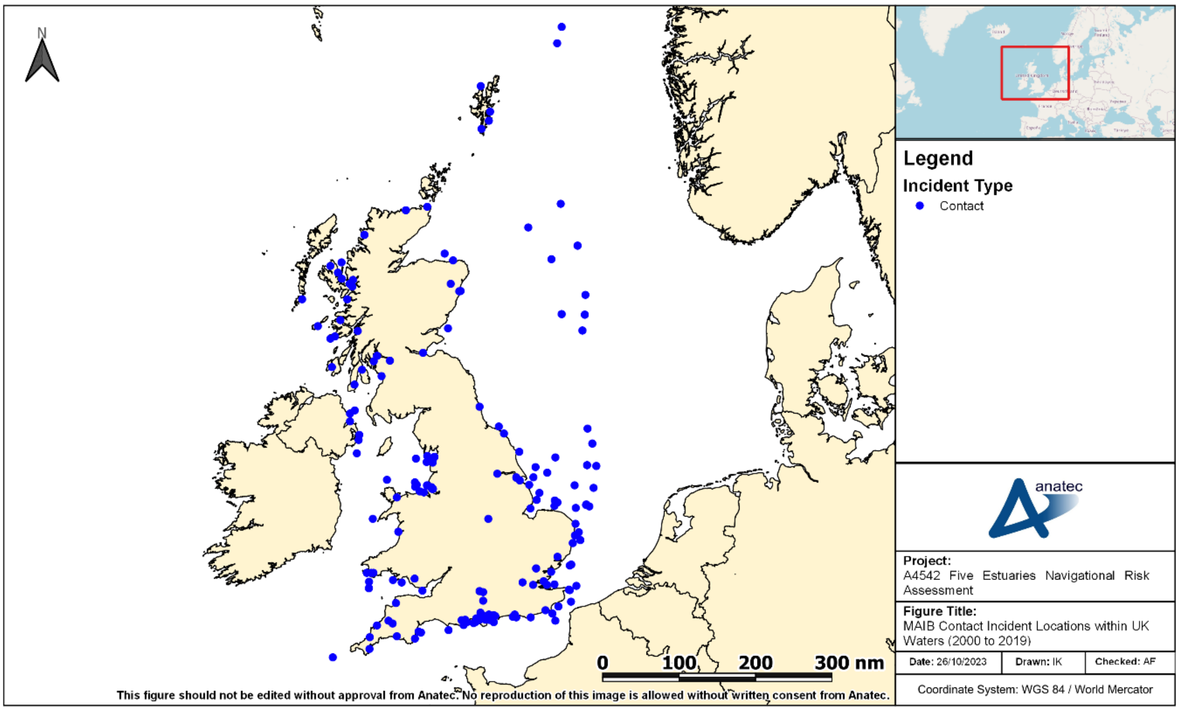

Figure E.10 MAIB Allision Incident Locations within UK Waters (2002 to 2021)

875. The distribution of allision incidents per year is presented in Figure E.11.

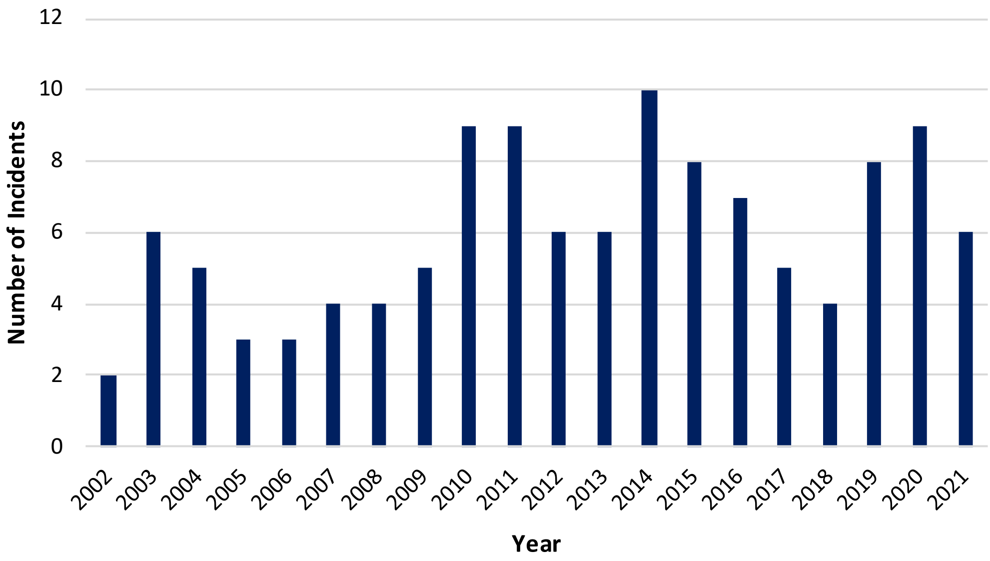

Figure E.11 MAIB Allision Incidents per Year within UK Waters (2002 to 2021)

876. The average number of allision incidents per year was six. As with collision incidents, there has been an overall slight increasing trend in allision incidents over the 20-year period, which may be due to better reporting of less serious incidents in recent years.

877. The distribution of vessel types involved in allision incidents is presented in Figure E.12.

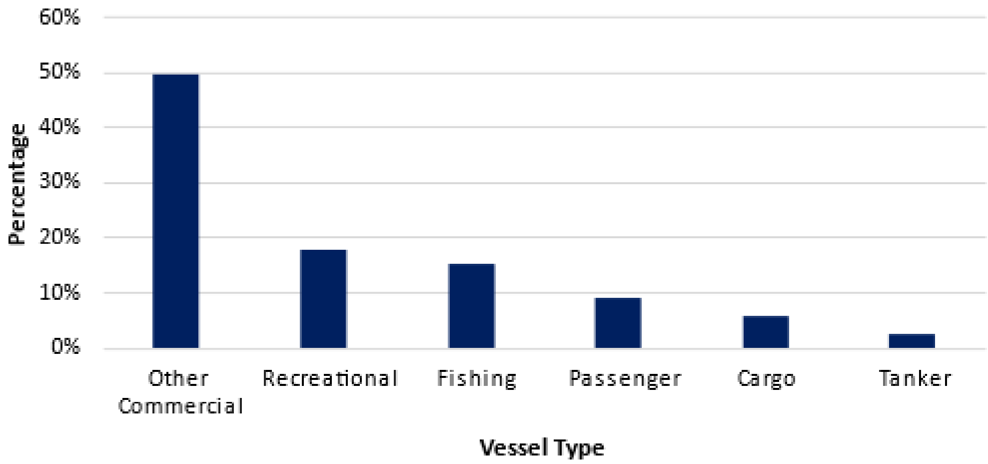

Figure E.12 MAIB Allision Incidents by Vessel Type within UK Waters (2002 to 2021)

878. The most frequent vessel types involved in allision incidents were other commercial vessels (50%), recreational vessels (18%) and fishing vessels (15%).

879. No fatalities were reported in MAIB allision incidents within offshore UK waters between 2002 and 2021.

E.3 Fatality Risk

E.3.1 Incident Data

880. 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 VE.

881. VE is 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.

882. Of these incident types, only vessel to vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in Section E.2 is considered directly applicable to these types of incidents.

883. The other scenarios of powered vessel to structure allision, drifting vessel to structure allision and fishing vessel to structure allision are not clearly represented by the MAIB data (as discussed in Section E.2.3). Additionally, none of the allision incidents reported by the MAIB between 2002 and 2021 resulted in a fatality.

884. Therefore, the MAIB collision fatality risk rate has also been conservatively applied for the allision incident types.

E.3.2 Fatality Probability

885. Five of the 504 collision incidents reported by the MAIB within UK waters between 2002 and 2021 resulted in one or more fatalities. This gives a 0.99% probability that a collision incident will lead to a fatal accident.

886. 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 E.4 presents the average number of POB estimated for each category of vessel navigating in proximity to VE. 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 E.4 Estimated Average POB by Vessel Category

Vessel Category	Subcategories	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	23
Passenger	RoRo passenger, cruise liner, etc.	Vessel traffic survey data / online information	1,657
Fishing	Trawler, potter, dredger, etc.	MAIB incident data	3.3
Recreational	Yacht, small commercial motor yacht, etc.	MAIB incident data	3.3

887. 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.

888. Using the average POB, along with the vessel type information involved in collision incidents reported by the MAIB (see Section E.2.2), there was an estimated 74,358 POB the vessels involved in the collision incidents.

889. Based upon five fatalities during the period 2002 to 2021, the overall fatality probability in a collision for any individual onboard is approximately 6.72×10^{-5} per collision.

890. 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 E.5. In addition, due to zero fatalities resulting from commercial vessel collisions between 2002 and 2021, the time period used to assess the fatality probability for commercial vessels has been extended by five years to ensure a meaningful probability is captured.

Table E.5 Collision Incident Fatality Probability by Vessel Category

Vessel Category	Subcategories	Fatalities	People Involved	Fatality Probability	Time Period
Commercial	Dry cargo, passenger, tanker, etc.	1	72,408	1.4×10^{-5}	1997 to 2021 (25 years)
Fishing	Trawler, potter, dredger, etc.	2	927	2.2×10^{-3}	2002 to 2021 (20 years)
Recreational	Yacht, small commercial motor yacht, etc.	3	1,023	2.9×10^{-3}	2002 to 2021 (20 years)

E.3.3 Fatality Risk due to Five Estuaries

891. The base case and future case annual collision frequency levels pre and post wind farm for VE are summarised in Table 16.1.

892. 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 VE for the base case and future case are presented in Figure E.13. The same distribution but excluding fishing vessels is presented in Figure E.14.

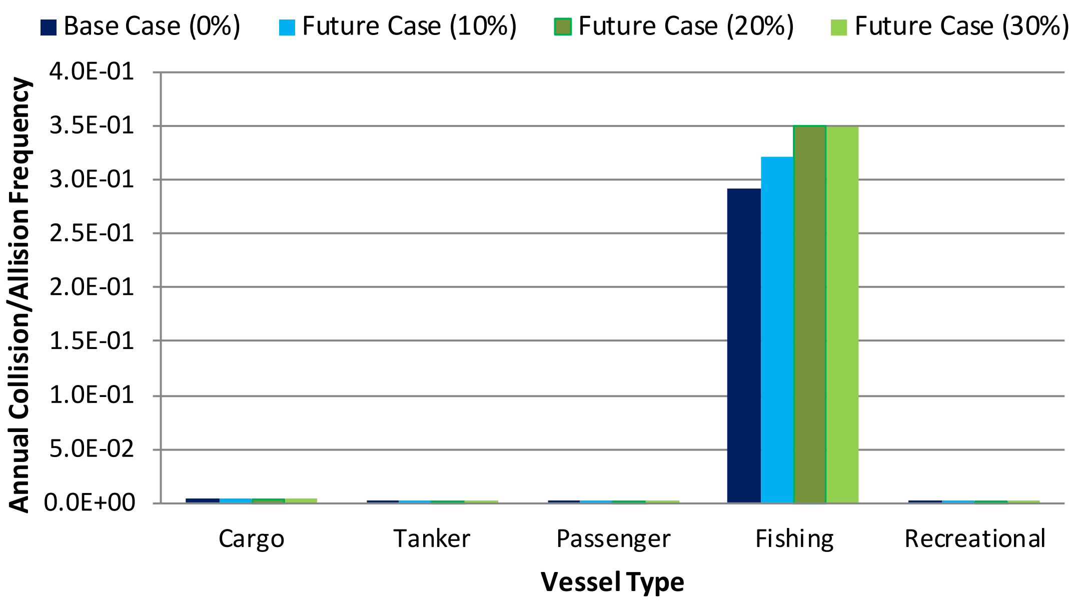

Figure E.13 Estimated Change in Annual Collision and Allision Frequency by Vessel Type

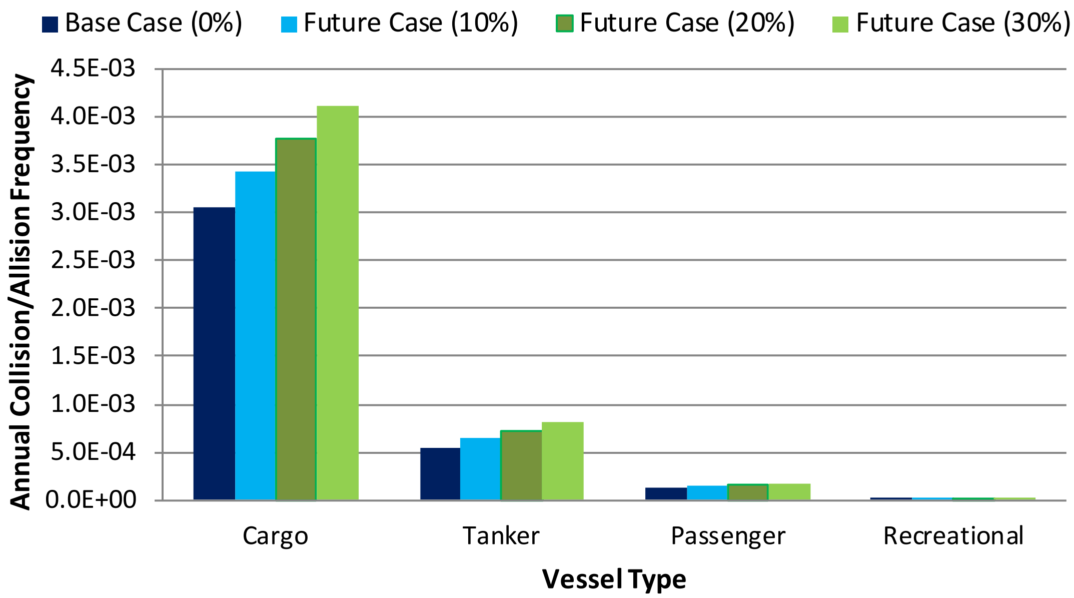

Figure E.14 Estimated Change in Annual Collision and Allision Frequency by Vessel Type (Excluding Fishing Vessels)

893. The change in collision and allision frequency is dominated by fishing vessels due to their active presence within and in proximity to the array area and the highly conservative nature of Anatec's COLLRISK model for fishing vessel allisions.

894. The second greatest collision and allision frequency change was associated with cargo vessels but was significantly lower than fishing vessels.

895. Combining the annual collision and allision frequency (see Table 16.1), estimated number of POB for each vessel type (see Table E.4) and the estimated fatality probability for each vessel type category (see Table E.5), the annual increase in PLL due to the presence of VE for the base case is estimated to be 2.96×10^{-1}, equating to one additional fatality every 3.4 years.

896. The estimated incremental increases in PLL due to VE, distributed by vessel type and for the base case and future case, are presented in Figure E.15. The same distribution but excluding fishing vessels is presented in Figure E.16.

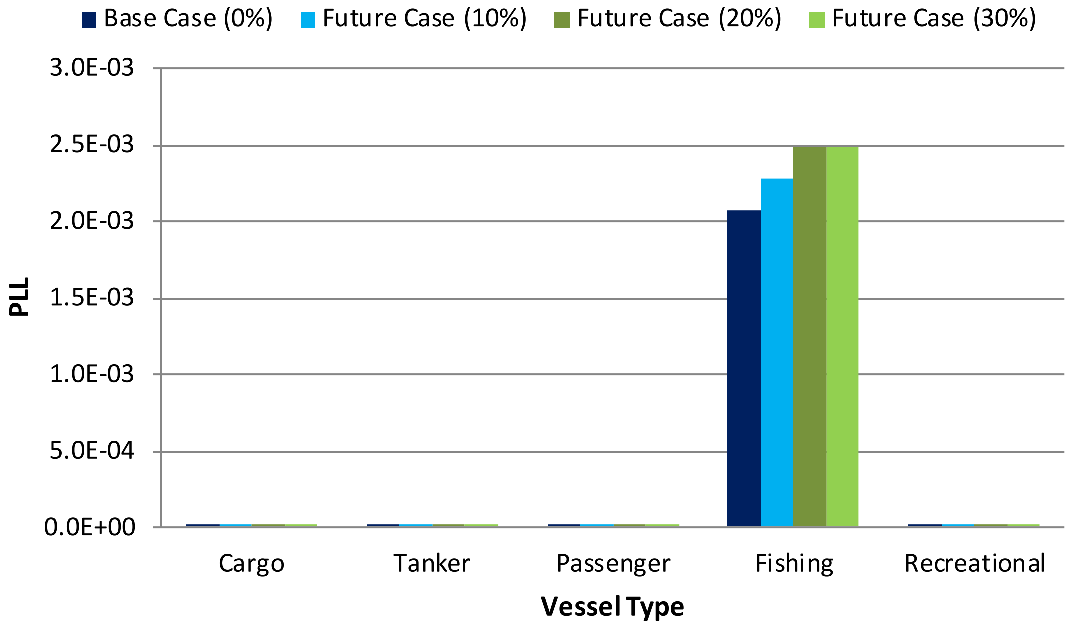

Figure E.15 Estimated Change in Annual PLL by Vessel Type

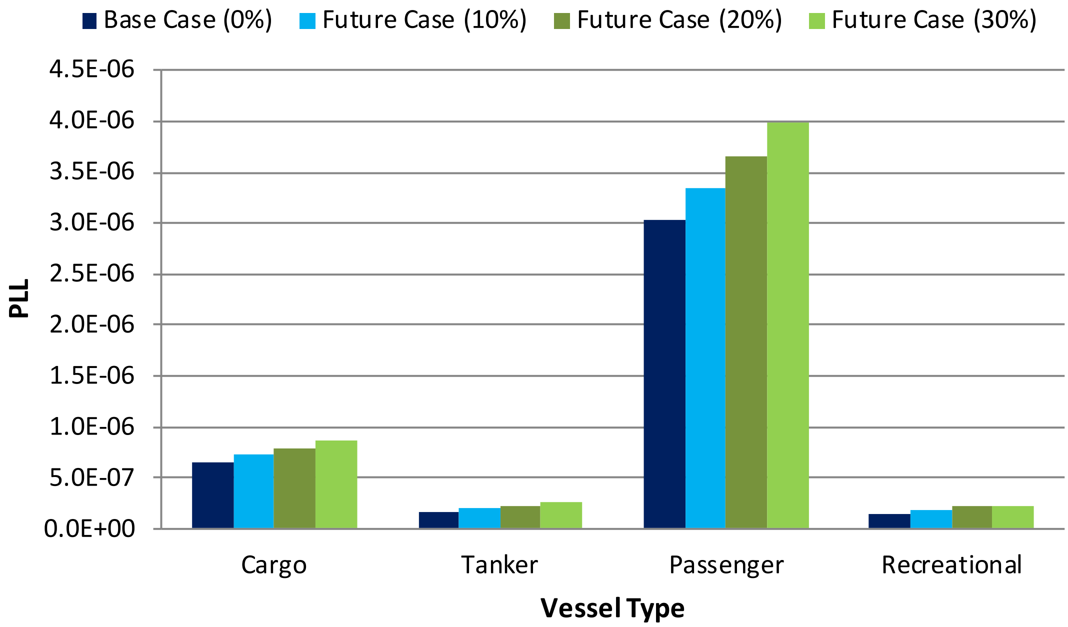

Figure E.16 Estimated Change in Annual PLL by Vessel Type (Excluding Fishing Vessels)

897. As with the change in collision and allision frequency, the change in annual PLL is dominated by fishing vessels which historically have a higher fatality probability than commercial vessels.

898. The second greatest annual PLL change was associated with passenger vessels due to much greater numbers of POB associated with this vessel type compared to others.

899. Converting the PLL to individual risk based upon the average number of people exposed by vessel type, the results are presented in Figure E.17. The same results but excluding fishing vessels is presented in Figure E.18.

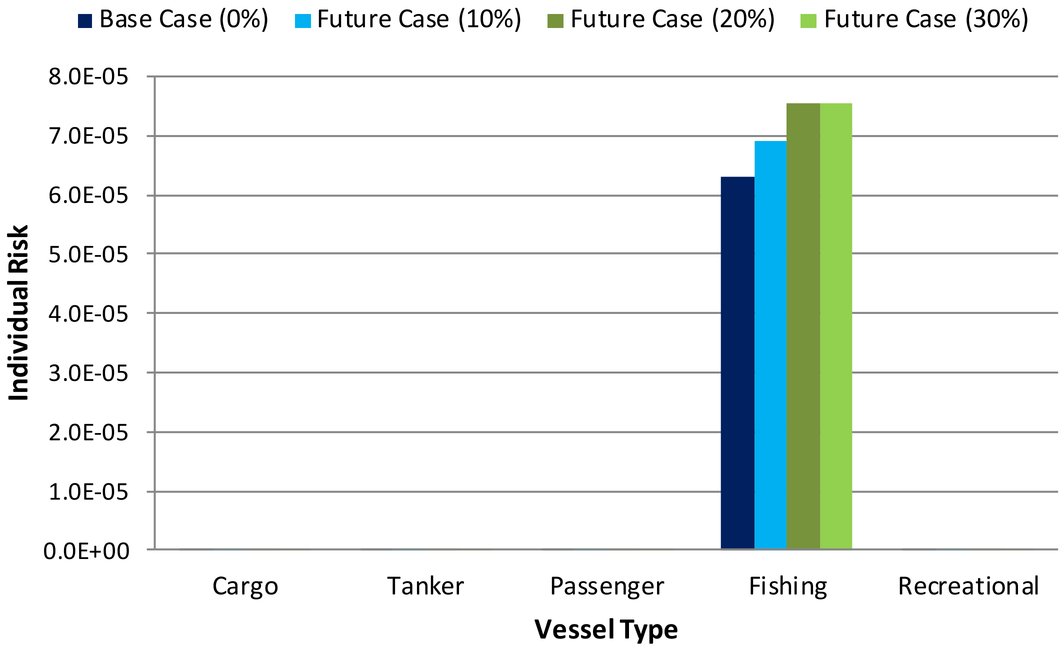

Figure E.17 Estimated Change in Individual Risk by Vessel Type

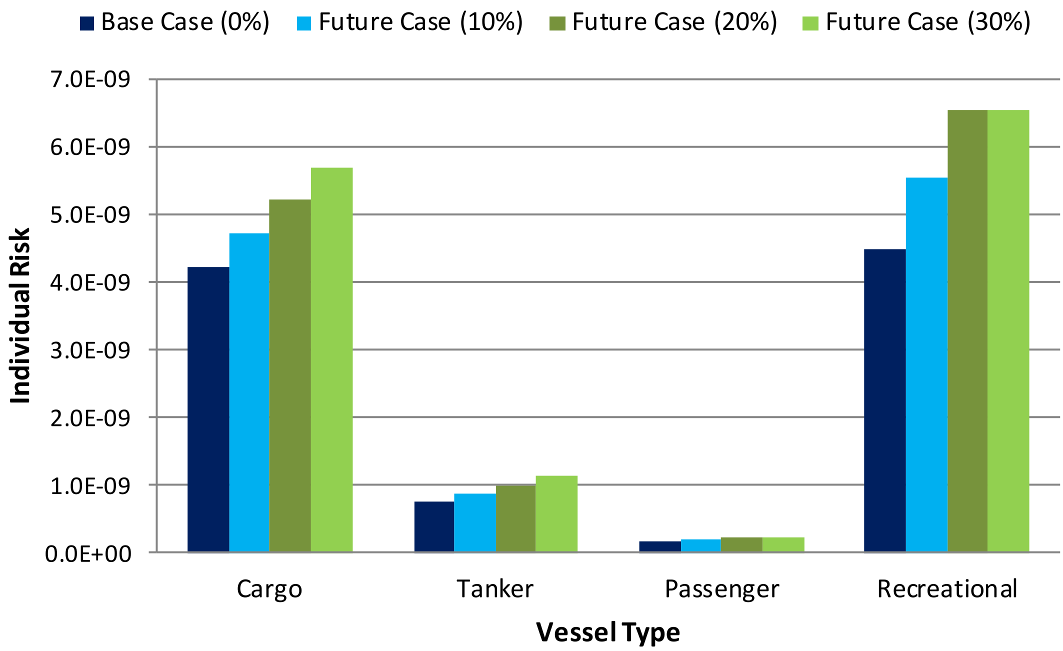

Figure E.18 Estimated Change in Individual Risk by Vessel Type (Excluding Fishing Vessels)

900. The change in individual risk to people is dominated by fishing vessels, again reflecting the higher probability of a fatality occurring in the event of an incident involving a fishing vessel compared to other vessel types.

901. The second greatest individual risk change was associated with recreational vessels, followed by cargo vessels.

E.3.4 Significance of Increase in Fatality Risk

902. In comparison to MAIB statistics, which indicate an average of 18 to 19 fatalities per year in UK territorial waters during the 20-year period between 2002 and 2021, the overall increase for the base case in PLL of one additional fatality per 3.38 years represents a small change.

903. In terms of individual risk to people, the change for commercial vessels attributed to VE (approximately 5.16×10^{-9} for the base case) is negligible compared to the background risk level for the UK sea transport industry of 2.9×10^{-4} per year.

904. For fishing vessels, the change in individual risk attributed to VE (approximately 6.30×10^{-5} for the base case) is low compared to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

E.4 Pollution Risk

E.4.1 Historical Analysis

905. The pollution consequences of a collision in terms of oil spill depend upon the following criteria:

- Spill probability (i.e., the likelihood of outflow following an incident); and
- Spill size (quantity of oil).

906. Two types of oil spill are considered in this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

907. The research undertaken as part of the DfT's MEHRAs project (DfT, 2001) has been used as it was comprehensive and based upon worldwide marine oil spill data analysis. From this research, the overall probability of a spill per incident was calculated based upon historical incident data for each incident type as presented in Figure E.19.

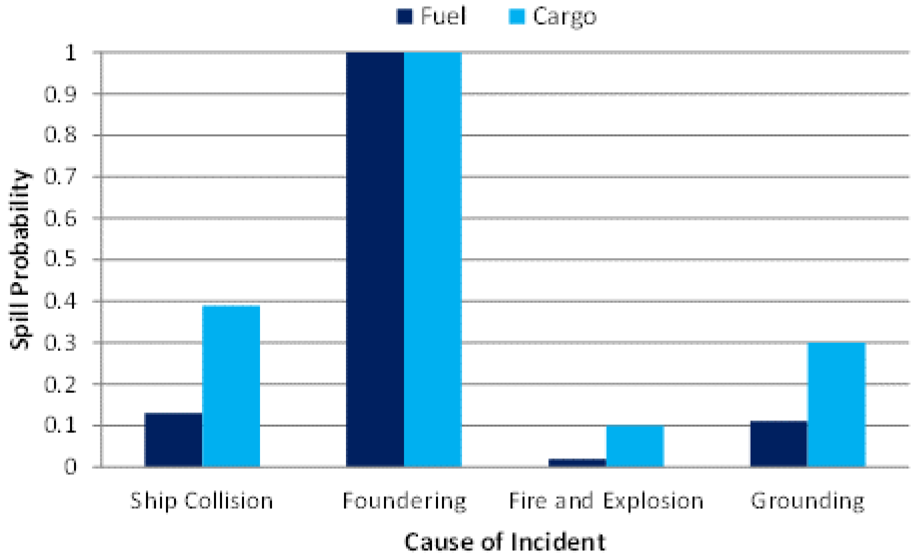

Figure E.19 Probability of an Oil Spill Resulting from an Accident

908. 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.

909. 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 bunker capacity, and in most incidents much lower.

910. For the types and sizes of vessels exposed to VE, an average spill size of 100 tonnes of fuel oil is considered a conservative assumption.

911. 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.

912. Based upon this data and the tankers transiting in proximity to VE, an average spill size of 400 tonnes is considered a conservative assumption.

913. 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.

E.4.2 Pollution Risk due to Five Estuaries

914. Applying the above probabilities to the annual collision and allision frequency by vessel type presented in Table 16.1 and the average spill size per vessel, the average amount of oil spilled per year due to the impact of VE is estimated to be 0.86 tonnes per year for the base case, rising to 1.06 tonnes for the 30% future case.

915. The estimated increase in tonnes of oil spilled, distributed by vessel type, for the base case and future case are presented in Figure E.20.

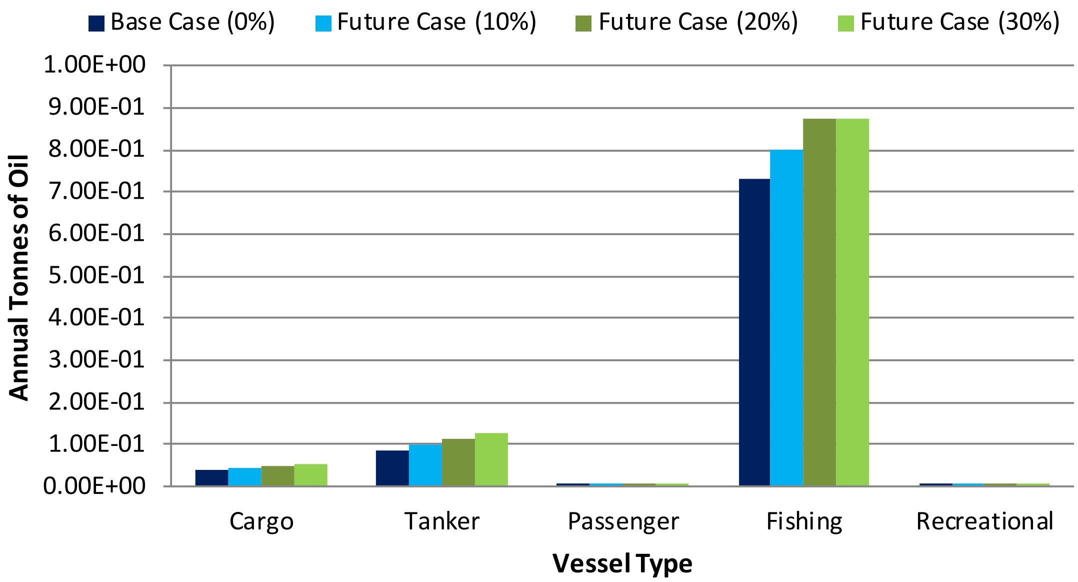

Figure E.20 Estimated Change in Pollution by Vessel Type

916. The annual oil spill results are dominated by fishing vessels due to their high associated annual collision and allision frequency. The second greatest contributor was tankers, reflecting the greater oil spill volume per incident associated with tankers.

E.4.3 Significance of Increase in Pollution Risk

917. To assess the significance of the increased pollution risk from vessels caused by VE, historical oil spill data for the UK has been used as a benchmark.

918. From the MEHRAs research, the annual average tonnes of oil spilled in UK waters due to maritime incidents in the 10-year period from 1989 to 1998 was 16,111. This is based upon 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 99% of the total while fishing vessel incidents accounted for less than 1%.

919. The overall increase in pollution estimated due to VE of 0.86 tonnes for the base case represents a 0.005% increase compared to the historical average pollution quantities from maritime incidents in UK waters. This may also be conservative given the potential for future changes towards less polluting vessel fuels.

E.5 Conclusion

920. This appendix has quantitively assessed the fatality and pollution risk associated with VE in the event of a collision or allision incident occurring. The assessment indicates that the fatality and pollution risk associated with fishing vessels is greatest.

921. Overall, the impact of VE on people and the environment is relatively low compared to the existing background risk levels in UK waters. However, this is the localised impact of a single offshore wind farm development and there will be additional maritime risks associated with other offshore wind farm developments in the southern North Sea and the UK as a whole.

922. Discussion of relevant mitigation measures and monitoring is provided in Section 21 of the NRA.

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