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APPENDIX BB

Navigation Safety Risk Assessment

Prepared for

Beacon Wind LLC

Photo credit: Matt Goldsmith, Equinor

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Beacon Wind Offshore Wind Project Navigation Safety Risk Assessment

Prepared by	Anatec Limited
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01	January 19, 2022	Revised Draft following Client Comments.
02	February 14, 2022	Final Updates.
03	February 16, 2022	Final First Submission Version.
04	April 27, 2022	Addition of BW2 cables.
05	June 23, 2022	Further Internal Updates.
06	November 29, 2022	PDE Updates and USCG Comments.
07	May 29, 2023	Further Updates

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Abbreviations Table

Abbreviation	Definition
°	Degree
µPa	Micro Pascal
ACPARS	Atlantic Coast Port Access Route Study
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ARPA	Automatic Radar Plotting Aid
AtoN	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BOEM	Bureau of Ocean Energy Management
BTS	Bureau of Transportation Statistics
CFR	Code of Federal Regulations
COLREGs	Convention on the International Regulations for Preventing Collisions at Sea
COMDTINST	Commandant Instruction
COP	Construction and Operations Plan
CT	Connecticut
CTV	Crew Transfer Vessel
dB	Decibel
DF	Direction Finding
DHS	Department of Homeland Security
DOD	Department of Defense
F	Fahrenheit
FAA	Federal Aviation Authority
FEIS	Final Environmental Impact Statement
FSA	Formal Safety Assessment
Ft	Foot
GT	Gross Ton
GPS	Global Positioning System

Abbreviation	Definition
GRP	Glass Reinforced Plastic
GVSU	Grand Valley State University
HAT	Highest Astronomical Tide
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IBTrACS	International Best Track Archive for Climate Stewardship
IEM	Iowa Environmental Mesonet
IMO	International Maritime Organization
IPS	Intermediate Peripheral Structure
ITAP	Institute für technische und angewandte Physik
Km	Kilometer
KHz	Kilohertz
LiDAR	Light Detection and Ranging
LNM	Local Notice to Mariners
m	Meter
m/s	Meters per Second
MA	Massachusetts
MAIB	Marine Accident Investigation Branch
MARIPARS	Port Access Route Study: The Areas Offshore of Massachusetts and Rhode Island
MEC	Munitions and Explosives of Concern
Metocean	Meteorological and Oceanic
MGN	Marine Guidance Note
MHWS	Mean High Water Springs
MLLW	Mean Lower Low Water
MMSI	Mobile Maritime Service Identity
MSL	Mean Sea Level
MW	Megawatt

Abbreviation	Definition
NAD83	North American Datum of 1983
NAVTEX	Navigational Telex
NC	North Carolina
NCDC	National Climactic Data Center
NEODP	Northeast Ocean Data Portal
NJ	New Jersey
nm	Nautical Mile
NNYBPARS	Northern New York Bight Port Access Study
NOAA	National Oceanic and Atmospheric Administration
NSRA	Navigation Safety Risk Assessment
NUC	Not Under Command
NVIC	Navigation and Vessel Inspection Circular
NY	New York
OCM	Office for Coastal Management
OPAREA	Operating Area
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PANYNJ	Port Authority of New York and New Jersey
PARS	Port Access Route Studies
PATON	Private Aid to Navigation
PDE	Project Design Envelope
PIANC	World Association for Waterborne Transport Infrastructure
PLA	Port of London Authority
PLL	Potential Loss of Life
RBDM	Risk Based Decision Making
REZ	Renewable Energy Zone
RI	Rhode Island
RNA	Regulated Navigation Area
ROD	Record of Decision
RYA	Royal Yachting Association

Abbreviation	Definition
SAR	Search and Rescue
SMA	Seasonal Management Area
SMS	Safety Management System
SONAR	Sound Navigation Ranging System
SPS	Significant Peripheral Structure
SSHWS	Saffir-Simpson Hurricane Wind Scale
TSS	Traffic Separation Scheme
U.K.	United Kingdom
UKHO	United Kingdom Hydrographic Office
U.S.	United States
USCG	United States Coast Guard
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMS	Vessel Monitoring System
VTS	Vessel Traffic Service
WEA	Wind Energy Area

Glossary of Terms

Abbreviation	Definition
Allision	Contact between a moving and stationary object.
As Low As Reasonably Practicable (ALARP)	Reduction of residual risk, post assessment, as far as reasonably practicable with consideration for people, environment, business and property. For a risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.
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 are required to carry AIS.
Base case	Assessment of risk based upon current vessel traffic levels and types.

Abbreviation	Definition
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	Contact between two moving objects.
COLLRISK	Anatec's industry leading collision and allision risk modelling software, recommended as best practice by the International Association of Oil & Gas Producers.
Commercial fishing vessel	A fishing vessel engaged in commercial fishing activity, where that activity forms the primary commercial means of those vessels.
Encounter	An instance of multiple vessels (i.e. two or more) being in close proximity within a short time period. Anatec's quantitative models assume a definition of multiple vessels being within one nautical mile within the same minute.
Submarine Export Cable Route Study Area	A 1 nm (1.9 km) area applied around submarine export cable route in order to ensure that focus is placed upon the vessel traffic relevant to the offshore export cables.
Future case	Assessment of risk based upon the predicted growth of future vessel traffic levels and types.
In isolation	Assessment of a development on a standalone basis without (or before) considering other developments within the region.
International Maritime Organization (IMO) routing measure	An internationally recognized shipping route established by IMO.
Main route	Defined transit routes (mean position) of commercial vessels identified within the region.
Marine Coordinator	An individual responsible for monitoring of the Project, including third party vessel and Project vessel traffic within the array. The Marine Coordinator is also responsible for monitoring weather conditions and controlling Project personnel accessing offshore wind structures.
Marine Guidance Note (MGN)	A system of guidance notes issued by the U.K. Maritime and Coastguard Agency which provide significant advice relating to the improvement of the safety of shipping and of life at sea, and to present or minimize pollution from shipping.

Abbreviation	Definition
Maximum design scenario	The set of parameters under realistic consideration (based on the Project Design Envelope) that would result in the maximum impact to shipping and navigation users.
Mean Lower Low Water (MLLW)	The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch (a 19-year period adopted by the National Ocean Service).
Navigation Safety Risk Assessment (NSRA)	A document which assesses the overall impact to shipping and navigation and Search and Rescue of a proposed Offshore Renewable Energy Installation based upon formal risk assessment (also known as a Navigation Risk Assessment (NRA).
Not Under Command (NUC)	Under Part A of the International Regulations for Preventing Collisions at Sea, the term 'vessel not under command' refers to a vessel which through some exceptional circumstance is unable to maneuver as required by these rules and is therefore unable to keep out of the way of another vessel.
Offshore Renewable Energy Installation (OREI)	A facility placed in the navigable waters of the United States that creates electricity by using sources other than oil or gas.
Project Design Envelope (PDE)	A series of maximum extents of a development for which the significant effects are established. The detailed design of the Project can then vary within this 'envelope' without rendering the assessment undertaken inadequate.
Radio Detection and Ranging (Radar)	An object detection system which uses radio waves to determine the range, altitude, direction or speed of objects.
Risk Based Decision Making (RBDM)	An iterative process within which risks are identified, assessed and managed with communication with stakeholders undertaken throughout.
Safety zone	Generally, a safety zone is an area of water and/or land designated for a certain time for safety or environmental purposes. To protect human safety or the environment, a safety zone will limit public access to the area.
Study Area	A 10 nautical mile area applied around the Lease Area in order to ensure that focus is placed upon the vessel traffic relevant to the proposed area of development.
Traffic Separation Scheme (TSS)	Area where vessel traffic is regulated by Rule 10 of the International Regulations for Preventing Collisions at Sea and traffic direction is dictated.

Abbreviation	Definition
Vessel Traffic Services (VTS)	Shore-side systems which range from the provision of simple information messages to vessels, such as the position of other traffic or meteorological hazard warnings, to extensive management of traffic within a port or waterway.

Executive Summary

Beacon Wind proposes to develop the entire Bureau of Ocean Energy Management (BOEM) OCS-A 0520 Lease Area with up to two individual wind farms, known as Beacon Wind 1 (BW1) and Beacon Wind 2 (BW2) (collectively referred to hereafter as the Project). The Project is a joint venture between Equinor and BP (hereby referred to as 'the Developer'). This Navigation Safety Risk Assessment (NSRA) includes an assessment of the major hazards associated with the development of the Project in relation to navigation and Search and Rescue (SAR).

The Project is located within BOEM offshore Lease Area OCS-A 0520 (hereby referred to as the 'Lease Area'). Aspects of the Project relevant to shipping and navigation have been described and the maximum design scenario from a shipping and navigation perspective has been outlined. The main guidance considered throughout is Navigation and Vessel Inspection Circular (NVIC) No 01-19 (United States Coast Guard (USCG 2019) and Commandant Instruction (COMDTINST) 16003.2B (USCG 2019).

To ensure the impact assessment is fully informed, a range of relevant information has been gathered and processed and is presented in this NSRA. This includes waterway, maritime traffic/vessel, and facility characteristics, as well as key responses received during consultation with stakeholders. Lessons learned from trials and existing offshore wind farms have been considered, and collision, allision and grounding risk modelling has been undertaken in order to provide assessment of the relevant shipping and navigation users and impacts on both a qualitative and (where appropriate) quantitative basis. Historical USCG incident response data has also been considered to determine baseline incident rates and resources.

Vessel traffic data has been collected over a 12 month period, with Automatic Identification System (AIS) data collected from both terrestrial and satellite receivers. This has been used to establish the existing maritime traffic behavior and patterns within and surrounding the Project. The majority of traffic in the area was observed to be comprised of fishing vessels (primarily transiting). A total of four main routes were identified, with a maximum of three expected to deviate as a result of the Project, noting that other low use routing and marine activity has also been considered. An average of between two and three unique vessels per day were recorded as intersecting the Lease Area.

A Formal Safety Assessment (FSA) undertaken as part of the NSRA process for the Project in isolation identified that deviation and allision impacts to fishing vessels, impacts to anchored vessels, and port access impacts associated with cable installation were **Tolerable with Mitigation**. All other impacts were considered **Broadly Acceptable.** On a cumulative basis, deviation and allision impacts were assessed to be **Tolerable with Mitigation**, with all other impacts assessed to be **Broadly Acceptable.**

All impacts are ALARP assuming consultation and liaison with PANYNJ, USCG, and the U.S. Army Corp of Engineers (USACE) in relation to the submarine export cable route, and targeted promulgation of information to the fishing industry in relation to the Project in general.

1 Introduction

1.1 Guidance

This NSRA for the Project has been undertaken to comply with the requirements set out in the main guidance documents as outlined in Section 1.1.1. However, where appropriate, the other supplementary references outlined in Section 1.1.2 have also been taken into consideration.

1.1.1 Main Guidance Documents

1.1.1.1 Navigation and Vessel Inspection Circular No. 01-19

The NVIC No. 01-19 (USCG 2019) forms the primary guidance document in relation to this NSRA. The NVIC sets out the guidance relevant to the factors which the USCG will consider when reviewing an application for a permit to build and operate an Offshore Renewable Energy Installation (OREI) within United States (US) navigable waters.

To ensure the NSRA fulfils all requirements as set out within the NVIC, a version of the checklist for NSRA development and review that is incorporated into the NVIC (Enclosure 6) has been completed and is provided in Attachment A.

1.1.1.2 Commandant Instruction 16003.2B

The Commandant Instruction (COMDTINST) 16003.2B (USCG 2019) sets out USCG policy, roles, and responsibilities in relation to ongoing and future marine planning and operations. The document outlines the methodology and topics which should be covered in a formal risk assessment of a development, sets out guidelines for marine planning and provides the methodology by which traffic routing measures should be determined.

1.1.2 Other Guidance Documents

Although NVIC No. 01-19 is the primary guidance document considered in this NSRA (see Section 1.1.1.1), it does note that "*guidelines from other recognized sources such as governmental agencies or classification societies that may be applicable*" should also be considered and referenced. Therefore, other guidance documents considered in this NSRA on this basis are outlined in Sections 1.1.2.1 to 1.1.2.5.

1.1.2.1 Information Guidelines for a Renewable Energy Construction and Operations Plan

The Information Guidelines for a Renewable Energy Construction and Operations Plan (COP) (Bureau of Ocean Energy Management (BOEM) 2020) provides details of the information that should be included within any COP. This includes requirements that are of relevance to the NSRA, including survey requirements and other project-specific information. It also provides details as to the need for an NSRA, and how the general NSRA process should be conducted.

The NSRA will be reviewed by the USCG in line with the contents of NVIC No. 01-19 (USCG 2019).

1.1.2.2 Port Access Route Studies

Relevant Port Access Route Studies (PARS) have been considered where appropriate within this NSRA, taking the location of the Lease Area into account. These are as follows:

- *Port Access Route Study: The Areas Offshore of Massachusetts and Rhode Island (MARIPARS) Final Report* (USCG 2020):
  - Objective 1: Determine what, if any, navigational safety concerns exist with vessel transits in the MARIPARS study area;
  - Objective 2: Whether to recommend changes to enhance navigational safety by examining existing shipping routes and waterway uses as any or all of the lease areas within the MA/RI WEA are partially or fully developed as wind farms; and
  - Objective 3: To evaluate the need for establishing vessel routing measures;
- *Atlantic Coast Port Access Route Study (ACPARS) Final Report* (USCG 2016) and *Advance Notice of Proposed Rulemaking: ACPARS* (USCG 2020):
  - Objective 1: Determine whether the USCG should initiate actions to modify or create safety fairways, Traffic Separation Scheme (TSS) lanes or other routing measures;
  - Objective 2: Provide data, tools and/or methodology to assist in future determinations of waterways suitable for proposed projects; and
  - Objective 3: Develop, in the near term, AIS products and provide other support necessary to assist USCG Districts with all emerging coastal and offshore energy projects.
- *Northern New York Bight Port Access Route Study (NNYBPARS) Final Report* (USCG, 2021):
  - *To analyze whether USCG should revise existing regulations to improve navigation safety in the Northern New York Bight.*

1.1.2.3 Lighting and Marking

Relevant and up to date guidance associated with lighting and marking guidance of offshore wind farms has been considered throughout the NSRA process, noting consultation with regards to lighting and marking will be ongoing with the relevant stakeholders:

- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) O-139[1] Recommendation on the Marking of Man-Made Offshore Structures (IALA 2013)[2];

[1] Noted that the IALA O-139 guidance was updated in December 2021 to R139/G1162 (IALA, 2021). The updates are under review and liaison will be ongoing with USCG and BOEM in terms of any applicable updates to relevant U.S. lighting and marking guidance.
[2] Note USCG is a member of IALA.

- Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021);
- USCG D1 LNM guidance on Lighting and Marking (2020); and
- USCG Aids to Navigation Manual (COMDTINST Manual (CIM 16500.7A) 2015);
- Federal Aviation Authority (FAA) Advisory Circular 70/7460-1M Chapter 13 - Marking and Lighting Wind Turbines (FAA 2020).

1.1.2.4 Revised Guidelines for Formal Safety Assessment for Use in the Rule-Making Process

The Revised Guidelines for Formal Safety Assessment (FSA) for Use in the Rule-Making Process (International Maritime Organization (IMO) 2018) has been adapted for the risk assessment process since there is no defined methodology provided in NVIC No. 01-19. The FSA process is iterative in nature and closely follows the RBDM basis detailed in NVIC No. 01-19. It is an internationally recognized standard and considered best practice for marine risk assessment.

1.1.2.5 Marine Guidance Note 654

Marine Guidance Note (MGN) 654 (Merchant & Fishing) Safety of Navigation Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Responses (Maritime and Coastguard Agency [MCA] 2021) is the key guidance used for United Kingdom (U.K.) offshore wind farms. The U.K. is currently the world's leading nation for offshore wind, both in terms of total megawatt (MW) capacity and number of operational wind turbines (WindEurope 2020).

Given the relative infancy of the offshore wind industry in the U.S., MGN 654 is considered a useful resource, noting that both it[3] and the MCA's closely related *Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (OREI)* are explicitly referenced in NVIC No. 01-19 and described as a "*well-regarded source*", noting that the methodology forms an annex to MGN 654.

1.2 Consultees and Stakeholders

A number of key marine and navigation stakeholders have been consulted during the NSRA process. Further details of consultation undertaken is provided in Section 3, noting key stakeholders include USCG and BOEM.

1.3 Lessons Learned

There is considerable benefit in considering the lessons learned within the offshore industry and specifically the offshore wind industry. Given the U.K.'s status as the global leader in offshore wind production, a number of U.K. based research papers and data sources have been considered on a supplementary basis, in addition to the available U.S. sources. These

[3] NVIC 01-19 references previous guidance version MGN 543. MGN 654 superseded MGN 543 in 2021.

papers and data sources are clearly referenced where appropriate throughout this NSRA, and are as follows:

- *Sharing the Wind – Recreational Boating in the Offshore Wind Strategic Areas* (RYA & Cruising Association 2004);
- *Results of the Electromagnetic Investigations* (MCA & QinetiQ 2004);
- *Offshore Wind and Marine Energy Health and Safety Guidelines* (RenewableUK 2014);
- *Offshore Wind Farm Helicopter Search and Rescue Trials Undertaken at the North Hoyle Wind Farm* (MCA 2005);
- *Interference to Radar Imagery from Offshore Wind Farms (Port of London Authority* (PLA) 2005);
- *Strategic Assessment of Impacts on Navigation of Shipping and Related Effects on Other Marine Activities Arising from the Development of Offshore Wind Farms in the UK Renewable Energy Zone (REZ)* (Anatec & The Crown Estate 2012); and
- *G+ Global Offshore Wind Health & Safety Organisation 2019 Incident Data Report* (G+ 2020).

1.4 MA/RI WEA Developments

During consultation with BOEM and the USCG (see Section 3), it was recommended that due consideration is given to submitted and reviewed NSRAs for other MA/RI WEA developments and any subsequent assessment undertaken by BOEM. On this basis the following documents have been considered during the Project NSRA process:

- Revised Navigational Risk Assessment prepared for Vineyard Wind (Clarendon Hill Consulting 2018);
- Mayflower Wind NSRA (Mayflower Wind 2021);
- Revolution Wind NSRA (Revolution Wind 2020);
- South Fork Wind Farm NSRA (Deepwater Wind South Fork 2018);
- South Fork Wind Farm and South Fork Export Cable Project Final Environmental Impact Statement (FEIS) (BOEM 2021) and Record of Decision (ROD) (BOEM, 2021); and
- Vineyard Wind 1 Offshore Wind Energy Project FEIS (BOEM 2021) and ROD (BOEM, 2021).

1.5 Data Sources

This subsection summarizes the main data sources used to assess the existing environment in terms of waterway characteristics (Section 5) and baseline shipping activities (Section 5.2) relative to the Beacon Wind Project. These are as follows:

- Vessel traffic data:

- AIS data recorded via satellite receivers between January and December 2019 (noting as per Section 3.1 the use of pre COVID data has been agreed with USCG and BOEM);
- AIS data recorded via coastal receivers between January and December 2019 (noting as per Section 3.1 the use of pre COVID data has been agreed with USCG and BOEM); and
- Visual observation data collected by the Project during 2019;

- Fishing specific data:
  - VMS Fishing Density recorded between 2015 and 2016 – Northeast Ocean Data Portal (Northeast Ocean Data 2018);
  - VMS Transit Counts recorded during 2019 – Northeast Ocean Data Portal (Northeast Ocean Data 2020); and
  - VMS Polar Histograms from January 2014 to August 2019 (BOEM 2021);
- Maritime incident data:
  - USCG Marine Information for Safety and Law Enforcement database (2011 to 2020) (USCG 2021); and
  - Marine Accident Investigation Branch collision and allision incident data (2000 to 2019) (MAIB 2020);
- Navigational features:
  - Code of Federal Regulations (CFR) (Office of the Federal Register 2021):
    - Title 30 – Mineral Resources;
    - Title 33 – Navigation and Navigable Waters;
    - Title 40 – Protection of Environment; and
    - Title 46 – Shipping;
  - NOAA Nautical Charts 12300, 12339, 12363, 13003, 13200 (accessed November 2021);
  - United States Coast Pilot 2 – 50th Edition (NOAA 2021);
  - UKHO Pilot NP68 (UKHO 2016);
  - Aids to Navigation (Office for Coastal Management [OCM] 2021);
  - Anchorage Areas (OCM 2021);
  - Artificial Reefs (OCM 2021);
  - Danger Zones and Restricted Areas (OCM 2021);
  - Military Operating Area Boundaries: Atlantic/Gulf of Mexico (OCM 2021);
  - Military Submarine Transit Lanes: Atlantic/Gulf of Mexico (OCM 2021);
  - Ocean Disposal Sites (OCM 2021);
  - Pilot Boarding Areas (OCM 2021);
  - Pilot Boarding Stations (OCM 2021);
  - Regulated Navigation Areas (OCM 2021);
  - Submarine Cables (OCM 2021);
  - Shipping Fairways, Lanes, and Zones for U.S. waters (Office of Coast Survey [OCS] 2021); and
  - Automated Wreck and Obstruction Information System data (OCS 2021);

- Meteorological and Oceanographic (Metocean) data;
  - Nantucket Memorial Airport Weather Station data (Iowa Environmental Mesonet of Iowa State University 2021);
  - Wave height data collected from the Global Reanalysis of Ocean Waves U.S. East Coast dataset – OceanWeather (Equinor 2020);
  - Tidal stream data taken from UKHO charts 2456, 2860 and 2890 (UKHO 2021);
  - International Best Track Archive for Climate Stewardship (IBTrACS) Project, Version 4 (NOAA National Centers for Environmental Information 2018) [accessed December 2021]; and
  - Tropical Cyclone Wind Exposure for the North Atlantic 1900-2016 (Office for Coastal Management 2021).

2 Navigation Safety Risk Assessment Methodology

This section details the methodology used within this NSRA to assess the impacts of the Project both in isolation and cumulatively.

2.1 Methodology for Assessment of the Project in Isolation

Using a RBDM approach, this NSRA identifies the impacts to shipping and navigation users that may arise from the construction, operation and maintenance, and decommissioning phases of the Project. As the decommissioning phase will represent a similar scenario, for shipping and navigation, to that of the construction phase (e.g., increased Project vessels on-site, presence of partial structures) but in reverse, impacts have only been assessed for the construction, and operation and maintenance phases. However, a separate NSRA specific to the decommissioning phase of the Project may be produced prior to the commencement of the decommissioning phase to reflect any changes in the baseline conditions that may have occurred, and to provide an up to date understanding of the decommissioning requirements.

The NSRA primarily addresses the safety-based impacts to third parties, rather than the impacts of the Project itself. Shipping and navigation users which may be affected by the Project and therefore considered within the impact assessment (introduced in Section 13) have been identified and assessed on this basis. Impacts associated with Project vessels will be mitigated by the processes implemented to control transits to/from the Lease Area and have been referenced where appropriate.

Impacts are identified via the results of the baseline characteristics assessment and consideration of the outputs from the consultation process.

It is noted that impacts relating to fishing vessels engaged in fishing activities have not been considered within this NSRA, but rather are assessed as part of the commercial fisheries assessment (see Section 8.8 of the COP).

2.1.1 Impact Significance

After identification, those effects for which the sensitivity level is determined to be low (i.e., there is no associated impact) are screened out of the impact assessment as part of the NSRA process. Impacts which carry some degree of sensitivity are then considered further in the impact assessment (see Section 13).

The impact assessment considers the following NSRA elements and, where applicable, a reference for the source of information will be included:

- Baseline data and statistical analysis;
- Expert opinion;
- Level of stakeholder concerns and feedback;
- Number of transits of a specific vessel and/or type;
- Magnitude of any vessel deviations;

- Results of collision, allision, and grounding risk modelling; and
- Lessons learned from existing offshore wind farm developments (primarily U.K. based).

The impact assessment takes account of embedded mitigations which will be implemented for the Project (see Section 22), and qualitatively determines the significance of each individual impact reviewed as either Broadly Acceptable, Tolerable, or Unacceptable.

Table 2.1 presents the definitions of these significance rankings, noting that the definitions are based upon the IMO's FSA process for the qualification of ALARP (See Section 2.1.2). This terminology is use throughout the NSRA to identify where impacts are considered ALARP, or weather further mitigation is required.

Table 2.1 Significance Definitions

Significance	Definition
Broadly Acceptable	A level of risk that is managed by standard mitigations in place for offshore wind energy projects. No further assessment is required.
Tolerable or Tolerable with Mitigation (either modifications, control measures, or monitoring)	Tolerable only with further controls in place i.e., additional mitigation other than those that are considered standard for offshore wind energy projects. Further assessment has identified that risk is As Low As Reasonably practicable (ALARP) with this mitigation in place; and therefore, the residual impact is Broadly Acceptable. The mitigations must be secured; if they are not secured then the impact remains as Tolerable with Mitigation.
Unacceptable	Risks cannot be managed through mitigation (modification, control measures, or monitoring) and the Project requires changes prior to res-assessment to bring the impact into ALARP parameters.

2.1.2 As Low As Reasonably Practicable

The ALARP principle is considered in the IMO's FSA process which is illustrated in Figure 2.1, which indicates that there is a risk level above the upper threshold of what is considered "tolerable", and therefore the significance of the risk is deemed unacceptable. This level of risk "cannot be justified and must be reduced, irrespectively of costs."

In contrast, Figure 2.1 also indicates there is a risk level below which the risk is negligible and therefore the significance of the risk is deemed broadly acceptable. For this level of risk there is "no risk reduction required."

For risk levels between the two thresholds – the ALARP risk region – the level of risk "should be reduced to meet economic responsibility" and when this has been achieved is considered to be acceptable.

Figure 2.1 ALARP Principle (IMO 2018)

2.1.3 Modelling Software

The risks associated with the Project have been assessed on a qualitative basis (see Section 13 where the impact assessment is introduced). However, the qualitative assessment has been informed via a comprehensive quantitative assessment undertaken using Anatec's suite of collision and allision risk models. These models have each been used in many successful offshore wind farm applications within the U.K., and are refined and improved on a continuous basis. Key models within this suite include:

- Encounters – identifies instances of vessel encounters within an AIS dataset;
- COLLRISK vessel to vessel collision – estimates the frequency at which two passing vessels (head on, crossing, or overtaking encounters) may collide within a pre-defined area;
- COLLRISK vessel to structure allision (powered) – estimates the frequency at which a passing vessel may allide with a wind farm structure under power;
- COLLRISK vessel to structure allision (drifting) – estimates the frequency at which a passing vessel may allide with a wind farm structure while Not Under Command (NUC); and

- COLLRISK fishing vessel to structure allision – estimates the frequency at which a fishing vessel either passing or operating internally within an offshore wind farm may allide with a wind farm structure.

Further details pertaining to the inputs and methodology of the models used are provided in the relevant subsections within Section 11.

2.2 Methodology for Assessment for Cumulative Effects

2.2.1 Cumulative Tiering

The identified impacts (identified as per the methodology outlined in Section 2.1) are also assessed for cumulative effects with the inclusion of other planned offshore wind farms in the region. Given the varying development status of current U.S. renewables developments, a tiered approach to cumulative assessment has been undertaken, which splits developments into tiers depending on:

- Development status[4];
- Level to which they are anticipated to cumulatively impact relevant users;
- Proximity to the Project; and
- Data confidence levels.

The tiers are summarized in Table 2.2. The screening of cumulative developments is provided in Section 10 prior to the cumulative effect assessment in Section 21.

Precedent is given to the distance from the Lease Area when determining the relevant tier of a development, e.g., a development greater than 150 nautical miles (nm) (278 kilometers [km]) from the Lease Area is screened out (Tier 4) irrespective of the development status, level to which they are anticipated to cumulatively impact relevant users and data confidence level.

Table 2.2 Cumulative Tiering

Tier	Status of Lease Area	Status of Development	Description (Specific to Shipping and Navigation)	Data Confidence Level	Proposed Assessment within NSRA
1	Active	Approved, Submitted or not submitted	▪ Within 100 nm (185 km) of the Lease Area; **and** ▪ May impact a route which transits through or within 1 nm (1.9 km) of the Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area.	High or medium	Quantitative cumulative re-routing of main routes.

[4] At the time of the NSRA being undertaken.

Tier	Status of Lease Area	Status of Development	Description (Specific to Shipping and Navigation)	Data Confidence Level	Proposed Assessment within NSRA
2	Active	Submitted or not submitted	▪ Within 150 nm (278 km) of the Lease Area, **and** ▪ May impact a route which transits through or within 1 nm (1.9 km) of the Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area.	High or medium	Qualitative cumulative re-routing of main routes.
3	Identified but not yet auctioned	Not submitted	▪ Within 150 nm (278 km) of the Lease Area; **and** ▪ May impact a route which transits through or within 1 nm (1.9 km) of the Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area.	Low	Qualitative assumptions of routing only given low confidence in future definition of planning area.
4	Any	Any	▪ Greater than 150 nm (278 km) from the Lease Area; or ▪ Within 150 nm (278 km) of the Lease Area but does not impact a route which transits through or within 1 nm (1.9 km) of the Lease Area and does not interact with traffic that may be directly displaced by the Lease Area.	Any	Screened out.

2.2.2 Cumulative Scenarios

As per Section 2.2.1, quantitative assessment of rerouting is being undertaken for Tier 1 developments. Based on consultation with BOEM and the USCG (see Section 3), and noting that Vineyard Wind 1 and South Fork both have public RODs (see Section 1.4), two cumulative scenarios have been considered within the NSRA for the purposes of the cumulative routing assessment undertaken in Section 12:

- Scenario 1: Project plus full build out of all other MA/RI WEA Lease Areas; and
- Scenario 2: Project plus Vineyard Wind 1 and South Fork only.

The output of the cumulative routing assessment has been used to assess a worst case within the assessment of cumulative impacts (see Section 21).

2.3 Consultation on Methodology

The proposed NSRA methodology was discussed with the USCG and BOEM in advance of commencement of the NSRA process (see Section 3). This included approach to marine traffic survey data collection and the overarching in isolation and cumulative methodologies.

2.4 Study Areas

2.4.1 Lease Area

A buffer of 10 nm (18.5 km) has been applied around the Beacon Wind Lease Area (hereby referred to as the Study Area'), as shown in Figure 2.2. The Study Area has been defined so that the focus is placed upon the vessel traffic of most relevance to the Lease Area in order to provide a comprehensive assessment of the vessel routing which could be impacted.

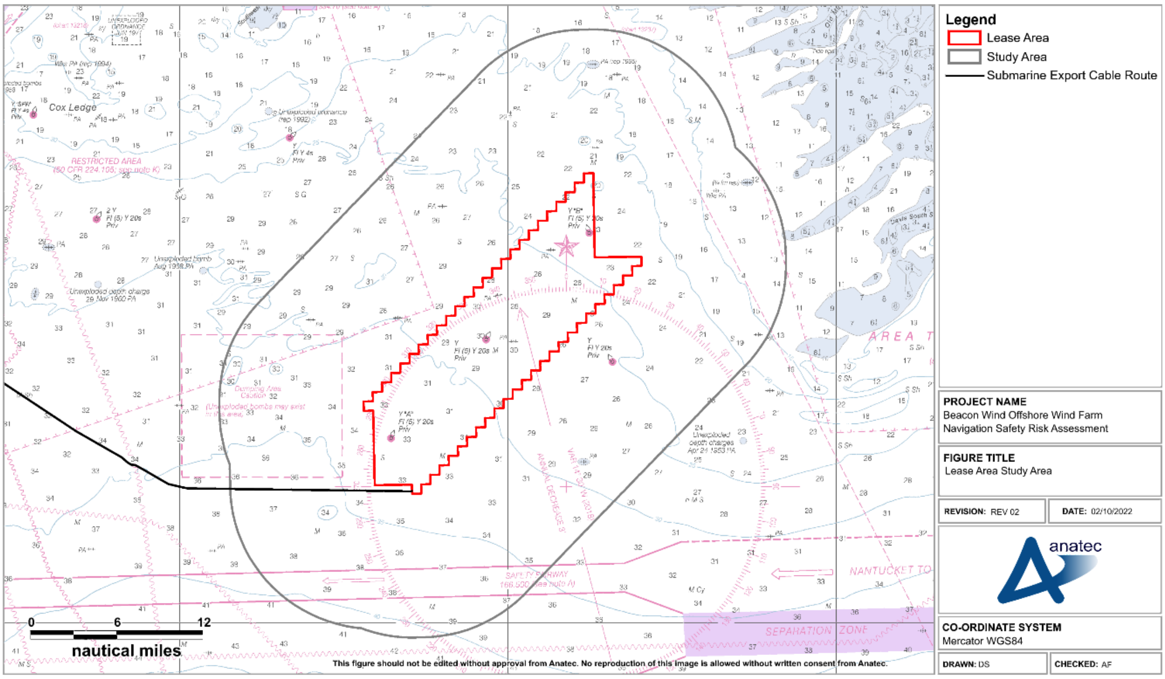

Figure 2.2 Study Area

2.4.2 Submarine Export Cable Route

A minimum[5] 1 nm (1.9 km) buffer has been applied around the submarine export cable route (hereby known as the 'Submarine Export Cable Route Study Area), as shown in Figure 2.3. The Submarine Export Cable Route Study Area has been defined to capture the relevant users and their movements and activities over and in proximity to the cables.

[5] Full 1 nm buffer based on a previous cable iteration. A variant has since been removed.

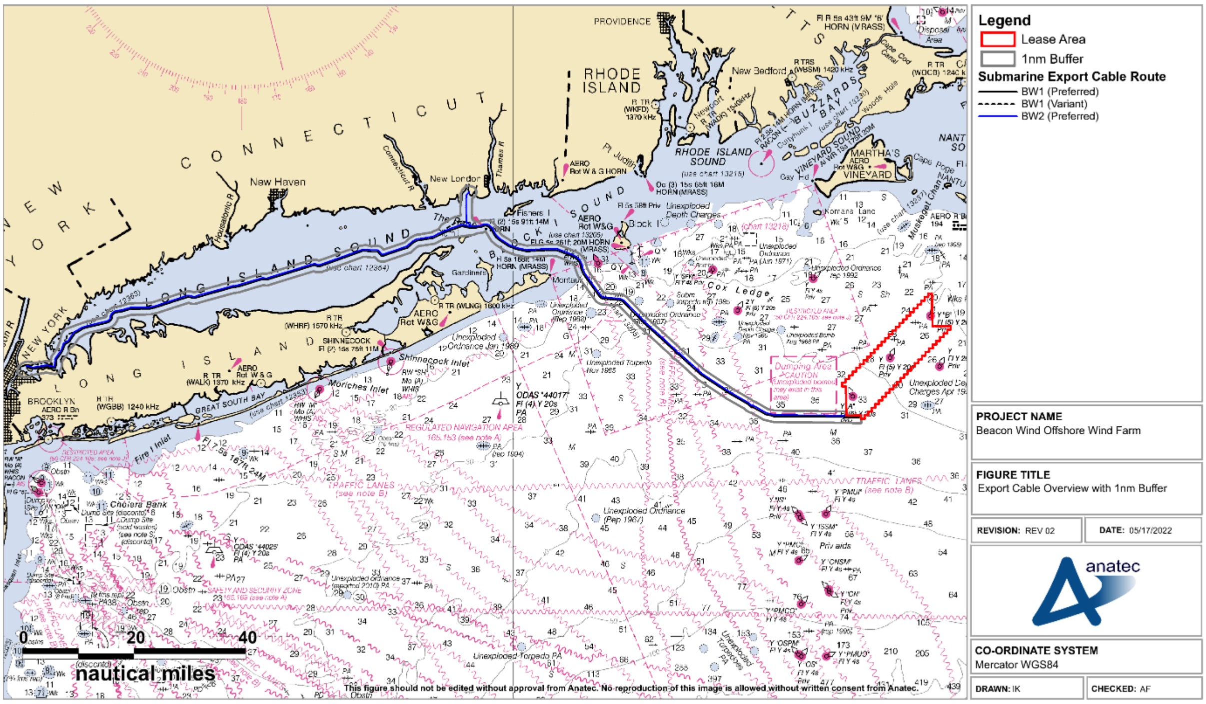

Figure 2.3 Submarine Export Cable Route Study Area

2.5 Assumptions

The shipping and navigation baseline and impact assessment has been undertaken conservatively (a realistic worst-case scenario), based upon the information available and responses received at the time of preparation. It has assessed a conservative scenario selected from within the Project Design Envelope (PDE), and on that basis whatever is constructed should still fall within the PDE and maximum design scenario that has been assessed. The maximum design scenario assessed within this NSRA is discussed in detail in Section 4.5.3.

It is assumed that any notable changes to the baseline (e.g., changes in traffic patterns) or PDE (such that the maximum design scenario may be affected) will be re-assessed and re-modelled if and when required.

Any key assumptions made are stated within the relevant sections of this NSRA. Similarly, any limitations associated with the referenced data sources are highlighted within the appropriate sections.

3 Consultation

3.1 NSRA Methodology

Meetings were held with the USCG and BOEM in May/June 2021 prior to commencement of the NSRA for the purposes of agreeing methodology and approach to marine traffic survey data collection. Key points agreed are detailed as follows:

- The Project has adopted the 1 × 1 nm (1.9 × 1.9 km) uniform grid approach recommended by the USCG under the MARIPARS final report (USCG 2020);
- The USCG and BOEM were content with the proposed study areas (see Section 2.4);
- The NSRA will follow NVIC 01-19 and COMDTINST 16003.2B as primary guidance (see Section 1.1.1) with other relevant documents including MGN 654 considered at a secondary level (see Section 1.1.2);
- Marine traffic data will primarily be based on 12 months of AIS data collected during 2019 to avoid any effects of the COVID-19 pandemic on shipping;
- The modelling will consider traffic increases of 10 percent and 20 percent;
- BOEM suggested on an indicative basis 40 percent of fishing vessels in the area may not be represented on AIS;
- The MARIPARS (USCG 2020) should be a key input;
- Findings of the Vineyard Wind and South Fork FEIS (noting RODs are now also publicized) should be considered, as should publicly available NSRAs submitted for other MA/RI WEA projects; and
- Cumulative assessment should consider the approved status of Vineyard Wind.

3.2 Additional Stakeholder Consultation

Extensive overarching consultation has been undertaken for the Project and this has fed into the NSRA where appropriate. Such consultation will be ongoing, with relevant input incorporated into NSRA updates as applicable. Consultees to date include representation from the fishing industry, recreational stakeholders and port authorities, with those deemed of relevance to the NSRA including:

- Atlantic Offshore Lobsterman's Association;
- Atlantis Anglers Association;
- Commercial Fisheries Center of RI;
- Department of Defense (DoD);
- Freeport Tuna club;
- Hudson River Safety, Navigation, and Operations Committee;
- Long Island Flyrodders
- Long Island Sound Lobstermen's Association;
- Massachusetts Lobstermen's Association;
- Montauk Boatmen and Captains Association;
- New Bedford Port Authority;

- New England Fisheries Management Council;
- NOAA Fisheries Greater Atlantic Region Fisheries Office;
- NOAA National Marine Fisheries Service;
- New York Harbor Ops;
- New York Vessel Traffic Services;
- Sector Long Island Sound Harbor Ops;
- Southern New England Lobstermen and Fishermen Association; and
- U.S. Army Corp of Engineers.

Specific elements of meetings deemed of relevance to the NSRA are detailed in Table 3.1, which includes reference to where the point raised have been addressed and/or incorporated into the NSRA.

Table 3.1: Summary of Consultation Meetings

Agencies/Organizations and Date	Topics Discussed	Where Addressed
RICRMC November 16, 2020	▪ Submarine export cable routing.	▪ Marine traffic assessment of submarine export cable route – Section 6.6; and ▪ Impact assessment – Sections 15 through 21.
USACE (New York and NE) January 21, 2021	▪ Submarine export cable routing; and ▪ Project vessel considerations along submarine export cable corridor.	▪ Marine traffic assessment of submarine export cable route – Section 6.6; and ▪ Impact assessment – Sections 15 through 21.
RICRMC January 27, 2021	▪ Submarine export cable routing.	▪ Marine traffic assessment of submarine export cable route – Section 6.6; and ▪ Impact assessment – Sections 15 through 21.
New York State (NYSDEC, NYDOS, NYSDPS, NYSERDA, NYSDOT) February 8, 2021	▪ Submarine export cable routing; ▪ Technical design; and ▪ Cable protection.	▪ Marine traffic assessment of submarine export cable route – Section 6.6; ▪ Impact assessment – Sections 15 through 21; and ▪ Project description including cable protection – Section 4.

Agencies/Organizations and Date	Topics Discussed	Where Addressed
New York Harbor Ops (Energy subcommittee); Tug Boat and Harbor Carriers of NY/NJ; Millers Launch March 16, 2021	▪ Baseline of waterway; ▪ Anchorage practices; and ▪ Submarine export Cable routing.	▪ Waterway characteristics – Section 5; ▪ Anchorage practices – Sections 5.1.3 and 6.6.3; ▪ Marine traffic assessment of submarine export cable route – Section 6.6; and ▪ Impact assessment – Sections 15 through 21.
New England Port Area Marine Group March 18, 2021	▪ Baseline knowledge of the waterway and its uses provided.	▪ Waterway characteristics – Section 5.
USCG VTS New York March 31, 2021	▪ Waterway baseline; ▪ Cable route; ▪ Data use; and ▪ Incident history.	▪ Waterway characteristics – Section 5; ▪ Marine traffic data – Section 6; and ▪ Incident assessment – Section 9.
DoD (US Navy) April 13, 2021	▪ Submarine export cable routing; and ▪ Understanding provided of relevant DoD areas.	▪ Marine traffic assessment of submarine export cable route – Section 6.6; ▪ Impact assessment – Sections 15 through 21; and ▪ DoD areas – Section 5.1.9.
SECLIS Harbor Ops (USCG (D1 and SECLIS), USACE, CT DEEP) April 28 and 29, 2021	▪ Anchorage use/planning; and ▪ PARS studies.	▪ Anchorage practices – Sections 5.1.3 and 6.6.3; and ▪ PARS – Section 6.7.5.
Hudson River Safety, Navigation, and Operations Committee (HRSNOC) April 29, 2021	General project updates.	▪ n/a
BOEM May 11, 2021	▪ See Section 3.1.	Relevant input applied as per Section 3.1.
USCG and BOEM May 28, 2021	▪ See Section 3.1.	Relevant input applied as per Section 3.1.
USCG (D1, LANTAREA, HQ) June 17, 2021	▪ See Section 3.1.	Relevant input applied as per Section 3.1.

Agencies/Organizations and Date	Topics Discussed	Where Addressed
New York M-TWG 2021-Present	Ongoing meetings, regular project updates provided and feedback discussed.	▪ n/a
Massachusetts FWG 2021-Present	Ongoing meetings, regular project updates provided and feedback discussed.	▪ n/a

4 Project Design Envelope

The section presents those aspects of the PDE deemed relevant to shipping and navigation, and the associated impact assessment. The following subsections outline the maximum extent of the Project parameters for which the impacts identified are assessed.

4.1 Project Boundaries

Figure 4.1 presents an overview of the location of the Lease Area, located approximately 20 nm (37 km) south of Martha's Vineyard, and covering an area of 123,474 acres (146 square nautical miles [nm^2]) or 500 square kilometers [km^2]) based on the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf for OCS-A 0520 (BOEM 2019). Charted water depths within the Lease Area range from approximately 120 ft (37 m) to 198 ft (60 m).

Figure 4.2 presents a detailed overview of the Lease Area with Table 4.1 presenting bounding coordinates for the Lease Area (given in North American Datum of 1983 [NAD83]).

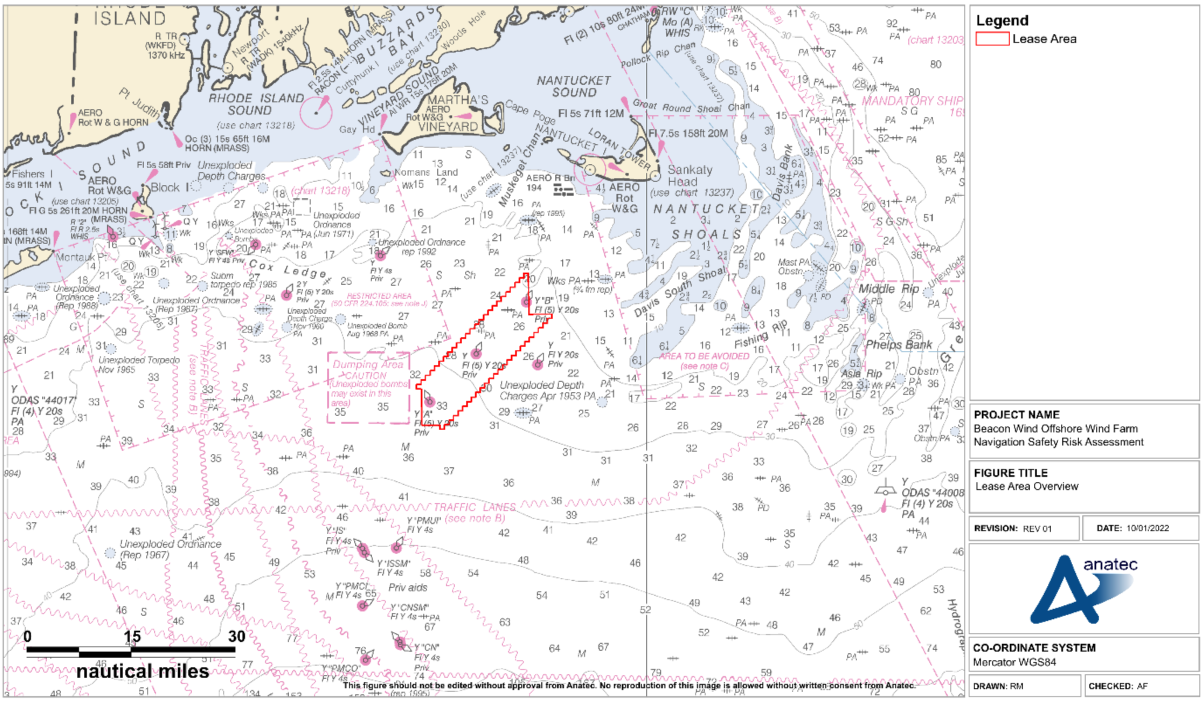

Figure 4.1 Lease Area Overview

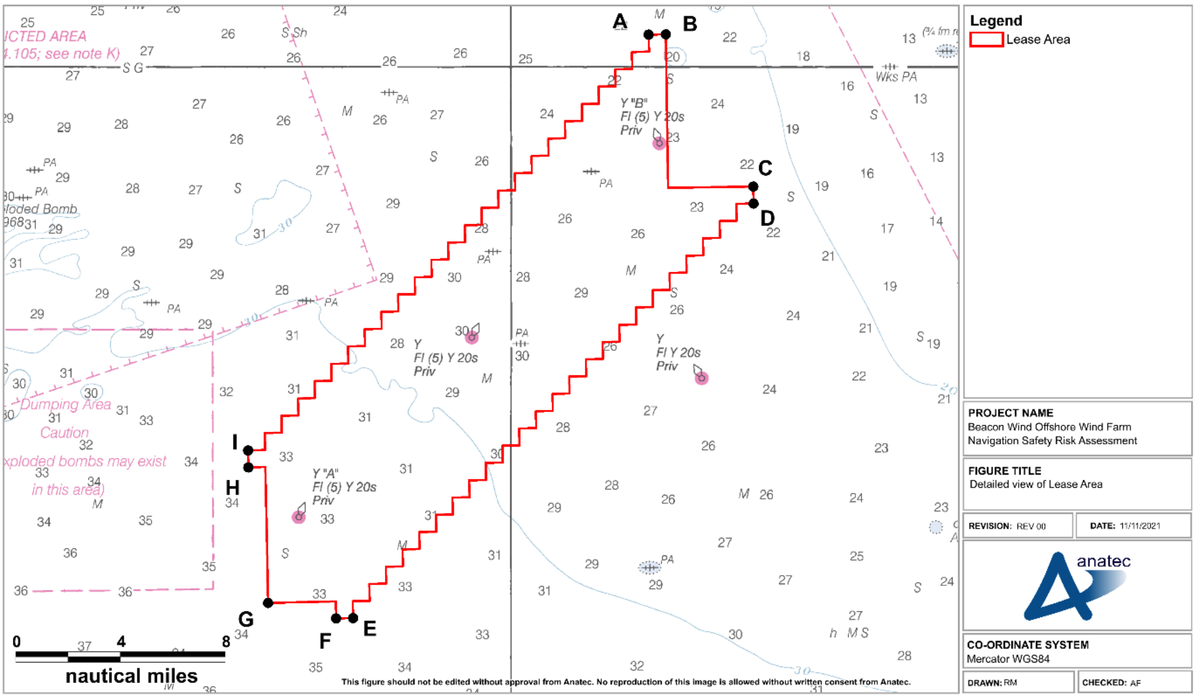

Figure 4.2 Detailed view of Lease Area

Table 4.1 Lease Area bounding coordinates (NAD83)

Vertex	Latitude	Longitude
A	41° 01’ 14.71” N	070° 23’ 04.01” W
B	41° 01’ 15.32” N	070° 22’ 12.64” W
C	40° 55’ 28.14” N	070° 17’ 49.94” W
D	40° 54’ 49.23” N	070° 17’ 48.18” W
E	40° 38’ 59.97” N	070° 37’ 56.05” W
F	40° 38’ 59.24” N	070° 38’ 47.13” W
G	40° 39’ 35.18” N	070° 42’ 12.42” W
H	40° 44’ 45.63” N	070° 43’ 11.50” W
I	40° 45’ 24.53” N	070° 43’ 12.50” W

4.2 Array Infrastructure

The layout assessed within the NSRA is based on the MARIPARS output (USCG 2020 - see Section 6.7.5.1), and contains the maximum possible number of structures, comprising 155 wind turbines and two offshore substation facilities maintaining a grid style layout, with a minimum center-to-center spacing of 1 × 1 nm (1.9 × 1.9 km) in north/south and east/west orientations. This allows for two primary lines of orientation through the Lease Area in north/south and east/west orientations. There is also secondary orientation in a north west/south east direction, with the relevant “corridors” being at least 0.6 nm (1.1 km) in width. This aligns with the MARIPARS USCG recommendations (see Section 6.7.5.1), noting that as per Section 3.1 the Developer has committed to a 1 × 1 nm (1.9 × 1.9 km) grid.

It is noted that an indicative structure labeling system has been pre-determined by the USCG for the MA/RI WEA projects. This is shown for the Project in Figure 4.4.

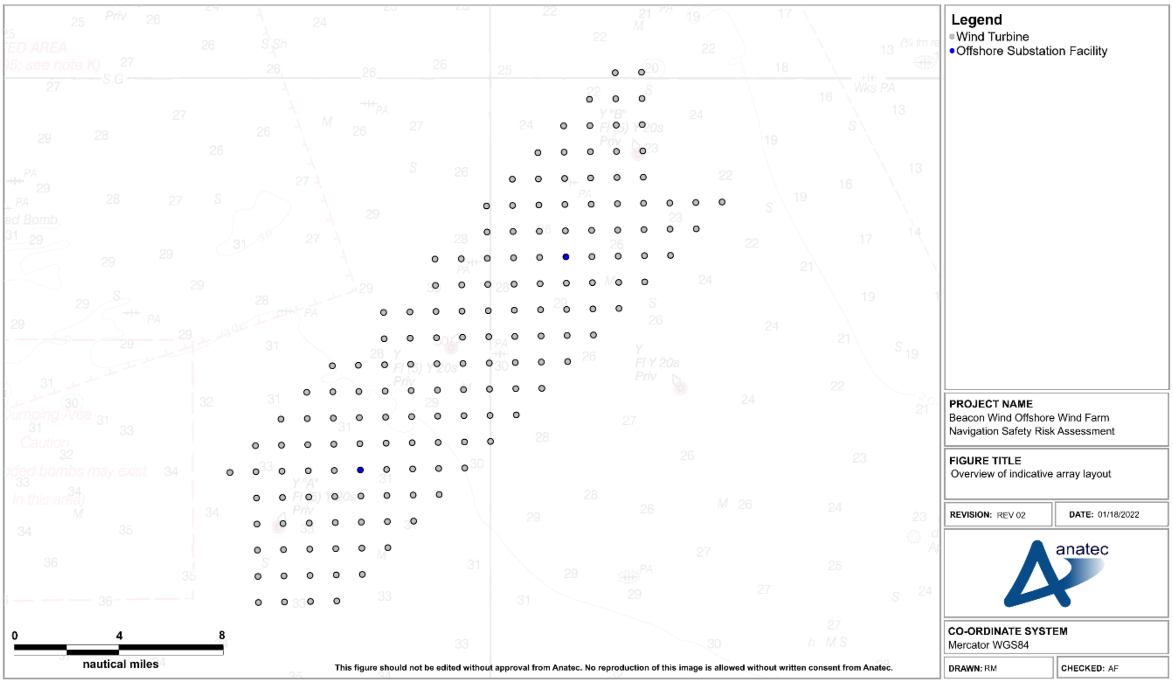

Figure 4.3 Overview of indicative array layout

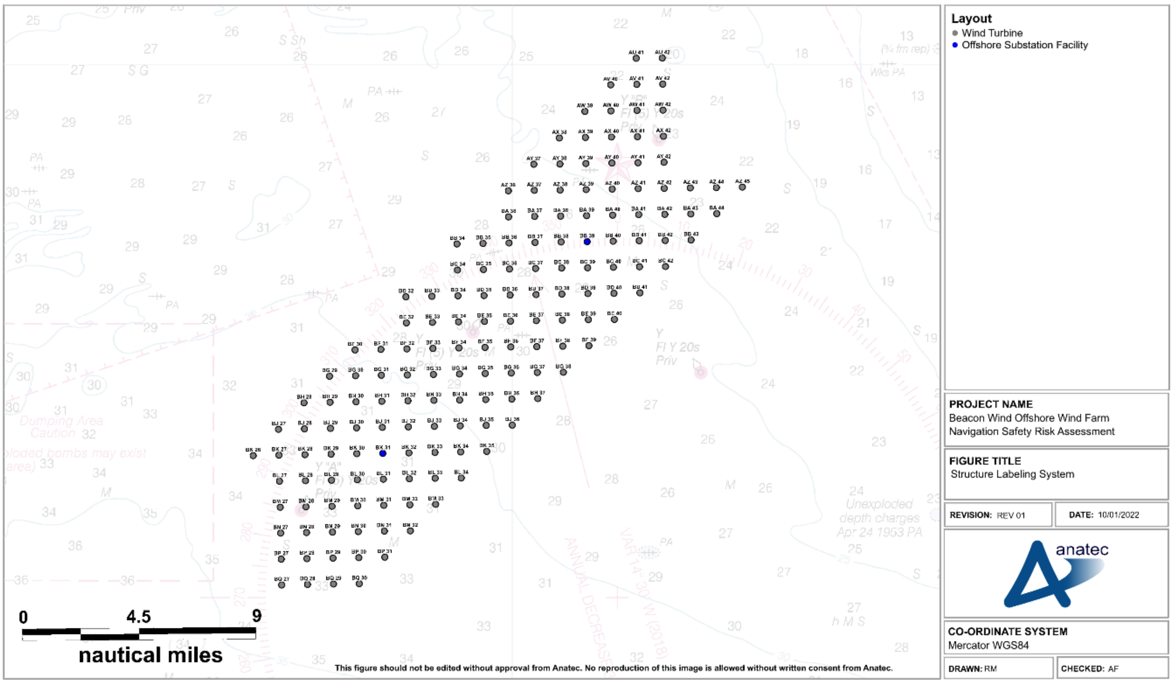

Figure 4.4 Structure Labelling System

4.2.1 Specifications

The array layout considered to be the maximum design scenario is the maximum number of wind farm structures under consideration within the PDE assuming full build out (to maximize vessel deviations and exposure to allision risk). This aligns with the layout defined upon the MARIPARS output (see Figure 4.3).

To further maximize allision risk exposure, the maximum design scenario for individual structures is considered, i.e., the structure parameters which cover the greatest area at the sea surface. For the wind turbines this consists of four-legged piled jackets with dimensions 112 × 112 ft (34 × 34 m) at the surface. For the offshore substation facilities, the maximum design scenario is considered the maximum topside dimensions which are 278 × 459 ft (85 × 140 m). The relevant wind turbine and offshore substation facility specifications are included in Table 4.2 and Table 4.3, respectively.

Floating foundations and gravity based structure foundations are not under consideration.

Table 4.2 Wind turbine specifications for shipping and navigation maximum design scenario

Parameter	Specification
Number of wind turbine foundations	155
Surface dimensions	112 ×112 ft (34 × 34 m)

Parameter	Specification
Hub height above HAT	591 ft (180 m)
Turbine tip height from HAT	1,083 ft (330 m)
Lower blade tip height (air gap above HAT)	85 ft (26 m)
Rotor diameter	984 ft (300 m)
Foundation Type	Four-legged jacket
Foundation orientation	Side perpendicular to predominant wind direction
Minimum spacing between structures	1 nm (1.9 km)

Table 4.3 Offshore substation facility specifications for shipping and navigation maximum design scenario

Parameter	Specification
Number of offshore substation foundations	2
Surface dimensions (w × l × h)	278 × 459 × 213 ft[6] (85 × 140 × 65 m)
Foundation Type	Rectangular jacket (230 × 230 ft [70 × 70 m])
Foundation orientation	Side perpendicular to predominant wind direction
Minimum spacing between structures	1 nm (1.9 km)

4.2.2 Shutdown Procedures

Where technically possible, the wind turbine design will satisfy the requirements of NVIC No. 01-19 (USCG 2019), which sets out standards and procedures for OREI shutdown in the event of an emergency situation requiring SAR intervention. The contents of the *Offshore Renewable Energy Installations: Requirements, Guidance and Operational Considerations for Search and Rescue and Emergency Response* (MCA 2021) (which is referenced by Annex 5 of MGN 654 [MCA 2021]) will also be considered with regard to wind turbine control for SAR assets.

In particular, it will be possible for the wind turbines to be controlled, either individually, by row or across the entire wind farm. All generators and transmission systems will be equipped with control mechanisms that can be operated remotely.

[6] Noted the PDE was updated in late 2022. This included a change in topside dimensions to 278 x 459 ft (85 x 140 m), with the original NSRA assuming dimensions of 230 x 410 ft (70 x 125 m). This change is not deemed to change any of the original NSRA findings.

This is in order to reduce the visual distraction, physical collision, and turbulence risk to SAR helicopters and/or rescue boats during SAR operations. The ability for wind turbines to be yawed to a more favorable position for SAR operations may also be considered. Further details regarding shut down procedures will be provided in the Safety Management System (SMS) prior to construction. The SMS is located within the COP as Appendix F.

4.3 Submarine Cables

4.3.1 Export Cables

Two High Voltage Direct Current (HVDC) cables will transfer energy from each of the two offshore substation facilities to the landfall locations. The landfall options under consideration are within the East River, New York (BW1 and BW2) and in Niantic Bay, Connecticut (BW2 only). The export cables will be installed along the submarine export cable route, with a total length of up to 202 nm (375 km)[7].

The preferred submarine export cable route is shown in Figure 4.5, however potential variant options have been included for reference.

The burial depth of the export cables is anticipated to be between 3 and 6 ft (0.9 and 1.8 m), noting that cable burial depth will be informed by a Cable Burial Risk Assessment in addition to any applicable burial regulations for any federally maintained areas.

It is also noted that up to 10 percent of the export cables and interarray cables may require protection where burial depths are not feasible however this will be confirmed via the Cable Burial Risk Assessment.

[7] BW1 submarine export cable route to Queens, New York up to 202 nm (375 km), with 87 nm (162 km) in federal waters and 115 nm (213 km) in state waters.
BW2 submarine export cable route to Queens, New York up to 202 nm (375 km), with 87 nm (162 km) in federal waters and 115 nm (213 km) in state waters.
BW2 submarine export cable route to Waterford, Connecticut up to 113 nm (209 km), with 87 nm (162 km) in federal waters, 26 nm (48 km) in state waters with 21 nm (39 km) in New York state waters and 5 nm (9 km) in Connecticut state waters.

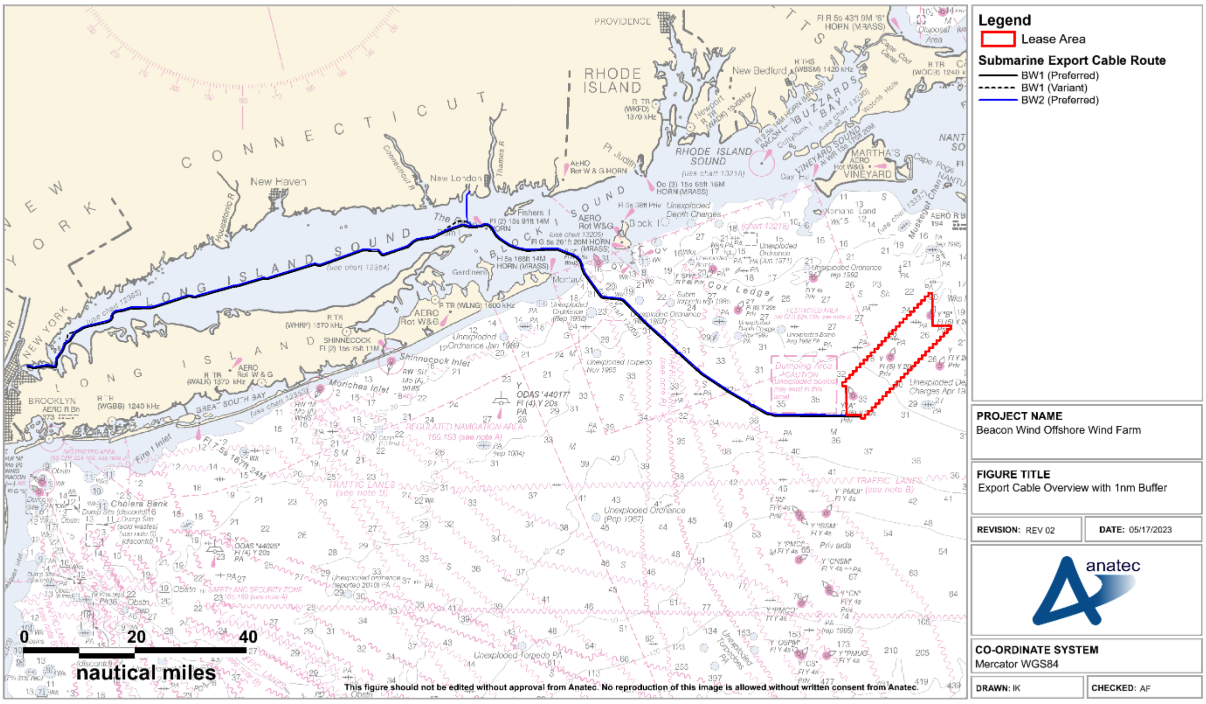

Figure 4.5 Submarine export cable route overview

4.3.2 Inter Array Cables

The total number and design of the inter array cable is dependent on the final layout which will be finalized post-consent (see Section 4.2). However, the length of inter array cable required will be a maximum of 324 nm (600 km), noting this is inclusive of both BW1 and BW2.

It is anticipated that the maximum burial depth of the inter array cables will be up to 6 ft (1.8 m).

It is also noted that up to 10 percent of the export cables and interarray cables may require protection where burial depths are not feasible.

4.4 Marine Coordination

The Project will establish Marine Coordination procedures prior to the commencement of construction to ensure Project vessel movements are managed. A “Marine Coordinator” will be appointed, who will be responsible for:

- General monitoring of the wind farm and surrounding area;
- Monitoring of third-party vessel traffic within the wind farm;
- Monitoring and coordinating project vessel traffic within the wind farm;
- Monitoring weather conditions and advise on changing weather patterns;
- Monitoring and controlling project personnel accessing wind turbines; and
- Conducting offshore certification checks.

The SMS produced by the Project will define emergency procedures and who in the event of an incident would take the role as Operations Section Chief. In coordination and cooperation with the relevant authorities, they would be responsible for the management and all operations directly applicable to the site of the incident, to maintain contact and support the allocation of resources where required.

4.5 Project Timeline

4.5.1 Construction

An indicative construction schedule is shown in Figure 4.6. It should be considered that actual schedules will be dependent on a variety of factors and therefore the timelines shown are subject to change.

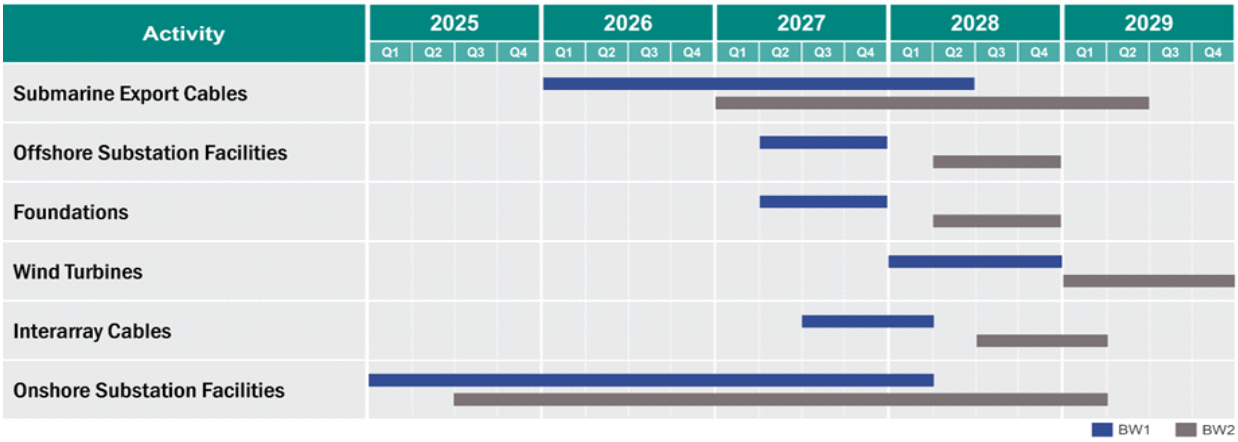

Figure 4.6 Indicative Construction Schedule

4.5.2 Operation and Maintenance

Noting the timeline outlined in Section 4.5.1, the start of operations is anticipated in Q4 2028 at the latest. The Project is expected to operate up to 35 years after construction is completed. Per 30 CFR § 585.235(a)(3) and Addendum B of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf of Lease Area OCS-A 0520, the operations term of the Project is 33 years, commencing on the date of COP approval. Prior to the end of operations term, the Developer may request renewal of its lease in accordance with 30 CFR §§ 585.425 through 429.

4.5.3 Decommissioning

As per 30 CFR § 585.902, the Project must be fully decommissioned within two years following the termination of the lease.

4.6 Maximum Design Scenario

Table 4.4 outlines the maximum design scenario under consideration in the NSRA for the Lease Area and submarine export cable route in each phase of the Project. The application of a maximum design scenario ensures that any refinement to PDE will not increase the significance of the impacts identified.

It is noted that the USCG has the existing authority to establish safety zones up to 12 nm (22.2 km) offshore. The William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 authorizes a two-year pilot program under which the USCG may establish safety zones to address special activities in the exclusive economic zone, including offshore energy development activities on or near a fixed platform. Discussions will be ongoing in this regard, and it has been assumed within this NSRA that safety zones will be applied for if allowed at the relevant time prior to construction. However, should formal safety zones not be allowed, the Project still intends to utilize advisory safe passing distances as per Section 22.

Table 4.4 Overview of shipping and navigation maximum design scenario

Phase	Project Element	Description of Maximum Design Scenario
Construction	Lease Area (wind turbines, offshore substation facilities, interarray cables)	▪ Buoyed construction area around the Lease Area for the full duration of the construction works, determined in consultation with the USCG and BOEM; ▪ Up to 157 partially completed structures (155 wind turbines and two offshore substation facilities); ▪ Up to 40 construction vessels; ▪ Up to three and a half year phased offshore construction period; and ▪ Safety zones and safe passing distances of up to 1,640 ft (500 m) in radius around structures where work is ongoing (if applicable).
	Submarine export cable route	▪ Cable installation of submarine export cable route by anchored vessel or dynamic positioning vessel; and ▪ Up to three and half year phased offshore construction period.
Operation and maintenance	Lease Area (wind turbines, offshore substation facilities, interarray cables)	▪ 155 wind turbines on jacket foundations, (34 × 34 m) at surface level; ▪ Minimum spacing of 1 nm (1.9 km) between structures; ▪ Two offshore substation facilities on piled foundations, topside dimensions of 85 × 140 m;

Phase	Project Element	Description of Maximum Design Scenario
		▪ 324 nm (600 km) of Inter Array cable, with maximum target burial depth of 6 ft (1.8 m) – up to 10 percent of export and inter array cables may require protection; and ▪ Up to 10 O&M vessels.

	Submarine export cable route	▪ Submarine export cable routes:
		  ▪ BW1 to Queens, New York up to 202 nm (375 km), with 87 nm (162 km) in federal waters and 115 nm (213 km) in state waters.
		  ▪ BW2 to Queens, New York up to 202 nm (375 km), with 87 nm (162 km) in federal waters and 115 nm (213 km) in state waters.
		  ▪ BW2 to Waterford, Connecticut up to 113 nm (209 km), with 87 nm (162 km) in federal waters, 26 nm (48 km) in state waters with 21 nm (39 km) in New York state waters and 5 nm (9 km) in Connecticut state waters.
		▪ Buried between 3 and 6 ft (0.9 and 1.8 m); and
		▪ Use of external Cable Protection where necessary (e.g., cable crossings) – up to 10 percent of export and inter array cables may require protection.

Decommissioning	Lease Area (wind turbines, offshore substation facilities, interarray cables)	▪ Buoyed decommissioning area around the Lease Area for the full duration of the decommissioning works, determined in consultation with the USCG and BOEM; ▪ Two-year decommissioning period; and ▪ Safety zones and safe passing distances of up to 1,640 ft (500 m) in radius around structures where work is ongoing (if applicable).
	Submarine export cable route	▪ Decommissioning within two years of termination of the Lease as per 30 CFR § 585.902.

5 Waterway Characteristics

5.1 Navigational Features

This section provides an overview of the navigational features which have a role in dictating vessel movements in the vicinity of the Project or have the potential to be impacted by or interact with an element of the Project.

5.1.1 Routing Measures

Existing routing measures within the vicinity of the Lease Area are presented in Figure 5.1. Potential / proposed fairways arising from the relevant PARS (see Section 1.1.2.2) are discussed and presented in Section 6.7.5.

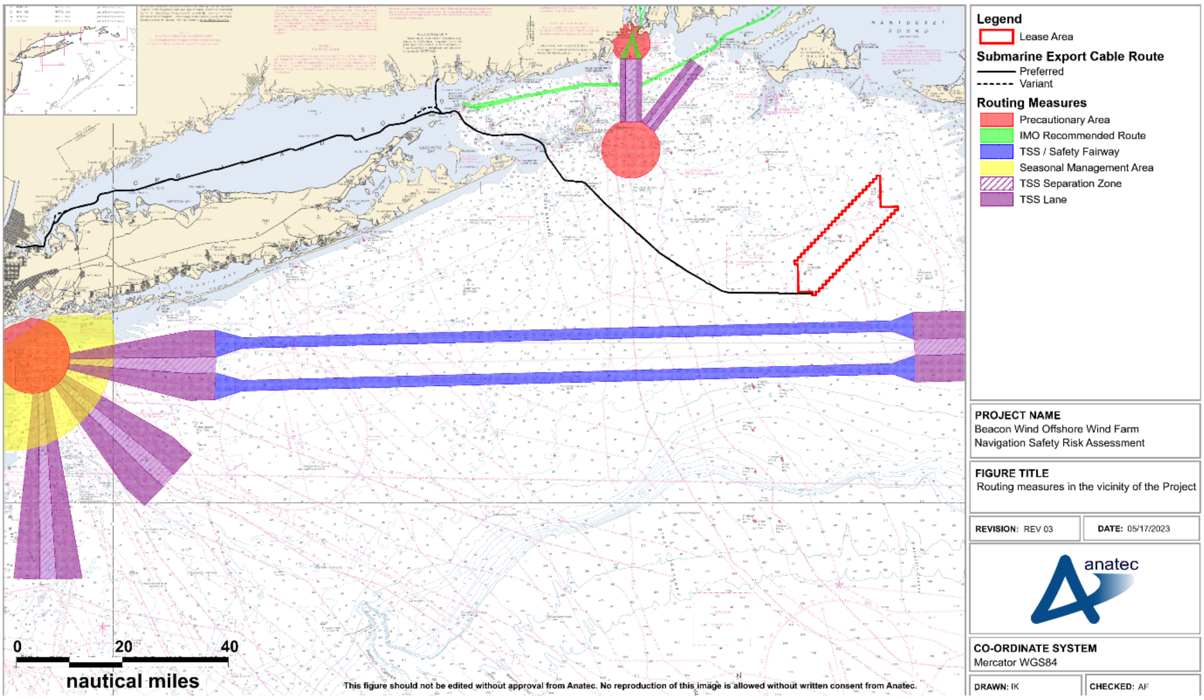

Figure 5.1 Routing measures in the vicinity of the Project (*see Section 6.7.5 for findings of relevant PARS studies)*

The westbound lane of the Off New York Shipping Safety Fairway (33 CFR § 166.500) between Nantucket and Ambrose intersects the southern section of the Study Area. This safety fairway is part of the Nantucket to Ambrose Traffic Separation Scheme (TSS) and is utilized primarily by transiting commercial vessels bound for Ambrose.

Other routing measures in proximity to the Lease Area include the Narragansett Bay TSS and the Buzzards Bay TSS, which are located approximately 13 nm (24.1 km) and 15 nm (27.8 km) northeast of the submarine export cable route, respectively. With regards to the Lease Area, they are located 28 nm (51.9 km) and 25 nm (46.3 km) to the northwest, respectively. These

TSS lanes may affect vessel routing within the Study Area due to vessels positioning themselves prior to entering the routing measures, with both TSS converging on a precautionary area located approximately 5 nm (9.3 km) northeast of the submarine export cable route and 20 nm (37 km) northwest of the Study Area.

5.1.2 Pilotage

The charted pilot boarding areas in the vicinity of the Project are presented in Figure 5.2 and Figure 5.3. There are no pilot boarding areas in proximity to the Lease Area, however there are two within the Export Cable Study Area:

- Montauk Point; and
- New York Harbor off Execution Rocks.

The Montauk pilot boarding area is deemed as a “secondary” location (NOAA 2021) and for use under special arrangement.

The *United States Coast Pilot 2* (NOAA 2021) states the following for the New York Harbor pilot boarding area location:

Foreign vessels and U.S. vessels under register entering or departing from the Port of New York and New Jersey from Long Island Sound must employ a pilot licensed by the State of New York. Enrolled vessels must have on board or employ a pilot licensed by the Federal Government. Pilotage service for vessels entering the Port of New York and New Jersey from Long Island Sound is available from the United New York New Jersey Sandy Hook Pilot Association. The pilot boat boarding area is off Execution Rocks.

There are also pilot boarding areas associated with Narragansett Bay and Buzzards Bay located to the north of the submarine export cable route, noting these areas are of relevance in terms of origins/terminus points of traffic within the Study Area. According to *United States Coast Pilot 2* (NOAA 2021), *‘Pilotage is compulsory for foreign vessels and U.S. vessels under register when entering and departing Narragansett Bay and all ports of the waters of the State of Rhode Island* and pilotage for Buzzards Bay is compulsory for *‘foreign vessels of 350 gross tons or more, U.S. vessels under register of 350 gross tons or more’*. The submarine export cable route is located approximately 5 nm (9.3 km) from the associated routing measures and precautionary area and in excess of 10 nm (18.5 km) from the relevant pilot boarding areas; as such, there will be no effect on the associated pilot boarding activities.

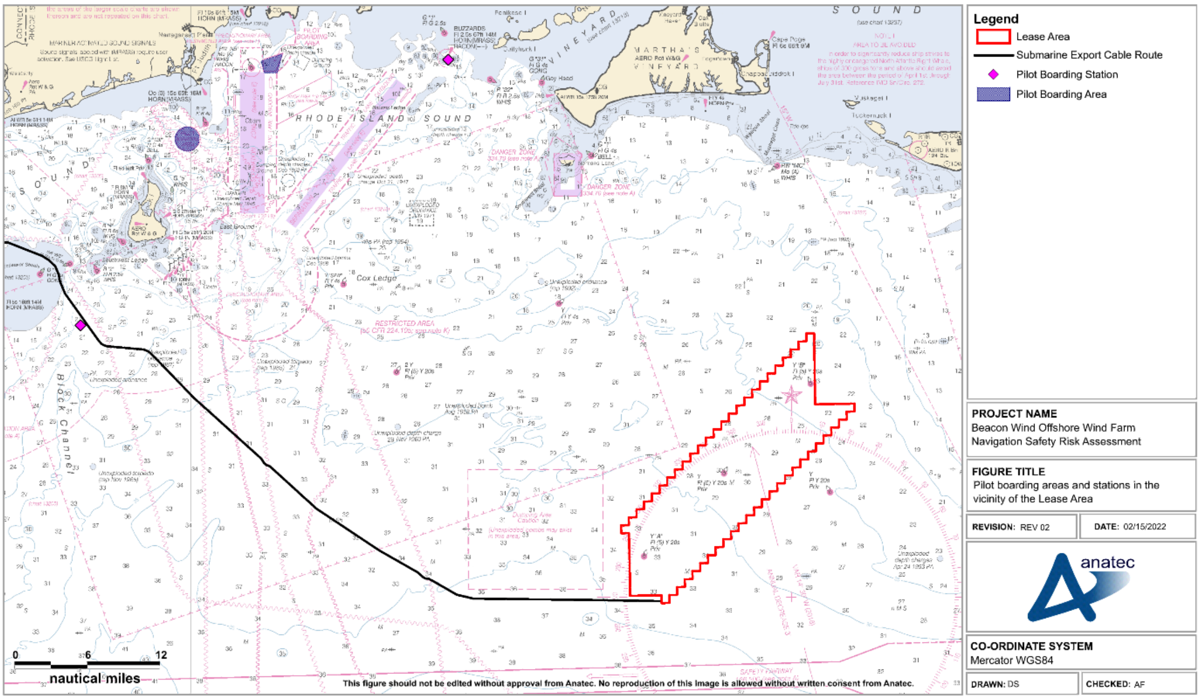

Figure 5.2 Pilot boarding areas in the vicinity of the Lease Area

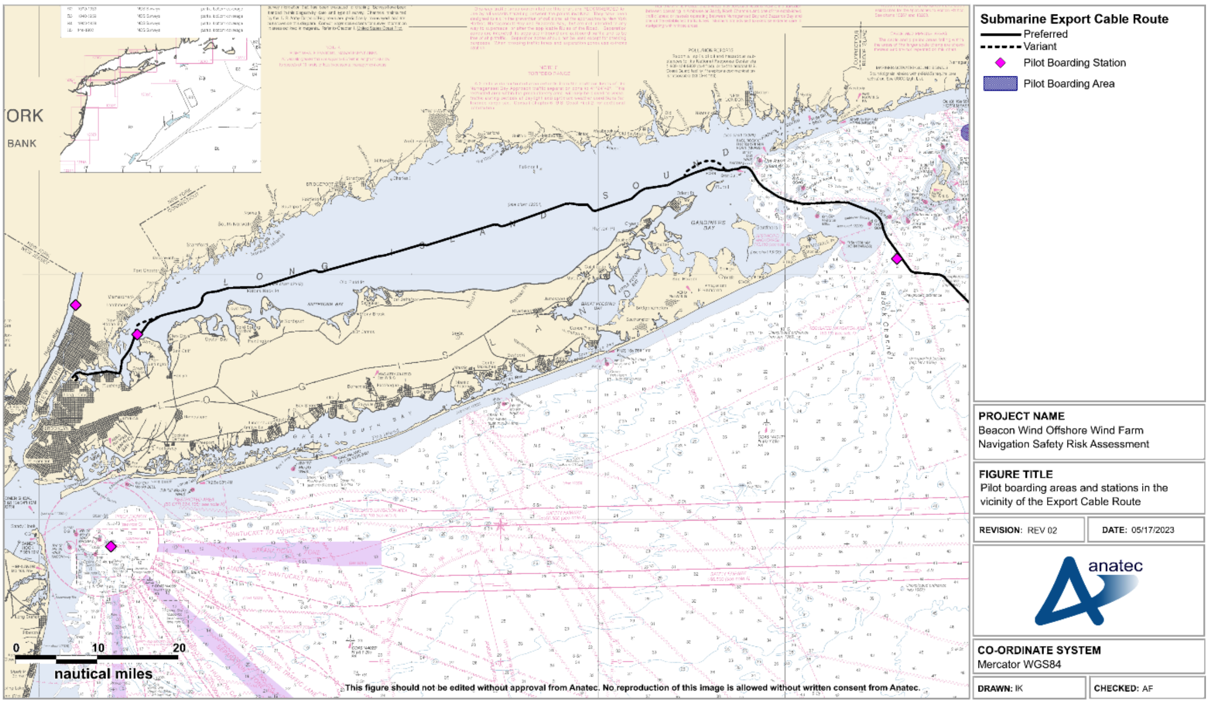

Figure 5.3 Pilot boarding areas in the vicinity of the submarine export cable route

5.1.3 Anchorage Areas

NOAA provides details of anchorages defined under the relevant CFRs. An overview of the anchorage areas identified as being in the vicinity of the Project is presented in Figure 5.4.

Following this, a detailed view of the area in and approaching the East River is shown in Figure 5.5, noting that this was the area where the majority of anchoring was identified to occur based on the marine traffic data (see Section 6.6.3). The marine traffic analysis also indicated more limited levels of anchoring in proximity to the Niantic Bay landfall, and in that regard it is noted that the Niantic anchorage area is located approximately 0.7nm to the west of the cable.

It is noted that an anchorage area is proposed under NNYBPARS. This anchorage presented and discussed in Section 6.7.5.

There are no anchorages within 7 nm (13 km) of the Lease Area, however a total of 22 anchorages were identified within the Submarine Export Cable Route Study Area, 19 of which fall under New York jurisdiction. This includes ten "unrestricted" anchorages in the East River and its approaches, defined under 33 CFR § 110.155.

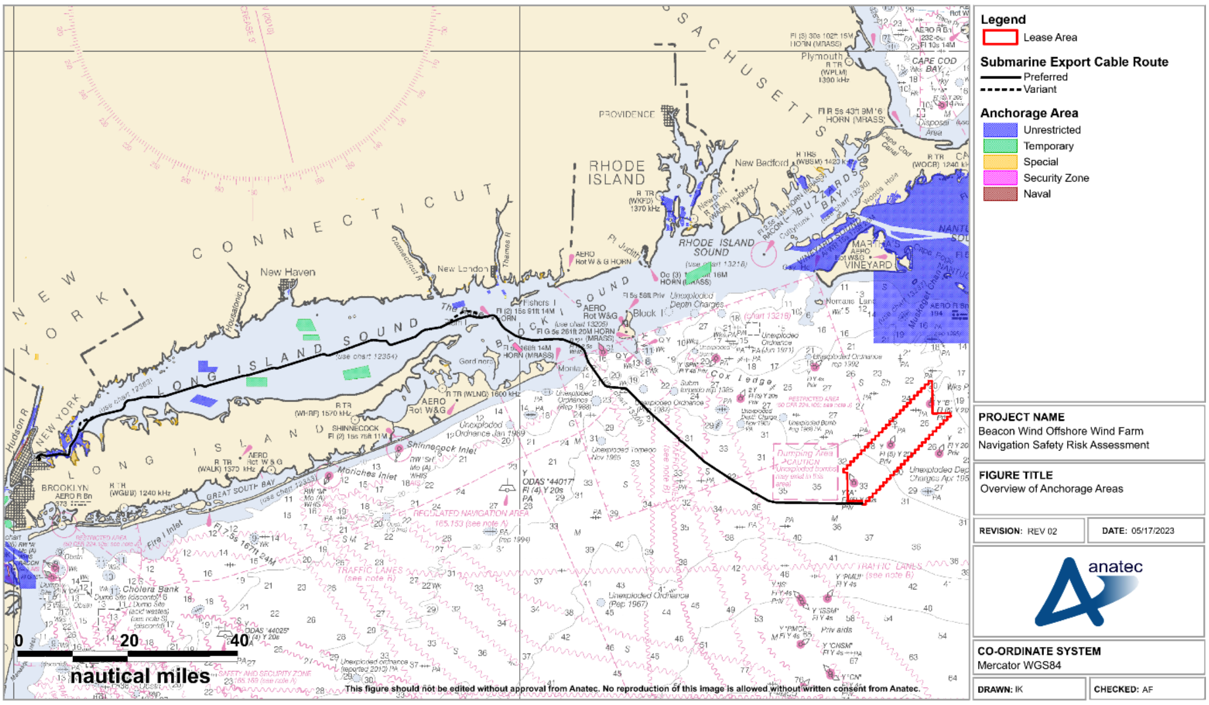

Figure 5.4 Overview of anchorage areas

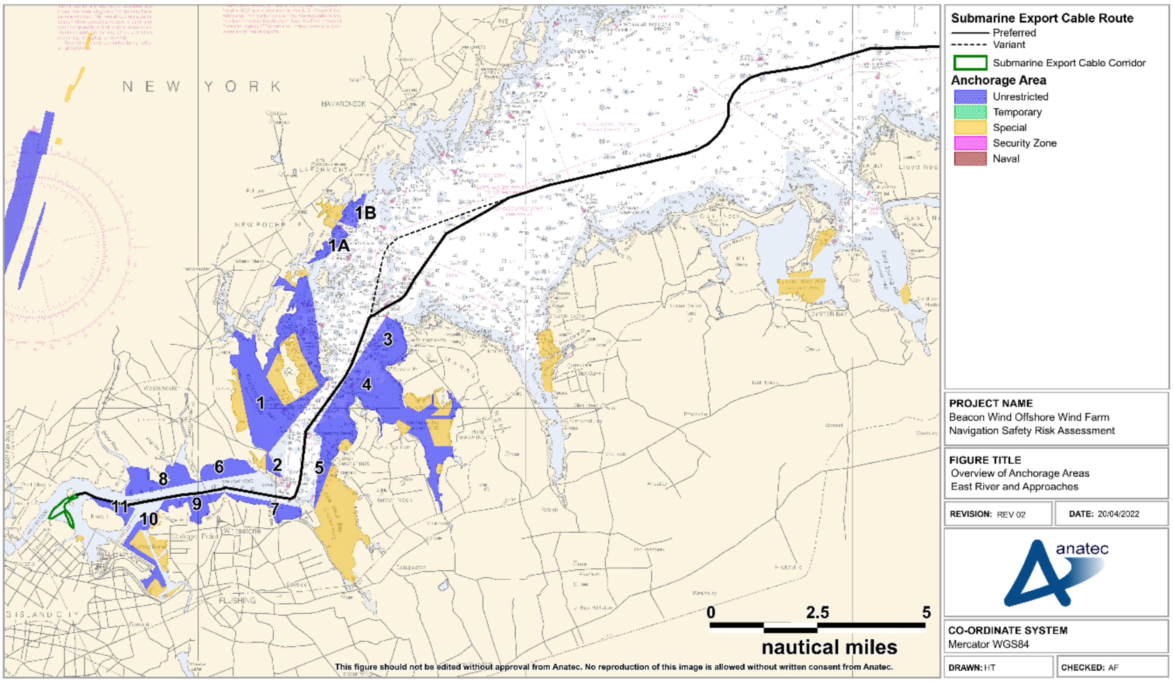

Figure 5.5 Anchorages – East River and Approaches

5.1.4 Regulated Navigation Area

Regulated Navigation Areas (RNAs), outlined in 33 CFR Part 165, are water areas within a defined boundary for which regulations for vessels navigating within the area have been established. In an area where conditions are determined to be hazardous, the District Commander may issue RNAs to control vessel traffic, usually stipulating which types or sizes of vessel may navigate within the area and in which manner they can do so.

Figure 5.6 presents an established RNA in the region which, according to 33 CFR § 165.153, encompasses '*All waters of the Long Island Sound Marine Inspection and Captain of the Port (COTP) Zone, as delineated in 33 CFR § 3.05-35, extending seaward 12 nautical miles from the territorial sea baseline*'. Within the RNA, vessels of 300 gross tons (GT) or more shall not exceed 8 knots and must issue security calls when engaged in towing barges.

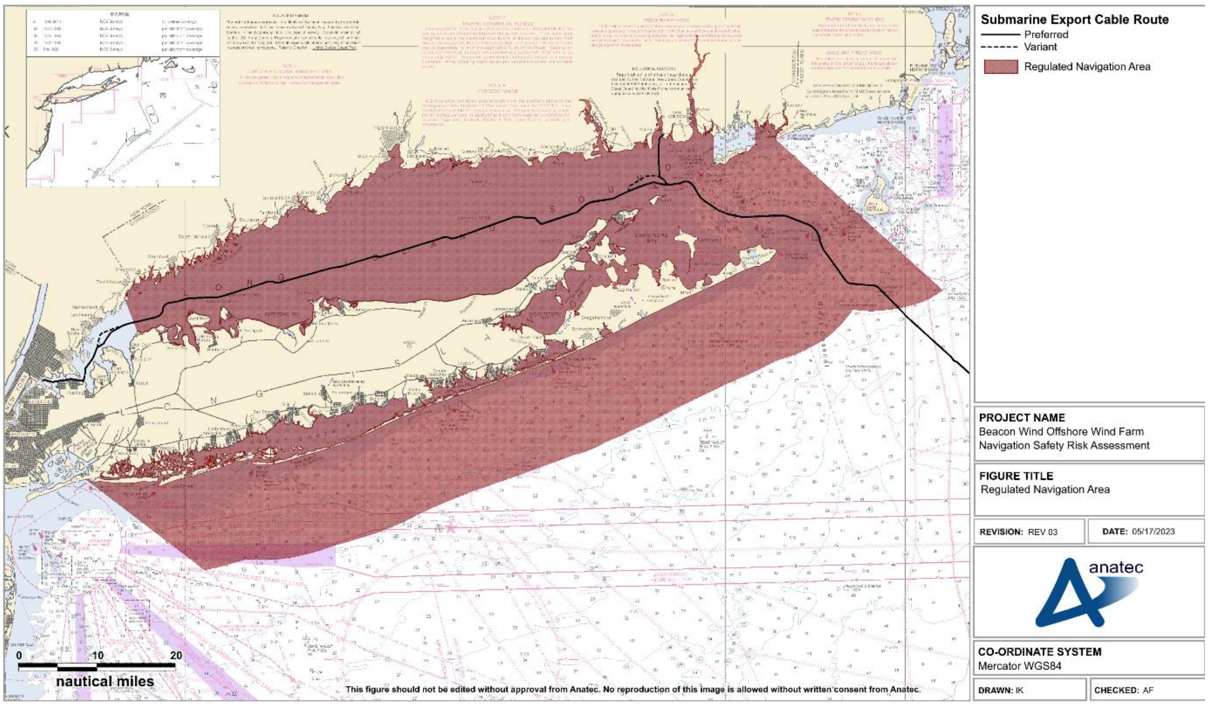

Figure 5.6 Regulated Navigation Area

5.1.5 Recommended Routes for Deep Draft Vessels

A note on NOAA charts indicates the presence of recommended vessel routes for deep draft vessels within Western Long Island Sound and the approaches to the East River:

"*Recommended vessel routes have been established for deep draft vessels (including tugs and barges) transiting Western Long Island Sound and the approaches to the East River. While not mandatory, deep draft commercial vessels (including tugs and barges) are requested to follow the designated routes at the master's discretion. Other vessels, while not excluded from these routes, should exercise caution in and around these areas and monitor VHF-FM channel 16 or 13 for information concerning deep draft vessels (including tugs and barges) transiting these routes*".

The corresponding area as displayed on charts is shown in Figure 5.7.

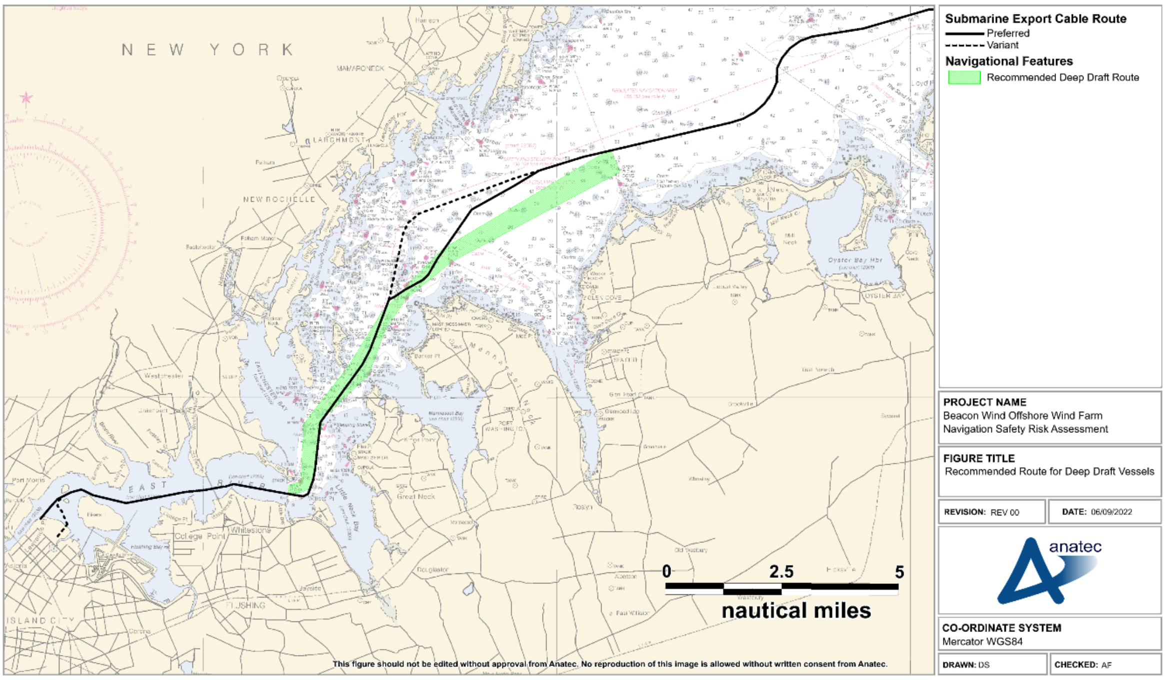

Figure 5.7 Recommended Route for Deep Draft Vessels

5.1.6 Aids to Navigation

An overview of Aids to Navigation (AtoNs) identified within the region associated with the Project are shown in Figure 5.8.

Based on information provided by the Office for Coastal Management (OCM), excluding three lighted buoys within the Lease Area itself associated with the Project, there are 157 AtoNs located within the Submarine Export Cable Route Study Area. The significant majority of these mark the approaches to harbors and other hazards within Long Island Sound (i.e., within the vicinity of the landfalls). Further detailed figures of the AtoN are included in Figure 5.9 and Figure 5.10.

It is estimated that three buoys are within 50m of the Submarine Export Cable Route, with the closest being 18m. All three buoys are located in the East River, north of the cable route along the existing navigation channel. The Project will work with USCG to fully understand concerns and applicable mitigations for any potential impacts to AtoN. It is expected that any impacts would be fully mitigated.

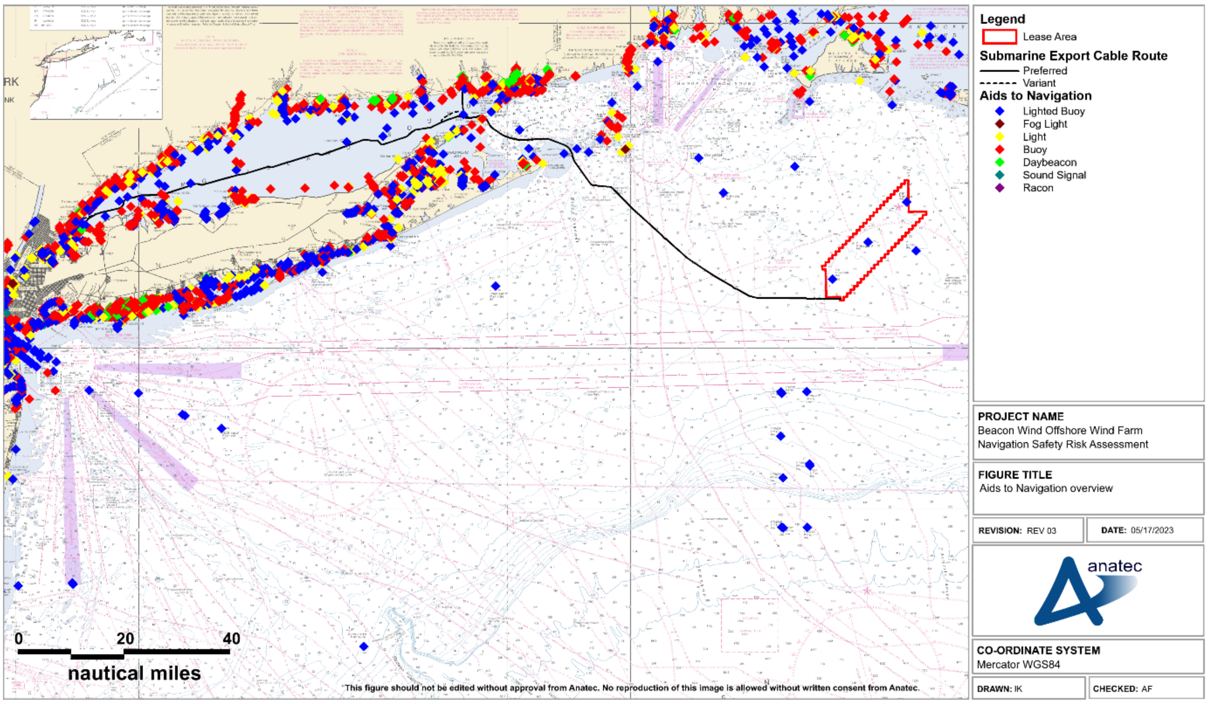

Figure 5.8 Aids to Navigation overview

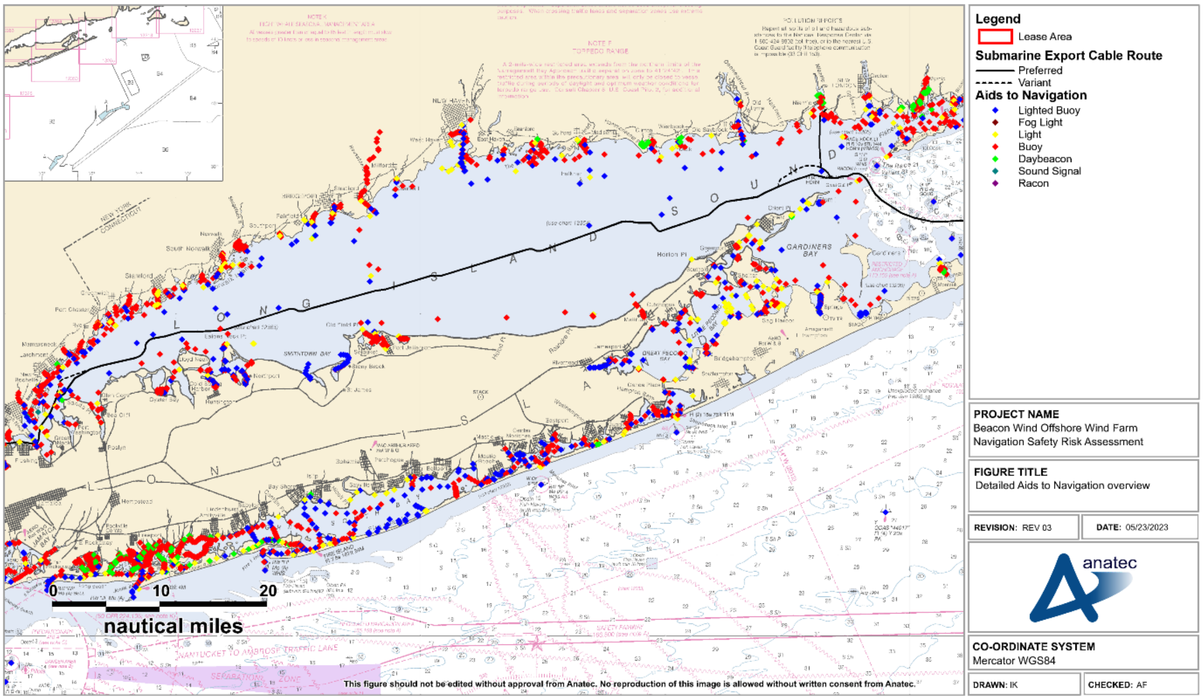

Figure 5.9 Detailed Aids to Navigation overview

One further AtoN (excluding the three associated with the Project), a LiDAR research buoy associated with Lease Area OCS-A 0521 (Mayflower Wind) to the south, is located within the Study Area, as shown in Figure 5.11.

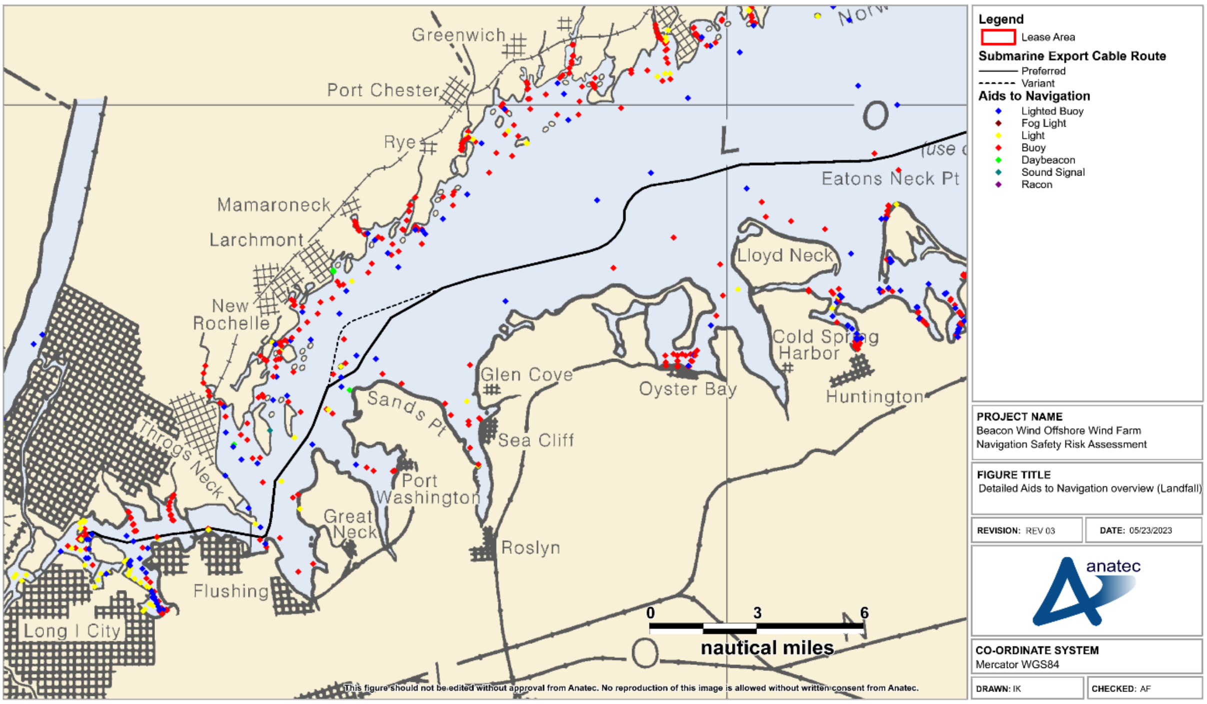

Figure 5.10 Detailed Aids to Navigation overview at landfall

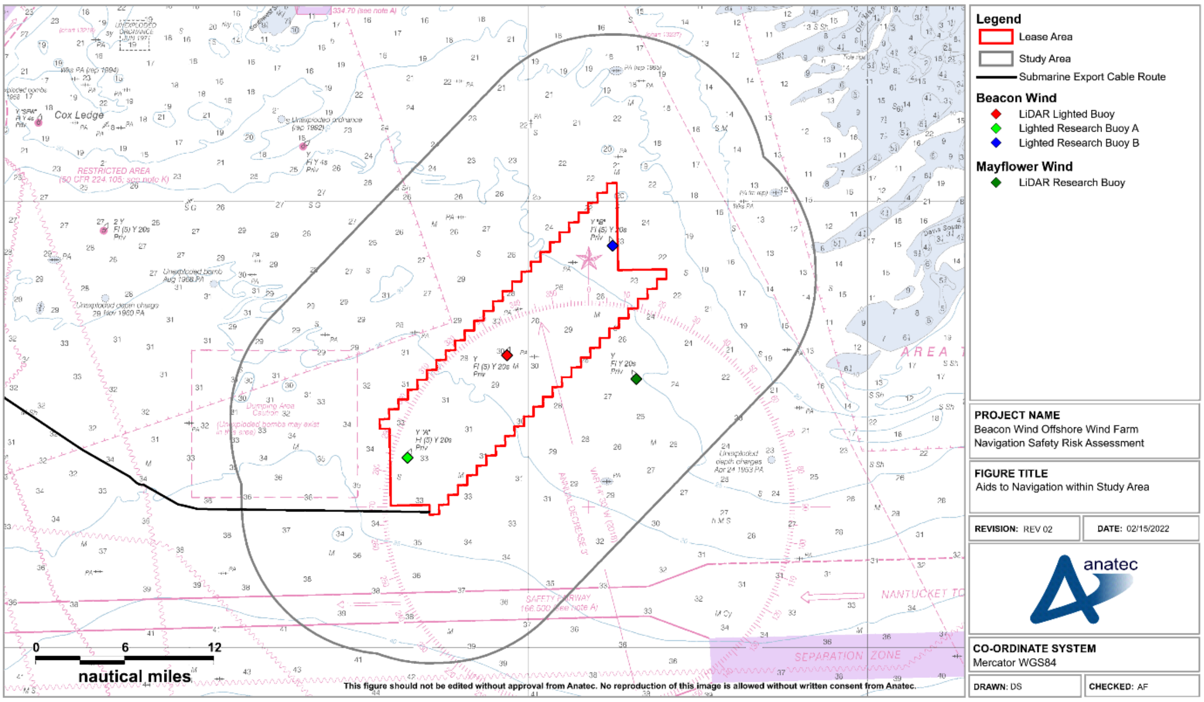

Figure 5.11 Aids to Navigation within the Study Area

5.1.7 Danger Zones, Restricted Areas and Disposal Areas

Restricted areas, danger areas and disposal areas in the vicinity of the Lease Area are presented in Figure 5.12. Following this, Figure 5.13 presents disposal areas in proximity to the submarine export cable route within Long Island Sound.

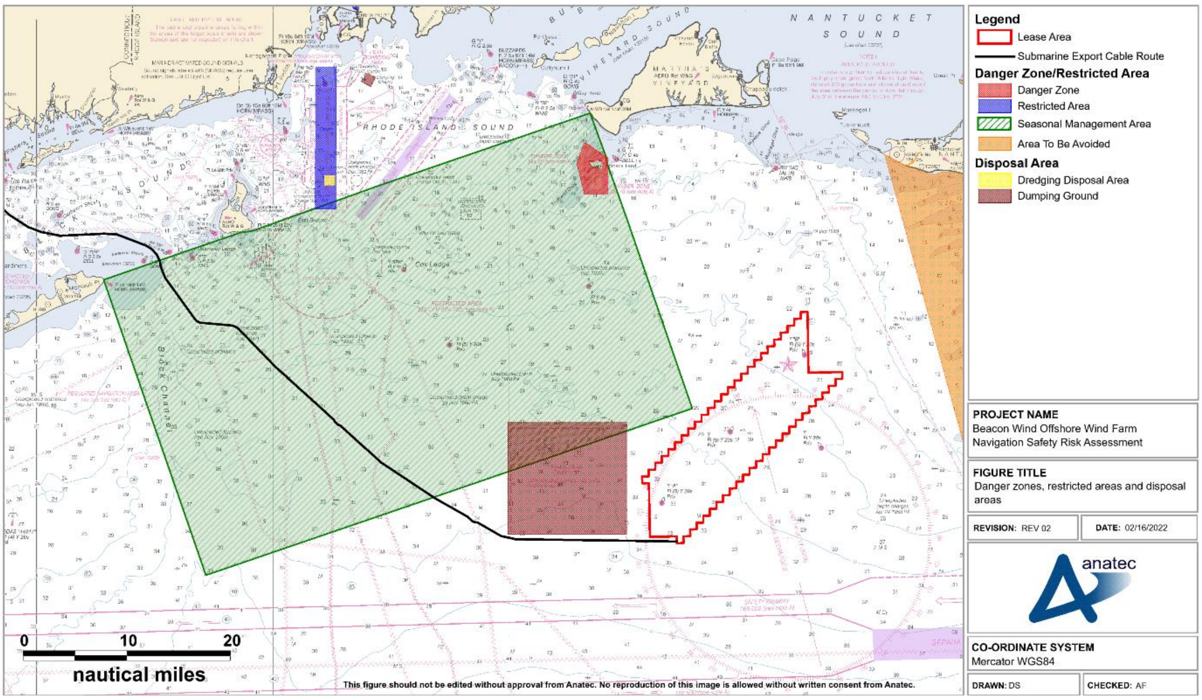

Figure 5.12 Danger zones, restricted areas and disposal areas in the vicinity of the Lease Area

From 50 CFR § 224.105, a Seasonal Management Area (SMA) for the protection of North Atlantic right whales is defined by bounding coordinates and the following restriction: "*vessels greater than or equal to 65 ft (19.8 m) in overall length … shall travel 10 knots or less over ground in the period November 1st to April 30th each year*".

An area to be avoided is located approximately 9.5 nm (17.6 km) east of the Lease Area. All vessels carrying cargoes of oil or hazardous materials and all other vessels of more than 1,000 GT are advised to avoid this area.

A dumping area is located 1.4 nm (2.6 km) west of the Lease Area, in which nautical charts note that unexploded bombs may be present.

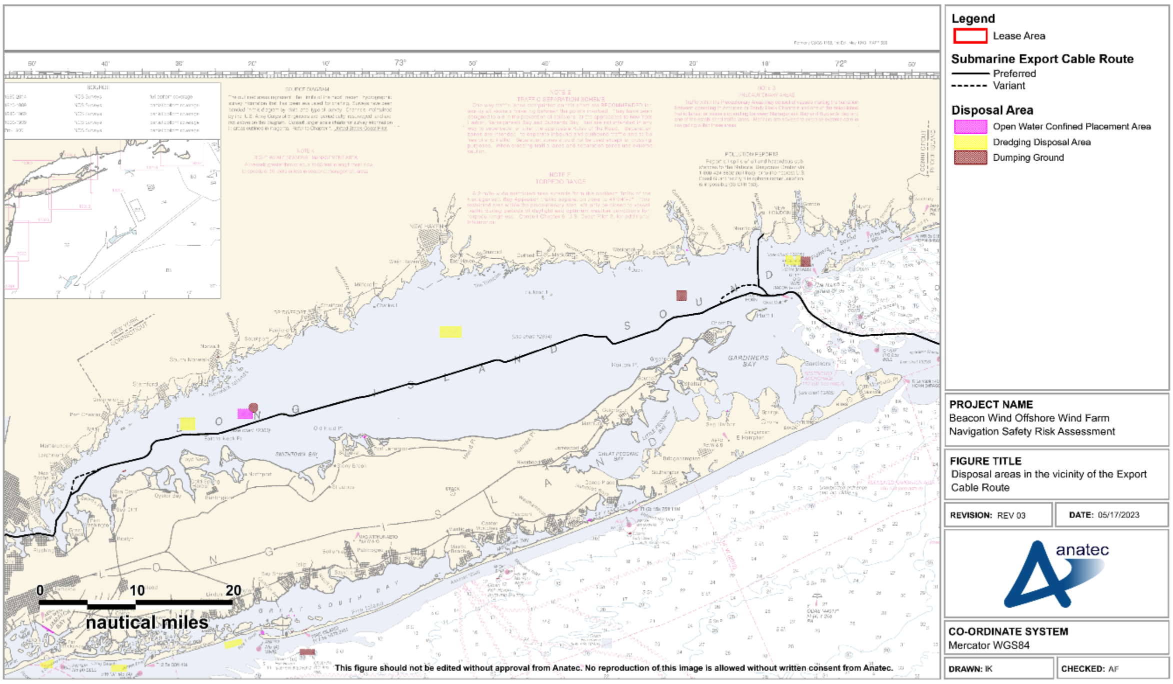

Figure 5.13 Disposal areas in the vicinity of the submarine export cable route

An active dredged material disposal area, defined as per 40 CFR § 228.15, is located approximately 0.4 nm (0.7 km) north of the Export Cable Route. A discontinued dumping ground and an open water confined placement area of unknown status are also located in close proximity to the Export Cable Route to the east of the active dredged material disposal area.

5.1.8 Unexploded Ordnance

There are a number of charted Unexploded Ordnance (UXO)/ Munitions and Explosives of Concern (MEC) positions in the region, although none are charted within the Study Area, with the closest situated in excess of 13 nm (24.1 km) to the south east. However, as noted in Section 5.1.7, unexploded bombs may exist in the dumping area located 1.4 nm (2.6 km) west of the Lease Area.

5.1.9 Military Areas and Transit Routes

The Lease Area lies within the Narragansett Bay OPAREA, as shown in Figure 5.14, while the submarine export cable route intersects the northern portion of the OPAREA. Submarine transit lanes are located 11 nm (20.3 km) to the southwest of the Lease Area.

It is noted that the Project has consulted with DoD to ensure cable placement within these lanes do not interfere with their missions.

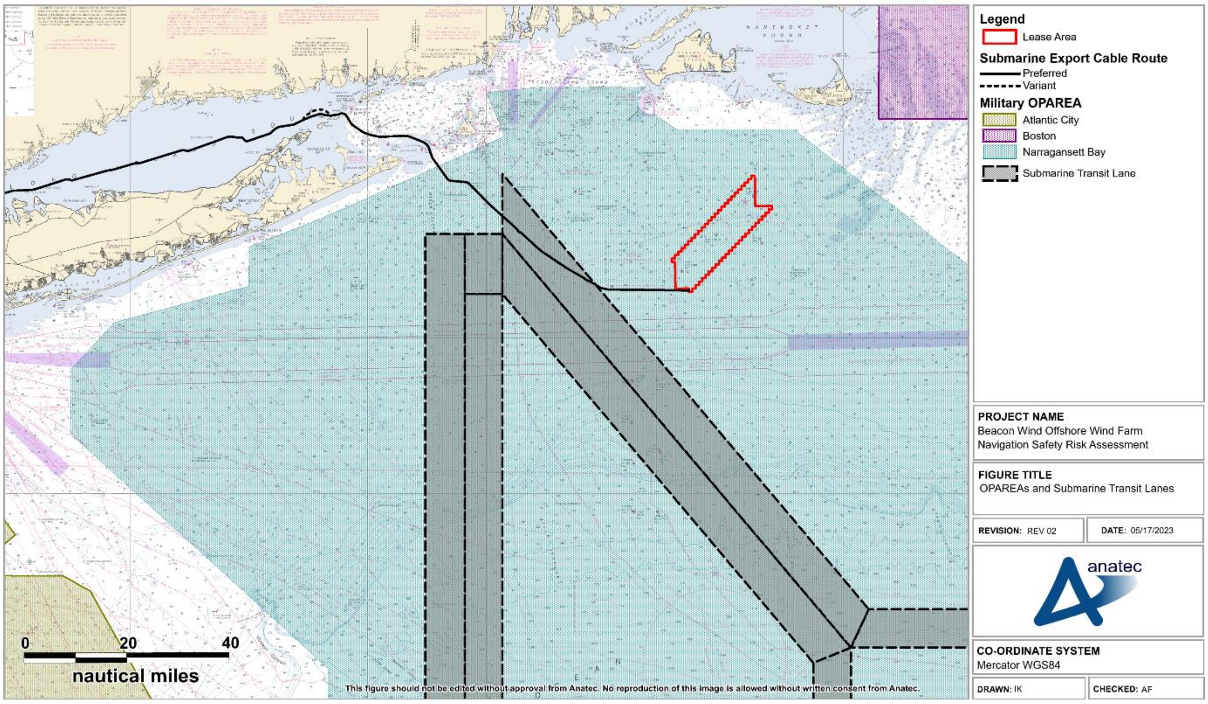

Figure 5.14 OPAREAs and Submarine Transit Lanes

5.1.10 Wrecks and Obstructions

Wrecks and obstructions have been identified using a combination of the OCS Automated Wrecks and Obstructions System (AWOIS) and charted position, noting that the AWOIS database ceased to be updated in 2016. Within the Study Area, 16 wrecks and two obstructions were identified, presented in Figure 5.15, of which two wrecks and one obstruction are located within the Lease Area itself. Within the Submarine Export Cable Route Study Area, 177 wrecks and 150 obstructions were identified, with the majority of these located in the approaches to New York, as illustrated by Figure 5.16.

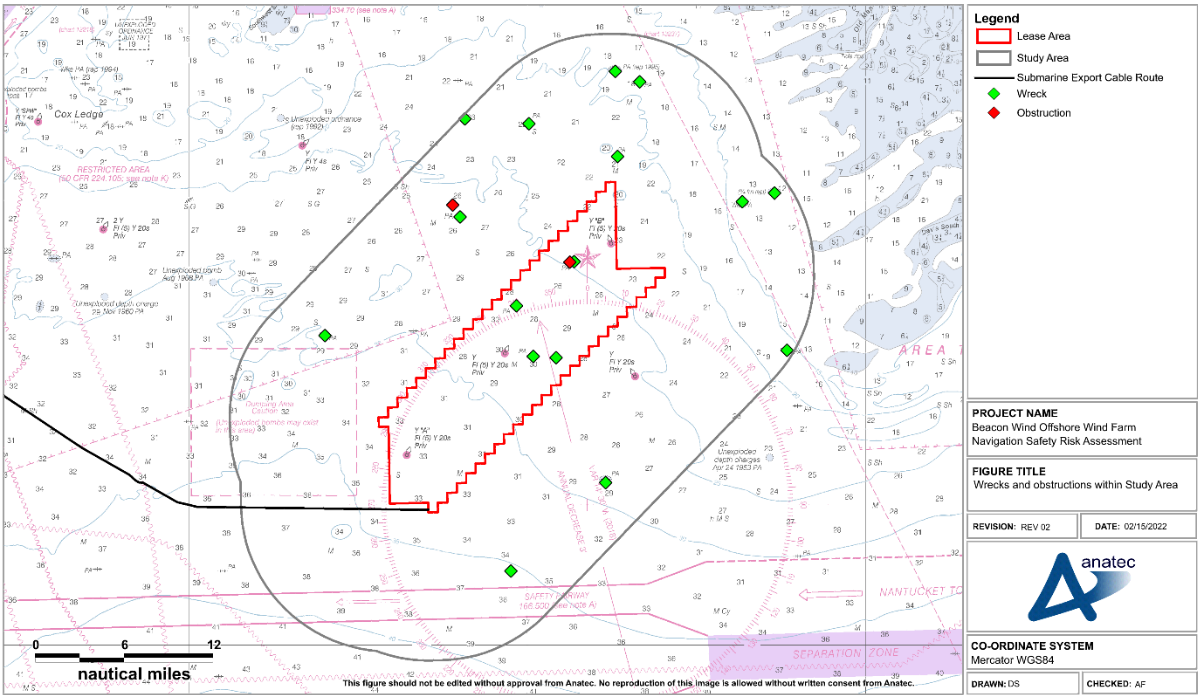

Figure 5.15 Wrecks and Obstructions within Study Area

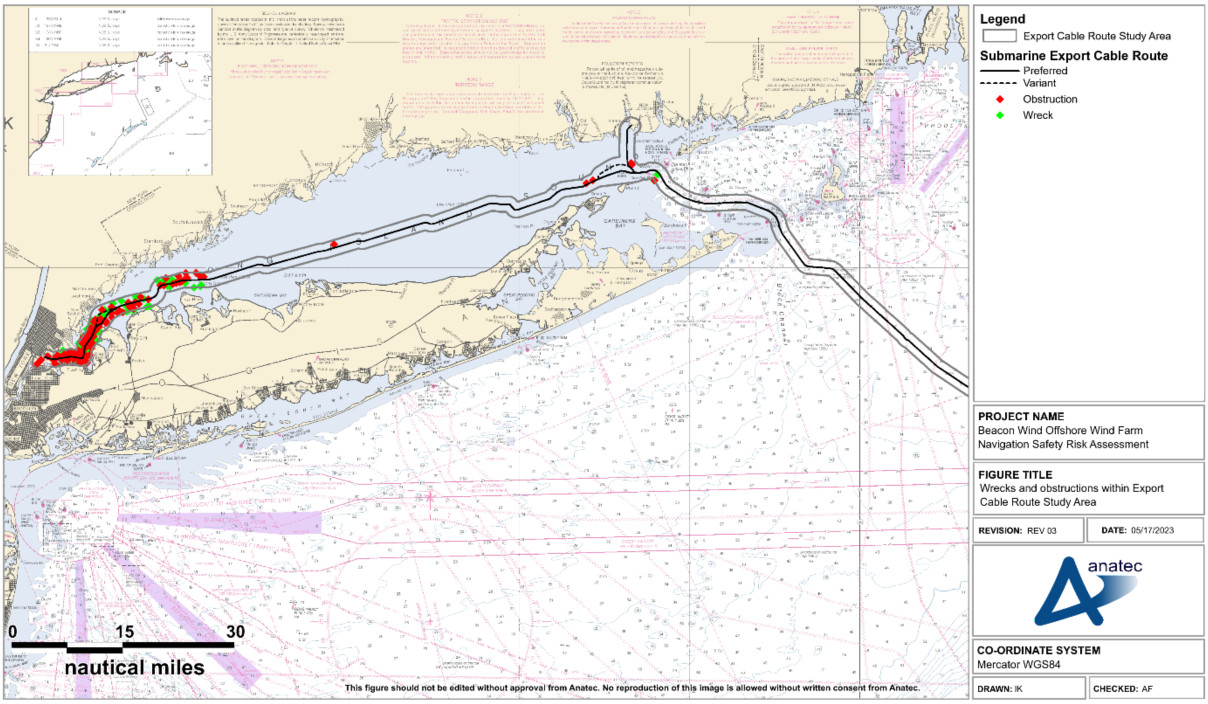

Figure 5.16 Wrecks and Obstructions within Submarine Export Cable Route Study Area

5.1.11 Submarine Cables and Pipelines

An overview of submarine cables (including telephone cables and power lines) and cable/pipeline areas is presented in Figure 5.17. It can be seen that the Atlantic-1 North telephone cable and Iroquois pipeline are situated alongside the submarine export cable route throughout Long Island Sound, with the Atlantic-1 North telephone cable crossing over in a southward direction bound for the Atlantic Ocean, and the Iroquois pipeline running north to Canada.

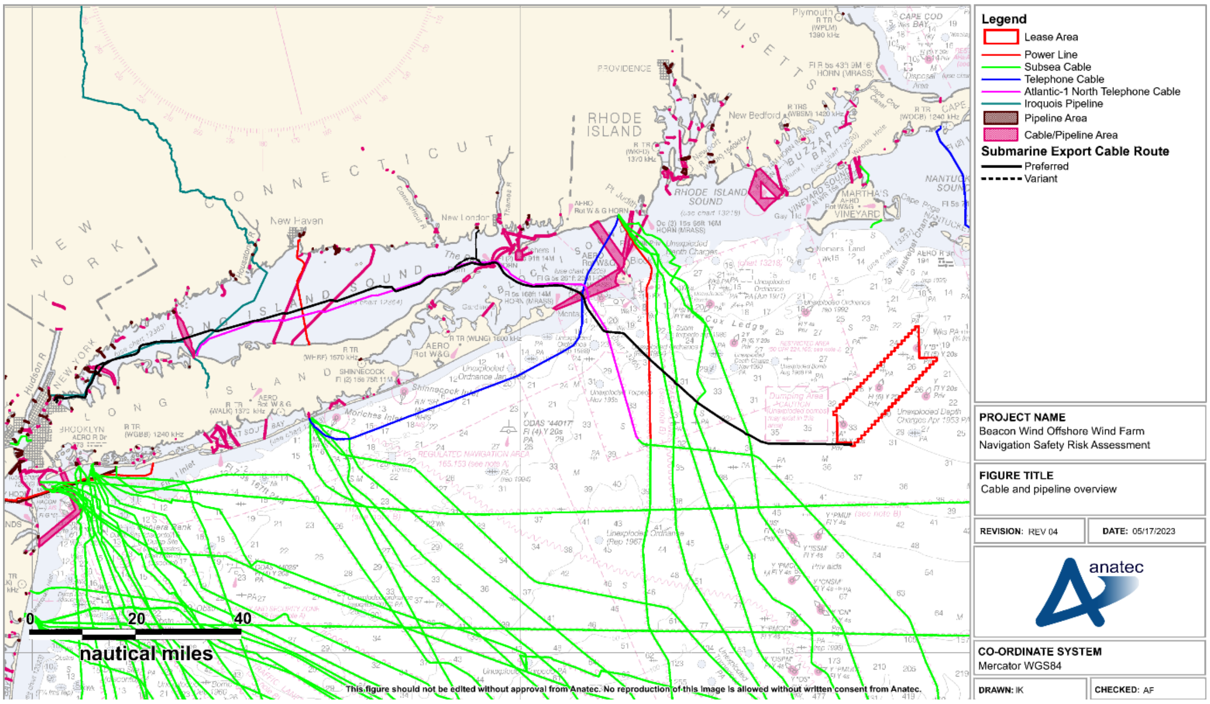

Figure 5.17 Cable and pipeline overview

There are several cable/pipeline areas intersecting the submarine export cable route near the East River landfall location, as presented in Figure 5.18.

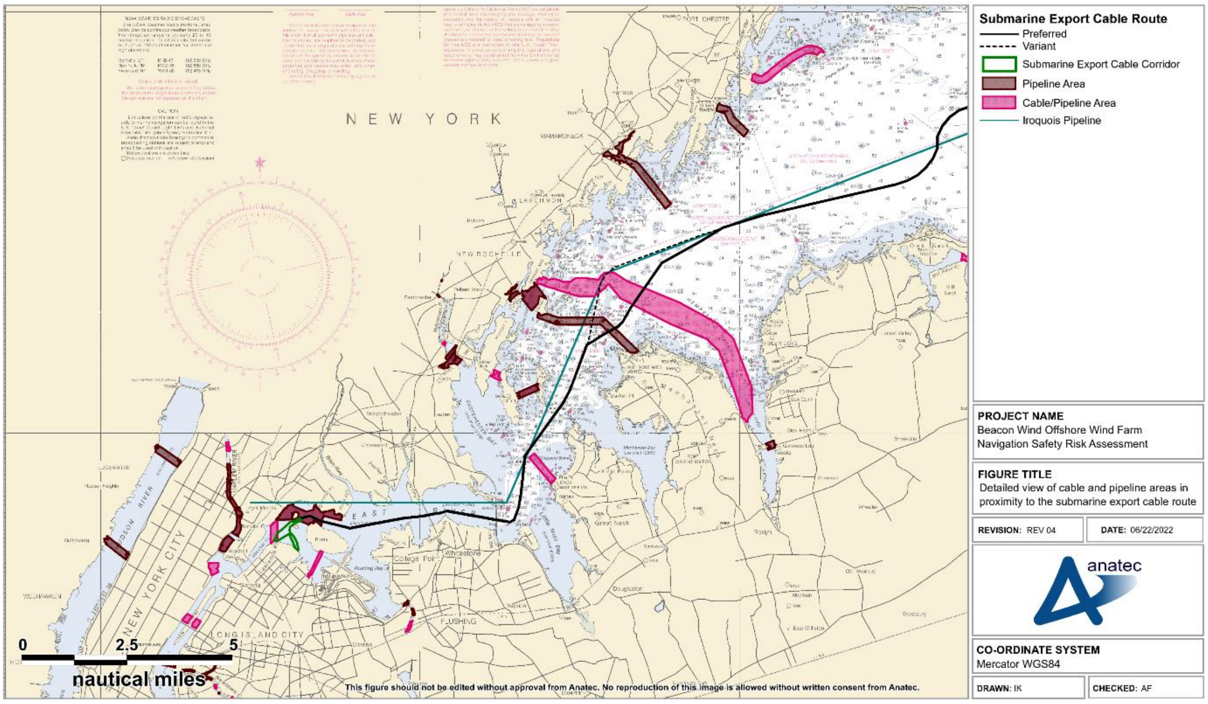

Figure 5.18 Detailed view of cable and pipeline areas in proximity to the submarine export cable route

5.1.12 Ports

Figure 5.19 presents the harbors and ports located in the vicinity of the Project. The closest harbor to the Lease Area is Nantucket, located approximately 20 nm (37 km) to the north east.

The Port of New York is located approximately 150 nm (277.8 km) west of the Project, with a significant volume of the marine traffic within the southern section of the Study Area transiting to the Port of New York and its subsidiaries utilizing the Ambrose/Nantucket Safety Fairway.

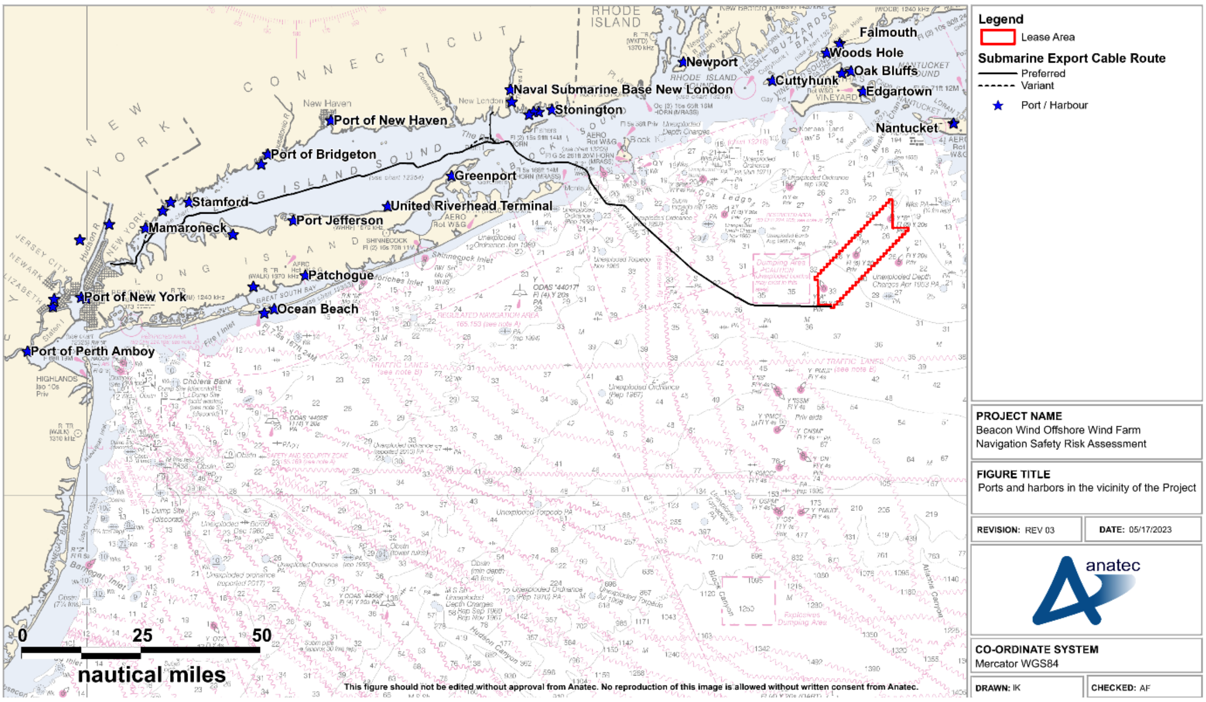

Figure 5.19 Ports and harbors in the vicinity of the Project

5.2 Bathymetric Data

5.2.1 Lease Area

The charted water depths within the Lease Area are presented in Figure 5.20, based on NOAA chart 12300. It is noted that NOAA presents water depths in fathoms over Mean Lower Low Water (MLLW) and these values have therefore been overlaid with the depths in feet over MLLW in Figure 5.20 for clarity.

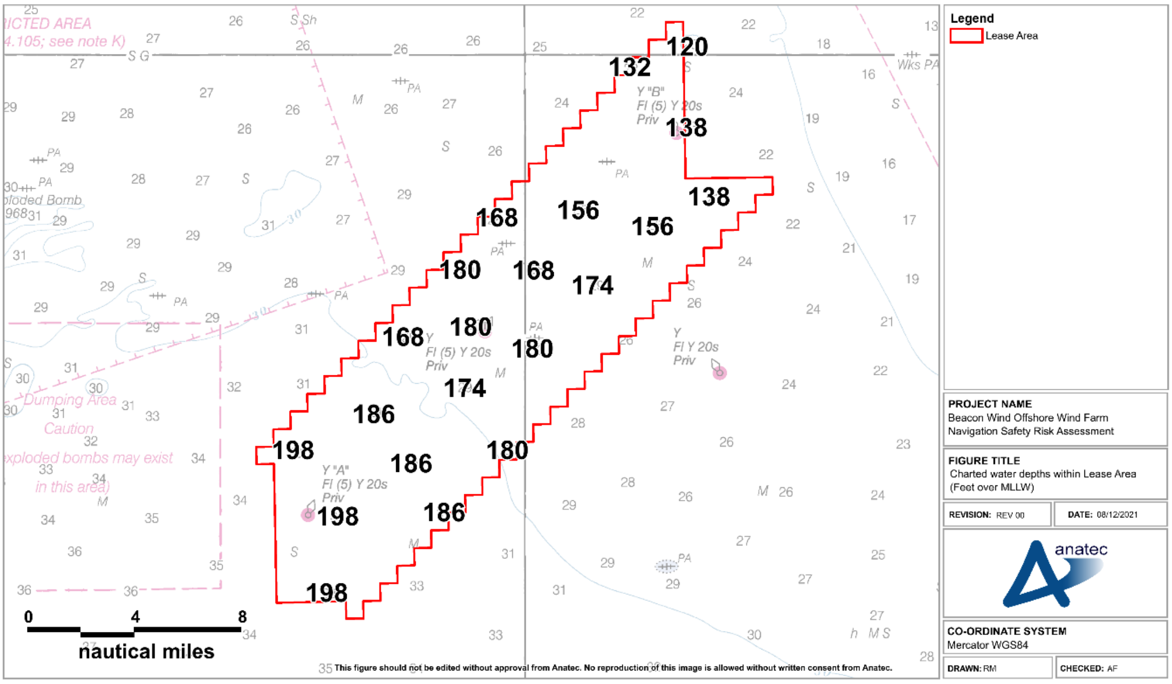

Figure 5.20 Charted water depths within Lease Area (Feet over MLLW)

Water depths are shallowest towards the northern extent of the Lease Area (approximately 120 ft [37 m]) and increase to the southwest to a maximum of 198 ft (60 m) at the southwestern extent.

5.2.2 Submarine export cable route

The shallowest charted water depths within the Submarine Export Cable Route Study Area are less than 1 ft (0.3 m) in the shallows in the East River and coastal areas throughout Long Island Sound, while depths of up to 311 ft (71.3 m) are charted at the entrance to Long Island Sound.

5.3 Meteorological Ocean Data

This section provides a high-level overview of the meteorological and oceanographical conditions in proximity of the Project. This data has been used as an input, where appropriate, for the collision, allision, and grounding risk modelling in Section 11.

5.3.1 Wind

Wind direction data is based on breakdowns at 10m above Mean Sea Level (MSL) based on hindcast modelling as detailed in the Equinor Metocean Report (ME2018-061) (Equinor 2020). The proportion of measurements within each wind direction category is provided in Table 5.1.

Table 5.1 Wind Direction Probabilities

Wind Direction (°)	Proportion (percent)
345–015	7.25
015–045	7.80
045–075	7.45
075–105	5.92
105–135	5.05
135–165	5.40
165–195	7.21
195–225	12.21
225–255	12.01
255–285	9.92
285–315	10.67
315–345	9.11

5.3.2 Wave

Sea state data is based on significant wave height data from the Global Reanalysis of Ocean Waves U.S. East Coast dataset provided by OceanWeather, and as reported in the Equinor Metocean Report (ME2018-061) (Equinor 2020). The three sea state categories and the corresponding proportion of measurements within each sea state category is provided in Table 5.2.

Table 5.2 Sea State Probability Data

Sea State	Significant Wave Height Range (m)	Proportion (percent)
Calm	0–1	19.19
Moderate	1–5	80.16
Severe	>5	0.65

5.3.3 Visibility

Visibility data is based on information from the *Admiralty Sailing Directions East Coast of the United States Pilot Volume 1 NP68* (UKHO 2016). From this source, the average probability of poor visibility within the area (defined as the proportion of the year where the visibility can be expected to be less than 1 km) is 8 percent.

It is noted that *United States Coast Pilot 2* (NOAA 2021) reports that on average the visibility in the "*coastal area south of Martha's Vineyard*" is less than 2 nm (3.7 km) for 10.7 percent of the year. The use of the 8 percent value for visibility less than 1 km is therefore considered suitable as a worst case input for modelling.

5.3.4 Tidal Streams

Tidal speed and direction data is based on the tidal diamond data taken from UKHO Admiralty charts. The peak flood and ebb directions and speeds for each tidal diamond considered is provided in Table 5.3.

Table 5.3 All-year peak flood and ebb tidal breakdown (UKHO Admiralty charts)

UKHO Admiralty Chart	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (knots)	Direction (°)	Speed (knots)
2456	M	020	4.2	200	3.7
2860	G	038	1.0	225	1.0
2860	H	031	2.8	205	2.6
2890	B	324	0.6	153	0.5

Based on the available data and the distance offshore of the Lease Area, no impacts are expected at high water that would not also be expected at low water, and vice versa. The surface structures located within the Lease Area are expected to have no impact on the existing tidal streams.

5.3.5 Tropical Cyclones

NOAA defines a hurricane as a tropical cyclone with sustained surface winds of ≥ 64 knots. The NOAA density grid illustrating tropical cyclone exposure (NOAA 2018) is shown relative to the Lease Area in Figure 5.21, with levels of exposure quantitatively defined using intersecting storm tracks, overlapping wind intensity areas, and mathematical return intervals. Following this, Figure 5.22 provides an indication of the density at a more localized level (within 50 nm [92.6 km) of the Lease Area) with suitably refined density range brackets.

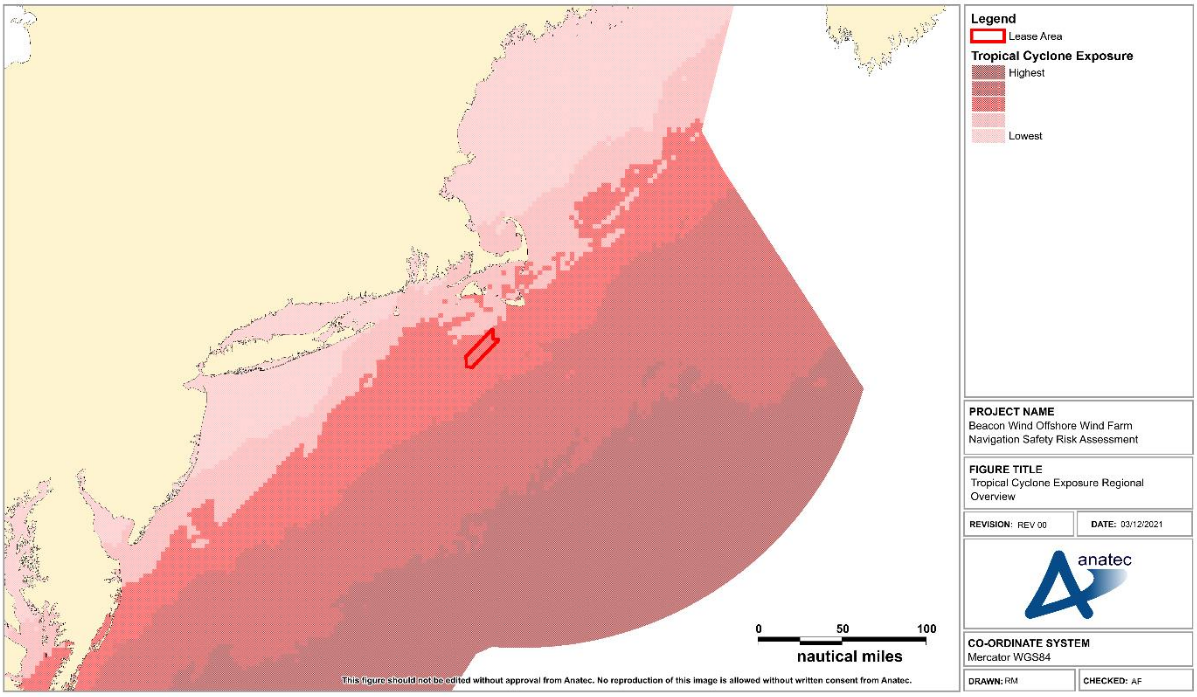

Figure 5.21 Tropical Cyclone Exposure Regional Overview

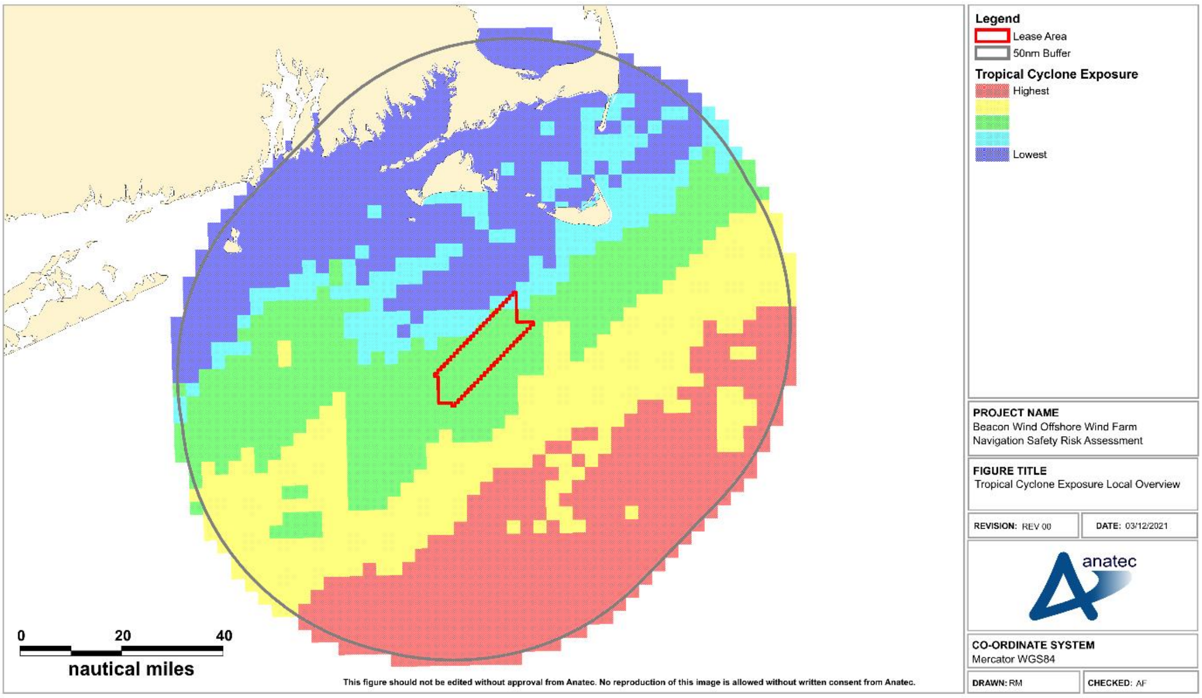

Figure 5.22 Tropical Cyclone Exposure Local Overview

The Lease Area is located in an area with moderate exposure to tropical cyclones. When considering a localized view, the exposure is again moderate owing to the proximity of the Lease Area to land, providing more shelter than areas further offshore with higher exposure.

Tropical cyclone data since 1900, based on data from the IBTrACS project provided by NOAA's National Centers for Environmental Information (NOAA 2021), is presented in Figure 5.23 within a 50 nm (92.6 km) area around the Lease Area color-coded based on the Saffir-Simpson Hurricane Wind Scale (SSHWS).

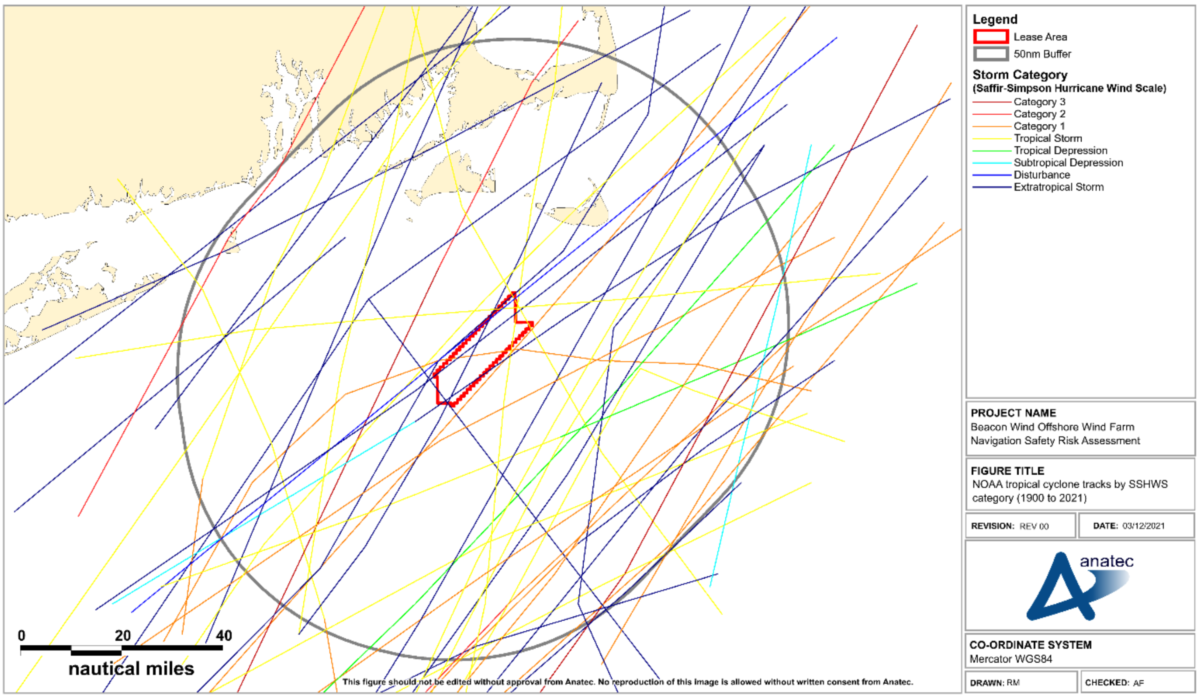

Figure 5.23 NOAA tropical cyclone tracks by SSHWS category (1900 to 2021)

Tropical cyclones recorded within 50 nm (92.6 km) of the Lease Area during this period included two Category 3 storms (*Hurricane Edna*, 1954 and *Hurricane Gerda*, 1969) and two Category 2 storms (*Hurricane Daisy*, 1958 and *Hurricane Bob*, 1991).

A total of nine tropical cyclones were recorded intersecting the Lease Area, consisting of one Category 1 storm (*Hurricane Esther* in September 1961), three Tropical Storms, five Extratropical Storms and one Disturbance. Four of these tropical cyclones were recorded since 2000, with the most recent being an extratropical storm in 2016.

Given that NOAA's Historical Hurricane Tracks database covers 120 years and no major hurricanes (defined as Category 3 or higher) have been recorded within the Lease Area, the likelihood of such an instance is low. In terms of the wider 50 nm (92.6 km) area around the Lease Area, the most recent major hurricane, *Hurricane Gerda* was recorded in September 1969, i.e., no major hurricanes have been recorded within 50 nm (92.6 km) of the Lease Area in the past 52 years.

Based on the low frequency of tropical cyclones at the Lease Area, and the generally low intensity of the few tropical cyclones which have been recorded, there is not anticipated to be any significant impacts on shipping and navigation relating to tropical cyclones, noting that in such circumstances vessels are less likely to be making passage in the area.

5.3.6 Ice

United States Coast Pilot 2 (NOAA 2021) states the following for the region spanning Cape Cod to Sandy Hook:

> *'Heavy winter weather can cause ice to collect on ships sailing these waters. At its worst superstructure icing can sink a vessel. When air temperature drops below the freezing point of sea water (About 28.6 °F) strong winds and rough seas will cause large amounts of sea spray to freeze to the superstructure and those parts of the hull that escape a frequent washing by the sea'.*

In terms of ice accumulation rates relative to air temperature and wind speeds, the following is observed:

> *'Moderate rate of ice accumulation usually occurs when air temperatures are equal to or less than 28°F with winds of 13 knots or more. When air temperatures drop to 16°F or below and winds reach 30 knots or greater, ice collects more rapidly'*.

In addition to sea ice, there is a possibility of icing of the wind turbine blades which may lead to ice throw during wind turbine operation, potentially striking vessels in proximity. The paper *Icing Problems of Wind Turbines in Cold Climates* (Hudecz, A., Hansen, M.O.L., Battisti, L. & Villumsen, A. 2014) found that for a case study of South Greenland low wind speeds, high relative humidity and sub-zero temperatures gave rise to the threat of turbine icing. The following subsections present recent historical data for air temperature, wind speed and humidity within an area local to the Project.

Within this subsection, weather data including air temperature, wind speed, and relative humidity have been taken from Nantucket Memorial Airport Weather Station, provided by the United States National Climactic Data Center (NCDC) and processed by the Iowa Environmental Mesonet (IEM) for a 10-year period between 2011 and 2020 inclusive.

5.3.6.1 Air Temperature

The distribution of air temperature is presented in Figure 5.24 based upon the weather data period detailed in Section 5.3.6.

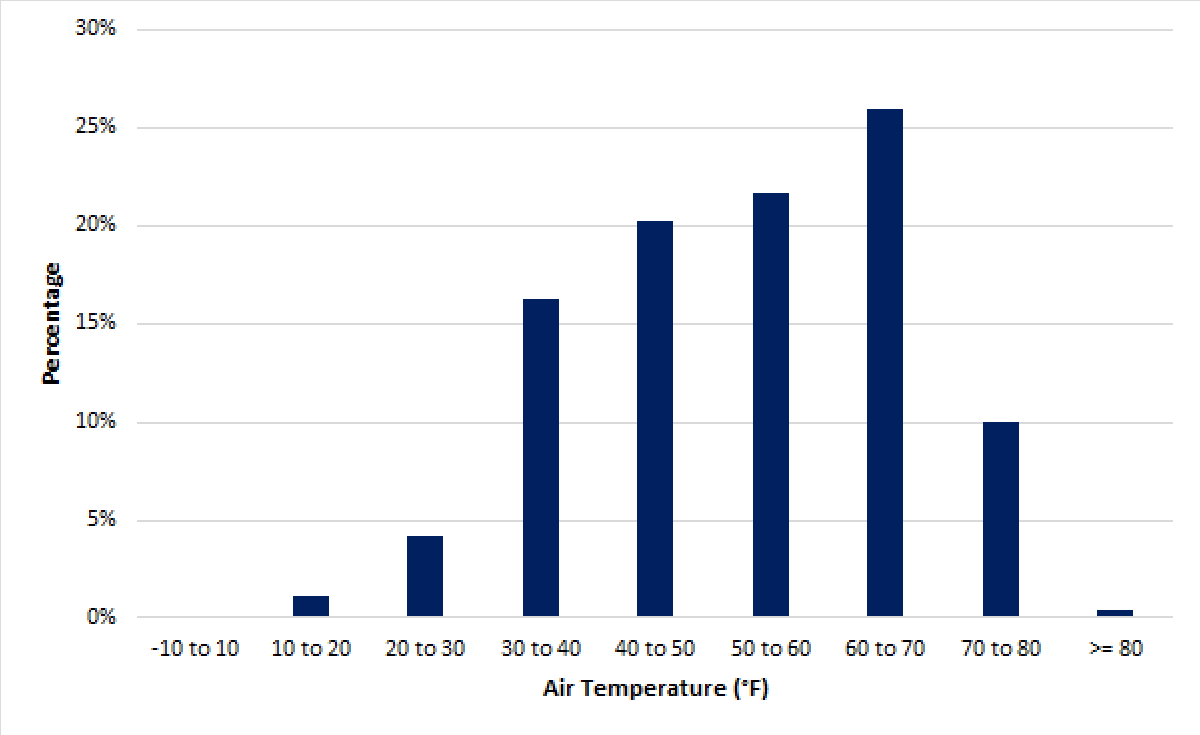

Figure 5.24 Air temperature distribution from 2011 to 2020 (NCDC & IEM 2021)

Based on the data presented in Figure 5.24, the air temperature is less than or equal to 28°F for on average 4.2 percent of the year, and less than or equal to 16°F (at which ice accumulates more rapidly) for on average 0.5 percent of the year.

5.3.6.2 Wind Speed

The distribution of wind speed based upon the weather data period detailed in Section 5.3.6 is presented in Figure 5.25.

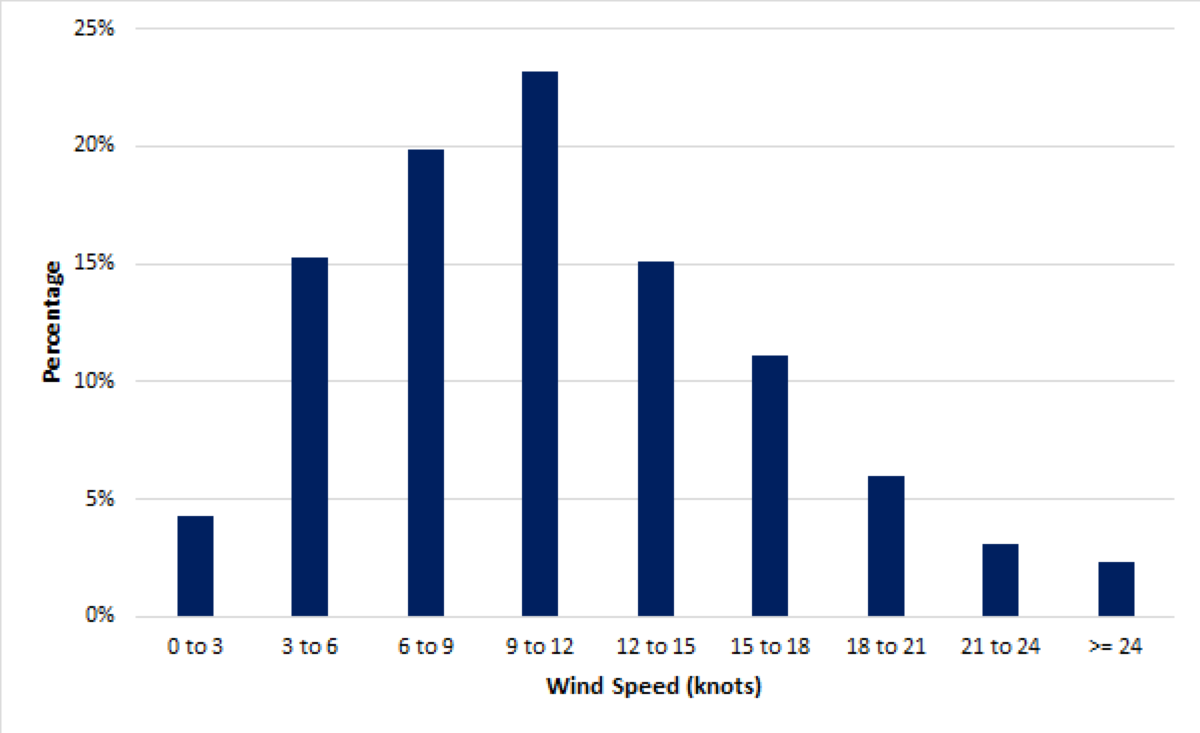

Figure 5.25 Wind speed distribution from 2011 to 2020 (NCDC & IEM 2021)

During the 10-year period, winds of 13 knots or greater were observed for on average 33 percent of the year while winds of 30 knots or greater occurred during on average 0.5 percent of the year.

5.3.6.3 Humidity

The distribution of relative humidity percentage based upon the weather data period detailed in Section 5.3.6 is presented in Figure 5.26, color-coded by temperature thresholds based on the freezing temperature of water.

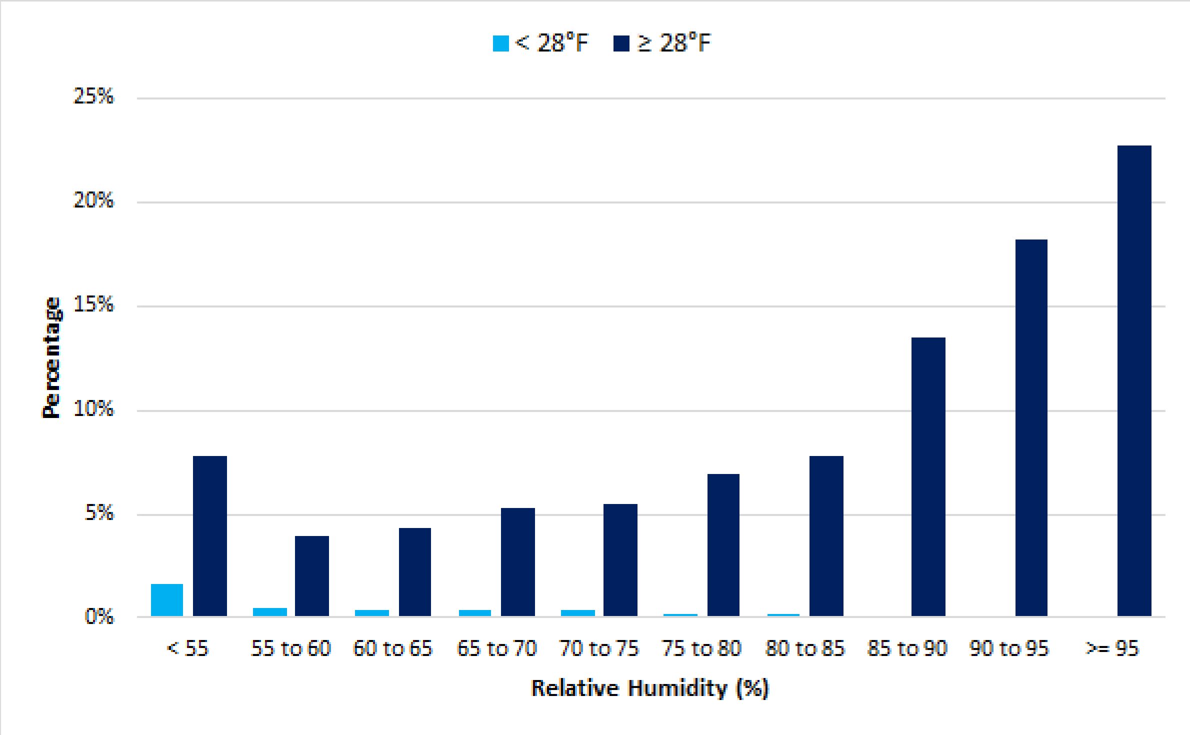

Figure 5.26 Relative humidity distribution from 2011 to 2020 (NCDC & IEM 2021)

It can be seen that the relative humidity for below freezing temperatures is significantly lower. The relative humidity at below freezing temperatures was recorded between 90 and 95 percent on average 0.1 percent of the year, while no instances of below freezing temperatures coinciding with relative humidity above 95 percent were recorded during the 10-year period.

5.3.6.4 Ice Impact Summary

In terms of sea ice, from the data sets presented and analyzed the combination of air temperature and wind speed conditions under which moderate ice accumulation occurs (less than or equal to 28°F and more than or equal to 13 knots, respectively) was observed on average during 2 percent of the year. The combination of air temperature and wind speed conditions resulting in rapid ice accumulation (i.e., less than or equal to 16°F and greater than or equal to 30 knots) occurred for on average 0.001 percent of the year.

In terms of ice throw from wind turbines, the conditions favorable to ice accretion on wind turbine blades (below freezing temperatures combined with relative humidity greater than or equal to 95 percent and wind speeds less than 5 meters per second (m/s)) were not found to occur simultaneously during the 10-year period analyzed.

Therefore, there are not anticipated to be any significant impacts on shipping and navigation relating to ice, both in terms of sea ice and ice throw from wind turbines.

6 Maritime Traffic and Vessel Characteristics

6.1 AIS Overview

AIS data collected during the entirety of 2019 has been assessed as per Section 1.4. To ensure coverage of the area is as comprehensive as practicable, this data has been commercially purchased from multiple sources, noting that this includes AIS transmissions collected by both satellite and terrestrial receivers. The transmissions have been combined into a single dataset, noting that this process includes the detection of duplicate transmissions between the separate datasets, such that only one instance of a transmission is included in the combined master dataset.

It is noted that the dataset spans a 12-month period which predates the global impact of the COVID-19 pandemic on the shipping industry, and has been agreed with the USCG and BOEM as suitable for the purposes of establishing the vessel traffic baseline (see Section 3.1).

Any recorded data from vessels determined to be engaged in works considered as temporary (e.g., survey work) has been excluded from the analysis in this section. Where there was doubt as to whether or not a vessel was engaged in temporary activity, the tracks have been retained.

6.1.1 Automatic Identification System Carriage Requirements

Regulation 19 of the International Regulations for the Safety of Life at Sea (SOLAS) Chapter V – Carriage requirements for vessel borne navigational systems and equipment, requires that AIS shall:

- Provide information – including the vessel's identity, type, position, course, speed, navigational status and other safety-related information – automatically to appropriately equipped shore stations, other vessels and aircraft; and
- Receive automatically such information from similarly fitted vessels; exchange data with shore-based facilities.

The SOLAS legislation has been translated in the U.S. Flag State legislation by the Code of Federal Regulations (CFR). It requires that the following vessels shall carry an AIS Class A device:

I. A self-propelled vessel of 65 ft (19.8 m) or more in length, engaged in commercial service;
II. A towing vessel of 26 ft (7.9 m) or more in length and more than 600 horsepower (HP), engaged in commercial service;
III. A self-propelled vessel that is certified to carry more than 150 passengers;
IV. A self-propelled vessel engaged in dredging operations in or near a commercial channel or shipping fairway in a manner likely to restrict or affect navigation of other vessels; and

V. A self-propelled vessel engaged in the movement of:

- Certain dangerous cargo as defined in 33 CFR § 160.204; or
- Flammable or combustible liquid cargo in bulk that is listed in 46 CFR § 30.25-1.

Certain vessels may carry an AIS Class B device in lieu of an AIS Class A device if they are not subject to pilotage by a person other than the vessel Master or crew, including:

- Fishing industry vessels;
- Vessels identified in regulation I. above that are certificated to carry less than 150 passengers and that:
    - Do not operate in a Vessel Traffic Service (VTS) or Vessel Movement Reporting System (VMRS); and
    - Do not operate at speeds in excess of 14 knots;
- Vessels identified in regulation IV above engaged in dredging operations.

On this basis, it should be considered that certain vessel types (notably recreational vessels and fishing vessels of less than 65 ft [19.8 m] in length) are not required to broadcast via AIS.

It should be noted that despite such vessels being exempt from AIS broadcast requirements, it is U.S. Navy policy for its warships to transmit via AIS when within congested areas during peacetime.

6.1.2 Data Coverage

It should be considered that within the AIS data set used, the collection frequency of the satellite receivers was less than that of the onshore receivers, and therefore coverage further offshore was observed to drop when compared to nearshore areas. Additionally, it should also be considered that the following factors can affect AIS coverage:

- Weather;
- Atmospheric conditions;
- Size of the vessel carrying the AIS transmitter;
- Antenna height on the vessel carrying the AIS transmitter; and
- Height of the onshore antenna.

The assessment of 12 months of data within this section is considered as accounting for any seasonal variations in vessel traffic levels, types, or behaviors.

6.1.3 Vessel Dimension Units

The *USCG AIS Encoding Guide* (USCG 2015) requires vessel dimensions transmitted via AIS to be in meters (m) (rather than ft). However, vessels transmitting their dimensions in ft were observed within the AIS data assessed in this NSRA. As far as is practicable, Anatec has made reasonable efforts to ensure that all vessel dimensions have been converted into a consistent unit system (dimensions within this report are presented primarily in ft, with metric units also included for reference in brackets where appropriate), however confirming the correct dimensions for every vessel recorded was not practical for the length and draft analysis undertaken given the high volume of data assessed.

6.2 Lease Area Automatic Identification System Data

Figure 6.1 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel type. It is noted that an Area To Be Avoided (see Section 5.1.7) is marked on NOAA charts and intersects a small fraction of the easternmost portion of the Study Area; it is noted on charts that *'all vessels carrying cargoes of oil or hazardous materials and all other vessels of more than 1,000 gross tons should avoid the area'*.

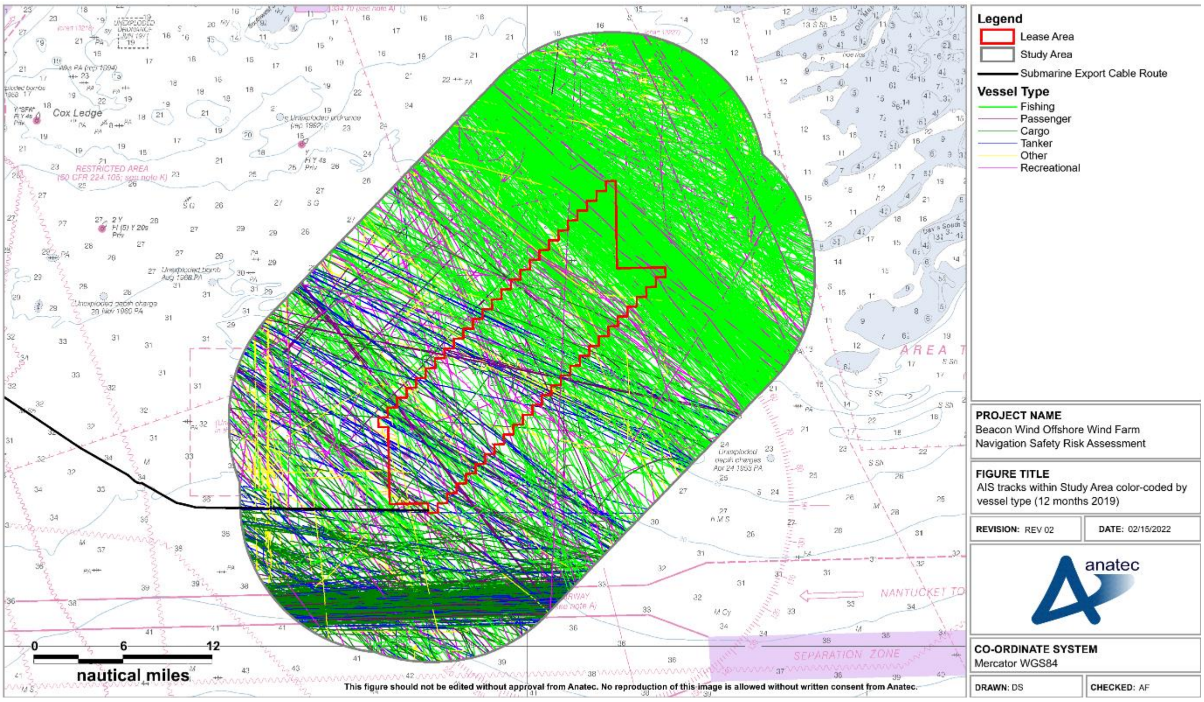

Figure 6.1 AIS tracks within Study Area color-coded by vessel type (12 months January to December 2019)

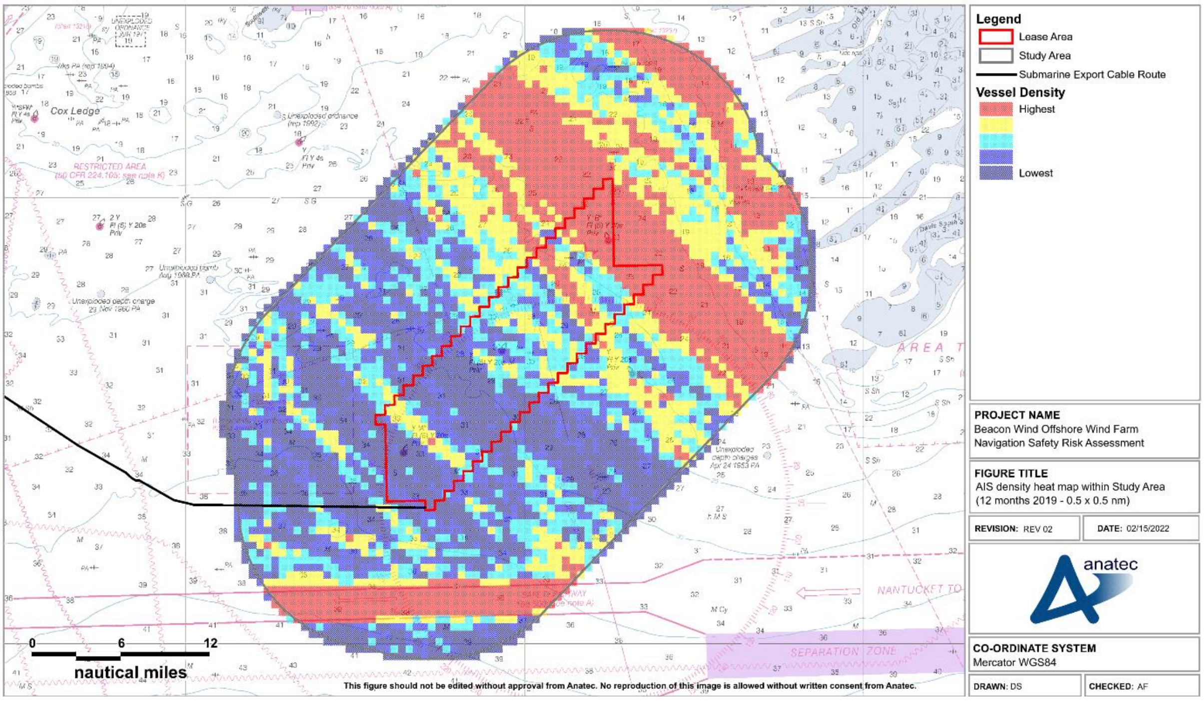

Figure 6.2 AIS density heat map within Study Area (12 months January to December 2019) – 0.5 × 0.5 nm (0.9 × 0.9 km) Cell Resolution

The highest density areas were the westbound Ambrose/Nantucket Safety Fairway lane to the south of the Lease Area, primarily used by commercial vessels, and the dense band of fishing vessels in the northern extent of the Lease Area, which were observed to be transiting in a NW-SE direction to fishing grounds in the vicinity of the Ambrose/Nantucket Safety Fairway separation zone to the SE. A number of fishing vessels also contributed to a high density area in the NE portion of the Study Area.

6.2.1 Vessel Count

Figure 6.3 presents the average number of unique vessels recorded per day for each month of 2019 within both the Study Area and the Lease Area itself.

It is noted that a unique vessel is defined as an individual vessel identified on any given calendar day, irrespective of the number of AIS tracks recorded for a given vessel on that day. This ensures that vessels are not over-counted. Individual vessels were identified using their Maritime Mobile Service Identity (MMSI) number.

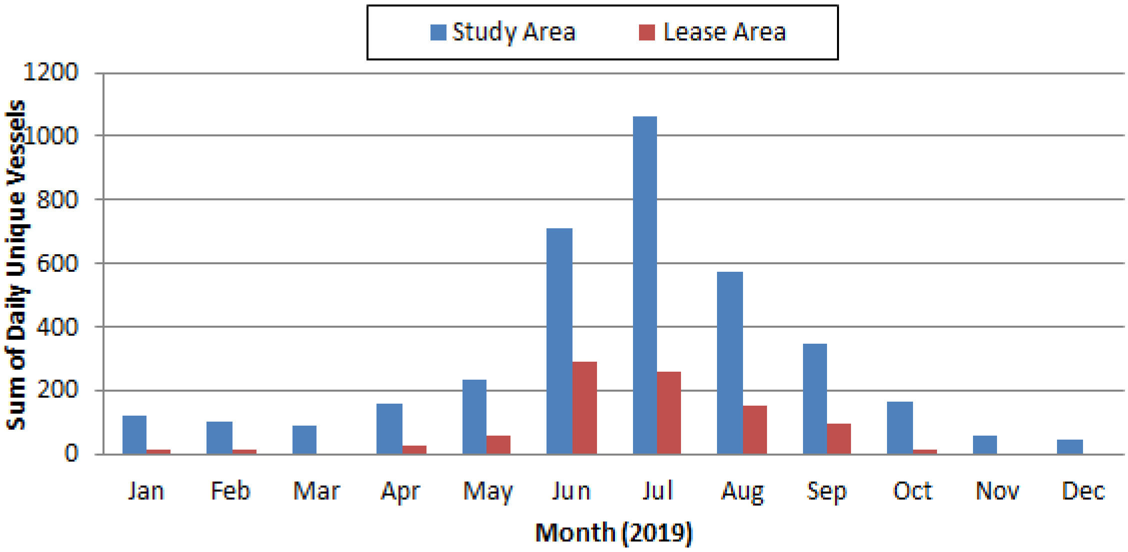

Figure 6.3 Average monthly vessel count

Throughout the survey period an average of approximately 10 unique vessels per day was recorded within the Study Area. The busiest month in 2019 was June, with an average of approximately 34 unique vessel per day, while the busiest day was 17th July with 57 unique vessels recorded. Vessel traffic was observed to be highest during the summer months, which is reflected in the high numbers of fishing vessels recorded in the data, which exhibited seasonal variation with higher vessel numbers between May and September.

Considering only those vessel tracks intersecting the Lease Area, there was an average of two to three unique vessels per day recorded during 2019. The busiest month was June, with an average of approximately 10 unique vessels per day, while the busiest individual day was 29th June, each with 23 unique vessels recorded. Overall, approximately 26 percent of vessels recorded within the Study Area intersected the Lease Area.

The AIS tracks recorded during the busiest month (July 2019) within the Study Area are presented in Figure 6.4.

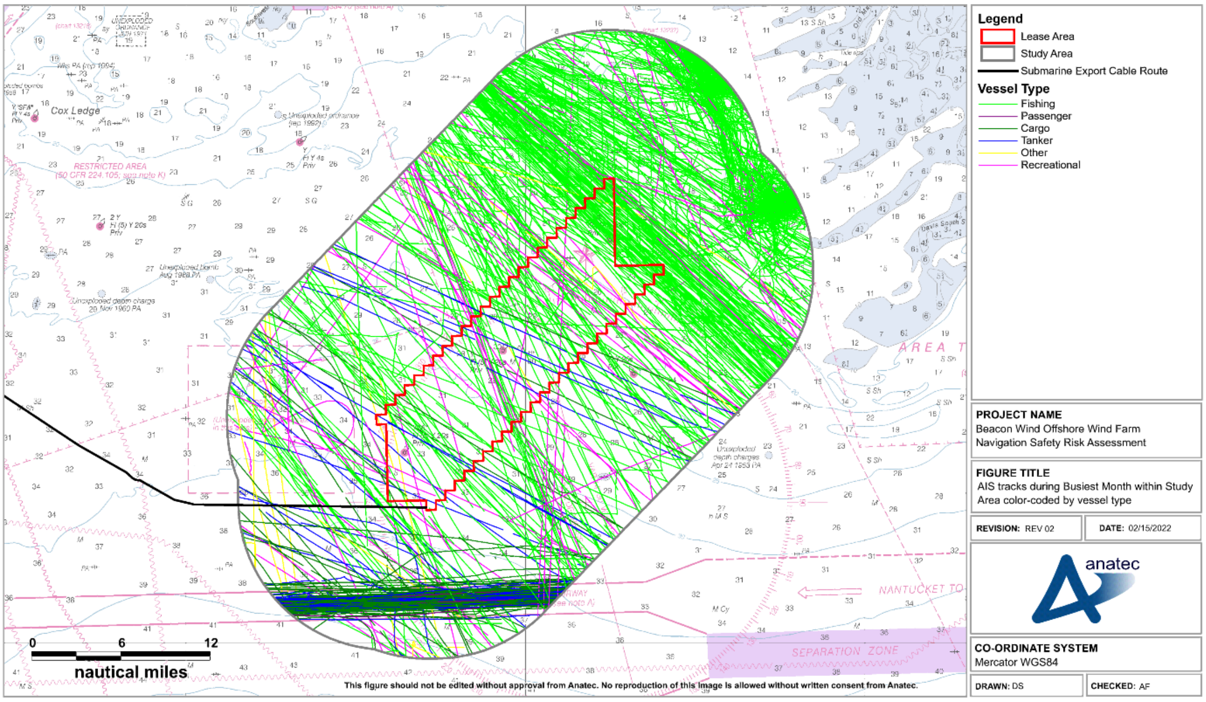

Figure 6.4 AIS tracks during Busiest Month within Study Area color-coded by vessel type

6.2.2 Vessel Size

This section assessed vessel size, based on the AIS data. It should be read in conjunction with Section 6.1.3.

6.2.2.1 Vessel Length

Figure 6.5 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel length. Following this, Figure 6.6 presents the corresponding distribution of vessel lengths. It is noted that a limited proportion of vessel tracks (approximately 1.5 percent) could not be associated with a valid length and have therefore been excluded from the analysis.

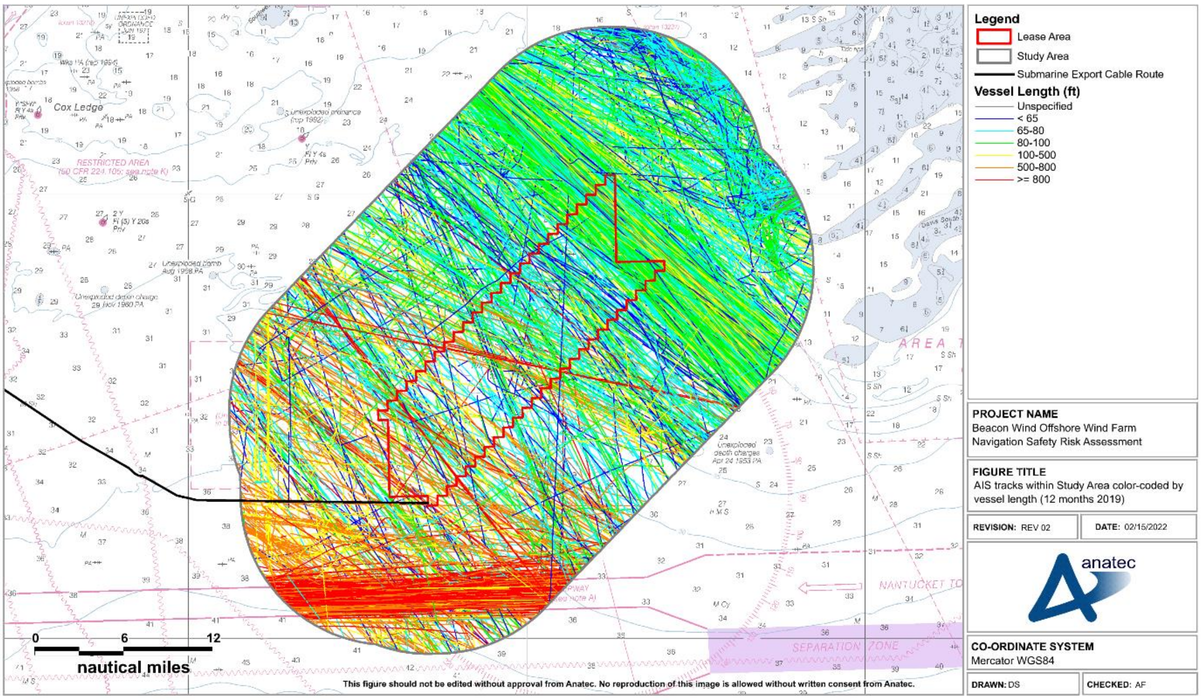

Figure 6.5 AIS tracks within Study Area color-coded by length (12 months January to December 2019)

The majority of larger vessels were observed to utilize the safety fairway to South, with vessels in the Lease Area tending to be smaller in size.

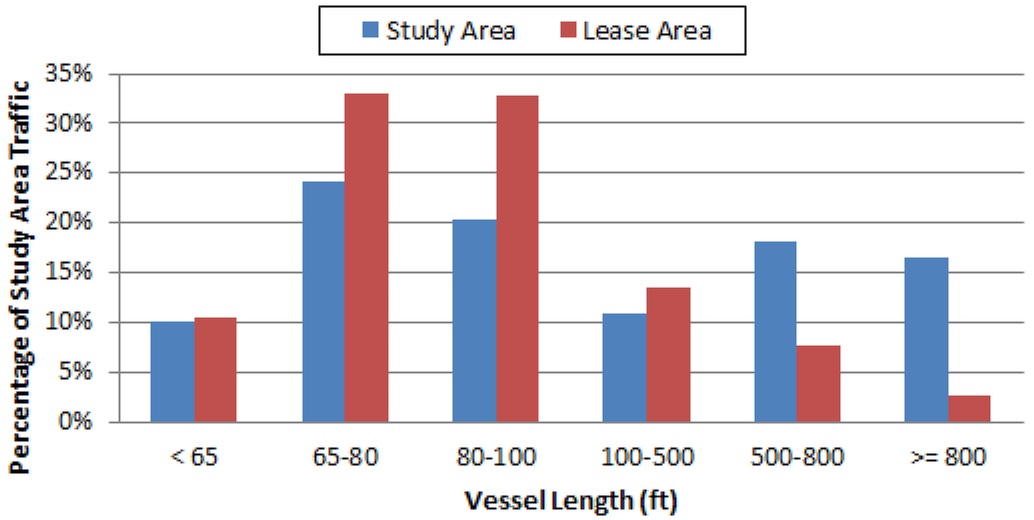

Figure 6.6 Vessel length distribution (12 months January to December 2019)

Excluding those vessel tracks without a valid length, the average length of vessels recorded within the Study Area throughout the survey period was 343ft (105 m).

6.2.2.2 Vessel Draft

Figure 6.7 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel draft. It is noted that 59 percent of vessel tracks did not broadcast a valid draft, largely due to the high number of fishing vessels with Class B AIS transceivers on board, for which broadcasting draft is not a requirement. Figure 6.8 presents the corresponding distribution of vessel drafts, excluding the tracks from vessels which could not be associated with a valid draft.

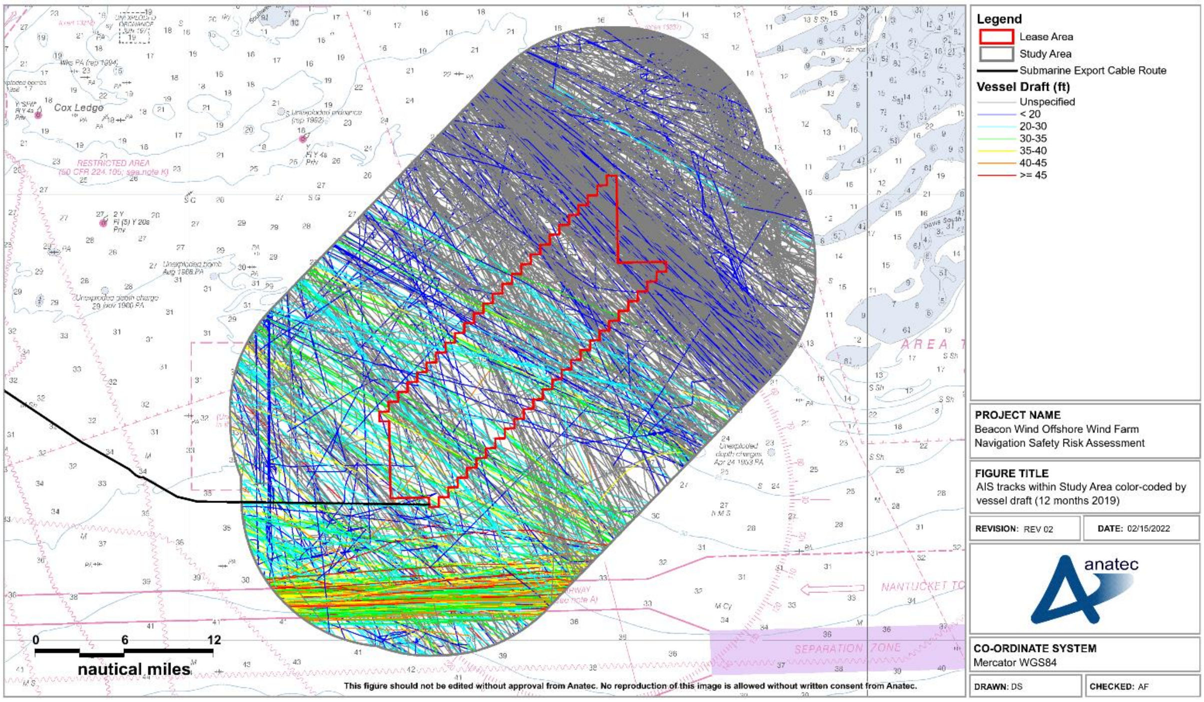

Figure 6.7 AIS tracks within Study Area color-coded by draft (12 months January to December 2019)

The majority of deeper drafted vessels were observed to utilize the Ambrose/Nantucket Safety Fairway to the south, with vessels in the Lease Area tending to have shallower drafts.

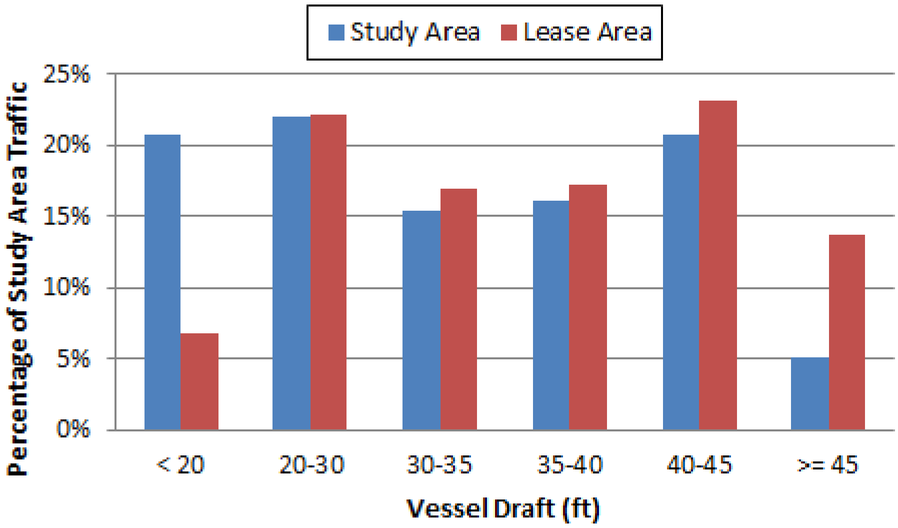

Figure 6.8 Vessel draft distribution (12 months January to December 2019)

Excluding those vessels not broadcasting a valid draft (the majority of which were observed to be military vessels), the average draft recorded within the Study Area was 30.8 ft (9.4 m).

The deepest draft recorded in the Study Area was 49.5 ft (15.1 m), recorded by a chemical and oil tanker.

When considering only those vessel tracks intersecting the Lease Area, the average draft of vessels was 21.2 ft (6.5 m). The deepest draft recorded within the Lease Area was 44.3 ft (13.5 m), recorded by a container vessel.

It should be considered that given vessels with unspecified drafts tend to be relatively small (e.g., fishing, recreation), the averages presented in this section are likely to be weighted towards larger vessels.

6.2.3 Vessel Speed

Figure 6.9 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel speed. Figure 6.10 then presents the corresponding distribution of vessel speeds.

It should be considered that the SMA described in Section 5.1.7 intersects the Study Area and as such, between the months of November and April, all vessels of 65 ft (19.8 m) in length or greater are restricted to speeds of 10 knots or less when entering the SMA. The SMA boundary is included in Figure 6.9 for reference.

Within this section, the speed of a track refers to the average of all speeds transmitted by the corresponding vessel associated with that track.

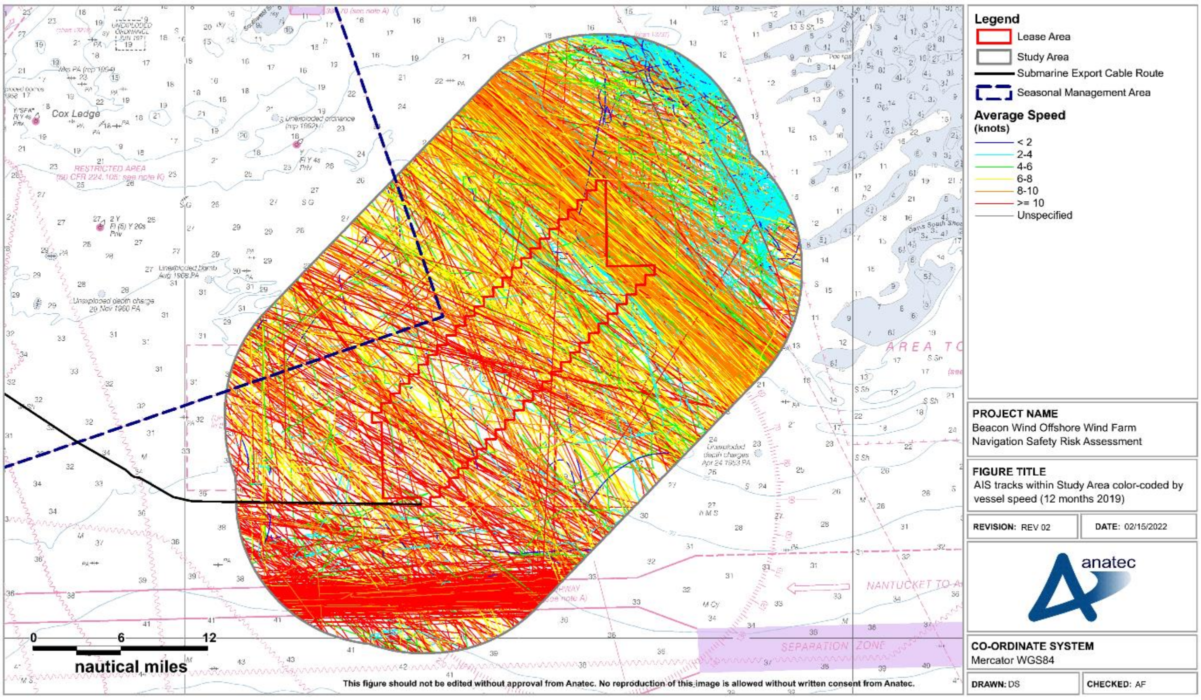

Figure 6.9 AIS tracks within Study Area color-coded by vessel speed (12 months January to December 2019)

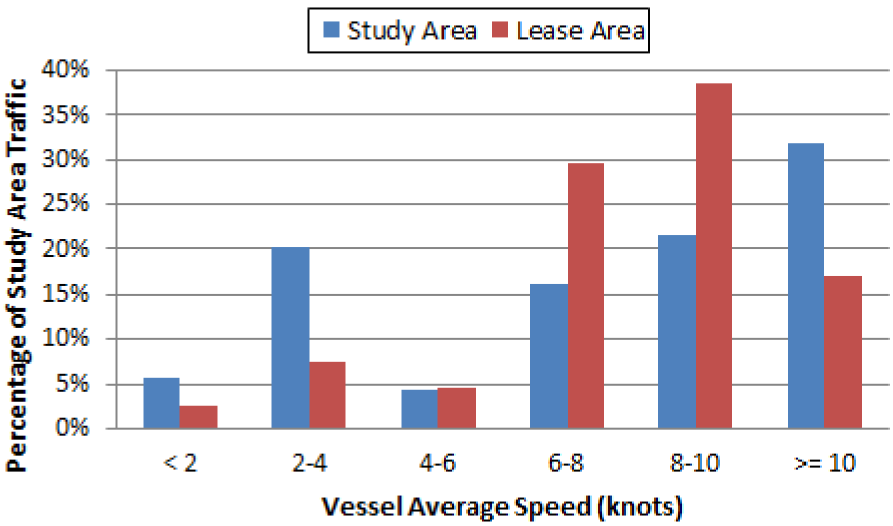

Figure 6.10 Vessel speed distribution (12 months 2019)

The average speed recorded within the Study Area was 8.5 knots, noting that no anchoring activity was recorded within the Study Area (see Section 6.6.3).

6.2.4 Vessel Type

6.2.4.1 Overview

Figure 6.1 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel type. The 'other' vessels category includes USCG cutters, research/survey vessels, and push/tow vessels.

Figure 6.11 presents the average daily unique vessel count by type within both the Study Area and the Lease Area itself.

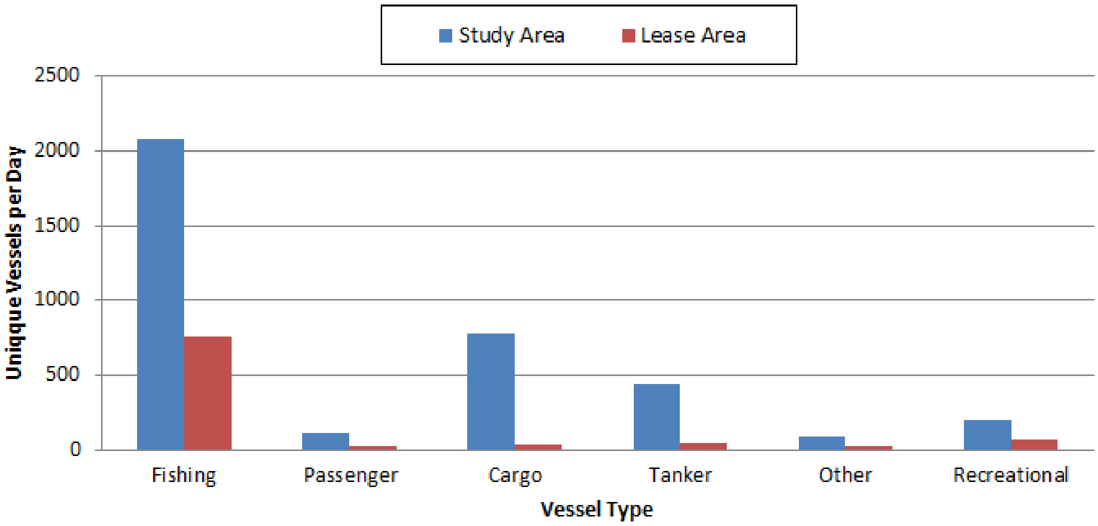

Figure 6.11 Vessel count by type

Throughout the survey period the most frequently recorded vessel types within the Study Area were fishing vessels (representing approximately 56 percent of all recorded traffic) followed by cargo vessels (21 percent) and tankers (12 percent).

When considering only those vessel tracks intersecting the Lease Area, fishing vessels remain the most frequently recorded vessel type (approximately 21 percent of all vessel traffic within the Study Area) followed by recreational vessels (2 percent) and passenger vessels (1 percent).

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

6.2.4.2 Fishing Vessels

Figure 6.12 presents a plot of the fishing vessel tracks recorded within the Study Area throughout the survey period color-coded by average track speed. Fishing vessels accounted for approximately 55 percent of traffic within the Study Area and 79 percent within the Lease Area.

As inferred in Section 6.1.1, the AIS carriage requirements do not extend to smaller craft including some fishing vessels. The AIS data alone is therefore not considered to provide a comprehensive characterization of fishing vessel movements within and in proximity to the Lease Area. Therefore, the NSRA also includes analysis of additional VMS fishing vessel data (see Section 6.4) and visual observation surveys (see Section 6.5) in order to validate the findings of the AIS data assessment.

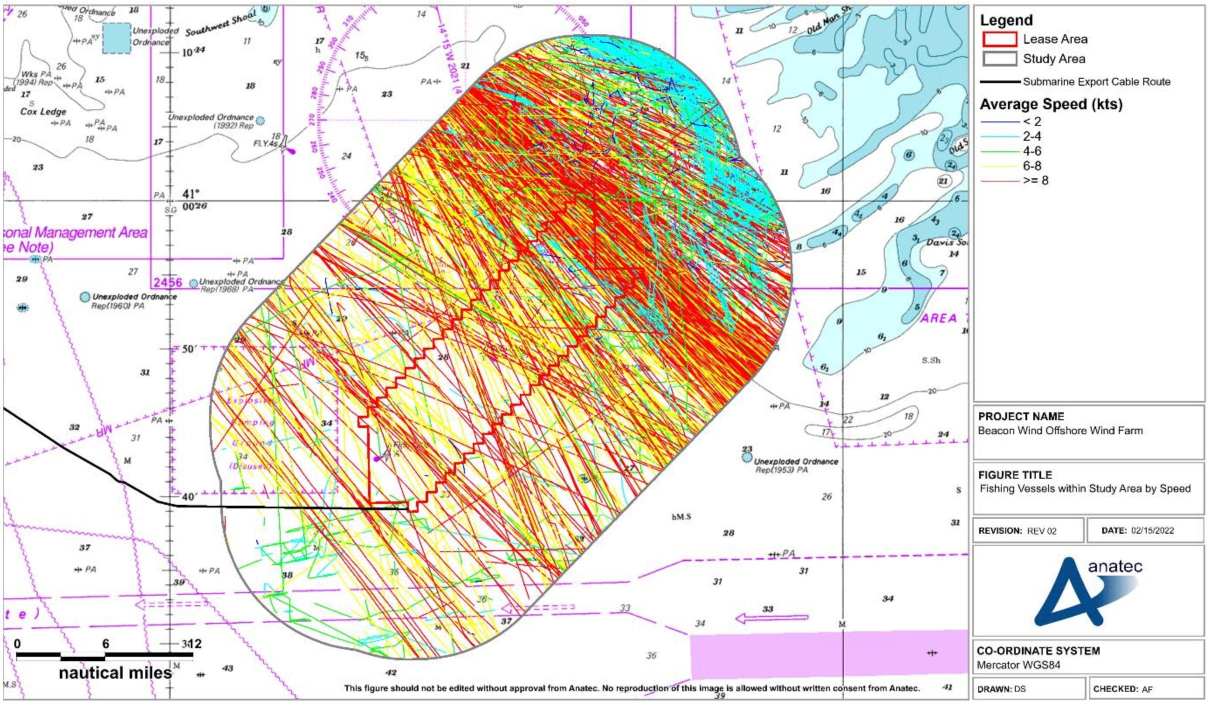

Figure 6.12 Fishing vessel tracks within Study Area by vessel speed (12 months January to December 2019)

Throughout the survey period an average of five to six unique fishing vessels per day was recorded within the Study Area, with two per day recorded intersecting the Lease Area itself. The high levels recorded are predominantly due to a NW-SE transiting fishing route passing through the northern part of the Lease Area, headed for fishing grounds located within the Ambrose/Nantucket Safety Fairway.

Fishing vessels were recorded both in transit through the Study Area and engaged in fishing activity (i.e., gear deployed). It is also known that non-AIS fishing activity does take place within the Lease Area, and therefore active fishing activity is likely to be underrepresented in the data. Further analysis of Vessel Monitoring System (VMS) data is undertaken for fishing vessels in Section 6.4.1, noting that this may not capture the smaller fishing vessels.

6.2.4.3 Commercial Vessels

Figure 6.13 presents a plot of the cargo vessel tracks recorded within the Study Area throughout the survey period, color-coded by cargo vessel type. Cargo vessels accounted for 21 percent of traffic within the Study Area and 4 percent within the Lease Area.

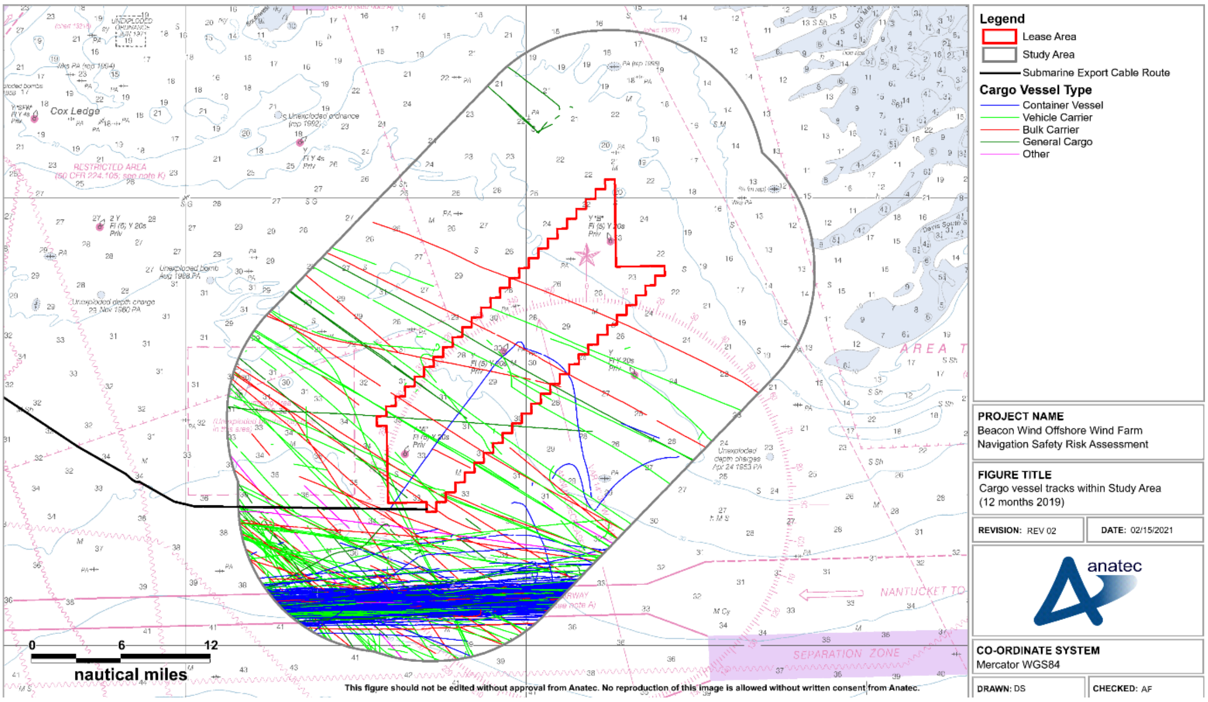

Figure 6.13 Cargo vessel tracks within Study Area (12 months January to December 2019)

Throughout the survey period, an average of two unique cargo vessels per day was recorded within the Study Area and an average less than one per week within the Lease Area. Container vessels were the most frequently recorded cargo vessel type within the Study Area (61 percent) followed by vehicle carriers (21 percent) and bulk carriers (12 percent).

The vast majority of cargo vessels were recorded transiting westbound within the Ambrose/Nantucket Safety Fairway south of the Lease Area.

Figure 6.14 presents a plot of the tanker tracks recorded within the Study Area throughout the survey period. Tankers accounted for approximately 12 percent of traffic within the Study Area and 5 percent within the Lease Area.

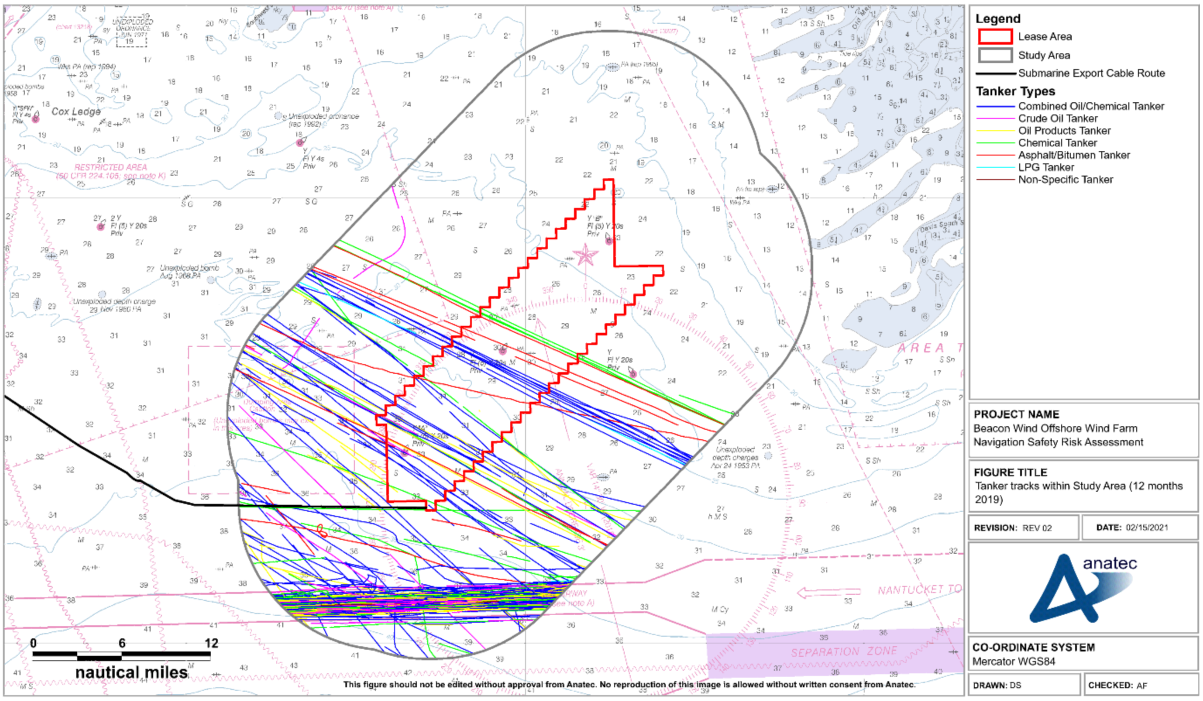

Figure 6.14 Tanker tracks within Study Area (12 months January to December 2019)

Throughout the survey period an average of one tanker per day was recorded within the Study Area and approximately one per week within the Lease Area.

As with cargo vessels, tankers were most prominently recorded within the Ambrose/Nantucket Safety Fairway, with a smaller proportion transiting NW-SE through the central and southern portions of the Lease Area.

Figure 6.15 presents a plot of the passenger vessel tracks recorded within the Study Area throughout the survey period. Passenger vessels accounted for approximately 3 percent of traffic within the Study Area and 2 percent within the Lease Area.

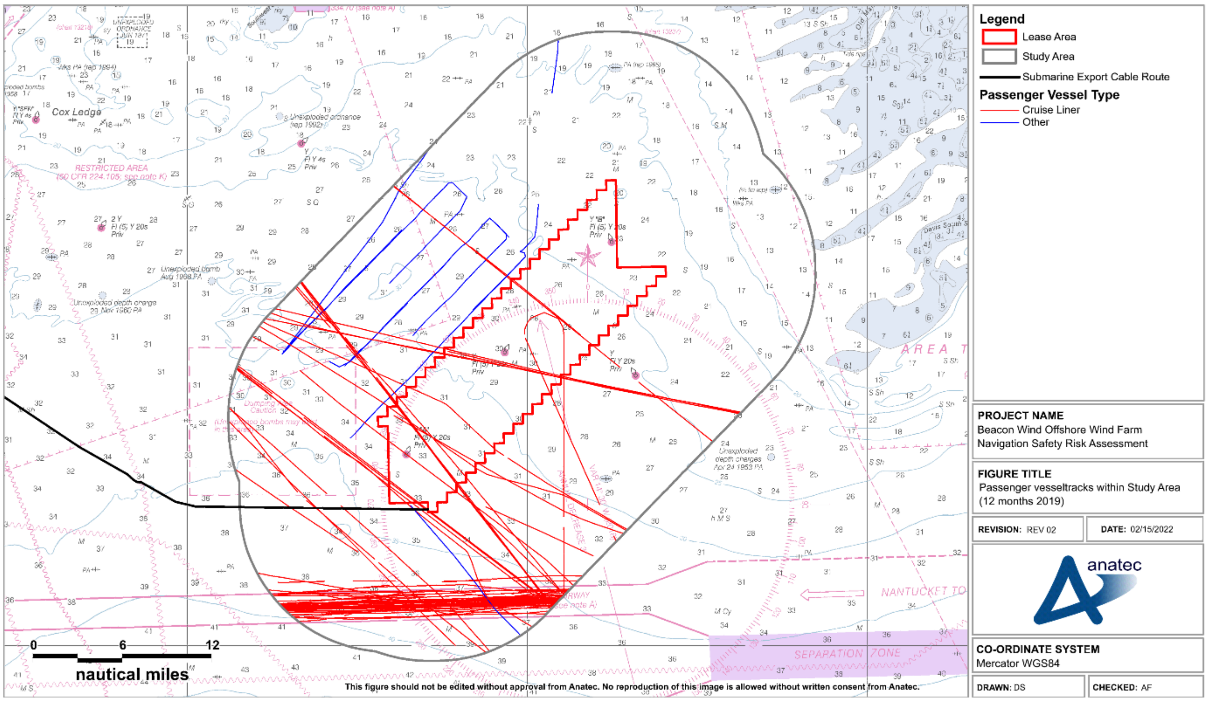

Figure 6.15 Passenger vessel tracks within Study Area (12 months January to December 2019)

Throughout the survey period an average of one passenger vessel every two days was recorded within the Study Area and approximately one per week within the Lease Area.

The majority of passenger vessels recorded were cruise ships within the Ambrose/Nantucket Safety Fairway.

6.2.4.4 Recreational Vessels

Figure 6.16 presents a plot of the recreational vessel tracks recorded within the Study Area throughout the survey period. Recreational vessels accounted for approximately 4 percent of traffic within the Study Area and 7 percent within the Lease Area. It is noted that recreational vessels include small privately chartered fishing excursions (transiting only).

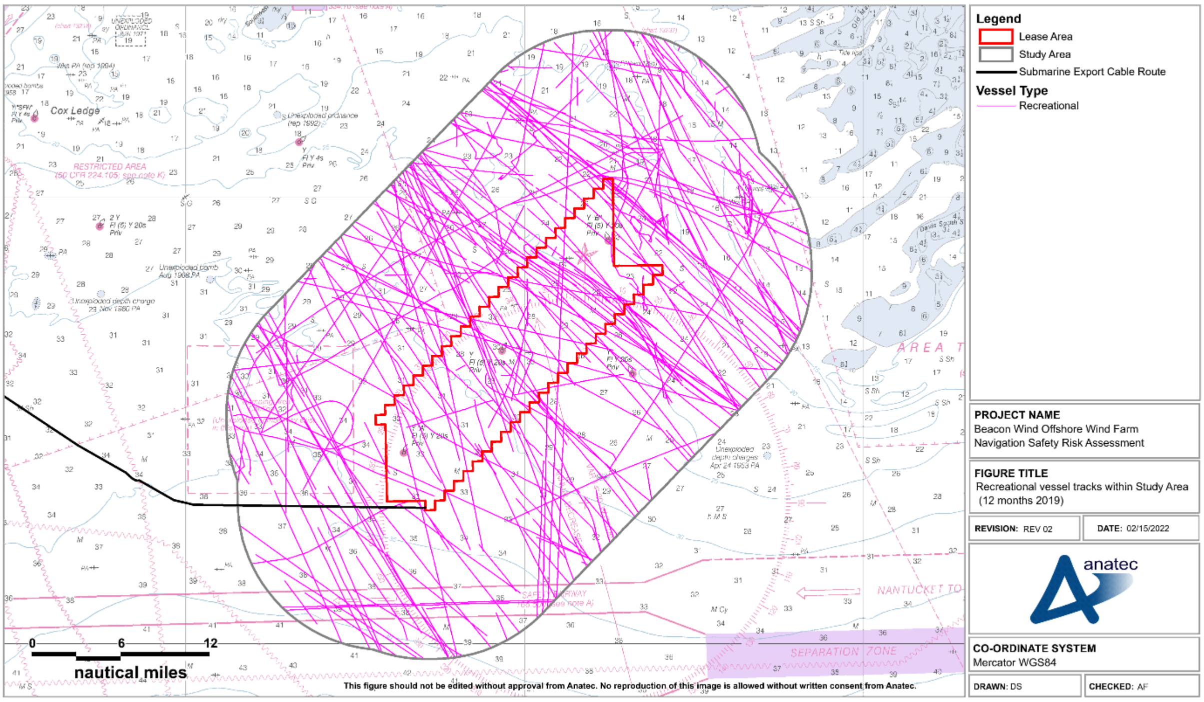

Figure 6.16 Recreational vessel tracks within Study Area (12 months January to December 2019)

The busiest months within the Study Area were June and July with two vessels per day recorded on average, while no month between October and May recorded more than one vessel per week.

A total of 68 recreational vessels were recorded via AIS within the Lease Area during the year of data analyzed, with the vast majority recorded in June and July. The majority of these were small privately owned sailing vessels or motor yachts averaging 50 ft (15.2 m) in length (noting this excludes any vessel that did not transmit length information via AIS).

It is likely a notable proportion of recreational vessels operating in the region do not broadcast on AIS, and therefore the tracks are considered to provide only an indication of the recreational activity in the area. However, the low level recorded via AIS is considered indicative of the offshore location of the Lease Area. As per Section 6.5, based on visual observation survey data it is estimated that approximately half of recreational vessels broadcast on AIS.

6.2.4.5 Anchored Vessels

Vessels at anchor have primarily been identified based on navigational status transmitted via AIS. However, given that this requires manual input into the vessel's AIS unit, an incorrectly transmitted navigational status is observed to be common. Therefore, the vessels transmitting a status other than "At Anchor" were filtered using a set of behavioral criteria[8]

[8] Vessels recorded travelling at less than 1 knot for at least 30 minutes.

to identify further potential anchored vessels. The vessels identified via both methods were then manually checked to ensure any vessels clearly not at anchor were removed.

There were no vessels recorded within the Study Area deemed to be at anchor based on the criteria applied.

6.3 Vessel Routing

6.3.1 Methodology for Route Identification

The vessel traffic data collected was used to identify both main routes and low-use transit routes passing within the Lease Area. Within this assessment, routes on which at least 100 vessels per year have been recorded are classed as Main Routes. However, the use of long term marine traffic data also allows the identification of other seasonal or low use routing and therefore such routes have also been captured to ensure comprehensive assessment of displacement, collision and allision impacts, noting that seasonally varied fishing routes are deemed of importance in the area.

The routes were identified statistically, with fishing vessels transiting at similar headings and to similar locations defined as using the same route, and similarly for commercial vessels. In terms of route origin/terminus points, this was based on either the information transmitted via AIS, the observed track data, or the VMS data (see Section 6.4) in the case of fishing vessels.

In cases of fishing vessels and commercial vessels transiting at similar headings and to similar locations, two separate routes have been defined for the purposes of assessing the varying levels of collision and allision risk posed by each of these two vessel categories for various scenarios. Therefore, the various collision and allision scenarios that may occur post wind farm may be assessed in turn to determine worst case from a shipping and navigation perspective (see Section 11.1).

The shipping route width is then calculated using the 90th percentile rule (as described in MGN 654 [MCA 2021]) from the median line of the route as shown in Figure 6.17. The 90th percentile method assumes that the route width covers the 90 percent of vessels that are nearest the median line.

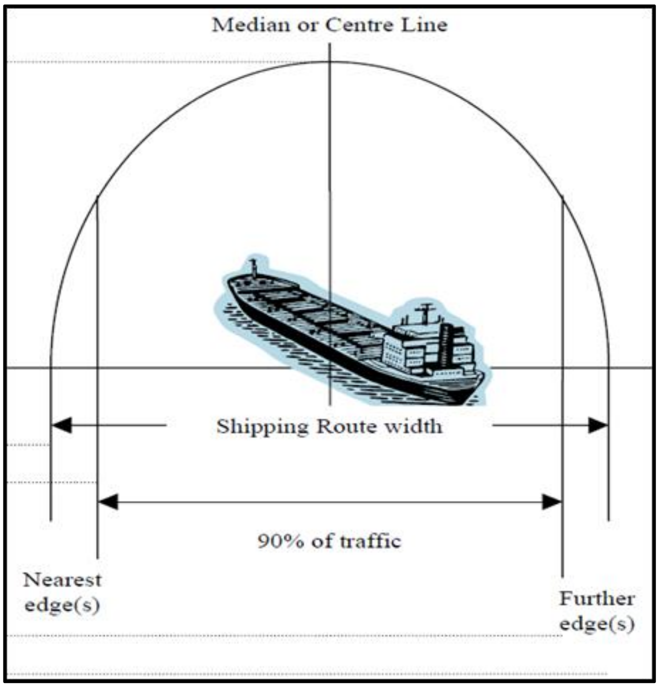

Figure 6.17 Illustration of route calculation (MCA 2021)

It is noted that the identification of routes assists the assessment of key fishing vessel and commercial vessel transits within the Study Area; however, all individual vessel tracks recorded have also been incorporated into the risk assessment (see Section 6.2).

6.3.2 Pre Wind Farm Routing

Applying the methodology outlined in Section 6.3.1, a total of four main routes were identified and are presented in Figure 6.18 alongside the corresponding 90th percentiles.

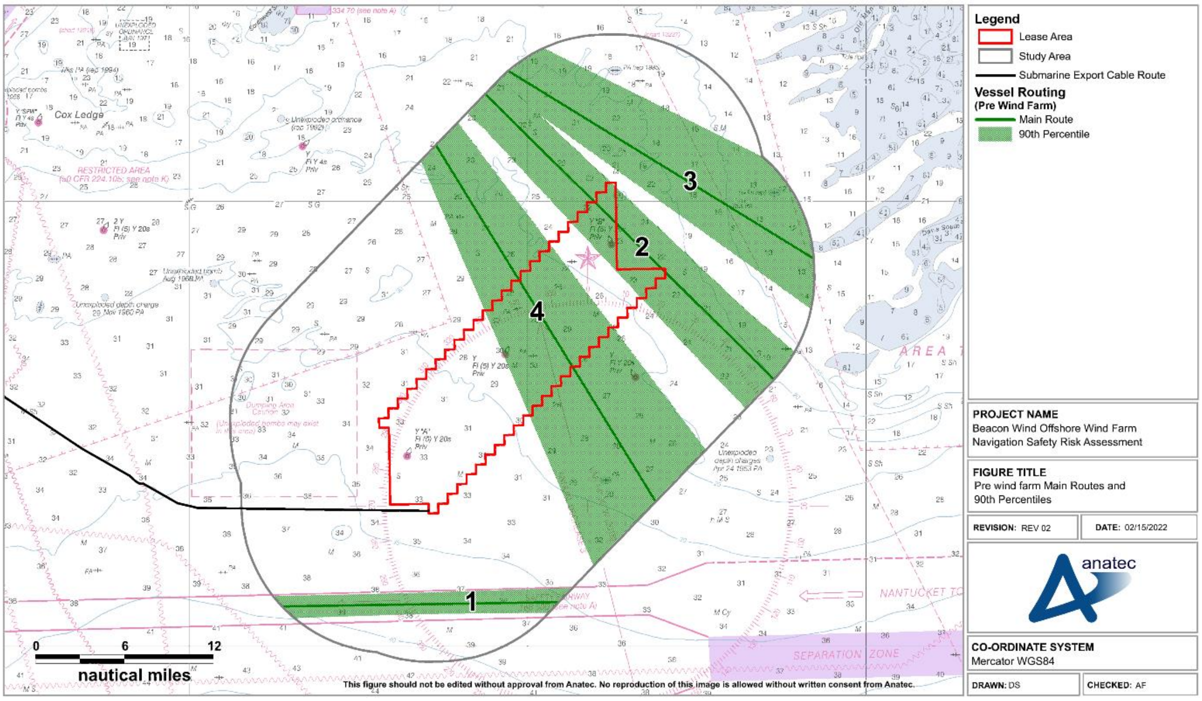

Figure 6.18 Pre wind farm routes and 90th percentiles within Study Area

To ensure comprehensive modelling, low use or seasonal routes have also been identified (see Section 6.3.1 for full details). Eight such routes were identified and are shown in Figure 6.18 with the Main Routes.

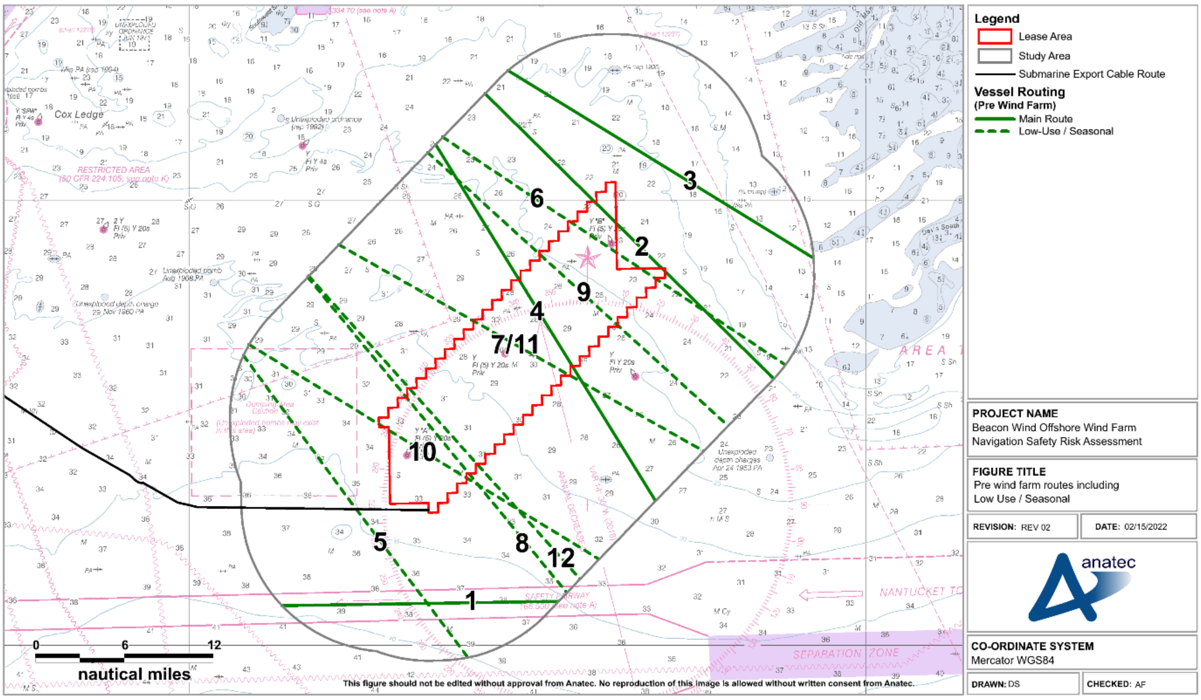

Figure 6.19 Low Use/Seasonal Routes and Main Routes

An overview of the volume, type, size, and destinations (based upon the AIS data and/or heading of the majority of vessels) of the vessel traffic on each route is provided in Table 6.1.

Table 6.1 Vessel routing within Study Area

Route Type	Route No.	Traffic volume	Description
Main Route	1	3 per day	Traffic on the westbound part of the Ambrose/Nantucket Safety Fairway. Primarily a cargo vessel (60 percent) and tanker (33 percent) route into Ambrose.
	2	2 per day	A transiting fishing vessel route between New Bedford, MA and fishing grounds located mainly within the separation zone of the Ambrose/Nantucket Safety Fairway.
	3	1 every 3 days	A transiting fishing vessel route between New Bedford, MA and Nantucket Shoals to the east of the Study Area.

Route Type	Route No.	Traffic volume	Description
	4	1 every 3 days	A transiting fishing vessel route between New Bedford, MA and fishing grounds at Veatch Canyon to the south of the Study Area.
Low Use/Seasonal	5	1 every 6 days	A transiting fishing vessel route between Point Judith, RI and fishing grounds at Veatch Canyon to the south of the Study Area.
	6	1 per week	A transiting fishing vessel route between Providence, RI and fishing grounds within the Ambrose/Nantucket Safety Fairway.
	7	1 every 9 days	A transiting fishing vessel route between Providence, RI and fishing grounds within the Ambrose/Nantucket Safety Fairway.
	8	1 every 9 days	A transiting fishing vessel route between Providence, RI and fishing grounds at Veatch Canyon to the south of the Study Area.
	9	1 every 9 days	A transiting fishing vessel route between Providence and fishing grounds within the Ambrose/Nantucket Safety Fairway.
	10	1 every 11 days	Primarily a cargo vessel (60 percent) and tanker (33 percent) route between New Haven, Connecticut and the Ambrose/Nantucket Safety Fairway.
	11	1 every 2 weeks	A cargo vessel (71 percent) and tanker (29 percent) route between Providence, RI and the Ambrose/Nantucket Safety Fairway.

Route Type	Route No.	Traffic volume	Description
	12	2 per month	Primarily a tanker (40 percent) and passenger vessel (40 percent) route between Providence, RI and the Ambrose/Nantucket Safety Fairway.

6.4 Lease Area Vessel Monitoring System Data

From 50 CFR § 660.14, any fishing vessel registered for use with a limited entry 'A' endorsed permit, that uses non-groundfish trawl gear, or uses open access gear for groundfish is required to have a VMS.

6.4.1 Northeast Ocean Data Portal

To enhance the fishing vessel baseline established by the AIS data, additional VMS data from 2015 and 2016 (Northeast Ocean Data Portal [NEODP] 2018) has been assessed (this data was the most recently available VMS data provided by the portal). The data has been utilized only to enhance and validate the fishing vessel baseline established by the AIS data and it is acknowledged that the VMS data alone is insufficient to characterize vessel movements in the area.

VMS fishing density plots are presented in Figure 6.20 to Figure 6.26, respectively, for following species groupings:

- Monkfish;
- Pelagic (Herring, mackerel and squid)
- Herring only;
- Squid only;
- Scallop; and
- Surfclam/quahog.

It is noted that to the west of the area shown in the VMS density plots (i.e., within Long Island Sound) such activity was not recorded except for very limited scallop and pelagic activity.

It can be from the VMS density plots that the highest density of fishing activity was recorded in the western and northern portions of the Study Area primarily from squid and pelagic activity. Within the Lease Area, high densities of squid and pelagic activity were recorded, as well as some groundfish activity.

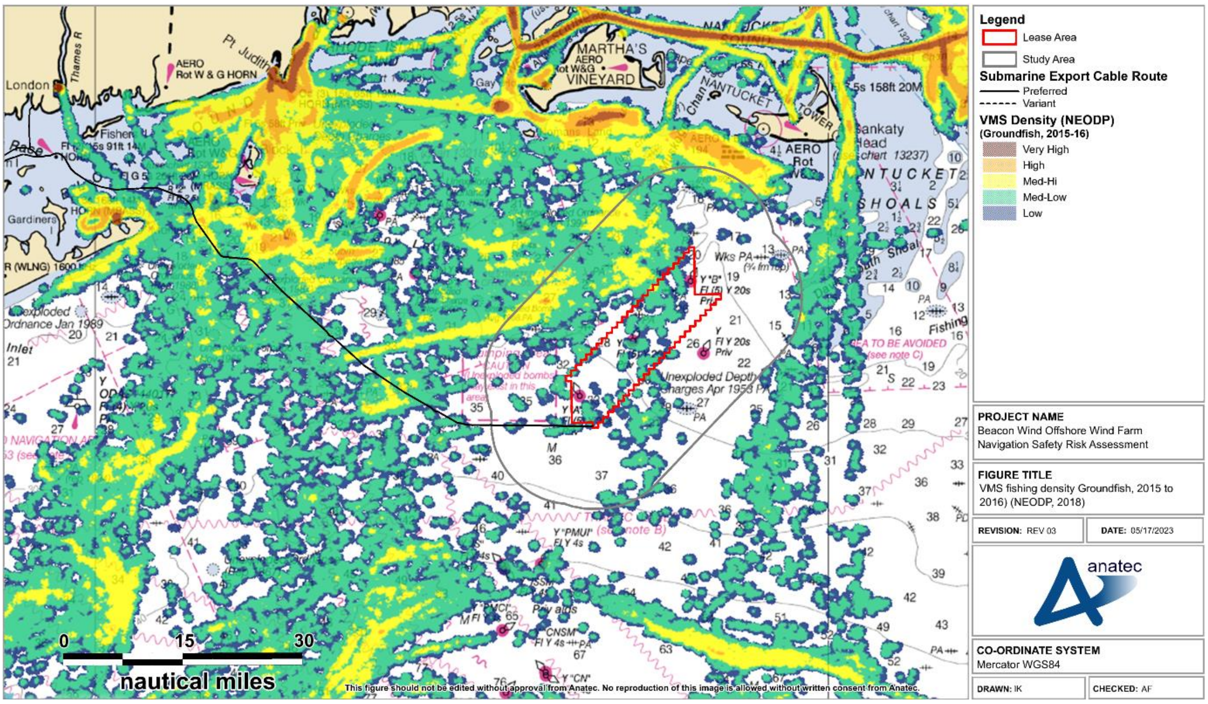

Figure 6.20 VMS fishing density (Groundfish, 2015 to 2016) (NEODP 2018)

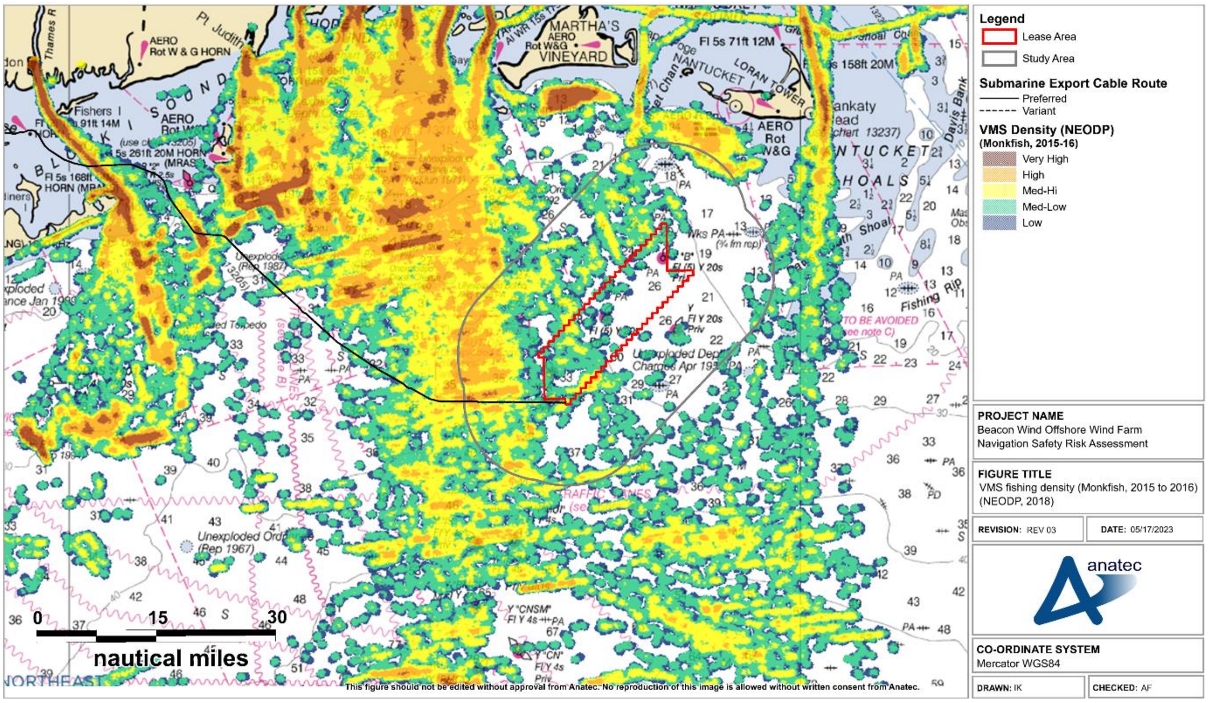

Figure 6.21 VMS fishing density (Monkfish, 2015 to 2016) (NEODP 2018)

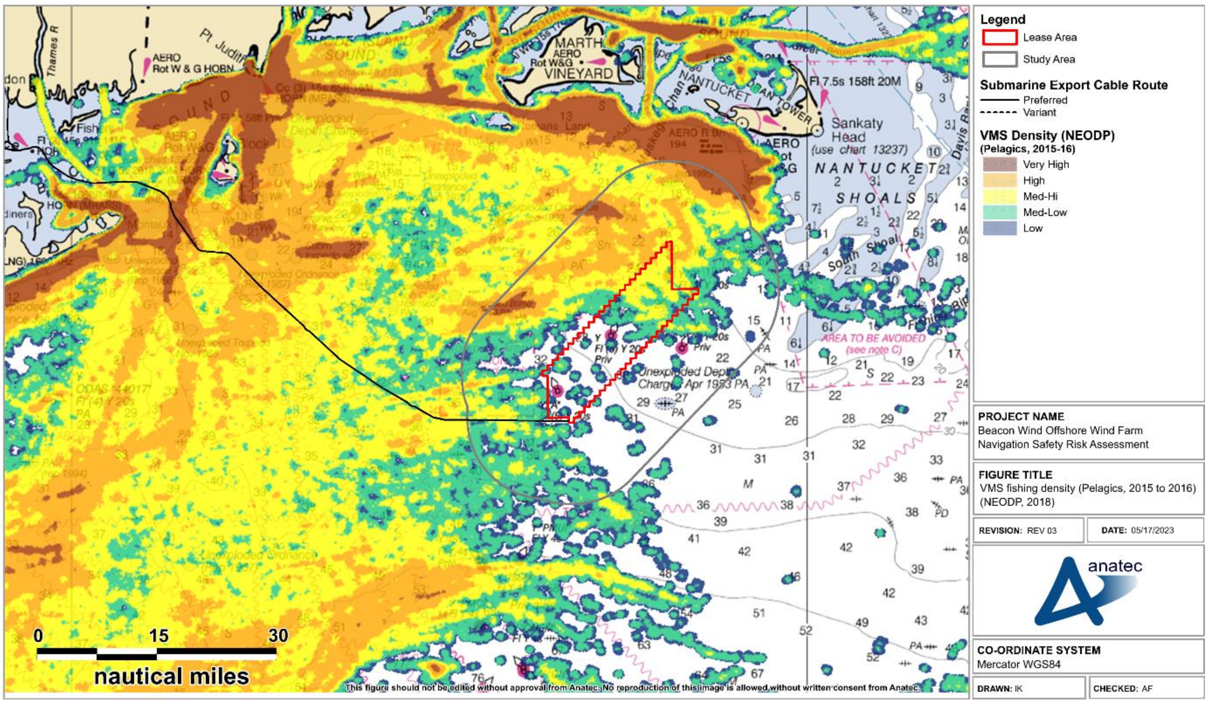

Figure 6.22 VMS fishing density (Pelagics, 2015 to 2016) (NEODP 2018)

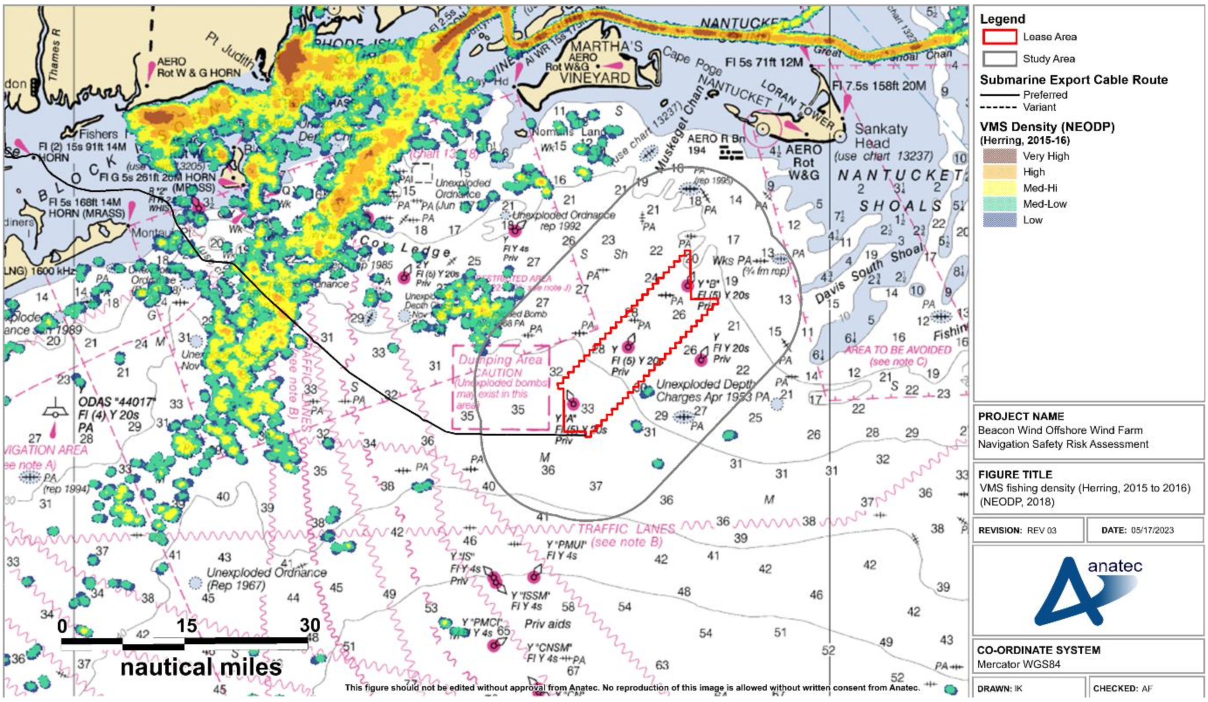

Figure 6.23 VMS fishing density (Herring, 2015 to 2016) (NEODP 2018)

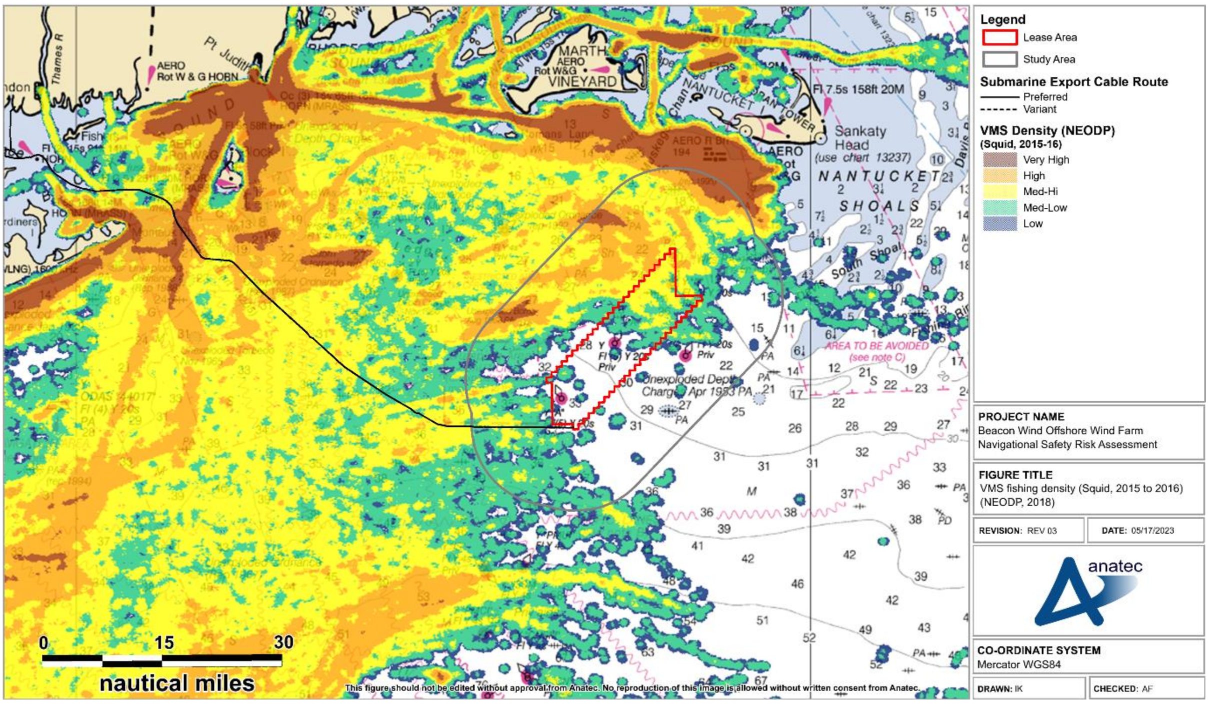

Figure 6.24 VMS fishing density (Squid, 2015 to 2016) (NEODP 2018)

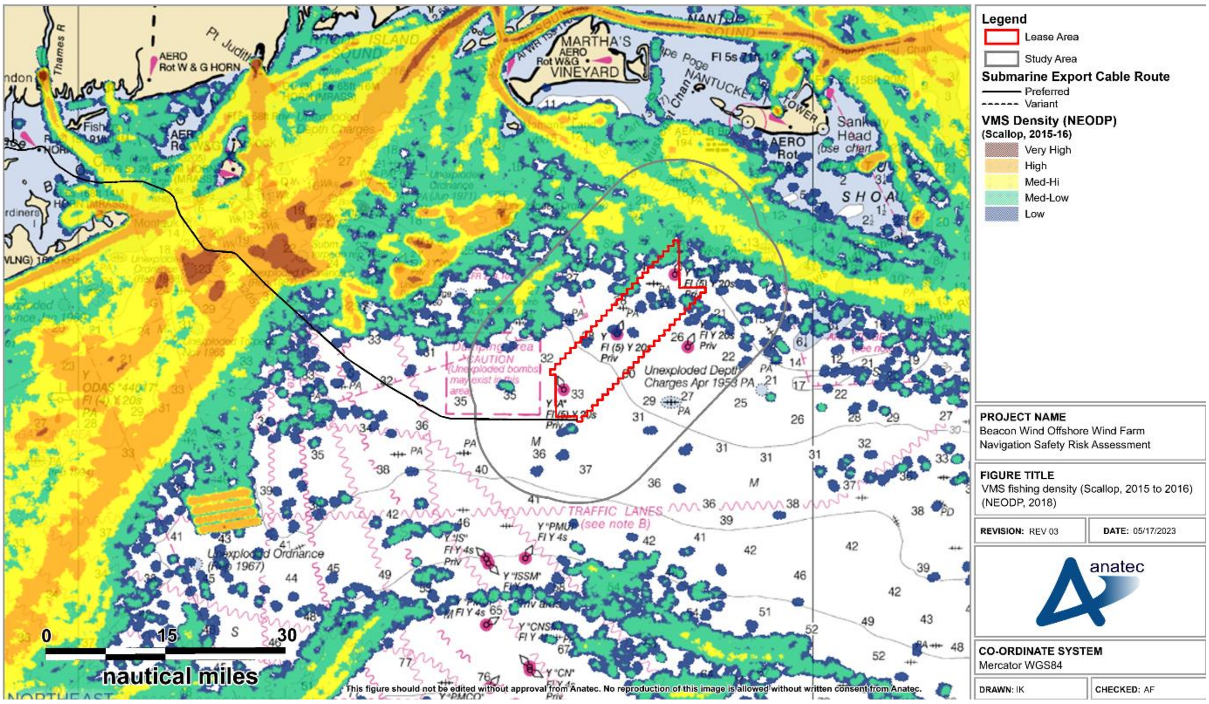

Figure 6.25 VMS fishing density (Scallop, 2015 to 2016) (NEODP 2018)

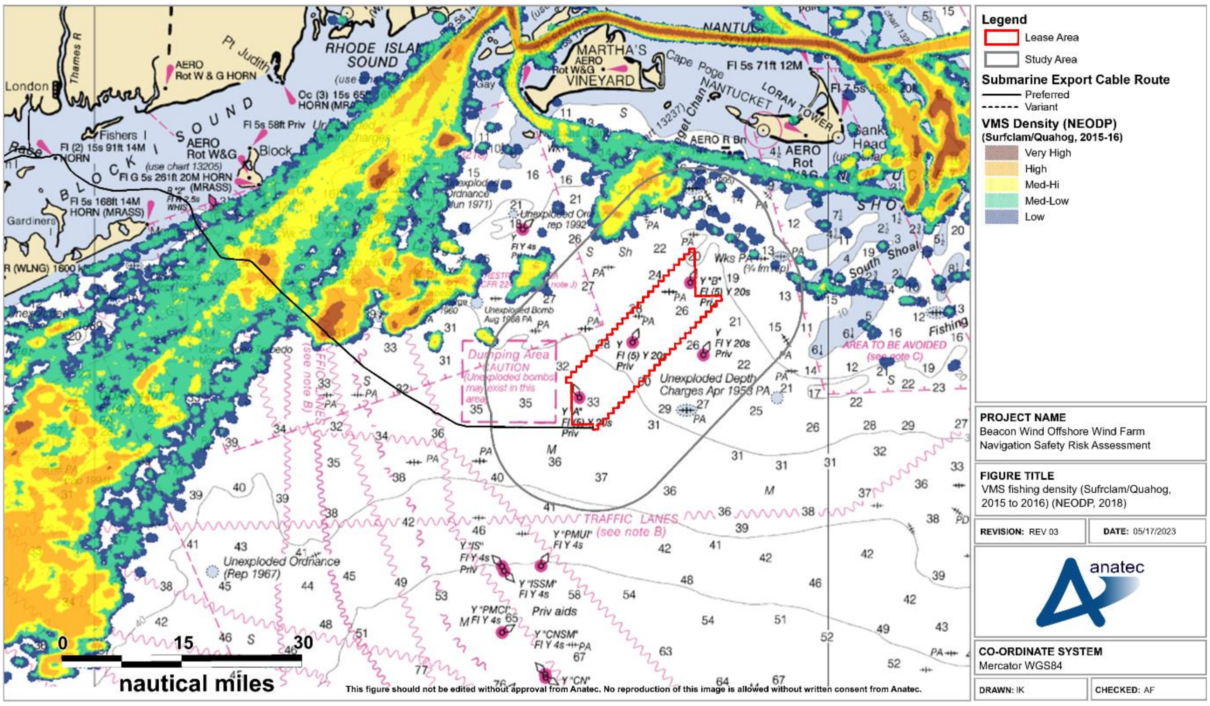

Figure 6.26 VMS fishing density (Surfclam/quahog, 2015 to 2016) (NEODP 2018)

6.4.2 VMS Polar Histograms

BOEM have provided VMS data analysis in the form of polar histograms covering the period of 2014 to 2019 (noting 2019 is partial) for the Lease Area. The data provides a breakdown of vessel course within the Lease Area by both activity (i.e., fishing or transiting) and fishery type. Activity has been determined by applying a speed threshold, with speeds below four knots assumed to be associated with vessels in transit (except for sea scallop fishery where a five know threshold is assumed). It should be considered that this approach may misrepresent activity for a minority of vessels.

Each histogram is split into 72 bins, with each bin representing a 5° range (e.g., 0 to 5°, 5 to 10°, etc.). Each bin then shows the unique number of VMS transmissions with average course falling within the corresponding range.

The histograms for all fisheries are shown in Figure 6.27 and Figure 6.28, for vessels actively fishing and actively transiting, respectively.

In summary, the data showed the majority of fishing vessels in the Lease Area were recorded at transiting speeds as opposed to actively fishing, with transits primarily from vessels travelling in a NW-SE direction.

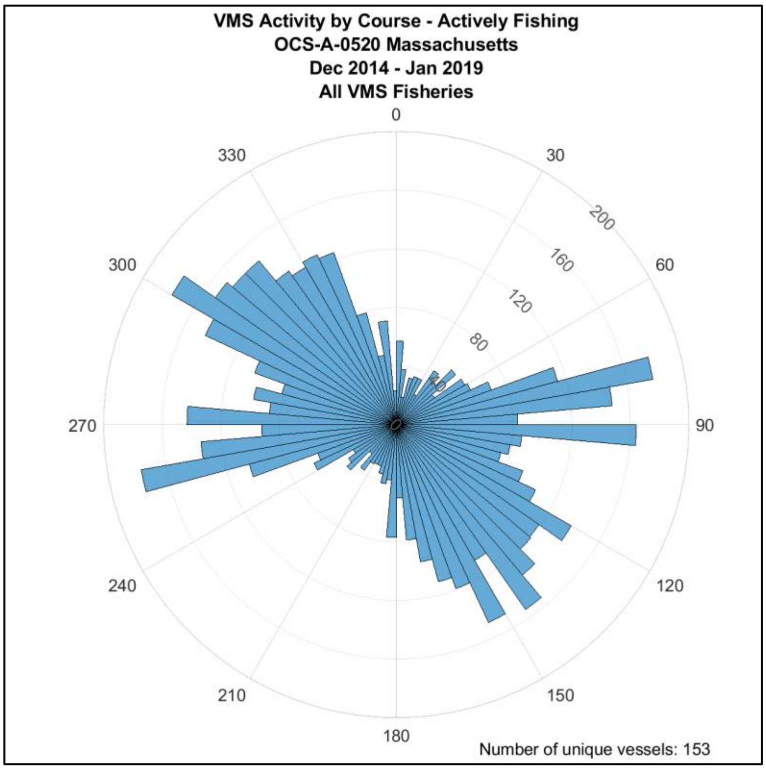

Figure 6.27 VMS polar histogram – All fisheries actively fishing (BOEM 2021)

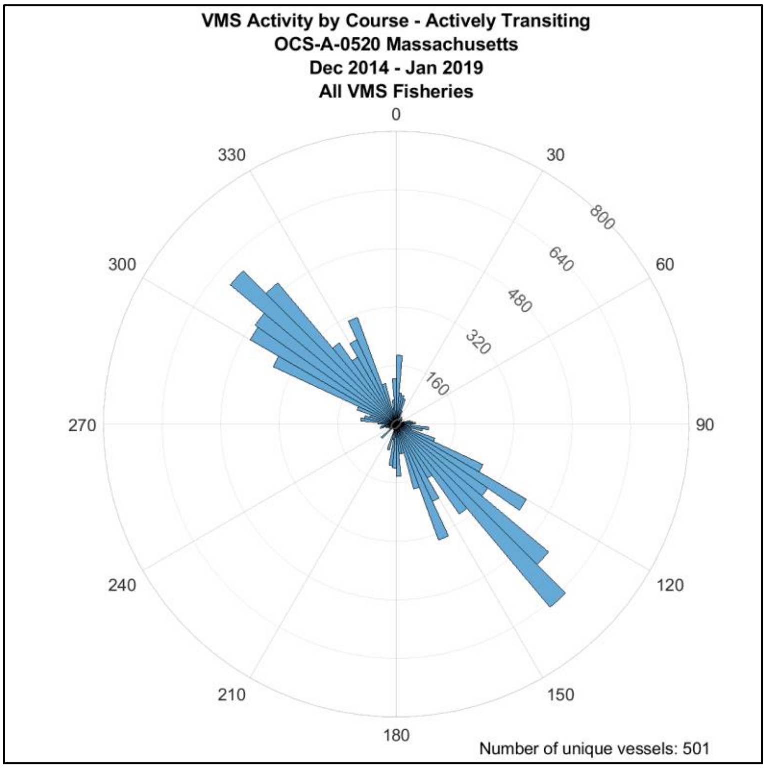

Figure 6.28 VMS polar histogram – All fisheries actively transiting (BOEM 2021)

6.5 Lease Area Visual Observation Data

For the purposes of assessing non AIS traffic levels, visual observation surveys have been undertaken by on site survey vessels associated with both the submarine export cable route and Lease Area. The surveyors recorded any vessels identified visually over a period of seven months, with the following details logged:

- Whether the vessel was transmitting via AIS;
- Whether the vessel was in or out of the Lease Area; and
- Vessel type (where available).

To ensure site specific assessment and noting key vessel types that may not be on AIS, only fishing and recreational vessels recorded within the Lease Area have been considered. The results of the assessment are shown in Table 6.2.

Table 6.2 Visual Survey – Levels of Non AIS Traffic

Vessel Type	Percentage Not on AIS
Fishing	17 percent
Recreation	54 percent

It is noted that as per Section 3.1, BOEM indicated approximately 40 percent of fishing vessels did not broadcast on AIS, which is higher than the visual survey indicates. Therefore, to ensure conservative assessment, the 40 percent value has been assumed within the quantitative assessment of fishing allision risk (see Section 11.3.5).

6.6 Submarine export cable route

6.6.1 Overview

This section provides assessment of maritime traffic of relevance to the submarine export cable route. Details of the export cables, including burial depths and external protection, are available in Section 4.3.

Figure 6.29 presents a plot of the vessel tracks recorded within the Submarine Export Cable Route Study Area throughout the survey period, color-coded by vessel type. Following this, Figure 6.30 presents the corresponding vessel density heat map for the same dataset.

It should be noted that the traffic density within the Submarine Export Cable Route Study Area was significantly higher than within the Study Area, and as such the density intervals in Figure 6.30 are relative only to the Submarine Export Cable Route Study Area (i.e., independent of the Study Area density shown in Figure 6.2).

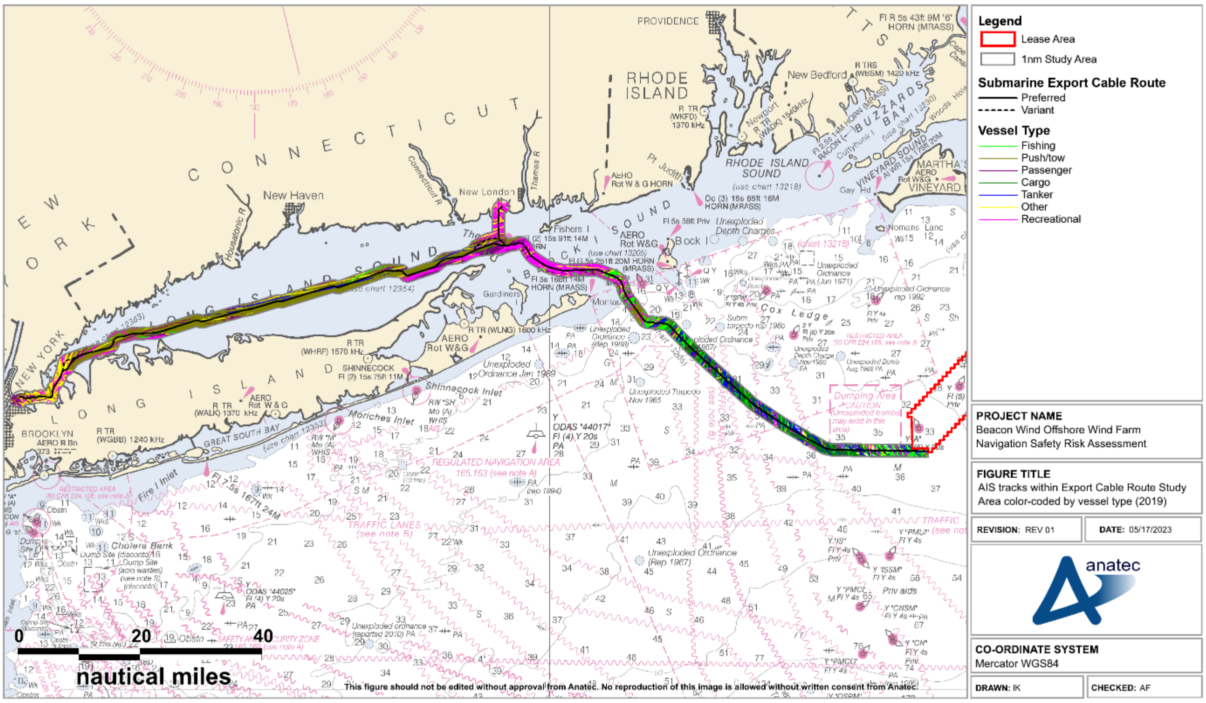

Figure 6.29 AIS tracks within Submarine Export Cable Route Study Area color-coded by vessel type (12 months January to December 2019)

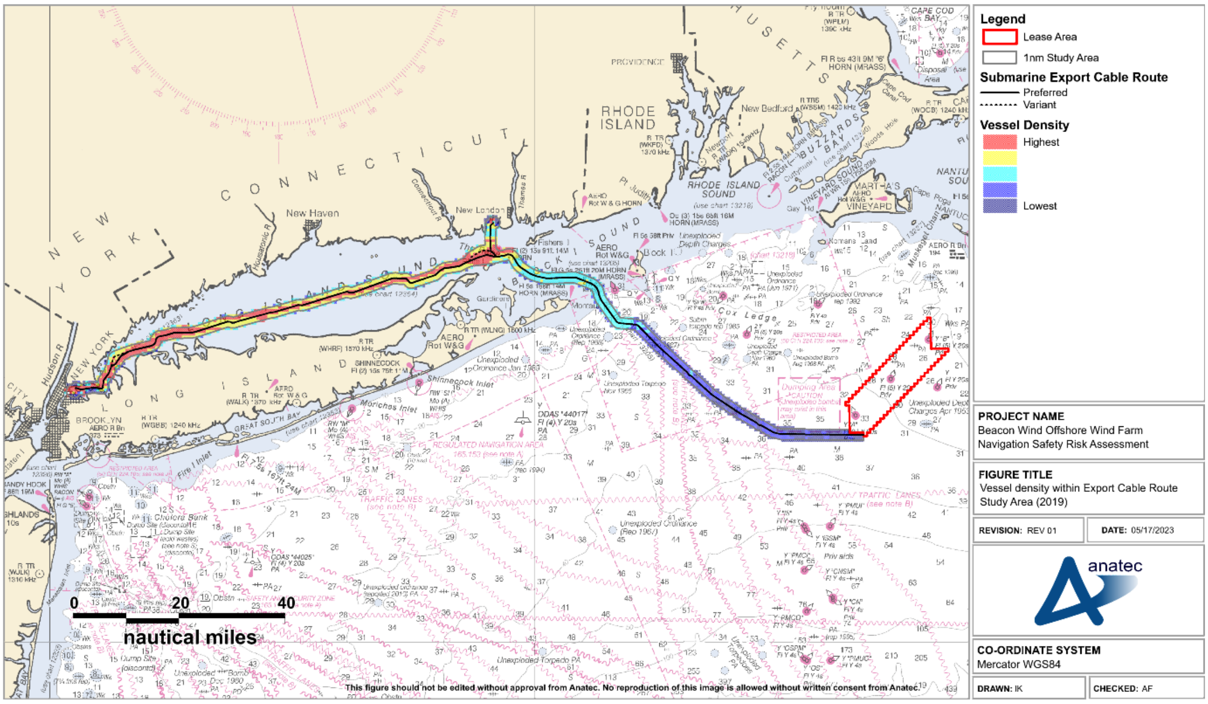

Figure 6.30 Vessel density within Submarine Export Cable Route Study Area (12 months January to December 2019)

On average, 106 unique vessels per day were recorded within the Submarine Export Cable Route Study Area. The vessel density is highest in the areas close to the East River landfall location, presented in detail in Figure 6.31, where smaller vessels such as push/tow vessels and recreational vessels operate in shallow waters. The density remains at a generally high level within Long Island Sound and gradually decreases as the submarine export cable route extends further offshore.

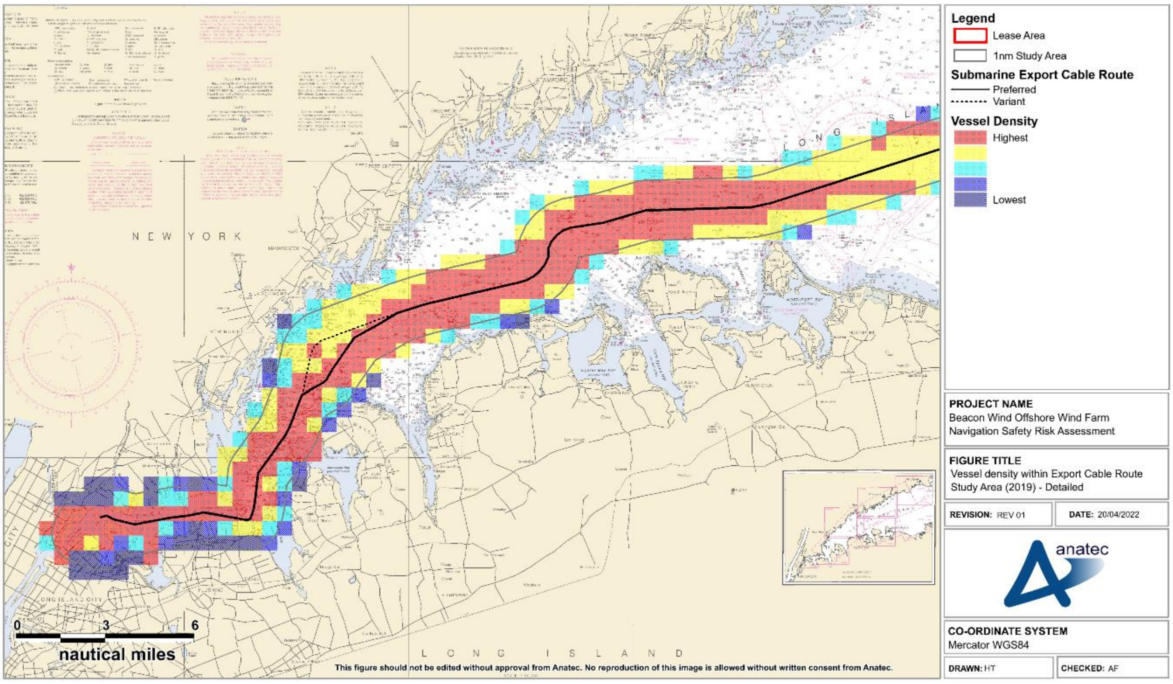

Figure 6.31 Vessel density in vicinity of submarine export cable – East River, New York landfall (2019)

As shown in the Figure 6.31, the vessel density is consistently high within the East River and the western part of Long Island Sound. Based on the 2019 data, it is estimated that average vessel numbers over the East River mouth are in excess of 25 per day, noting that is AIS only. For reference, a corresponding plot of the Niantic Bay, Connecticut BW2 cable landfall is shown in Figure 6.32.

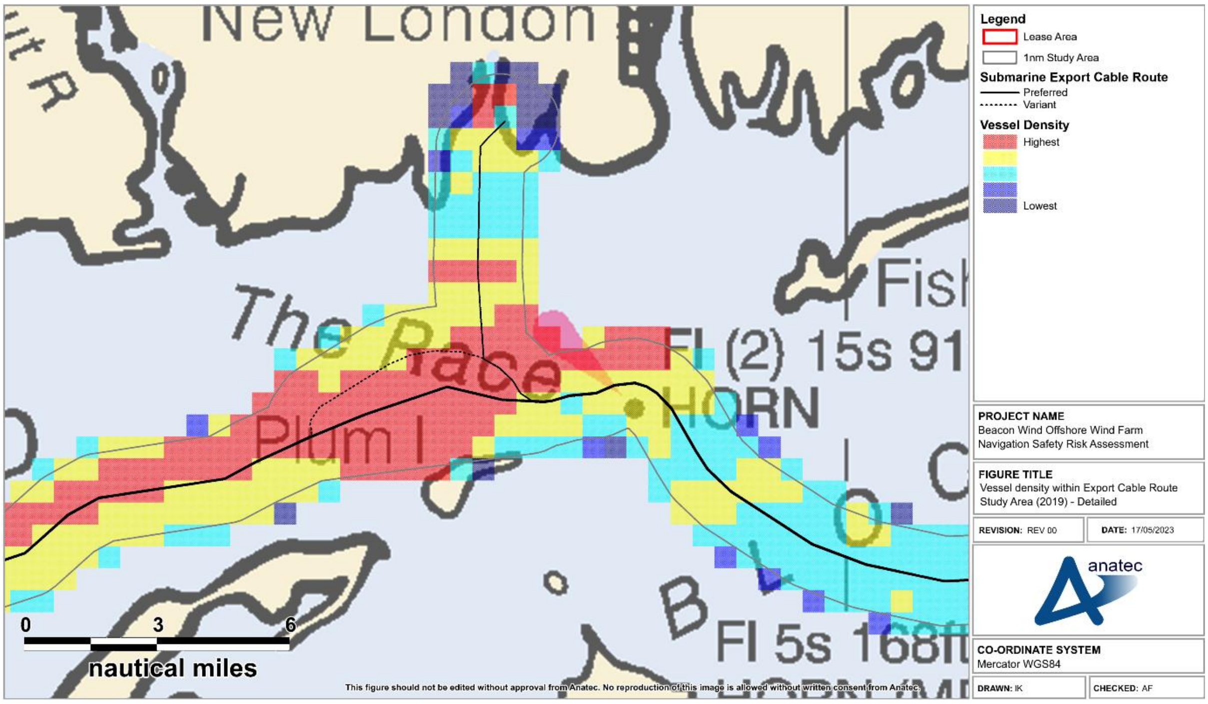

Figure 6.32 Vessel density in vicinity of submarine export cable route – Niantic Bay, Connecticut landfall (2019)

6.6.2 Vessel Draft

During the 12 month survey period of AIS data analyzed, 20 percent of tracks recorded on AIS within the Submarine Export Cable Route Study Area broadcast a valid draft (of the 20 percent which did not broadcast a valid draft, 67 percent were carrying Class B AIS, through which draft data is not available). The broadcast draft information within the Submarine Export Cable Route Study Area is presented in Figure 6.33.

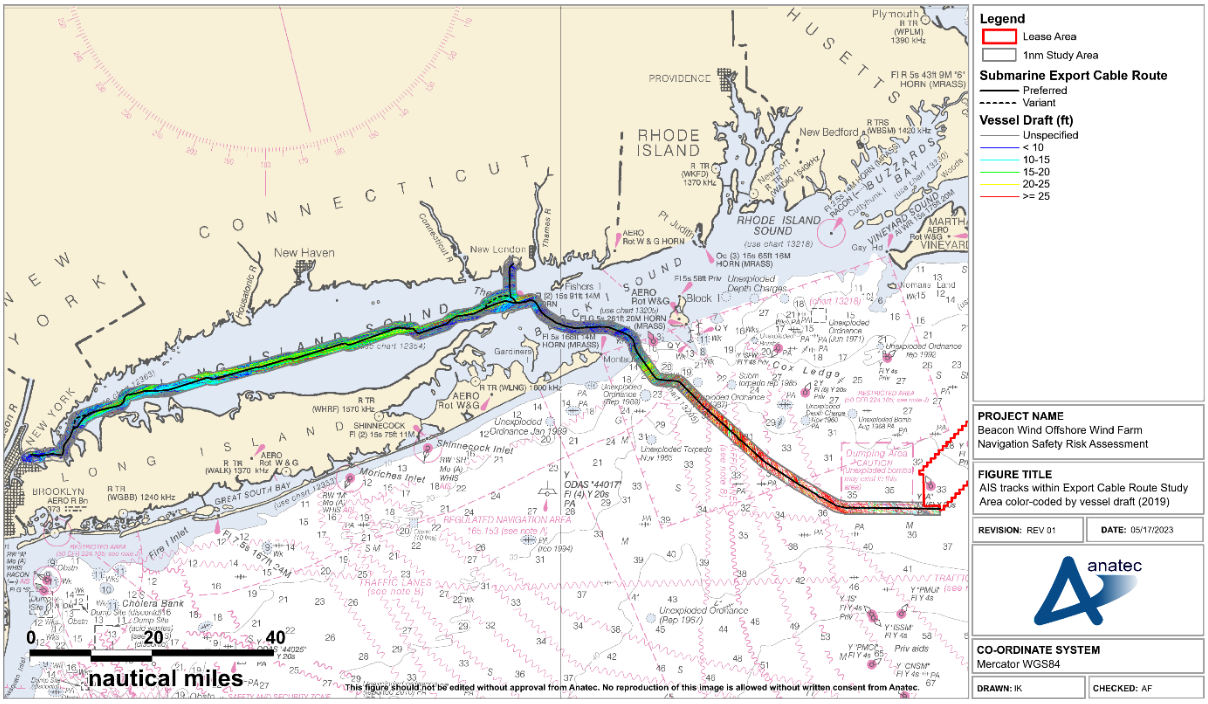

Figure 6.33 AIS tracks within Submarine Export Cable Route Study Area color-coded by vessel draft (12 months January to December 2019)

Excluding those vessels which did not broadcast a valid draft (overwhelmingly recreational vessels which use Class B AIS), the average draft recorded within the Submarine Export Cable Route Study Area was 13 ft (4 m). The deepest draft recorded in the Submarine Export Cable Route Study Area was 53 ft (16.3 m), transmitted by a crude oil tanker. The shallowest drafts were generally recorded within the East River and the approaches to Long Island Sound, while the deepest draughts tended to be further offshore.

A detailed overview of the East River traffic proximity to the north landfall is presented in Figure 6.34. Following this Figure 6.35, shows the traffic in proximity to the Niantic Bay, Connecticut landfall.

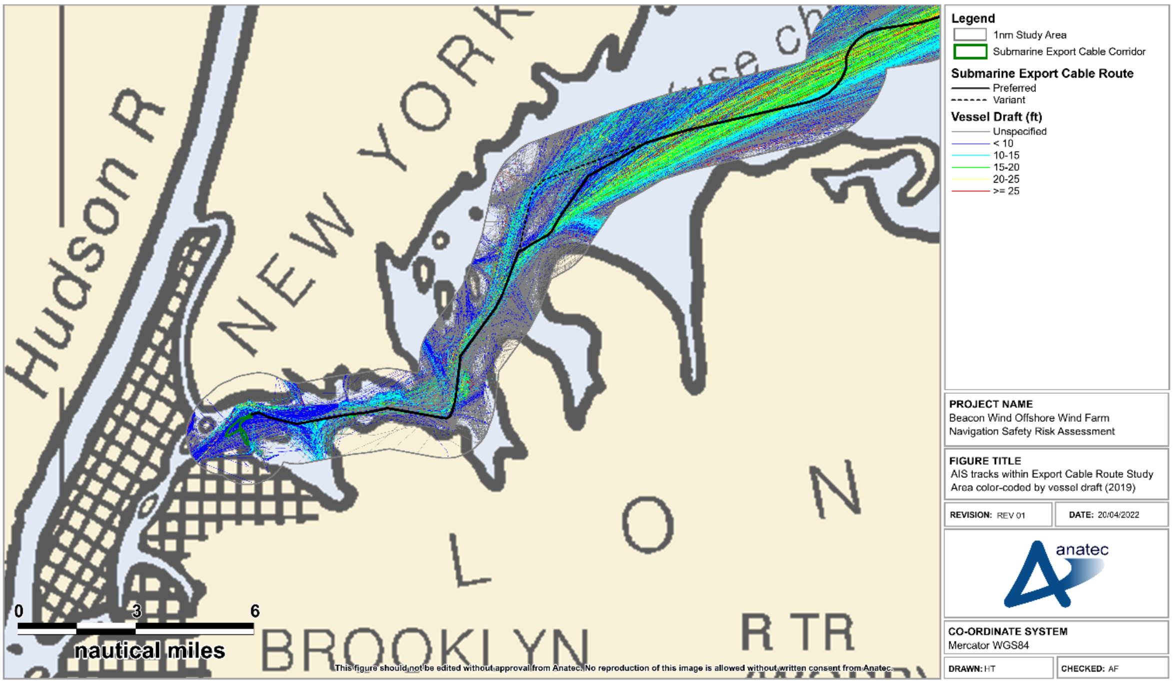

Figure 6.34 AIS tracks within Submarine Export Cable Route Study Area color-coded by vessel draft (12 months January to December 2019) – East River Overview

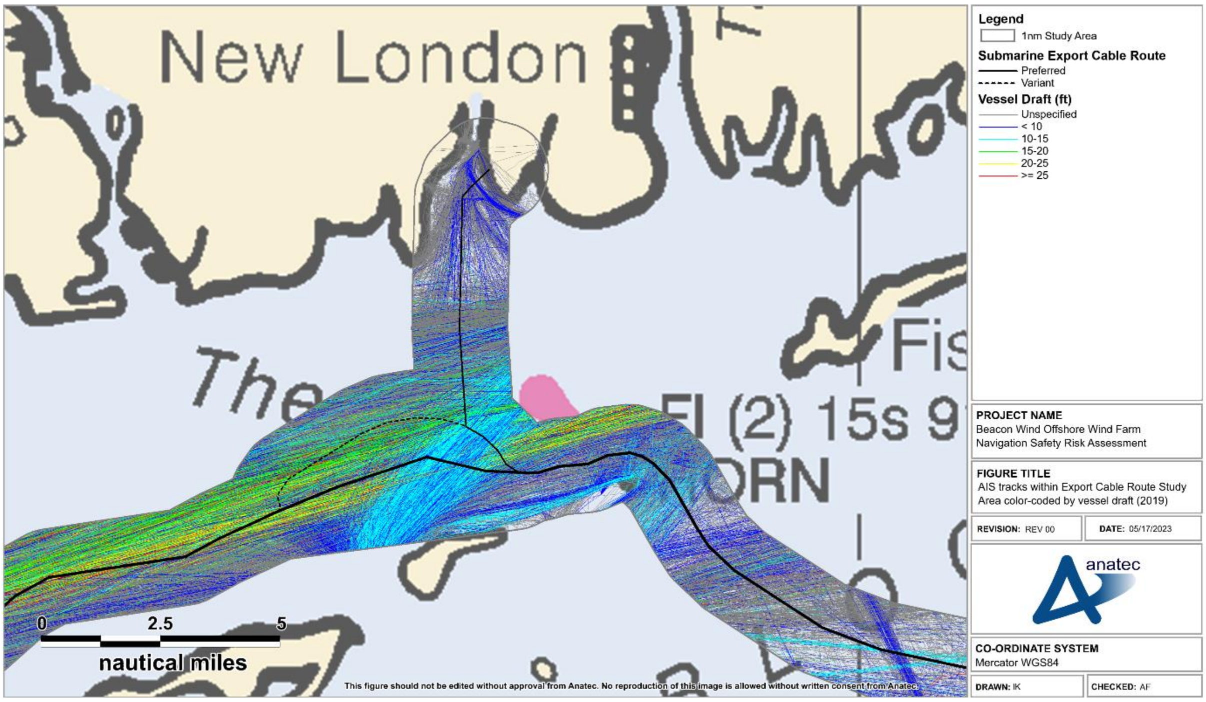

Figure 6.35 AIS tracks within Submarine Export Cable Route Study Area color-coded by vessel draft (12 months January to December 2019) – Niantic, Connecticut Landfall

6.6.3 Anchored Vessels

Vessels at anchor have primarily been identified based on navigational status transmitted via AIS. However, given that this requires manual input into the vessel's AIS unit, an incorrectly transmitted navigational status is observed to be common. Therefore, the vessels transmitting a status other than "At Anchor" were filtered using a set of behavioral criteria[9] to identify further potential anchored vessels. The vessels identified via both methods were then manually checked to ensure any vessels clearly not at anchor were removed. After applying these criteria, on average approximately three unique vessels per day were deemed to be at anchor within the Submarine Export Cable Route Study Area. All vessel activity deemed to be at anchor was recorded within the western portion of the Submarine Export Cable Route Study Area, all of which is captured in the detailed plot presented in Figure 6.36. Push/tow vessels accounted for approximately 70 percent of the overall distribution of vessels deemed to be at anchor, with the next most common type bring recreational vessels which accounted for 17 percent.

The vessel activity deemed to be at anchor within the East River, along with the anchorage areas, is presented in further detail in Figure 6.37. Following this, the anchoring activity at the Niantic Bay, Connecticut landfall is presented in Figure 6.38.

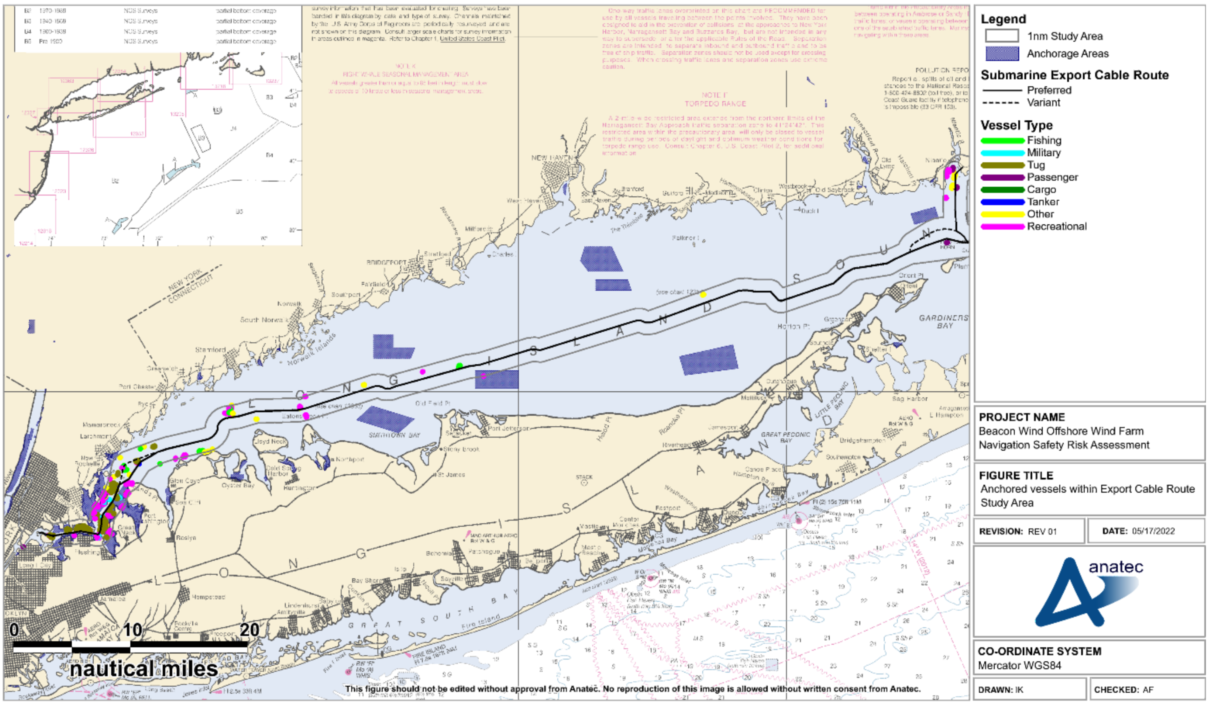

Figure 6.36 Anchored vessels within Submarine Export Cable Route Study Area

[9] Vessels recorded travelling at less than 1 knot for at least 30 minutes.

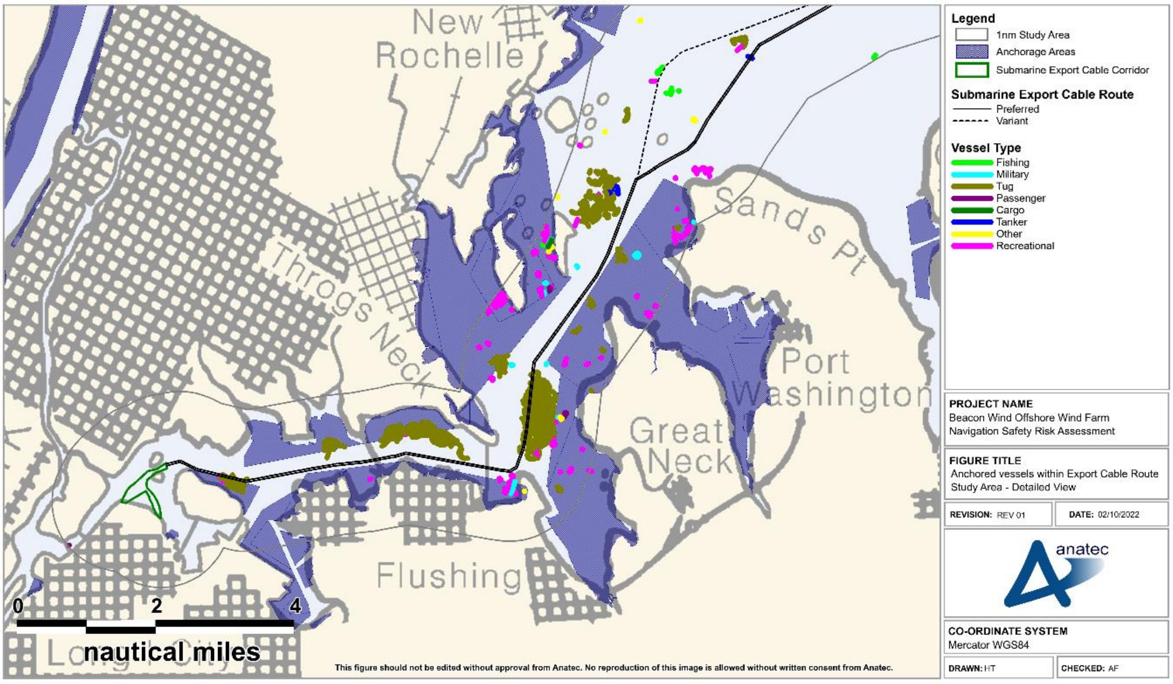

Figure 6.37 Detailed view of anchored vessels within Submarine Export Cable Route Study Area – East River

The majority of anchoring activity was observed to occur within and in proximity to the approach to the East River, with this activity largely comprising push / pull vessels. It is noted that a proportion of this activity occurred over the submarine export cable route from vessels at anchor outside of the anchorage areas. Recreational anchoring was also recorded, however the majority of this activity occurred within the anchorage areas.

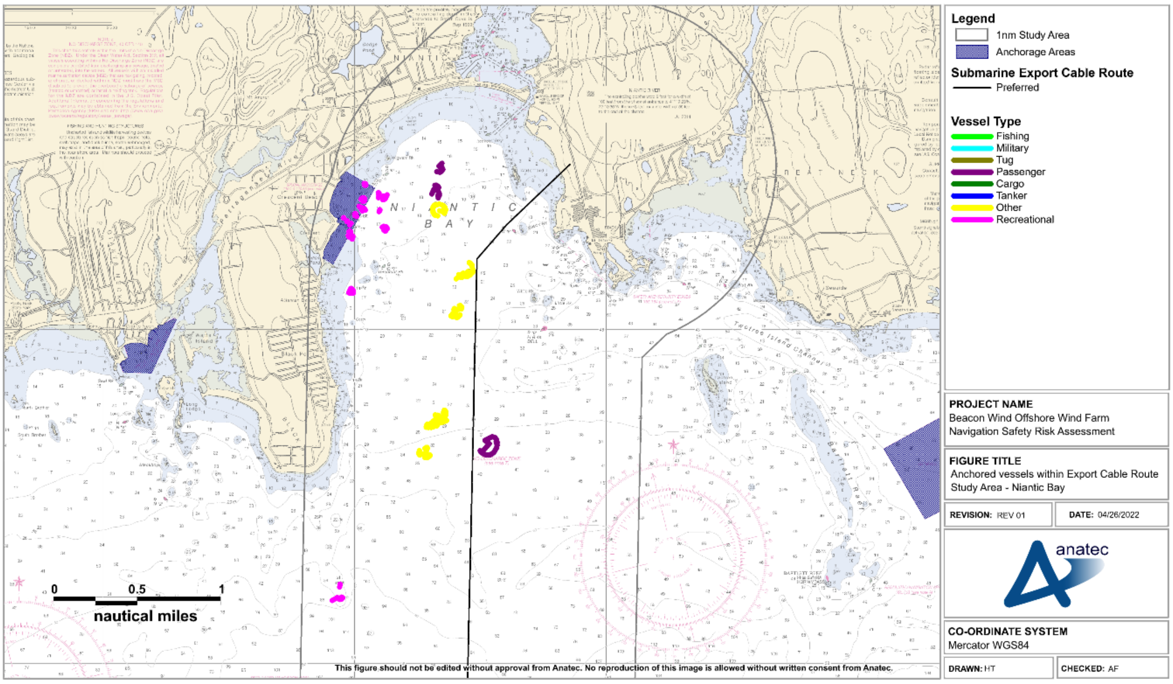

Figure 6.38 Detailed view of anchored vessels within Submarine Export Cable Route Study Area – Niantic Bay, Connecticut Landfall

The majority of anchored vessels in proximity to the landfall at Niantic Bay Connecticut were observed to be recreational users utilizing the Niantic anchorage area. Anchoring activity was recorded outside of the anchorage area including in proximity to the cable however this was observed to be an infrequent occurrence. The closest instance of anchoring to the submarine export cable route in Niantic Bay occurred within 50m, and was from a USCG vessel.

6.7 Future Case Vessel Traffic

The current level and nature of vessel traffic as outlined in previous sections is considered the base case scenario within the collision, allision and grounding risk modelling (see Section 11). This subsection outlines the level and nature of vessel traffic anticipated for the future case scenarios. This involves estimating the potential growth in shipping movements and traffic types as well as any foreseeable changes in the marine environment relevant to the Project.

6.7.1 Increases in Commercial Vessel Activity

There is a general trend of vessels growing larger and a subsequent decrease in the number of vessels, a trend which is supported by a study undertaken by the International Transport Forum at the Organization for Economic Cooperation and Development on the impact on "*Mega Ships*" (Organization for Economic Cooperation and Development and International Transport Forum 2015).

It is noted in this regard that the Port Authority Of New York & New Jersey Port Master Plan 2050 (PANYNJ, 2019) aligns with these findings in terms of increases in vessel sizes. The

Master Plan does not provide predictions on vessel numbers, but does indicate that larger vessels will need to be accommodated to account for increased container demand.

Given the uncertainty associated with long-term forecasting of vessel traffic growth, including the potential for any major new developments in U.S. ports, two conservative and independent scenarios of potential growth in commercial shipping movements of 10 percent and 20 percent have been applied directly to the base case as a set increase of traffic volume. With the trends outlined above considered, these assumptions are considered highly conservative and in reality future case traffic growth fluctuates up and down depending on seasonality and cargo and industry trends.

The 10 and 20 percent increase values were discussed and agreed with the USCG and BOEM as per Section 3.1.

6.7.2 Increases in Commercial Fishing Activity

Due to the large number of direct and indirect factors and the level of AIS coverage for fishing vessels, there is uncertainty associated with the long-term forecasting of vessel traffic growth. Therefore, again to ensure a conservative approach, a 10 percent and 20 percent growth in fishing vessel activity (both actively fishing and transiting) has been considered.

6.7.3 Increases in Recreational Vessel Transits

There are no major developments currently known which may impact the activity of recreational vessels in the Study Area, i.e., yachts, motor cruisers. It is also considered that there is a lack of formalized routing with respect to recreational craft, i.e., transits are undertaken on an individual basis rather than following designated routes. Therefore, based on the discussion presented, no notable growth in recreational vessel movements has been considered, noting that recreational vessels have not been quantitatively modelled in Section 11 but future case scenarios have been considered in Section 17.

It is noted that there could be an increase in future case recreational fishing given the benefit of aggregation around the foundations; this is qualified in Section 17, noting the distance offshore at which the Lease Area is sited, it is expected that greater increases in recreational vessel activity in the Study Area would be associated with favorable weather conditions.

6.7.4 Post Wind Farm Routing Methodology

Following construction of the Project, commercial vessels are considered likely to deviate around the Lease Area (as opposed to transiting internally within it). Given that it is not possible to consider all potential deviation options, the shortest and therefore most likely alternatives have been considered within this NSRA, with a worst case re-routing passage plan applied to ensure a conservative approach (noting this maximizes wind turbine exposure to allision risk). It is not anticipated that any changes to vessel emission requirements will result in variations to routing patterns in proximity to the Lease Area.

A detailed methodology for the assessment of various collision and allision scenarios is presented in Section 11.1.

6.7.5 Port Access Studies

Due consideration within the post wind farm routing scenarios has been given to the relevant port access studies undertaken by the USCG (see Section 1.1.2.2). The relevant studies are summarized in this section.

6.7.5.1 MARIPARS

The PARS study of most relevance to the Project is the MARIPARS given it covers the MA/RI Wind Energy Area (WEA) which includes the Project. The USCG publicized their findings on the MARIPARS (USCG 2020) which included a summary of the consultation responses received and USCG recommendations based on the study outputs. The key USCG recommendations were as follows, noting that these are dependent on final layouts that will be defined and approved through BOEM and as such are not definitive:

- The layouts of MA/RI WEA projects should be developed along a standard and uniform grid pattern with at least three lines of orientation and standard spacing to accommodate vessel transits, traditional fishing operations, and SAR operations. The adoption of a standard and uniform grid pattern through BOEM's approval process will likely eliminate the need for the USCG to pursue formal or informal routing measures within the MA/RI WEA at this time:
  - Lanes for vessel transit should be oriented in a northwest to southeast direction, 0.6 to 0.8 nm (1.1 to 1.5 km) wide. This width will allow vessels the ability to maneuver in accordance with the COLREGS while transiting through the MA/RI WEA;
  - Lanes for commercial fishing vessels actively engaged in fishing should be oriented in an east to west direction, 1 nm (1.9 km) wide; and
  - Lanes for USCG SAR operations should be oriented in a north to south and east to west direction, 1 nm (1.9 km) wide. This will ensure two lines of orientation for USCG helicopters to conduct SAR operations;
- Mariners transiting in or near the MA/RI WEA should use extra caution, ensure proper watch and assess all risk factors:
  - The operator’s experience and condition with regard to fitness and rest;
  - The vessels characteristics, which should include the size, maneuverability, and sea keeping ability. The overall reliability and operational material condition of propulsion, steering, and navigational equipment;
  - Weather conditions – both current and predicted including sea state and visibility; and
  - Voyage planning to include up-to-date information regarding the positions of wind farm structures (completed or under construction) and any associated Project vessels. A great deal of consideration should also be given to whether the transit will be conducted during day or night.

The report notes that should the MA/RI WEA project proposals diverge from a standard and uniform grid pattern approved in previous projects, the USCG will revisit the need for informal and formal measures to preserve safe efficient navigation and SAR operations.

6.7.5.2 ACPARS

The ACPARS study included recommendations by the USCG with regards to safety fairways to facilitate vessel transit along the Atlantic coast. The fairways are shown in Figure 6.39 relative to the Project and the other MA/RI WEA areas. None of the ACPARS lanes were located in or pointing towards the Study Area, and as such were not deemed to influence the routes identified within the Study Area (see Section 6.3.2), however it should be considered that they are of relevance to general vessel routing in the overarching area around the MA/RI WEA.

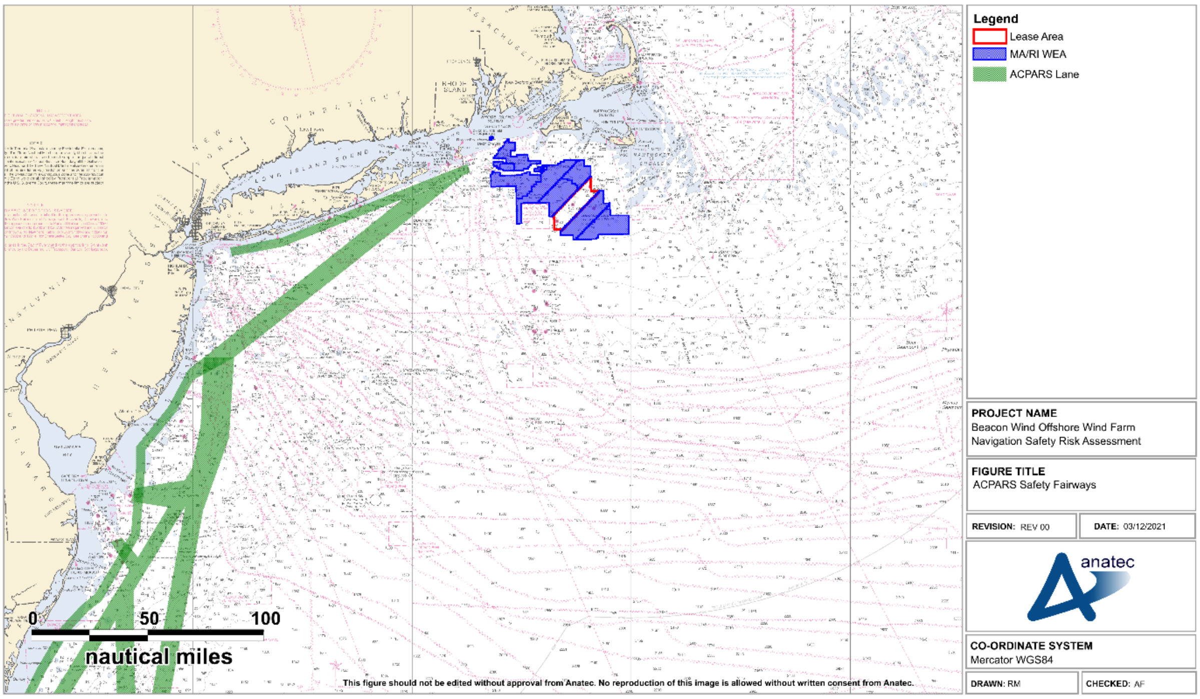

Figure 6.39 ACPARS Safety Fairways

6.7.5.3 NNYBPARS

The USCG released the NNYBPARS Final Report (USCG, 2021) in December 2021. The key output of the study was proposals to revise/establish fairways and the Ambrose anchorages within the NNYBPARS study area. The proposed fairways and anchorage are shown in Figure 6.40, noting that the existing fairways (see Section 5.1.1) are also shown for reference.

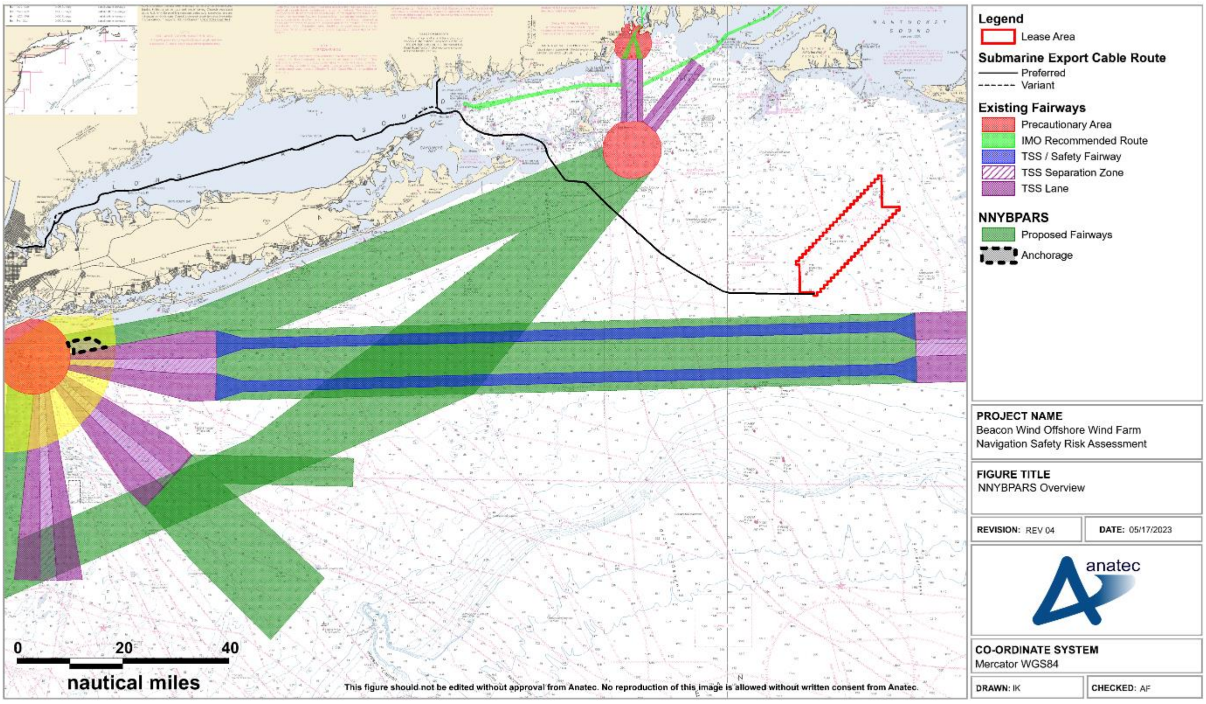

Figure 6.40 NNYBPARS Overview

It is noted that the fairway amendments include a proposal to amalgamate the separate Nantucket/Ambrose Fairways into a single fairway, which is of overarching relevance to the MA/RI WEAs. However, given the distance from the Lease Area (see Section 5.1.1) the proposed change is unlikely to have any notable effect on the Project.

Of relevance to internal navigation is calculations within the NNYBPARS Final Report which use the content of the World Association for Waterborne Transport Infrastructure (PIANC) MarCom working group report (PIANC, 2018) to estimate fairway widths based on vessel lengths and number of vessels. The USCG concluded that assuming a maximum vessel length of 153 feet and less than 4,400 vessels per year, a width of 0.62 to 0.89 nm is sufficient. It should be considered that the USCG make clear that these calculations are not intended to provide definitive suitable minimum spacing within wind farms:

"To be clear, the First Coast Guard District is not setting a minimum spacing requirement between offshore structures with these study calculations. The calculations have been included only to illustrate what would be considered safe navigation parameters if establishing a fairway or traffic separation scheme. Further evaluation for safe navigation within and adjacent to all OREI under development will be reviewed by the Coast Guard as a cooperating agency with BOEM during the leasing and development process."

However, it is considered pertinent that the spacing calculated is less than the minimum spacing which will be available at the Project, noting based on the year of marine traffic data studied only one fishing vessel of length greater than 165 ft in length intersected the Lease Area (the vessel was 177ft).

7 Facility Characteristics

Wind farm structures associated with the Project will be lit and marked in line with the guidance provided in COMDTINST M16500.7A (A*ids to Navigation Manual*) (USCG 2015) and will also comply with the *Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development* (BOEM 2021) unless any variance is approved by the relevant agency as part of lighting and marking discussions.

Wind turbine and general array characteristics applied in order to satisfy the USCG guidance includes the features outlined in this section. In addition, the wind farm structures will also comply with FAA requirements, namely the appropriate lighting of offshore obstructions (BOEM recommends lighting of structures 200 ft or more in height above the sea surface).

It is noted that the specific locations of lighting and marking features will only be able to be determined once the final layout is confirmed via BOEM approval, noting the MARIPARS output (USCG 2020) as per Section 6.7.5.1. The Developer will comply with BOEM's lighting and marking guidance subject to final design decisions and where required will work with the USCG, BOEM and the FAA to achieve equivalent and proportionate levels of aids to navigation safety performance if the 2021 guidance is not practical given final design. This aligns with the MARIPARS final report (USCG 2021) which states that:

"Structures within a wind farm, in addition to being obstructions, will possibly serve as aids to navigation as well. Developers constructing and operating wind farms in the MA/RI WEA will mark and light each structure in accordance with Federal regulations and international standards. BOEM may, as a condition of a construction and operations permit, require the wind energy companies to submit a comprehensive aids-to-navigation plan for USCG review.

The USCG would seek to develop a special and perhaps unique system of aids-to-navigation marking and lighting for Wind Turbine Generators to assist mariners to identify specific locations and navigate safely within the WEA."

The overarching lighting and marking agreement process will cover:

- Marine lighting;
- Aids to navigation;
- Aviation lighting; and
- Safety markings such as paint colors.

As a minimum the Project will:

- Be marked as an offshore wind farm with relevant structures marked as Significant Peripheral Structures (SPS) and intermediate Peripheral Structures (IPS);
- Be marked during construction, any temporary incomplete wind farm structures will be marked with quick yellow obstruction lights;
- Consider the following aids to navigation for wind turbines/offshore substation facilities:

  - Marking with RACONs;
  - Additional use of Radar reflectors and Radar target enhancers;
  - Sound signals; and
  - AIS;
- Have aeronautical obstruction lights that are compatible with night vision imaging systems;
- Have visual aids to support hover referencing which will be applied as per FAA, USCG and BOEM requirements;
- Be marked during the construction and/or operation and maintenance phases by navigational buoyage (as required/agreed);
- Have a unique alphanumeric marking scheme which has been pre-determined in coordination with the USCG (see Section 4.2); and
- Have air draft values which will be marked on the wind turbines. As per Section 4.2.1 blade clearance will be a minimum of 85 ft (26 m) above HAT.

8 Navigation, Communication and Position Fixing Equipment

This section considers the potential impacts that may arise from the structures and cables associated with the Project upon communication and position fixing equipment of vessels operating within the area.

8.1 Very High Frequency Communications (Including Digital Selective Calling)

In 2004, trials were undertaken at the North Hoyle Offshore Wind Farm, located off the coast of North Wales, U.K. (QinetiQ and MCA 2004). As part of the trials, tests were undertaken to evaluate the operational use of typical small vessel Very High Frequency (VHF) transceivers (including Digital Selective Calling) when operated close to offshore wind farm structures.

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

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

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

Since the trials detailed above, no significant issues with regards to VHF have been observed or reported in relation to U.K. offshore wind farms.

Taking into consideration these reports and the absence of any reported issues at existing developments, the Project is anticipated to have no significant impact upon VHF communications.

8.2 Very High Frequency Direction Finding

During the North Hoyle Offshore Wind Farm trials, the VHF Direction Finding (DF)) equipment carried in the trial boats did not function fully when in close proximity to wind turbines (within 164 ft (50m)). This is deemed to be a relatively small-scale impact due to the limited use of VHF DF equipment and the fact that interference occurs within the rotor sweep area and will therefore have no impact on operational or SAR activities (QinetiQ and MCA 2004).

Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King radio homer system utilizes the lateral displacement of a vertical bar on an instrument to indicate the sense of a target relative to the aircraft heading. Wirth the aircraft and the target vessel within the array, at a range of approximately 1 nm (1.9 km), the homer system operated as expected with no apparent degradation.

Since the trials detailed above, no significant issues with regards to VHF DF have been observed or reported in relation to U.K. offshore developments.

Taking into consideration these reports and the absence of any reported issues at existing developments, the Project is anticipated to have no significant impact upon VHF DF.

8.3 Rescue 21

Rescue 21 is the USCG command, control and DF communications system. The system includes:

- DF capability that provides SAR responders with lines of bearing to vessels in distress;
- Digital Selective Calling support, which allows mariners with Digital Selective Calling equipped and registered radios to transmit, at the push of a button, their exact Global Positioning System (GPS) position and vital vessel information to the USCG and other Digital Selective Calling equipped vessels; and
- Automated transmission of urgent marine information broadcasts.

Figure 8.1 presents the line of sight coverage for the Rescue 21 system in proximity to the Project location.

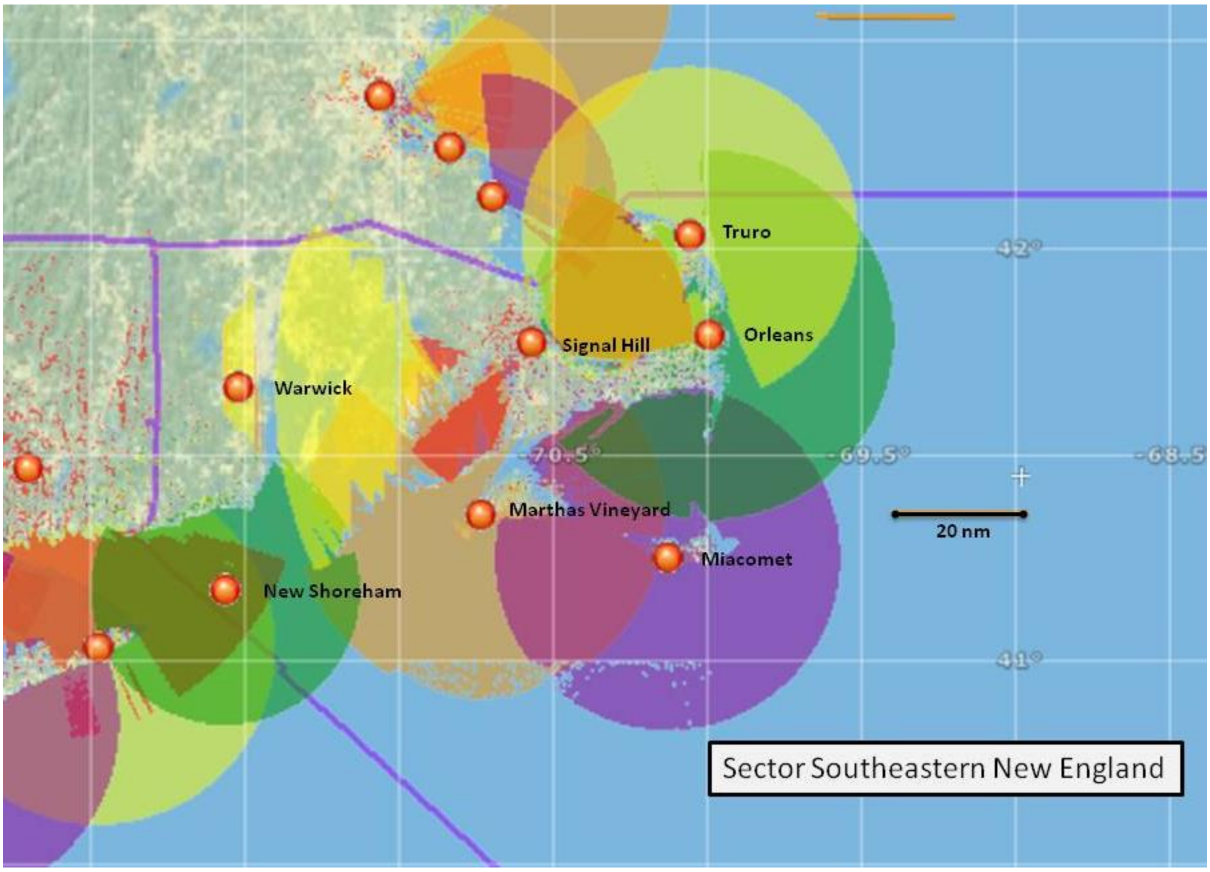

Figure 8.1 Rescue 21 regional coverage of VHF antennas based on geographical line of sight (USCG)

The Miacomet shore-based antenna, located approximately 17 nm (46 km) northeast of the Lease Area on Nantucket Island, is of most relevance to the Project. It is noted that this distance means there may not be comprehensive coverage of the Lease Area.

8.4 Automatic Identification System

No significant issues with interference to AIS transmission from offshore wind farms have been observed or reported at existing developments to date, including the trials undertaken at North Hoyle (QinetiQ and MCA 2004).

In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e., blocking the line of sight) of the AIS. However, with no such issues reported at existing developments to date, no significant impact is anticipated for any AIS signals being transmitted or received within the Lease Area.

8.5 Navigational Telex System

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

There are two NAVTEX frequencies. All transmissions on NAVTEX 518 kilohertz, the international channel, are in English. NAVTEX 518 kilohertz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings, and navigational 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. In the U.S., NAVTEX is broadcast from various USCG facilities, with the nearest to the Project being USCG Station Boston.

Although no specific trials have been undertaken, no significant effect on NAVTEX has been noted art existing developments and therefore no effects are expected to arise due to the Project.

8.6 Global Positioning System

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

Additional tests showed that "even with a very close proximity of a wind turbine to a GPS antenna, there were always enough satellites elsewhere in the sky to cover for any that might be shadowed by the wind turbine tower".

Therefore, there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the Lease Area.

8.7 Long Range Navigation Systems

Long Range Navigation (Loran)-C is a radio system which uses multilateration principles to compare the difference in reception time of low frequency radio signals transmitted by radio beacons located onshore, thus allowing the receiver's position to be computed. This system was used extensively by the USCG but is no longer commonplace due to developments in GPS, financial reasons, and the USCG discontinuing use of the system in 2010. An upgraded version of Loran-C called Enhanced Loong Range Navigation is currently in use outside of the U.S.

Based on technology used for Loran-C it is assumed that since similar systems are not expected to be impacted by the Project, that Loran-C will similarly not be significantly affected.

8.8 Electromagnetic Interference

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 magnetized pointed (usually marked on the north end) free to align itself to the earth's magnetic field. A compass can be used to calculated heading, used with a sextant to calculate latitude, and a marine chronometer to calculate longitude.

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 a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited. The important factors with respect to cables that affect the resultant deviation are:

- Water depth;
- Burial depth;
- Current (alternating or direct) within the cables;
- Spacing or separation of two cables in a pair (balanced monopile and bipolar design); and
- Cable route alignment relative to the earth's magnetic field.

The cables in the submarine export cable route will consist of two HVDC cables and one fiber optic cable per wind farm (BW1 and BW2), while the interarray cables for the Project will be High Voltage Alternating Current (HVAC). Studies indicate that HVAC does not emit an electromagnetic field significant enough to impact marine magnetic compasses (Convention for the Protection of the Marine Environment of the North-East Atlantic 2008). With regards to HVDC, impacts on larger vessels using inertial navigation systems and GPS as their main navigational system are expected to be limited. Smaller craft which may only carry a magnetic compass and operate within near shore waters are likely to experience the highest effects but only for any period where they are directly above an unbundled HVDC cable.

No problems, with respect to magnetic compasses, have been reported to date in any of the trials undertaken (inclusive of SAR helicopters). However, small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to wind turbines as with any structure in which there is a large amount of ferrous material (QinetiQ and MCA 2004)

8.9 Marine Radar

Summaries of the trials and studies undertaken in relation to Radar effects from offshore wind farms in the U.K. and U.S. are provided in the following subsections. It is important to note that since the times of the discussed trials and studies, wind turbine technology has advanced significantly, most notably in terms of the size of the wind turbines available to be installed and utilized. The use of these larger wind turbines allows for a greater minimum spacing than was achievable at the time of the U.K. studies being undertaken, which is beneficial in terms of Radar interference effects (and surface navigation in general) as detailed below.

8.9.1 U.K. Trials

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

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

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 ranges (below 1.5 nm (2.8 km)) 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 8.2.

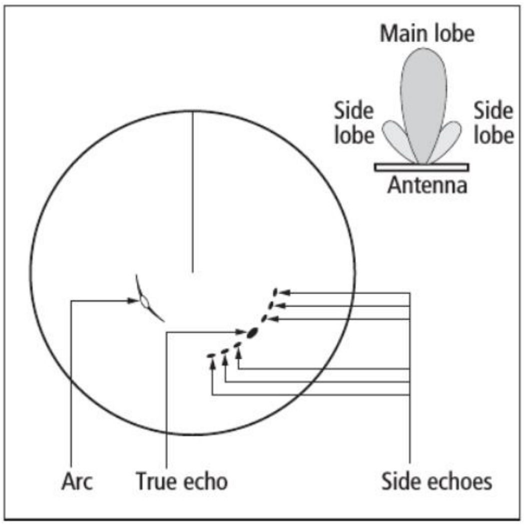

Figure 8.2 Side Lobes

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 8.3.

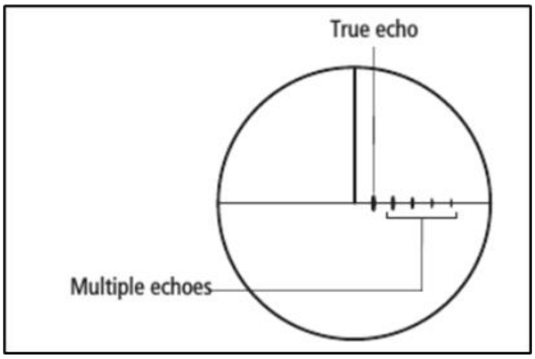

Figure 8.3 Multiple Reflected Echoes

Based upon the result of the North Hoyle trials, the MCA produced a *"Shipping Route Template"* designed to give guidance to mariners on the distances which should be considered when assessing safe passing between shipping routes and offshore wind farms – noting it is intended not to be prescriptive but applied intelligently on a case-by-case basis. However, as experience of effects associated with the use of marine Radar in proximity to offshore wind farms has grown, the MCA have refined their guidance, offering more flexibility within the most recent version contained within MGN 654 (MCA 2021). MGN 654 has been used within this NSRA to assist consideration of Radar impacts given that the U.S. guidance does not yet have specific detail.

A second set of trials conducted at the Kentish Flats Offshore Wind Farm in 2006 (British Wind Energy Association 2007) also found that Radar antennas which are sited unfavorably with respect to elements of the vessel's structure can enhance 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.

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, U.K., on marine Radar systems (Atlantic Array 2012) considered a wider spacing of wind structures than that considered within the earlier trials. The main outcomes of the modelling were:

- Multiple and indirect echoes were detected under all modelled parameters;
- The main effects noticed were stretching of targets in azimuth (horizontal) and appearance of ghost targets;
- There was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the wind farm structures and safe navigation;
- Even with Radar operator settings artificially set to be poor, there was significant clear space around each wind farm structure that did 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 structures the easier it was 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 scanners;
- It is important for passing vessels to keep a reasonable separation distance (see Table 8.1) between the wind farm structures in order to minimize the effects of multipath and other ambiguities;
- The potential 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 the vicinity (i.e., those not broadcasting on AIS which are usually fishing vessels and recreational craft); and
- The performance of a vessel's Automatic Radar Plotting Aid (ARPA) could also be affected when tracking targets in or near the array. However, although greater vigilance is required, during the Kentish Flats trials false targets were quickly identified as such by the mariners and then by the equipment itself.

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

The MCA has also produced guidance to mariners operating in vicinity of OREIs in the U.K. which highlights Radar issues amongst others to be considered when planning and undertaking voyages in the vicinity of OREIs (MCA 2008). The interference 'areas' presented in Table 8.1 are based on primarily on MGN 654 (MCA 2021) but also consider the content of MGN 371 (MCA 2008), MGN 543 (MCA 2016) and MGN 372 (MCA 2008). This information has been used given that U.S. guidance does not contain specific information relating to Radar interference. It is noted that this information is intended to be used on a case-by-case basis noting that since these trials were undertaken spacing within offshore wind farms has increased.

Table 8.1 Distances at which Impacts on Marine Radar Occur

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

0.5 nm (0.9 km)	▪ Under MGN 654 impacts on Radar use within 0.5 nm (0.9 km) are "very high" risk and are deemed intolerable.
	▪ Detail included in MGN 371 (now archived) noted that:
	  ▪ X-band Radar interference is intolerable <0.25 nm (0.46 km).
	  ▪ Vessels may generate multiple echoes on shore-based Radars under 0.45 nm (0.83 km).

0.5 to <1 nm (0.9 to 1.9 km)	▪ Under MGN 654 impacts on Radar are "high" risk but can be Tolerable if ALARP.
1 to <1.5 nm (1.9 to 2.8 km)	▪ Under MGN 654 impacts on Radar between 1 nm to <1.5 nm (1.9 to 2.8 km) are "medium" risk but can be Tolerable if ALARP ▪ Detail included in MGN 371 (now archived) noted S-band Radar interference was present at < 1.5 nm (2.8 km). ▪ Echoes develop at approximately 1.5 nm (2.8 km), with progressive deterioration in the Radar display as the range closes. Where a main vessel routes passes within this range considerable interference may be expected along a line of wind turbines. ▪ Noting that the wind turbines produced strong Radar echoes giving early warning of their presence.

As noted in Table 8.1, the onset range from the wind turbines of false returns is approximately 1.5 nm (2.8 km), with the progressive deterioration in the Radar display as the range closes. If interfering echoes develop, the requirements of the COLREGs *Rule 6 Safe speed* are particularly applicable and must be observed with due regard to the prevailing circumstances. In restricted visibility, *Rule 19 Conduct of vessels in restricted visibility* applies and compliance with *Rule 6* becomes especially relevant. In such conditions, mariners are required, under *Rule 5 Lookout* to take into account information from other sources which may include sound signals and VHF information, for example from a VTS or AIS (MCA 2021).

For the purposes of SAR within the array it is noted that the intolerable effects do not block targets from being seen but instead could create multiple echoes; however, this would need the vessel (Radar scanner) and target to be within close proximity to the wind turbines at which point visual observations are likely to be undertaken. This situation is considered similar to SAR within an enclosed waterway whereby shore-based features could interfere with Radar returns.

8.9.2 U.S. Trials / Studies

8.9.2.1 USCG Simulation Study 2008

A simulation study into the effects of OREI on marine Radar was commissioned by the USCG (USCG 2008) for the purposes of assessing navigational safety impacts associated with the Cape Wind Project. The study concluded that while all targets within an offshore wind farm would remain visible on the Radar screen, other than during transient periods of short duration, additional mitigation was necessary to ensure the targets were noticeable to the Radar operator given the false targets produced by the wind turbines.

The key mitigation proposed by the study was to ensure measures were in place to minimize the Radar cross section of the wind turbines. The Radar cross section is the size and ability of a target to reflect Radar energy. It is noted that although the Radar cross section of wind turbines using non-lattice foundations is increasing so is the spacing between wind turbines meaning that a transiting vessel will observe multipath or side lobe effects less frequently than in a dense array with smaller wind turbines.

The study found no concerns around targets outside the array.

8.9.2.2 National Academies Study 2022

In 2022, the National Academies Press (NAP) published results of a BOEM funded and directed National Academies Study (NAS) into potential impacts from wind turbines on vessel radars (NAP, 2022). The NAS was based on review of existing literature and did not include any new trials.

The NAS concluded that vessel radars were affected in a "situation-dependent manner", and made the following recommendations with regards to practical mitigations that could be considered for implementation:

- Enhanced training;
- Use of radar reflectors on small vessels;
- Use of reference buoys outside wind farms;
- New radar designs optimized for operation in or in proximity to wind farms; and
- Research and development into wind turbine design to limit effects on radar.

Of these, the most pertinent at this stage at developer level is considered to be the use of reference buoys. This will therefore be discussed with USCG as part of the lighting and marking agreement process as per Section 7.

8.9.3 Experience from Existing Developments

The evidence from mariners operating in the vicinity of existing offshore wind farms is that they quickly learn to adapt to any effects (with no recorded incidents). An example is given in Figure 8.4, which shows the wind turbines installed within the Galloper Offshore Wind Farm and Greater Gabbard Offshore Wind Farm in the U.K., relative to the nearby Sunk TSS. Despite the proximity of these existing developments to the TSS, there have been no reported incidents or issues raised by mariners who operate in the region. The interface 'areas' presented in Figure 8.4 are as per the information provided in Table 8.1.

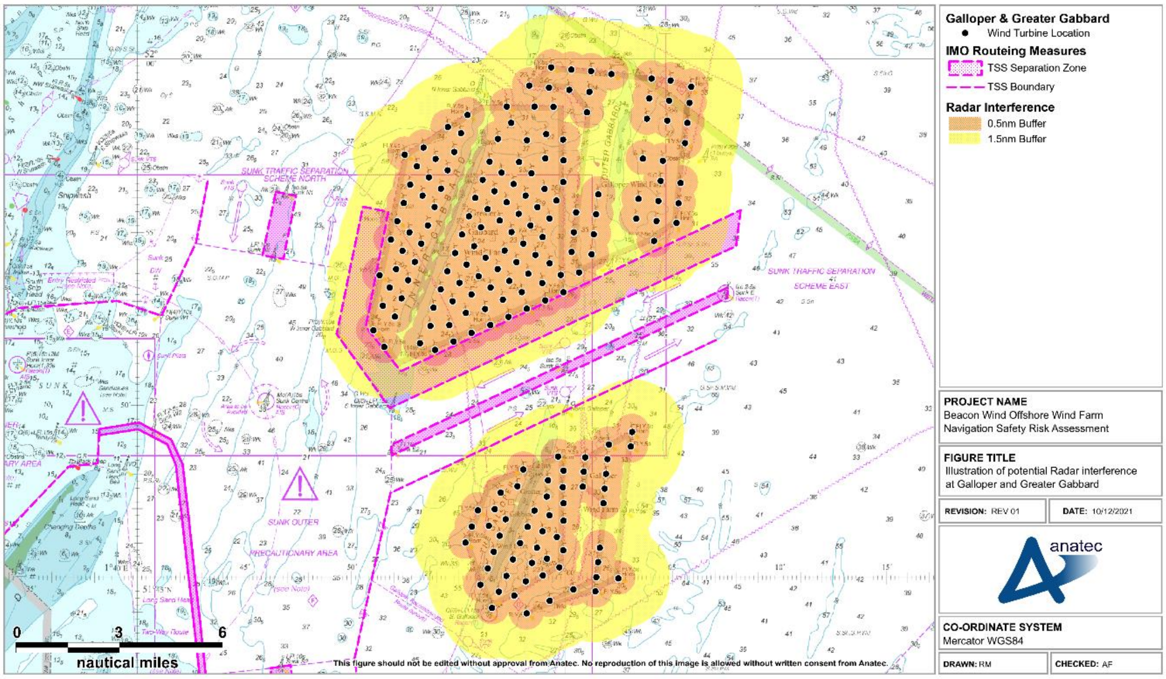

Figure 8.4 Illustration of Potential Radar Interference at Galloper and Greater Gabbard

As indicated by Figure 8.4, vessels utilizing the TSS East will experience some Radar interference based on the available guidance. Both projects are operational, and each of the Sunk TSS East lanes are used by five vessels per day on average. However, to date, there have been no incidents recorded (including any related to Radar use) or any concerns raised by the users.

AIS information can also be used to verify the targets of larger vessels (generally vessels above 65 ft (20 m) length – the threshold at which commercial vessels must carry an AIS Class A device according to 33 CFR § 164.46). It is noted that approximately 10 percent of the vessel traffic recorded within both the Study Area and the Lease Area was below 65 ft (20 m) length. There are increasing numbers of smaller vessels, particularly fishing vessels and recreational vessels, which are voluntarily utilizing an AIS Class B device, which therefore allows the verification of these small craft when in proximity to an offshore wind farm.

8.9.4 Increased Target Returns

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 on its size, shape, and aspect angle.

Larger wind turbines (either in height or width) will return greater target sizes and/or stronger false targets. However, there is a limit to which the vertical beam width would be affected (20 to 25°) dependent on the distance from the target. Therefore, increased wind turbine height will not create any effects in addition to those already identified from existing developments (i.e., interfering side lobes, multiple, and reflected echoes).

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

8.9.5 Fixed Antenna Use in Proximity to an Operational Wind Farm

It is noted that there are multiple existing developments including Galloper in the U.K. 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 marine coordination centers.

8.10 Sound Navigation Ranging Systems

No evidence has been found to date with regard to existing offshore wind farms to suggest that they produce any kind of Sound Navigation Ranging Systems (SONAR) interference, which is detrimental to the fishing industry or to military systems. No impact is therefore anticipated in relation to the Project.

8.11 Noise

8.11.1 Surface Noise

The sound level from an offshore wind farm at a distance of 1,150ft (350m) has been predicted to be between 51 decibels (dB) and 54dB. Furthermore, modelling undertaken during the consenting process for the Atlantic Array Offshore Wind Farm showed that the highest predicted level due to operational wind turbine noise (for a 410ft (125m) tall 8 MW wind turbine) is around 60dB (Atlantic Array. 2012).

A vessel's whistle for a vessel of 23 ft (7 m) should generate in the order of 138 dB and be audible at a range of 1.5 nm (2.8 km) (IMO 1972/77); hence this should be heard above the background noise of the wind turbines. Similarly, foghorns will also be audible over the background noise due to the Project.

There are therefore no indications that the sound level of the Project will have significant influence on marine safety, including the ability of the USCG to undertake rescue missions and the health of the vessel crew.

8.11.2 Underwater Noise

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

During the operation and maintenance of the Project, the subsea noise levels generated by the wind turbines will likely be greater than that produced at Horns Rev given the larger wind turbine size, however it is not expected to have any significant impact as they are designed to work in pre-existing noisy environments.

8.12 Existing Aids to Navigation

The only AtoN within 10 nm (19 km) of the Lease Area (excluding the LiDAR and research buoys associated with the Project) is the Mayflower Wind LiDAR research buoy to the southeast of the Lease Area. There may be some effect on visibility of these AtoNs by the presence of the wind farm structures. However, the AtoNs to be installed on the wind farm structures (see Section 7) are considered as compensating for any such effect.

As per Section 5.1.6, there are AtoNs located in proximity to the submarine export cable route. The Project will work with USCG to fully understand concerns and applicable mitigations for any associated potential impacts to AtoN. It is expected that any impacts would be fully mitigated through this consultation.

On this basis, no impact on existing AtoNs is anticipated from the Project.

8.13 Summary

Table 8.2 summarizes the impacts of the Project on communication and position fixing equipment.

Table 8.2 Summary of Impacts on Communication and Position Fixing Equipment

Topic		Sensitivity	Screening (Isolation)	Screening (Cumulative)
Type	Specific			
Communication	VHF	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	VHF DF	No notable degradation and therefore no anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	Rescue 21	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	AIS	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	NAVTEX	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	GPS	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out

Topic		Sensitivity	Screening (Isolation)	Screening (Cumulative)
Type	**Specific**			
Electromagnetic Fields	Subsea Cables	No anticipated impacts.	Screened out	Screened out
	Wind Turbines	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Marine Radar		Vessels have sufficient sea room to distance themselves from the array in line with the “Shipping Route Template” to mitigate any effects. Relevant rules of COLREGS (e.g., 5,6,19) would apply to vessels near or within the Lease Area.	Screened out	Screened out
SONAR		No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Noise		No anticipated impacts. Not impacted by layout design.	Screened out	Screened out

9 Search, Rescue, Environmental Protection and Salvage

9.1 United States Coastguard

9.1.1 Stations and Assets

The mission of the USCG is to ensure maritime safety, security, and stewardship in the U.S. There are two area commands (Atlantic Area and Pacific Area) which are split into a number of district commands. The Project is located within the 1st District in Sector Southeastern New England for the purpose of the USCG.

The First District office is based in Boston, MA and is responsible for USCG activities in northern New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont and Maine. The locations of the USCG stations in proximity to the Lease Area are shown in Figure 9.1.

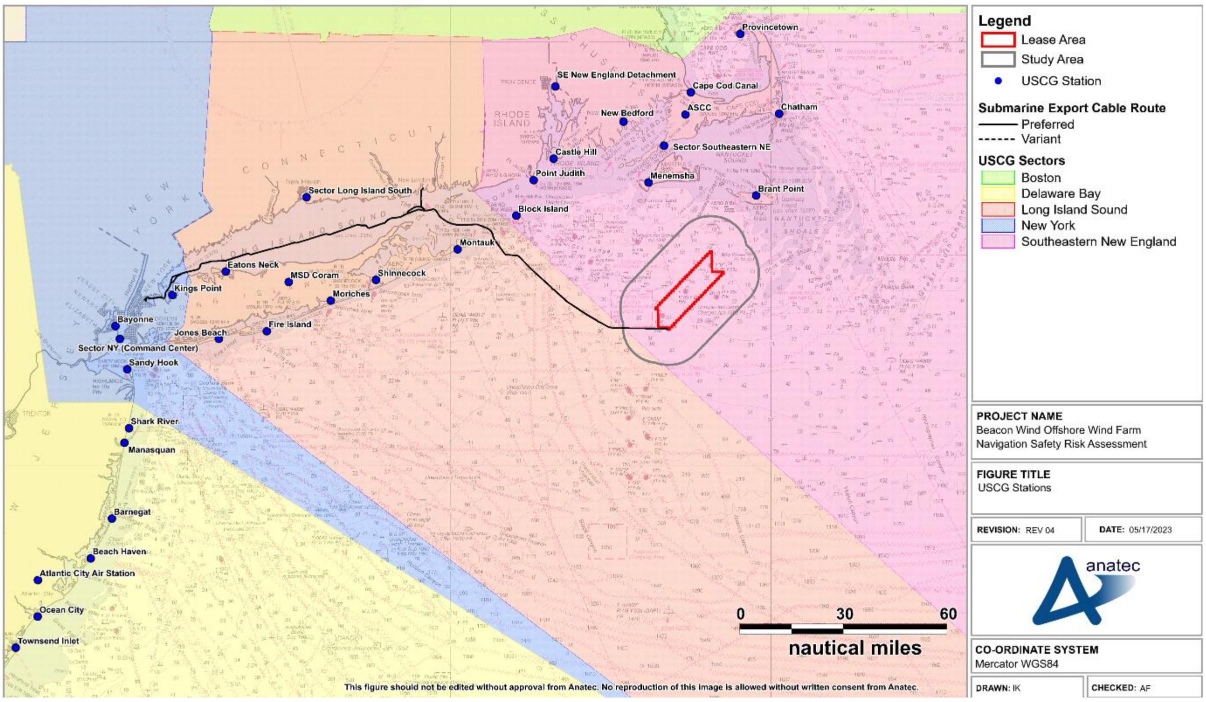

Figure 9.1 USCG Stations located in proximity to the Project

The closest USCG station to the Lease Area is located on Brant Point located approximately 20 nm (37 km) to the northeast.

There is one aviation facility operated by the USCG in the region, the USCG Air Station Cape Cod (ASCC), located approximately 40 nm (74km) north of the Lease Area. This station operates Sikorsky MH-60T Jayhawk helicopters and HC-144A Ocean Sentry fixed-wing aircraft and is responsible for the waters between New Jersey and the Canadian border (U.S. Department of Homeland Security [DHS] 2021).

9.1.2 Incident Assessment – Lease Area

Incident data from the MISLE database has been provided by the USCG over a ten year period covering 2011 to 2020. This includes approximate positional data for both the SAR incidents themselves and SORTIE locations of the assets involved.

9.1.2.1 SAR Incident Types

The locations of the SAR incidents (where a location was identified) or SORTIE locations associated with incidents to which the USCG have responded over the 10-year period between 2011 and 2020 are shown in Figure 9.2. It should be noted that multiple responses/SORTIES may be associated with the same incident.

It should be considered that while the data provides a specific point location, SAR incidents may involve a wider area of search, and therefore the application of the Study Area (see Section 2.4) ensures that incidents with a location specified outside of the Lease Area which may have required some degree of search within these areas are considered.

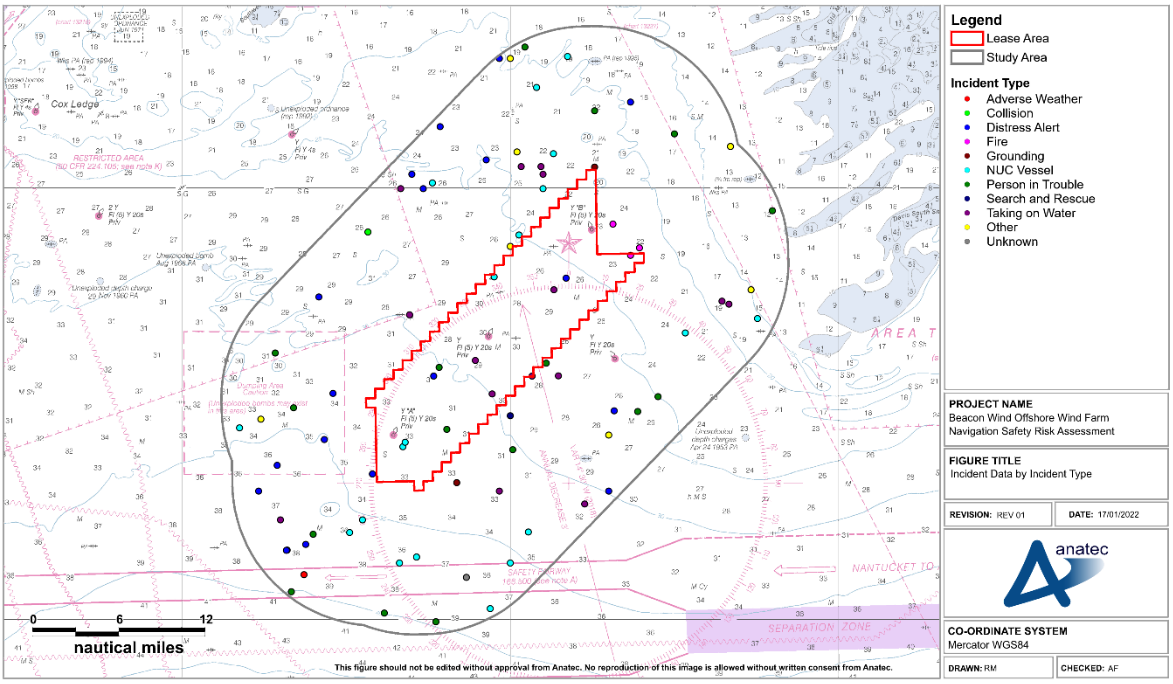

Figure 9.2 USCG SAR incident responses within the Study Area (2011 to 2020)

Between 2011 and 2020, the data indicated a total of 73 SAR incidents may have been associated with the Study Area. This corresponds to an average of seven per year.

Of the 73 incidents, approximately 25 percent were associated with a potential NUC vessel situation ("Disabled Vessel" or "Adrift/Unmanned"). Other key incident types included "Distress Alert" (22 percent) and "Person in Trouble" (21 percent).

The breakdown of proximity to the Lease Area that each potential NUC vessel scenario identified occurred is shown in Figure 9.3. A total of 20 incidents were identified in total, ten of which occurred within 5 nm (9.3 km). Of these, three were in the Lease Area itself.

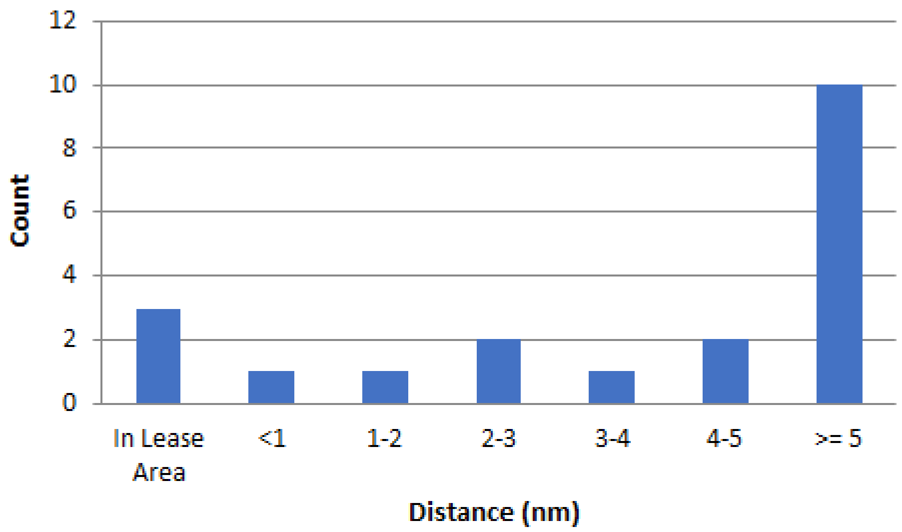

Figure 9.3 Proximity of NUC Incidents to Lease Area

9.1.2.2 SAR Resource Types

The resources utilized during incident responses within the Study Area are shown in Figure 9.4. As per Section 9.1.2, multiple resources may respond to the same incident.

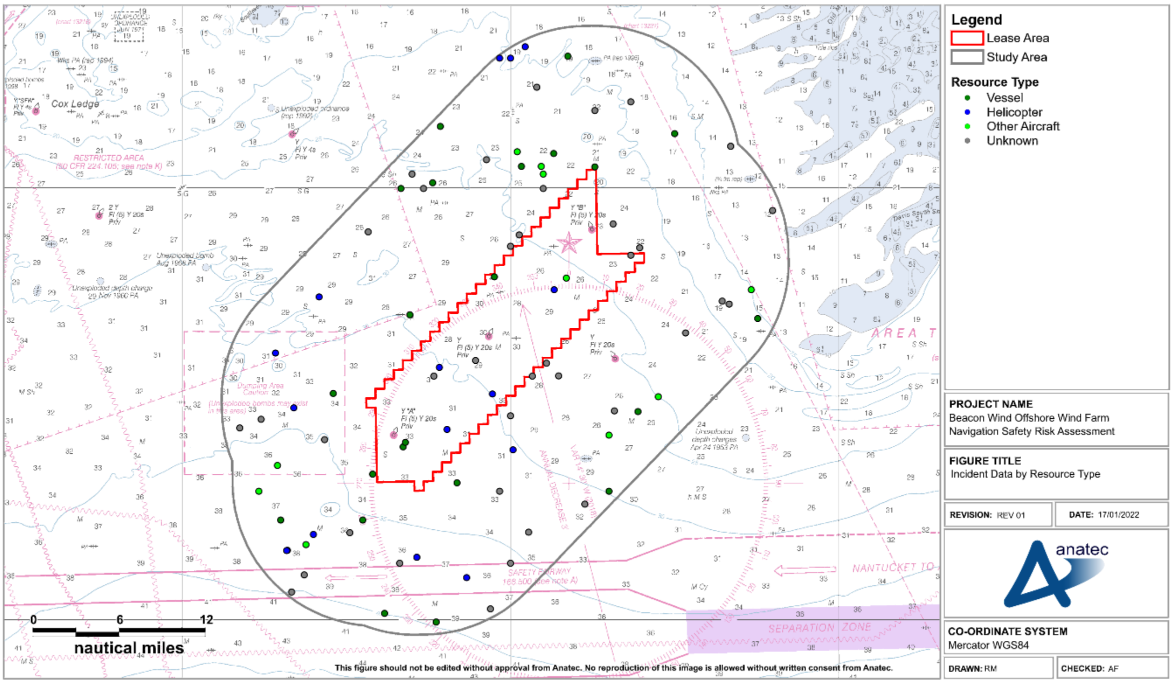

Figure 9.4 USCG SAR incident responses by resource type (2011 to 2020)

Excluding cases where resource type was unknown, approximately half of responses were from vessels (i.e., surface based resources). Helicopters accounted for approximately 30 percent, and "Other Aircraft" for the remaining 20 percent.

9.1.2.3 Pollution

Pollution incidents within the MISLE database reported as occurring in the Study Area between 2010 and 2019 are detailed in Table 9.1. A total of eight incidents were reported corresponding to an average of approximately one per year.

Table 9.1 Pollution Incidents in the Study Area

Year	Vessel Type	Substance	In Lease Area
2011	Fishing	Oil (Lubricating)	No
2011	Unspecified	Oil (Lubricating)	No
2012	Fishing	Oil (Lubricating)	No
2013	Fishing	Bilge slops	No
2013	Fishing	Oil (Diesel)	No
2014	Recreational	Gasoline (Unleaded)	No
2020	Fishing	Oil (Diesel)	No
2020	Recreational	Oil (Diesel)	Yes

9.1.3 Incident Assessment – Submarine Export Cable Route

9.1.3.1 SAR

Based on the ten years of USCG incident data, a total of 729 incidents occurred within the Submarine Export Cable Route Study Area. This corresponds to an average of 73 per year. However, as shown in Figure 9.5, the significant majority of these incidents occurred within the Long Island Sound, with incidents further offshore being much more limited (which aligns with the corresponding Lease Area assessment, see Section 9.1.2).

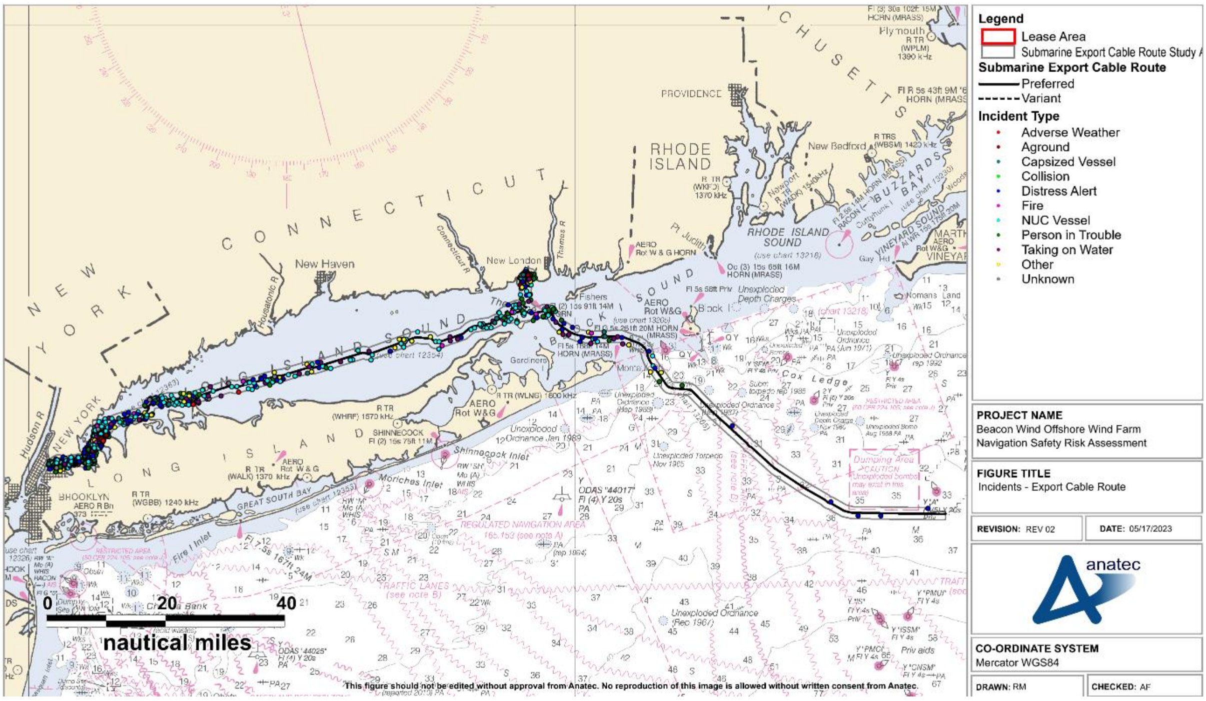

Figure 9.5 USCG SAR Incident Responses within the Submarine Export Cable Route Study Area (2011 to 2020)

Potential NUC vessel scenarios were the most common incident type, accounting for 37 percent of the total. Of note to the assessment of cable protection are grounding incidents which accounted for 4 percent of incidents. This corresponds to an average of three groundings per year. As shown in Figure 9.6, these all occurred in or near the East River.

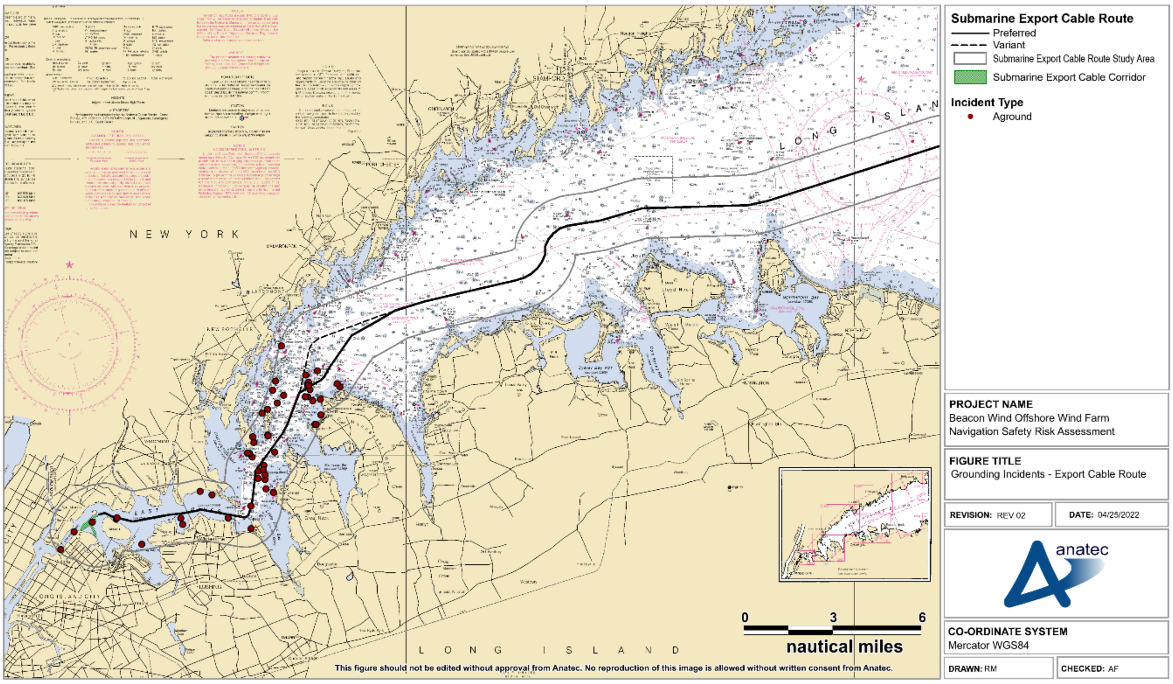

Figure 9.6 Grounding Incidents in Submarine Export Cable Route Study Area

9.1.3.2 Pollution

Pollution incidents within the MISLE database reported as occurring in the Submarine Export Cable Route Study Area between 2010 and 2019 are detailed in Table 9.2. A total of three incidents were reported corresponding to an average of approximately one every three years.

Table 9.2 Pollution Incidents in the Submarine Export Cable Route Study Area

Year	Vessel Type	Substance
2011	Towing	Oil (Other)
2017	Passenger	Oil (Motor)
2019	Towing	Oil (Diesel)

9.2 Historical Offshore Wind Farm Collision and Allision Incidents

9.2.1 United Kingdom Incidents

As of 14 December 2021, there are 39 fully commissioned and operational offshore wind farms in the U.K., ranging from the North Hoyle Offshore Wind Farm (fully commissioned in 2003) to Kincardine Offshore Wind Farm (fully commissioned in 2021). These developments consist of approximately 17,200 fully operational wind turbine years[10] (including years for now decommissioned developments whilst they were operational).

To date there have been no collisions (vessel to vessel) as a result of the presence of an offshore wind farm in the U.K.. The only reported collision incident in relation to a U.K. offshore wind farm involved a project vessel hitting a third-party vessel while in harbor.

To date there have been ten reported allision incidents between a vessel and a wind turbine (during any phase – construction, operational, or disused) in the U.K., with nine involving a wind farm support vessel for the development and all ten from vessels under power (as opposed to NUC). Therefore, considering the number of operational wind turbine years, and the number of allision incidents, there has been an average of 1,721 years per wind turbine allision incident in the U.K., noting that this is a conservative value considering that, within the calculations, only operational wind turbine hours have been included whereas allision incidents considered include non-operational wind turbines.

The worst consequences reported for vessels involved in an allision incident involving a U.K. offshore wind farm has been minor flooding, with no life-threatening injuries to persons reported. No material damage to wind turbines has been reported in any of the allision incidents.

9.2.2 United States

Given the early stage of offshore wind development in the U.S., there is limited historical data for consideration in relation to collision and allision incidents involving offshore wind farms.

However, one incident has occurred near the Block Island Offshore Wind Farm, the only currently operational offshore wind farm in the U.S. This incident involved a fishing vessel in January 2019 which issued a mayday call stating that the vessel was taking on water near the site (The Martha’s Vineyard Times 2019). The first responder reported the rescue of one fisherman and that the vessel had capsized, leaving two fishermen missing. A USCG helicopter and response vessel were dispatched to conduct a search but were forced to return to their respective bases due to low visibility and unsafe weather conditions. Although the search was later resumed, the two missing fishermen were not found, with the sunken vessel discovered a month later.

Although the incident itself was considered unrelated to the offshore wind farm, it is understood from the review of publicly available information that a case study was/is undertaken by the USCG to determine if the presence of the wind farm had any impact on the USCG’s SAR operation. At the time of writing, this case study (investigation) has not been released to the public.

10 A WTG year is defined as a 365-day period after a WTG has been fully constructed and commissioned whilst the entire site where it is situated at is fully operational.

10 Cumulative Development Screening

Prior to the assessment of the cumulative effect by impact, it is necessary to determine the degree to which each cumulative feature in the region should be considered. Table 10.1 presents details of any cumulative developments assigned into Tiers 1 or 2 based on the methodology outlined in Section 2.2.1. Following this, Figure 10.1 presents the location of the cumulative developments relative to the Project, color-coded by tier.

As per Section 2.2.2, two cumulative scenarios have been considered, one of which is the Project plus Vineyard Wind and South Fork scenario. On this basis, Vineyard Wind and South Fork has been placed into their own Tier 1 subcategory (1a).

Table 10.1 Cumulative Tiering

Development	Lease Area	Development Status	Distance from Lease Area (nm)	Data Confidence	Tier
Vineyard Wind 1	OCS-A 0501	Pre construction	0 (Adjacent)	High	1a
South Fork	OCS-A 0517	Consent authorized	24.2	High	1a
Park City Wind / Commonwealth Wind	OCS-A 0534	Consent submitted	0 (Adjacent)	High	1b
Mayflower Wind / Mayflower Wind 2	OCS-A 0521	Consent submitted	0 (Adjacent)	High	1b
Vineyard Northeast	OCS-A 0522	Concept/Early Planning	6.4	Medium	1b
Bay State Wind	OCS-A 0500	Consent submitted	7.8	High	1b
Sunrise Wind / Sunrise Wind 2	OCS-A 0487	Consent submitted	13.1	High	1b
Revolution Wind	OCS-A 0486	Consent submitted	18.3	High	1b
Empire Wind 1 / Empire Wind 2	OCS-A 0512	Consent submitted	110.6	High	2
Vineyard Mid-Atlantic	OCS-A 0544	Concept/Early Planning	106.2	Medium	2

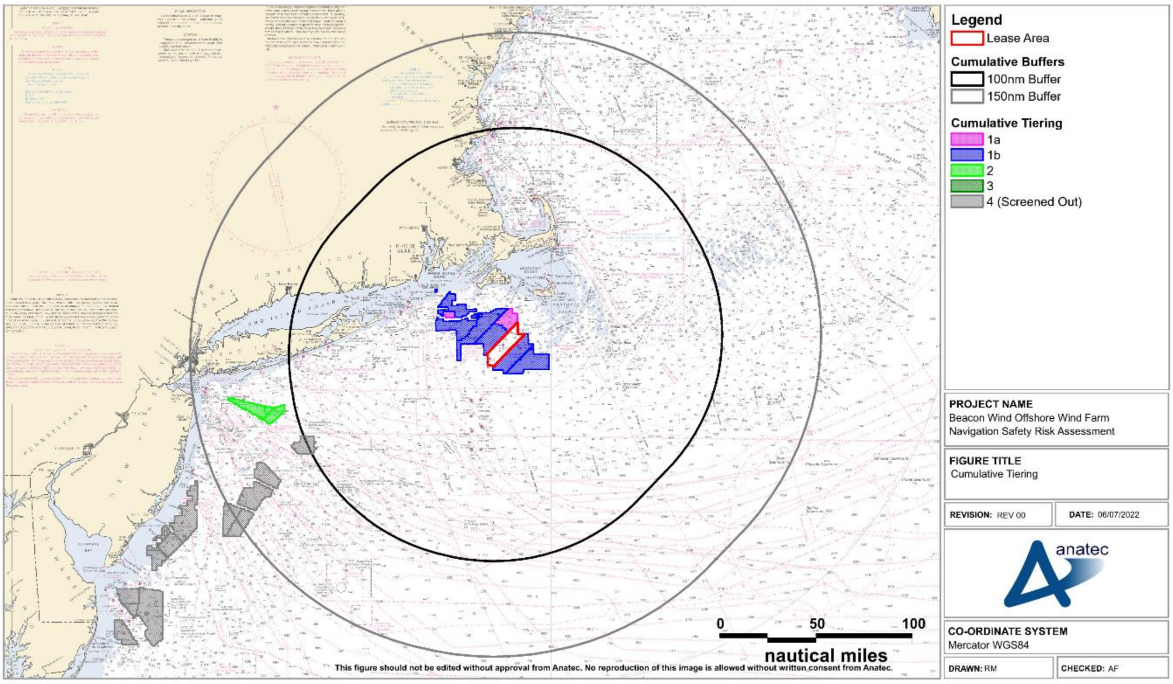

Figure 10.1 Cumulative Tiering Overview

11 Collision, Allision and Grounding Risk Modelling

This section provides a quantitative assessment of potential interactions associated with the development of the Project. It is noted that, the quantitative assessment forms only one part of the NSRA, and feeds into the qualitative assessment introduced within the impact assessment.

11.1 Methodology

11.1.1 Quantitative Impacts Assessed

A base case and future case are assessed, with hazards assessed including:

- Vessel to vessel collision risk;
- Powered vessel to structure allision risk;
- Drifting vessel to structure allision risk;
- Internal fishing vessel to structure allision risk; and
- Vessel grounding risk.

11.1.2 Vessel Traffic Growth Scenarios Assessed

The base case has been produced based upon the one-year AIS data period collected during 2019 (see Section 6.2). The future case scenarios are then produced by considering the potential vessel traffic growth as detailed in Section 6.7. Two future case scenarios are considered on this basis, 10 and 20 percent.

11.1.3 Routing Scenarios Assessed

Two distinct post wind farm routing scenarios have been assessed for the various risk types (collision, allision), with the worst case of the two scenarios presented in each case.

- In the first routing scenario, presented in Figure 11.1, commercial routes (i.e., those containing cargo vessels, tankers and passenger vessels) are assumed to deviate around the Lease Area while fishing vessels are assumed to continue the existing transit routes through the Lease Area.
- In the second scenario, shown in Figure 11.2, the transiting fishing vessels have been assumed to deviate around the Lease Area in the same manner as the commercial vessel routing.

Internal and external studies undertaken by Anatec at a number of offshore wind farms in U.K. waters including large developments in high traffic density areas such as the London Array and Walney Extension Offshore Wind Farms have to date indicated that commercial vessels generally avoid transiting internally within arrays but do pass consistently and safely within 1 nm (1.9 km) of established offshore wind farms with the case-by-case passing distance dependent on the sea room available and prevailing conditions. The evidence suggests that the mariner defines their own safe passing distance (outside of defined routing measures) based on the conditions and nature of the vessel traffic at the time, but they are shown to frequently pass 1 nm (1.9 km) off established developments. Therefore, a mean distance of 1 nm (1.9 km) from the Lease Area has been assumed when re-routing commercial vessel and transiting fishing traffic around the array.

Any shallow waters and/or known routing preferences have also been considered.

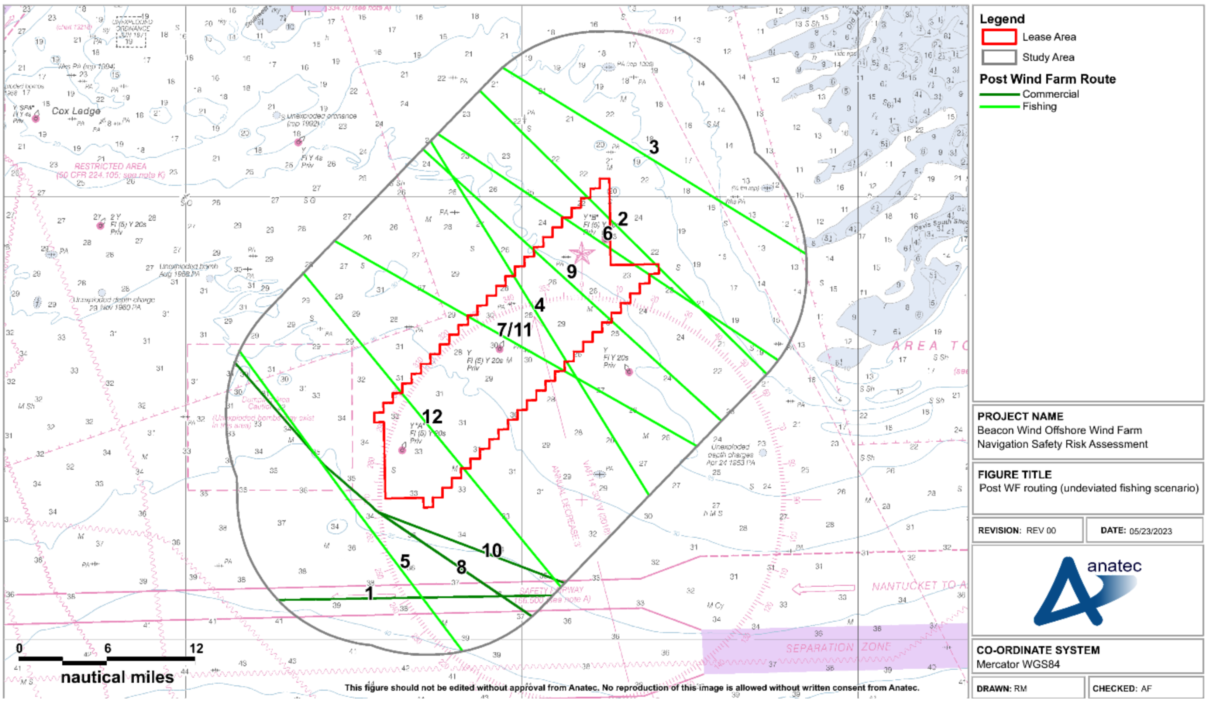

Figure 11.1 Post wind farm routing – Scenario 1

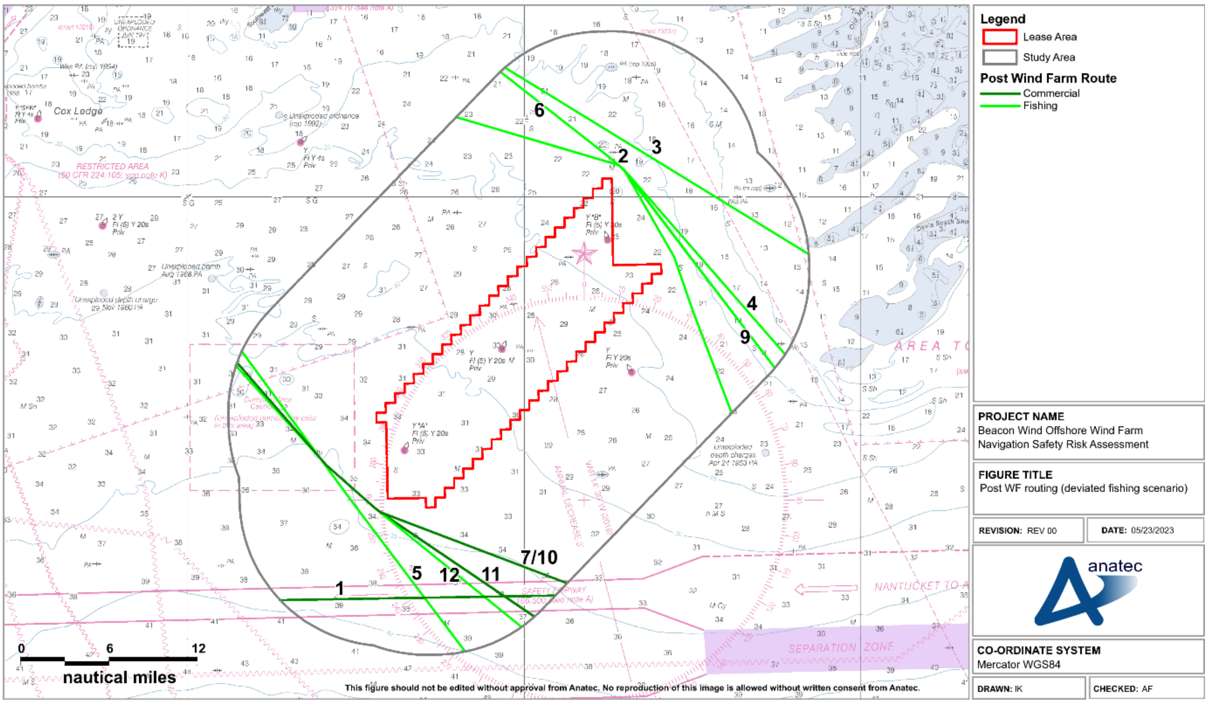

Figure 11.2 Post wind farm routing – Scenario 2

11.1.4 Return Periods

Quantitative assessment results are generally reported as a return period (i.e., the expected number of years between occurrences[11], noting that annual frequency (i.e., the number of expected occurrences per year; the inverse of the return period) is referenced, where appropriate.

11.2 Pre-Wind Farm

11.2.1 Encounters

This section presents a quantitative assessment of the number of encounters within the Study Area, based on modelling of one year of AIS data (see Section 6.2).

The input data was run through Anatec's Encounters program which identified any instance of two (or more) vessels located within 1 nm (1.9 km) of each other within a one-minute interval. On this basis, the program checks the position of each AIS transmission for any further transmissions from other vessels recorded at positions within 1 nm (1.9 km) and within 60 seconds. Where any such instance is identified, the program extracts all associated transmissions from the associated vessels.

[11] For example, a return period of 1 in 100 years indicates that over a 100-year period the expected number of occurrences is one. This differs from the notion that it will take 100 years for one instance to occur.

It should be noted that only close proximity independent of vessel course is accounted for, i.e., no account has been given as to whether the encounters are head on or stern to head.

The output of the model as then manually filtered to identify encounters that were resulting from planned multiple vessel operations (e.g., surveys, towing). Any such case was removed from the assessment to ensure the focus remained on genuine encounter situations (i.e., multiple vessels engaged in independent activities including transits). Note, a conservative approach has been used within the manual assessment and any encounter with a degree of doubt has been retained.

The output of the Encounter model is presented in Figure 11.3, color-coded by vessel type. A total of 1,144 encounters were identified, which is equivalent to approximately three encounters per day on average.

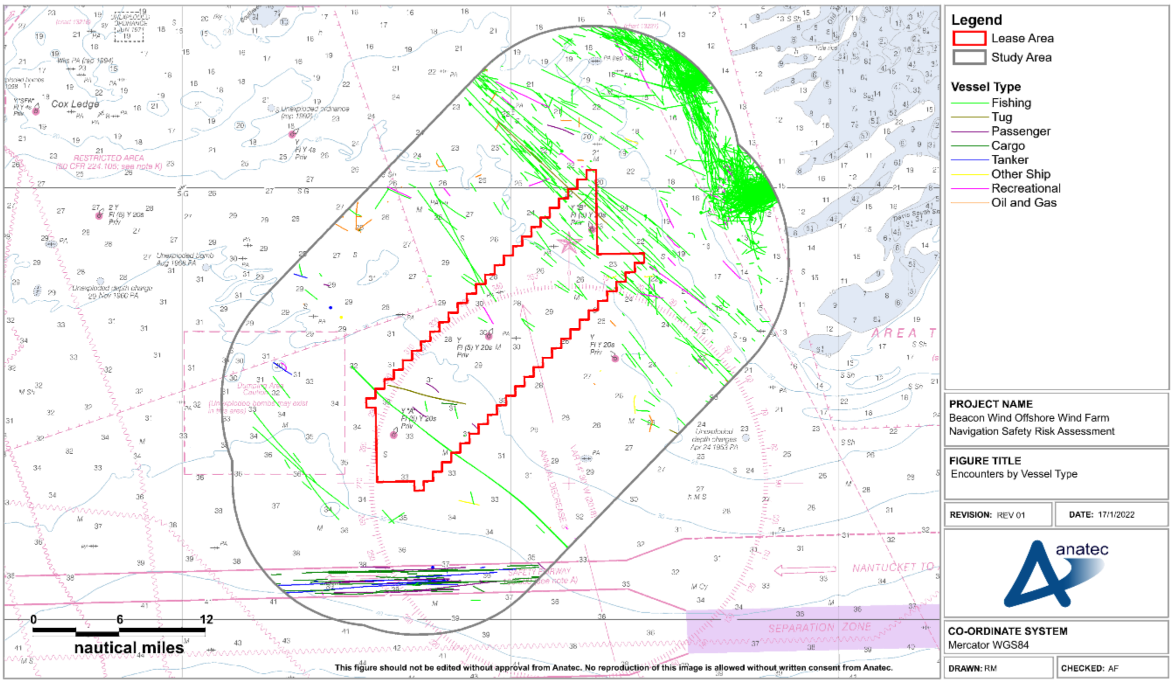

Figure 11.3 Encounters by Vessel Type

A significant majority of encounters (approximately 90 percent) were observed to be between fishing vessels. This included encounters within the Lease Area between vessels in transit; however, encounters between fishing vessels actively engaged in fishing were also observed to the north east extent of the Study Area. It is noted that encounters were also observed between transiting commercial vessels in the westbound lane of the Ambrose/Nantucket Safety Fairway.

11.2.2 Vessel to Vessel Collision Risk

Vessel to vessel collision risk pre-wind farm has been assessed based on the pre-wind farm routes presented in Section 6.3.2. These were used as an input, in addition to meteorological data, to the collision risk function Anatec's COLLRISK software to determine the vessel to vessel collision risk pre-wind farm.

The COLLRISK software considers the vessel numbers, types, sizes, mean route positions, and route widths to calculate the potential collision frequency. The likelihood of a major incident considers the probability of poor visibility (as collisions are more likely to occur when visibility is poor) and has been calibrate against historical maritime incident data.

Figure 11.4 presents a 0.5 × 0.5 nm (0.9 × 0.9 km) heat map of the pre-wind farm vessel to vessel collision risk within the Study Area.

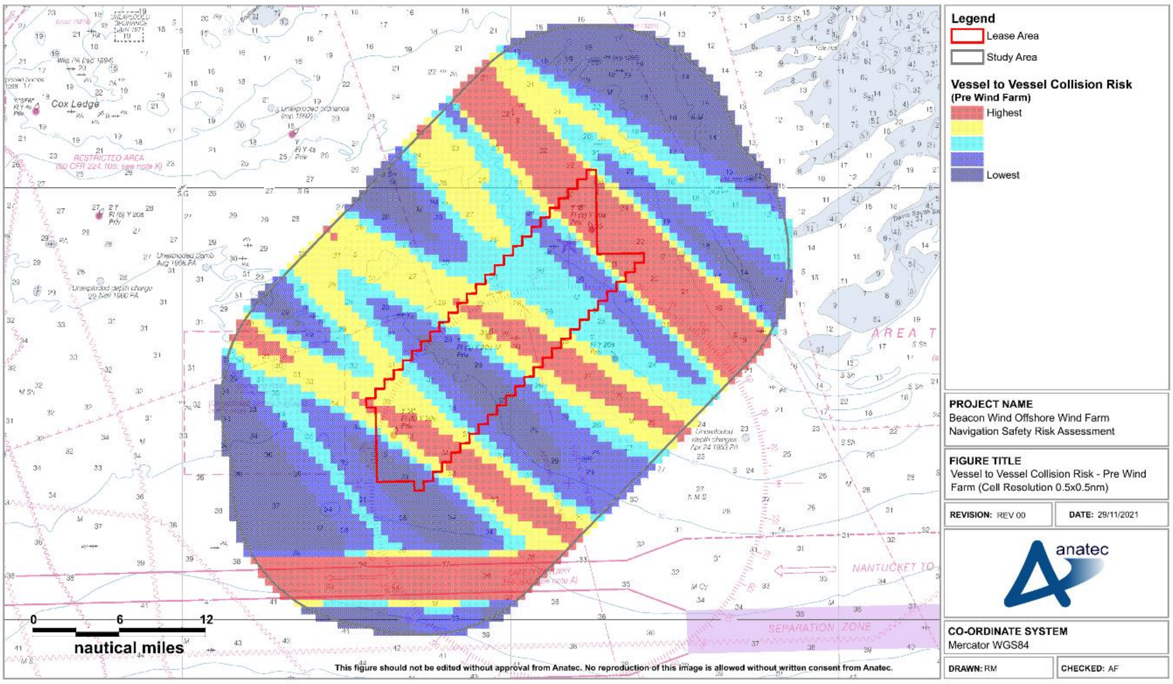

Figure 11.4 Vessel-to-Vessel Collision Risk – Pre-Wind Farm

Based on the pre-wind farm base case modelling scenario, a vessel to vessel collision would occur once in 2,620 years within the Study Area. As indicated in Figure 11.4, the majority of the risk is associated with the westbound traffic utilizing the Ambrose/Nantucket Safety Fairway and the NW-SE transits by fishing vessels intersecting the northern edge of the Lease Area boundary.

Assuming a 10 percent traffic increase to represent potential future vessel traffic trends (see Section 6.7), it was estimated that the annual collision return period would increase to one in 2,165 years, corresponding to an increase of approximately 21 percent compared to the base case. For a 20 percent traffic increase, it was estimated that the annual collision return period would increase to 1 in 1,819 years, corresponding to an increase of approximately 44 percent compared to the base case.

It should be considered that the vessel to vessel collision risk model is calibrated using major incident data at sea which allows for benchmarking but does not encompass all incidents, such as minor impacts. Other incident data from the USCG, which considers minor impact, is presented in Section 9.1.

11.3 Post Wind Farm

11.3.1 Route Deviations

The post wind farm routes and the corresponding methodology for each of the two routing scenarios assessed are presented in Section 11.1.3, including the allocation of mean route positions to maintain a minimum distance of 1 nm (1.9 km) from the Lease Area. The deviated fishing vessel scenario (Scenario 2 as per Figure 11.2) has been used for the purposes of assessing deviation distances.

Based on the deviated fishing vessel scenario, a deviation is anticipated to be required for nine out of the 12 routes identified, comprising two main routes and seven low use routes. Table 11.1 provides a summary of the change in route length for the mean position for each of these routes where a deviation was deemed necessary.

Table 11.1 Summary of post wind farm route deviations

Route Type	ID	Pre Wind Farm Distance (nm)	Post Wind Farm Distance (nm)	Change (nm)	Change (percent)
Main Route	1	229.5	229.5	0.0	0.0
	2	87.4	87.8	0.4	0.4
	3	97.9	97.9	0.0	0.0
	4	113.6	116.0	2.4	2.1
Low Use	5	98.4	98.4	0.0	0.0
	6	129.2	130.6	1.4	1.1
	7	113.5	121.3	7.8	6.8
	8	130.1	131.5	1.4	1.1
	9	112.4	114.3	2.0	1.7
	10	201.1	203.8	2.7	1.3
	11	156.2	162.3	6.1	3.9
	12	161.8	162.3	0.5	0.3

The largest absolute increase in distance to a main route was 2.4 nm (4.4 km) to Route 4, which equates to a percentage increase of 2.1 percent. The largest absolute increase in distance to a low use route was 7.8 nm (14.4 km) to Route 7, which equates to a percentage increase of 6.8 percent.

11.3.2 Simulated Automatic Identification System Data

Using the post wind routes, their associated standard deviations from the mean position and the average number of vessels on each route, Anatec's AIS Track Simulator has been used to gain insight into the potential re-routed vessel traffic following the installation of the Project.

Figure 11.5 presents a plot of 12 months of simulated AIS tracks (to match the length of the survey period for the primary vessel traffic data used in the baseline assessment) based on the undeviated fishing scenario. Following this, Figure 11.6 presents 12 months of simulated AIS tracks based on the deviated fishing scenario. It is emphasized that the simulated tracks consider only regular commercial routes and transiting fishing vessel routes.

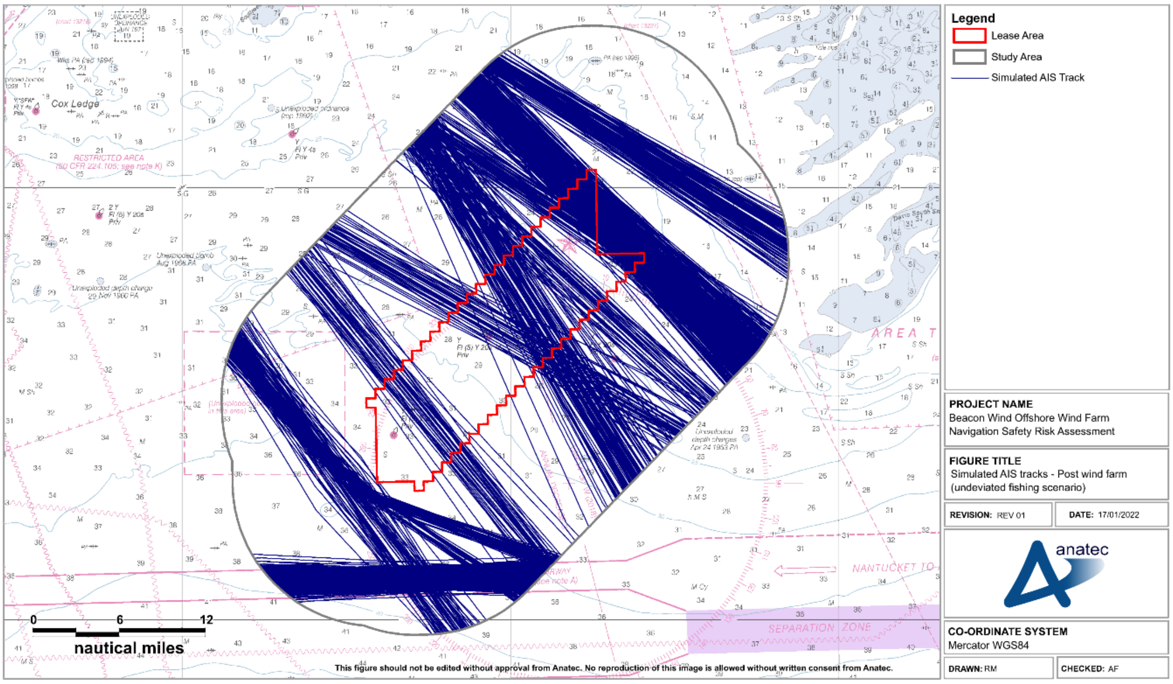

Figure 11.5 Simulated AIS tracks – Post wind farm (undeviated fishing scenario)

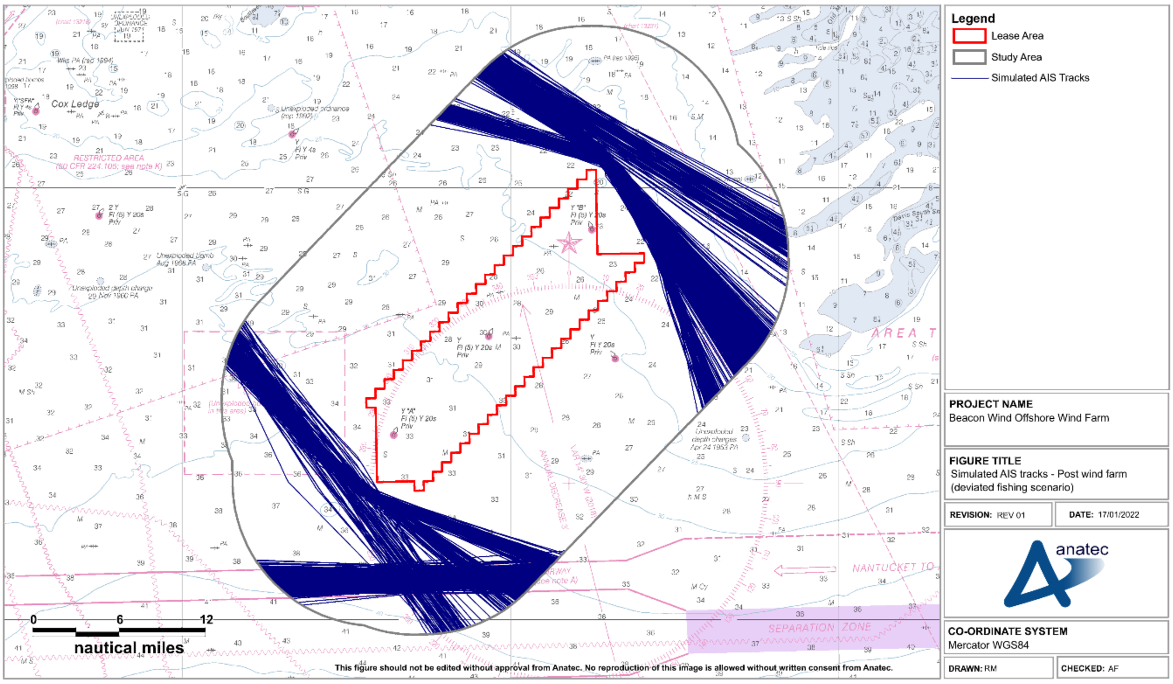

Figure 11.6 Simulated AIS tracks – Post wind farm (deviated fishing scenario)

11.3.3 Vessel to Vessel Collision Risk

The post-wind farm routing and local meteorological data were used as inputs to the collision risk function of Anatec's COLLRISK software to calculate the collision risk for vessels post-wind farm for both the base and future case.

On this basis, Figure 11.7 presents the worst-case vessel to vessel collision risk heat map within the Study Area, which is based on the scenario in which fishing vessels deviate around the Lease Area (Scenario 2 as per Figure 11.2).

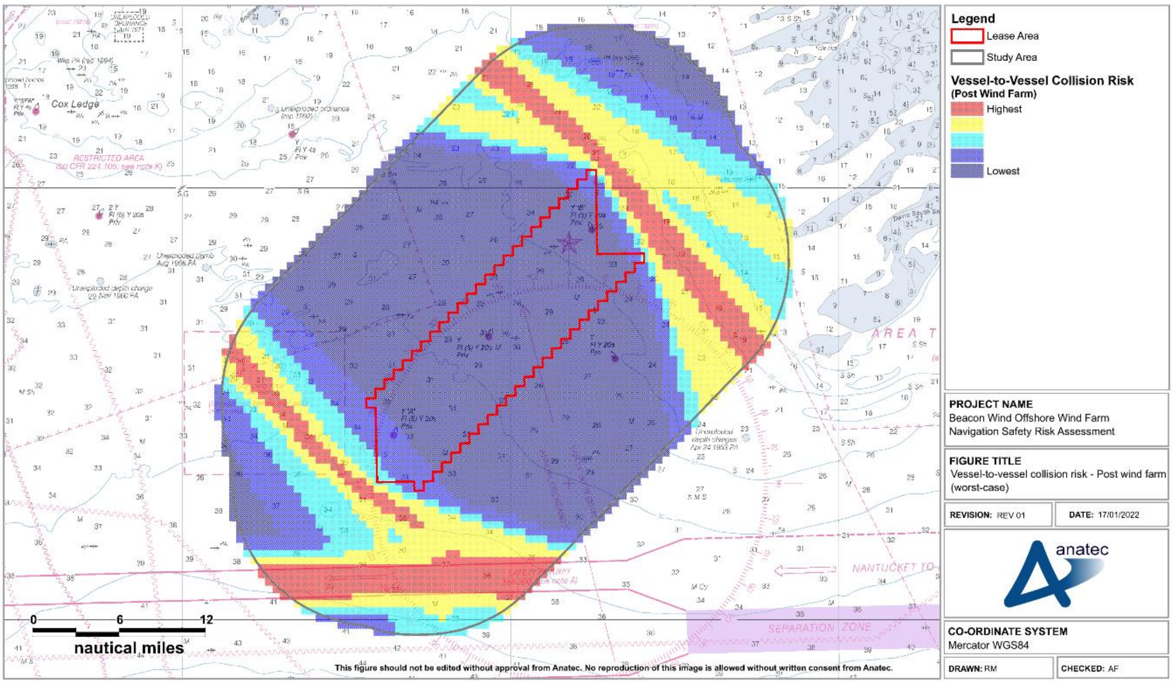

Figure 11.7 Vessel to vessel collision risk – Post wind farm

Based on the worst-case scenario post wind farm collision modelling output, it was estimated that a vessel would be involved in a collision once in 1,986 years assuming base case traffic volumes. This represents a 32 percent increase in annual collision risk from the pre wind farm scenario.

In terms of future case risk, the return period rose to one in 1,642 years assuming a 10 percent increase in traffic levels, and one in 1,379 years assuming a 20 percent increase in traffic.

In this routing scenario, both commercial vessels and fishing vessels on the transiting routes are assumed to deviate to avoid the Lease Area, and as such collision risk within the Lease Area associated with such vessels will decrease. However, collision risk increases within the Study Area as a whole, particularly immediately to the north and south of the Lease Area where vessels passing through the Lease Area are anticipated to deviated post-wind farm in the worst case. This is illustrated in Figure 11.8, which presents the change in vessel to vessel collision risk between the pre wind farm and worst-case post wind farm scenarios, assuming base case traffic levels.

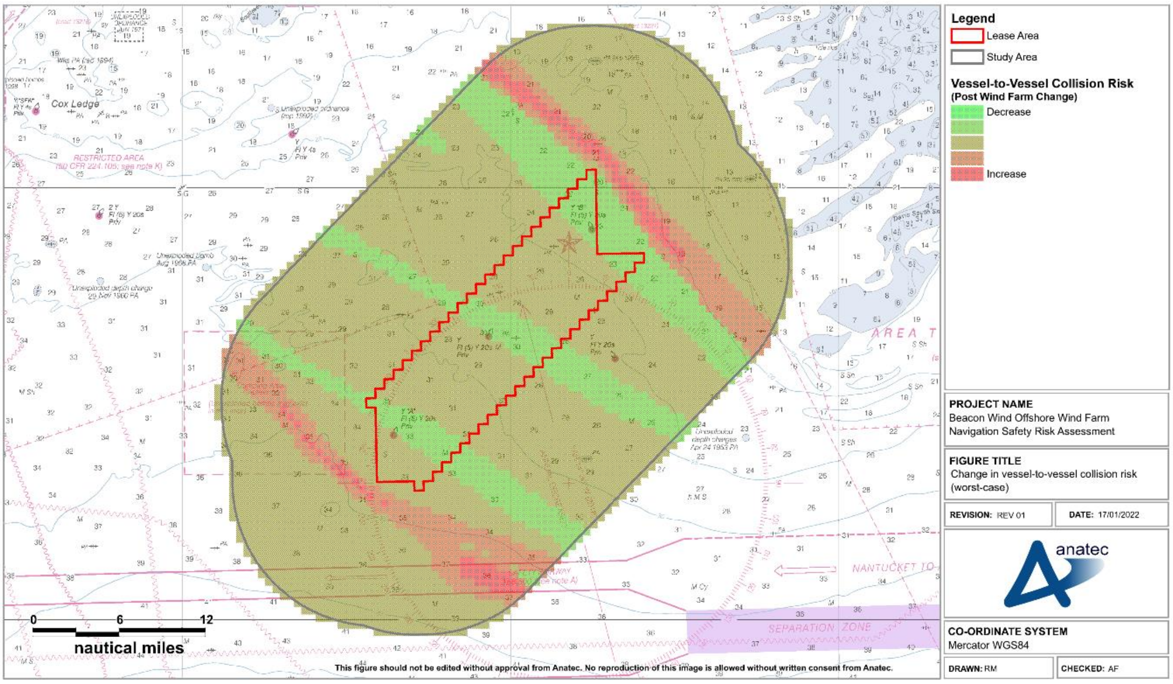

Figure 11.8 Change in vessel to vessel collision risk

11.3.4 Vessel-to-Structure Allision Risk – Commercial Vessels

This section considers the allision impact from routed commercial vessels for both powered (Section 11.3.4.1) and NUC (Section 11.3.4.2) scenarios. Fishing vessel allision risk is considered separately in Section 11.3.5.

11.3.4.1 Powered Allision Risk

The post-wind farm commercial vessel routing was used as an input to the powered allision function of Anatec's COLLRISK software to calculate the risk of a powered allision at the Project.

A powered allision is defined as a scenario during which an errant vessel under power deviating from its route to the extent that it comes into proximity of a surface piercing structure associated with the Project resulting in an allision. The COLLRISK powered allision model considers the vessel numbers, types, sizes, mean route position, route widths, structure positions, and structure dimensions. The likelihood of a major allision incident considers the probability of poor visibility and has been calibrated against historical maritime incident data.

On this basis, Figure 11.9 presents the powered vessel to structure allision risk for the individual wind farm structures within the Lease Area. It is noted that the size ranges used to illustrate the powered allision risk to individual structures is tailored to the output of the powered assessment and, as such, Figure 11.9 is not directly comparable to the corresponding commercial drifting and fishing allision assessment plots.

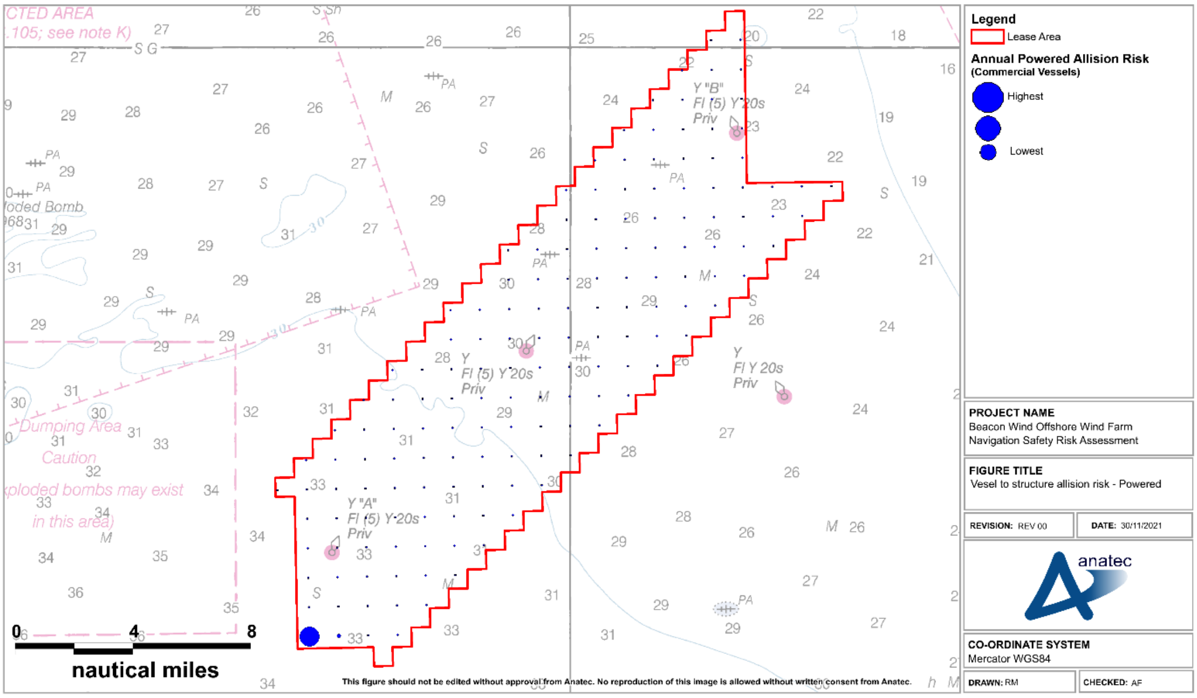

Figure 11.9 Powered Vessel to Structure Allision (Commercial Vessels)

Based on the post-wind farm base case modelling scenario, the powered allision frequency for commercial vessels was estimated at 2.45×10^{-9}. Based on this result, the allision risk to the wind farm structures due to transiting commercial vessel routes is negligible on a quantitative basis, which is reflective of observed commercial vessel routing in the area, with the significant majority of commercial vessel traffic passing well clear of the Lease Area within the safety fairway to the south. However, it should be considered that a negligible quantitative frequency for routed commercial vessels does not mean there is no allision risk to commercial vessels. The risk is assessed on a qualitative basis in Section 16.3.

11.3.4.2 Drifting Allision Risk

Using the worst-case post-wind farm commercial vessel routing as an as input to the drifting allision function of Anatec's COLLRISK modelling software suite, the potential drifting vessel to structure allision risk following the installation of the Project has been assessed.

A drifting allision is defined as a scenario during which a vessel is NUC, for example due to an engine failure, causing the vessel to drift from its route to the extent that it comes into proximity of a surface piercing structure associated with the Project resulting in an allision. The likelihood of a major incident considers the likely drift speed and direction based on local meteorological data (both tidal and weather data) and has been calibrated against historical maritime incident data.

The model is based upon the premise that the propulsion on a vessel must fail before a vessel would begin to drift, with the type and size of the vessel, number of engines, average time to repair, and differing sea conditions all considered. The exposure times or a drifting scenario are based upon the vessel hours spent in proximity to the wind farm structures (up to 10 nm [18.5 km] from the perimeter of the Lease Area). which have been estimated based on the vessel traffic levels, speeds, and routing patterns.

Using this information, the overall rate of mechanical failure within the Study Area was estimated. The probability of a vessel drifting towards one of the Project’s surface structures are dependent on the prevailing wind, wave, and tidal conditions at the time of the incident.

The following three drift scenarios have been modelled:

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

The probability of vessel recovery when it begins to drift is based on the speed the vessel is drifting and, hence, the amount of time available to take corrective action before reaching one of the Project’s surface structures.

After modelling each of the drift scenarios listed above, it was determined that the flood dominant drift produced the worst-case results and therefore has been presented within this NSRA for the purposes of assessing drifting vessel to structure allision risk.

On this basis, Figure 11.10 presents the drifting vessel to structure allision risk for the individual wind farm structures within the Lease Area. It is noted that the size ranges used to illustrate the drifting allision risk to individual structures is tailored to the output of the drifting assessment and as such Figure 11.10 is not directly comparable to the corresponding commercial powered and fishing allision assessment plots.

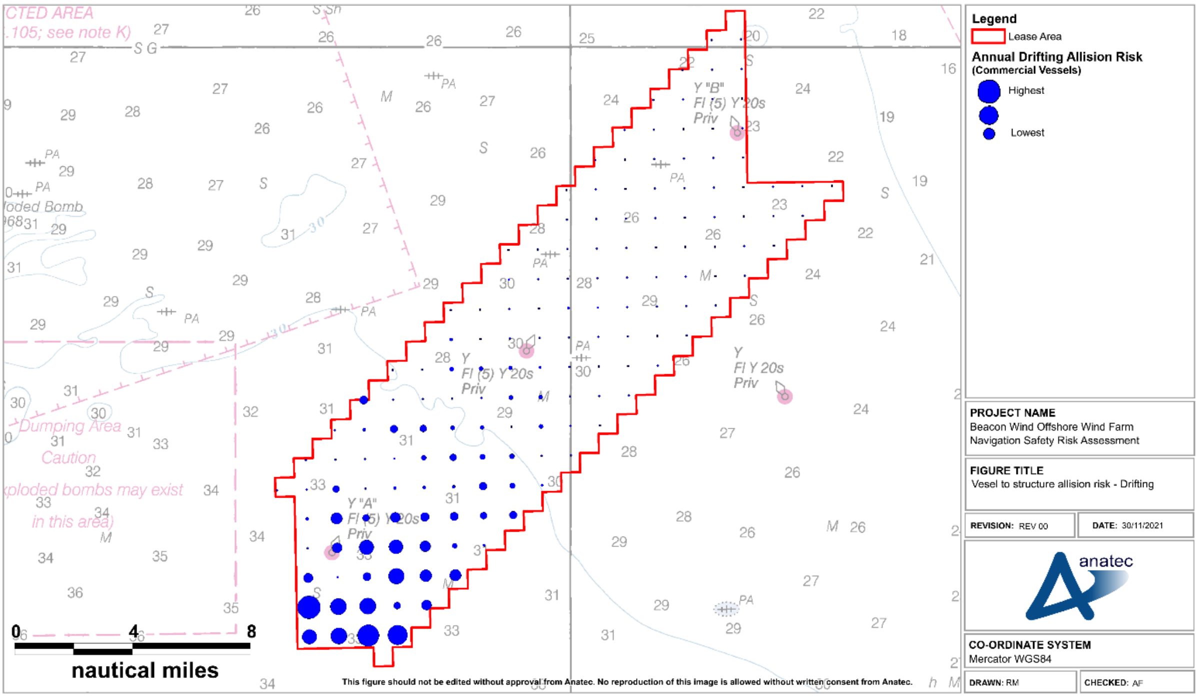

Figure 11.10 Drifting Vessel to Structure Allision

For the base case scenario, it was estimated that the annual drifting allision return period across all wind farm structures was one in 13,859 years. As indicated in Figure 11.10, the majority of the post wind farm drifting allision risk is associated with the wind turbines in the southern part of the Lease Area, particularly those closest to the routes pass through the Lease Area in the pre wind farm scenario deviating to the south of the Lease Area.

Based on the modelling, the wind farm structure most at risk of a drifting allision was a wind turbine on the southwestern boundary of the Lease Area, for which the estimated drifting allision frequency was one in 77,301 years.

In terms of future case risk, the return period rose to one in 12,599 years assuming a 10 percent traffic increase, and one in 11,549 years assuming a 20 percent traffic increase.

11.3.5 Fishing Vessel-to-Structure Allision Risk

Using the 12 months of AIS data (see Section 6.2.4.2) as input to the fishing allision function of Anatec's COLLRISK modelling software suite, the potential fishing vessel to structure allision risk following the installation of the Project has been assessed.

A fishing vessel allision is classified separately from other allisions since, unlike in the case of the commercial traffic characterized via the main routes, fishing vessels may be either in transit or actively fishing within the area. Moreover, fishing vessels could be observed internally within the array in addition to externally. The COLLRISK fishing allision model uses vessel numbers, sizes (length and beam), array layout, and structure dimensions. The likelihood of an allision incident has been calibrated against historical maritime incident data and historical AIS vessel traffic data within operational offshore arrays, and is inclusive of powered and drifting scenarios.

Given that not all fishing vessels broadcast on AIS, the vessel density observed has been scaled up to account for non-AIS fishing vessels, with the assumption made that 40 percent of fishing vessels in the area do not broadcast on AIS noting this aligns with input from BOEM (see Section 3.1). It should be considered that this value is conservative when compared against the findings of the visual observation surveys (see Section 6.5). On this basis, for reference, the modelling has also been run assuming a value of 17 percent which aligns with the visual observation survey data.

Following the running of the model, Figure 11.11 presents the fishing vessel to structure allision risk for each individual wind farm structure assuming a 40 percent non AIS factor. It is noted that the size ranges used to illustrate the fishing allision risk to individual structures is tailored to the output of the fishing vessel assessment and as such Figure 11.11 is not directly comparable to the corresponding commercial allision assessment plots.

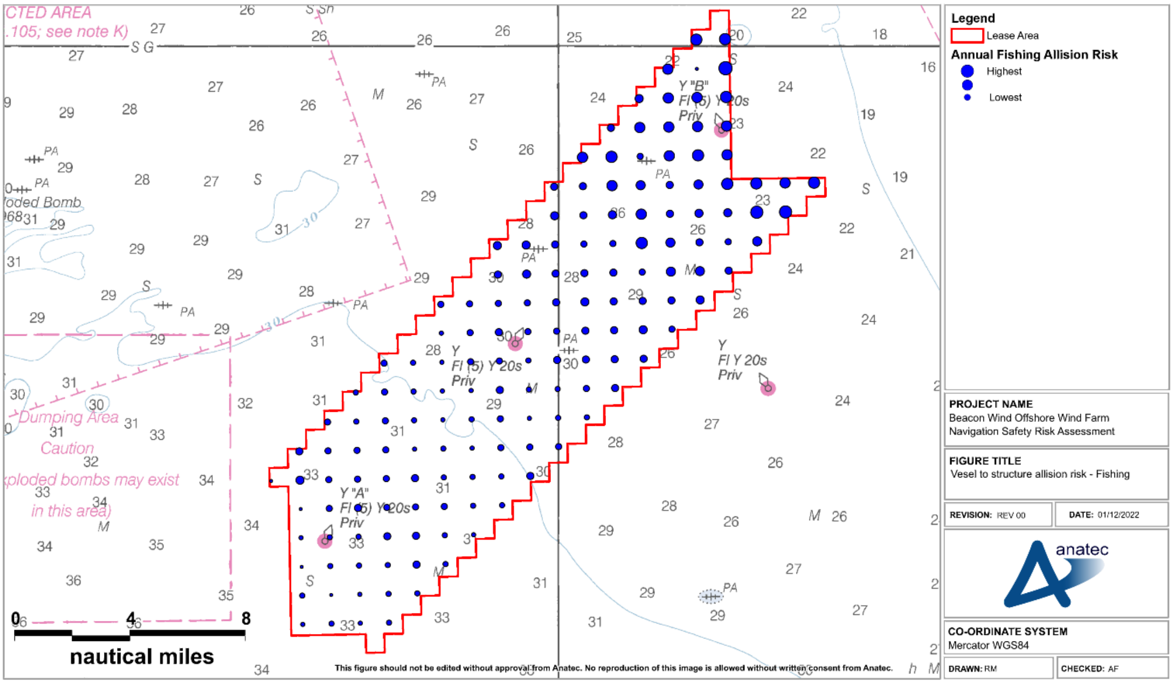

Figure 11.11 Vessel to structure allision risk – Fishing vessels

For the base case scenario and assuming a 40 percent non AIS factor, it was estimated that the annual fishing vessel allision return period across all wind farm structures was one in 8.7 years. If a 17 percent non AIS factor is applied (see Section 6.5), the return period drops to one in 11.3 years.

As indicated in Figure 11.11, the majority of the post wind farm fishing vessel allision risk is associated with structures within the north eastern portion of the Lease Area, although some of the risk is also distributed to the central and southern parts of the Lease Area. The greatest annual fishing vessel allision return period associated with any individual structure was one in 193 years for a wind turbine on the northern periphery of the Lease Area. (It is noted that this accounts only for fishing vessels recorded on AIS, and analysis of fishing activity based on VMS data for various fishing gear types is presented in Section 6.2.4.2).

Assuming a 10 percent traffic increase to represent potential future vessel traffic trends, it was estimated that the annual fishing vessel allision return period would be one in 8.1 years. For a 20 percent traffic increase, it was estimated that the annual fishing vessel allision return period would be one in 7.7 years.

11.3.6 Vessel Grounding Risk

The only underwater devices forming part of the Project are the interarray and export cables. As noted in Section 4.3, there is potential for the interarray and export cables to require protection where burial depths are not feasible and residual risk remains. The maximum height of cable protection (above the seabed) is estimated to be no more than 5 ft (1.5 m). Should this protection reduce navigable water depths, there may be an increased risk of vessel grounding in shallower waters. However, the extent and locations of any required external protection are not known at the time of writing, and therefore a detailed quantitative assessment of the grounding risk has not been undertaken. However, a high-level assessment (including some quantification) based on the information available at the time of writing has been undertaken, noting that for the submarine export cable route, a corridor of width 500m with respect to the submarine export cable route has been analyzed.

With respect to the Lease Area:

- Water depths within the Lease Area range between approximately 120 and 198 ft (37 and 60 m) over MLLW;
- The Lease Area is located approximately 16 nm (30 km) off the coast of the nearest landmass (Nantucket Island) in an area with significant available sea room; and
- The largest valid vessel draft broadcast throughout the vessel traffic survey of the Lease Area was 49.5 ft (15.1 m).

Taking these factors into account, there is not considered to be any additional risk to vessels of grounding within the Lease Area due to the presence of the Project.

With respect to the submarine export cable route 500m corridor:

- Navigable water depths along the submarine export cable route 500m corridor range from 3 to 234 ft (0.9 to 71.3 m) over MLLW, noting that there are shallower waters within the East River, but from the vessel traffic survey data these are not navigated;
- At shallower depths, vessels (which tend to have shallow drafts) primarily navigate in alongside to the submarine export cable route 500m corridor rather than crossing it and therefore may be located within the submarine export cable route for extended durations;

- Further offshore, in deeper waters, vessels (which tend to have deeper drafts) primarily cross over the submarine export cable route rather than navigating alongside, and therefore are located within the submarine export cable route for only short durations;
- The largest valid vessel draft broadcast throughout the submarine export cable route 500m corridor was 53 ft (16.3 m). The average draft within the Submarine Export Cable Route Study Area was 13 ft, with the shallowest drafts generally recorded within the East River and its approaches as well as the approaches to Long Island Sound;
- Based on baseline incident data (see Section 9.1.3), the highest risk in terms of grounding incidents along the submarine export cable route 500m corridor is in nearshore areas within Long Island Sound; and
- As per Section 9.1.3, an average of three groundings per year occurred within the Submarine Export Cable Route Study Area with the majority occurring in or near the East River.

Taking these factors into account, there may be additional risk to vessels of grounding within the Submarine Export Cable Route Study Area due to the presence of the Project, dependent on the cable protection implemented. This will be required to be studied in more detail as part of the Cable Burial Risk Assessment, noting that this NSRA assessment is high level, and based on charted depths (as opposed to comprehensive bathymetry data), and does not account for non-AIS data vessels. The Cable Burial Risk Assessment will consider a up to date understanding of cable protection, including at cable crossing points (see Section 5.1.11).

Should a grounding incident occur, the most likely consequences would be low, with the vessel able to refloat and make port without support and only minor damage incurred. The worst case consequences are the foundering of the vessel, with pollution caused, but this is considered highly unlikely.

11.4 Risk Results Summary

A summary of the worst-case collision and allision risk modelling results is provided in Table 11.2. The annual frequency for each risk is presented alongside the corresponding return period for the scenarios assessed. The total annual frequency and return period for the collision and allision risk based upon the contributing factors are also provided.

Table 11.2 Summary of worst-case annual collision and allision frequency results

Table Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	Base case	3.82×10^{-4} (2,620 years)	5.03×10^{-4} (1,986 years)	1.22×10^{-4} (8,214 years)
	Future case (10 percent)	4.62×10^{-4} (2,165 years)	6.09×10^{-4} (1,642 years)	1.47×10^{-4} (6,789 years)
	Future case (20 percent)	5.50×10^{-4} (1,819 years)	7.25×10^{-4} (1,379 years)	1.75×10^{-4} (5,705 years)
Powered vessel to structure allision	Base case	N/A	2.45×10^{-9} (Negligible)	2.45×10^{-9} (Negligible)
	Future case (10 percent)	N/A	2.70×10^{-9} (Negligible)	2.70×10^{-9} (Negligible)
	Future case (20 percent)	N/A	2.94×10^{-9} (Negligible)	2.94×10^{-9} (Negligible)
Drifting vessel to structure allision	Base case	N/A	7.22×10^{-5} (13,859 years)	7.22×10^{-5} (13,859 years)
	Future case (10 percent)	N/A	7.94×10^{-5} (12,599 years)	7.94×10^{-5} (12,599 years)
	Future case (20 percent)	N/A	8.66×10^{-5} (11,549 years)	8.66×10^{-5} (11,549 years)
Fishing vessel to structure allision	Base case	N/A	1.15×10^{-1} (8.7 years)	1.15×10^{-1} (8.7 years)
	Future case (10 percent)	N/A	1.23×10^{-1} (8.1 years)	1.23×10^{-1} (8.1 years)
	Future case (20 percent)	N/A	1.31×10^{-1} (7.7 years)	1.31×10^{-1} (7.7 years)
Total	**Base case**	**3.82×10^{-4} (2,620 years)**	**1.16×10^{-1} (8.6 years)**	**1.16×10^{-1} (8.7 years)**
	Future case (10 percent)	**4.62×10^{-4} (2,165 years)**	**1.24×10^{-1} (8.1 years)**	**1.23×10^{-1} (8.1 years)**
	Future case (20 percent)	**5.50×10^{-4} (1,819 years)**	**1.31×10^{-1} (7.6 years)**	**1.31×10^{-1} (7.6 years)**

11.5 Consequences

11.5.1 Third Party

The most likely consequences for the majority of hazards associated with shipping and navigation are anticipated to be minor (such as collision/allision resulting in no hull breaches, foundering or injury to personnel). While the COLREGs Rule 5 requires that "every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision"; in the worst case scenario, the consequences of a collision may be severe, including events resulting in PLL. For larger commercial vessels an allision incident would likely result in the collapse of the wind farm structure before it is able to significantly damage the hull of the vessel (see Section 11.5.2). The breach of a vessel's fuel (bunker) tank is considered unlikely, and, in the case of vessels carrying cargoes which could be deemed to be hazardous (e.g., liquid tankers or gas carriers), the additional safety features associated with these vessels would further mitigate the risk of pollution (for example mandatory double hulls). Similarly, in a drifting allision incident the wind farm structure would likely absorb the majority of the impact energy, particularly given the likely low speed of the errant vessel, with some energy being retained by the vessel in the form of rotational movement.

For smaller vessels such as fishing vessels and recreational vessels, the worst case consequences would be the risk of vessel damage leading to foundering of the vessel and PLL.

A quantitative assessment of the potential consequences of a collision or allision incident is provided in full in Attachment B. This assessment applies the risk results presented in this section to historical data regarding collision and allision incidents, and oil pollution. Full details are provided in Attachment B, but in summary, the overall annual increase in PLL estimated due to the impact of the Project on passing vessels is approximately one fatality per 1,200 years, assuming no increase in traffic (i.e., base case). In terms of individual risk to people, the incremental increase estimated due to the impact of the Project for the base case (and future cases) is low. Given these very low results the fatality risk resulting from the Project is not considered to be significant.

It was estimated that should the Project be built, the overall increase in oil spilled from passing vessels would be approximately 93 gallons per year, assuming no increase in traffic. Based upon data available from the Bureau of Transportation Statistics (BTS) (BTS, 2019), the annual average volume of petroleum oil spilled from all vessels affecting navigable US waterways between 1995 and 2016 was approximately 600,000 gallons. Therefore, the overall change in pollution estimated due to the Project represents a low increase in the total volume of oil spilled (< 0.02%).

11.5.2 Wind Farm Structure Integrity

As discussed in Section 9.2.1, there have been ten reported allision incidents with wind turbines in U.K. wind farms to date, and none have resulted in reported material wind turbine damage or catastrophic damage to vessels. It should be considered that eight of these involved vessels involved with the wind farm itself, and the remaining incident involved a fishing vessel. Given that there have been no reported allisions to date from a large commercial vessel with a wind turbine (reflective of the effectiveness of the relevant mitigations utilized), there is no data available as to the damage that could arise to the structure from such an allision.

Should a large commercial vessel at transit speed allide with a wind turbine, it is likely that the majority of the impact would be absorbed by the wind turbine rather than the vessel, noting that the collapse of the wind turbine is a possibility in this instance (Grand Valley State University (GVSU) 2014). However, the likelihood of such an allision is low based on both historical incident data for operational wind farms and the allision assessment undertaken within this NSRA (see Section 11.3.4).

A study into potential oil spills associated with the Cape Wind Energy Project (Schmidt Etkin 2006) found that should vessels of 1,200 GRT or larger at transit speeds allide with a wind turbine, there is the potential that the wind turbine could collapse after impact. However, the study also noted that vessels in the area would be unlikely to cause wind turbine collapse should a drifting allision occur. It should be considered that vessels considerably larger than this are present within proximity to the Lease Area, however as discussed above, the potential for such an allision is low.

In the event of an allision with a wind farm structure, an assessment of the residual structural integrity would be undertaken, with the results submitted to the USCG. This will include details of the incident cause and structural integrity of the wind turbine structure. Details of the incident and results of the assessment of the residual structural integrity will also be provided to the Bureau of Safety and Environmental Enforcement.

12 Cumulative Routing Assessment

As outlined in Section 2.2.2, two cumulative scenarios have been considered within the NSRA in terms of potential cumulative routing assessment:

- Scenario 1: Project plus full build out of all other MA/RI Lease Areas; and
- Scenario 2: Project plus Vineyard Wind 1 and South Fork.

Overarching routing methodology is as for the approach to post wind farm routing for the Project in isolation (see Section 6.7.4).

12.1 Scenario 1 – Full Build Out of MA/RI Lease Areas

As per Section 2.2.1 and 10, all MA/RI Lease Areas were classed as Tier 1 developments, and as such have been included within the cumulative routing assessment in Scenario 1.

On this basis, the anticipated cumulative deviations for Scenario 1 are shown in Figure 12.1.

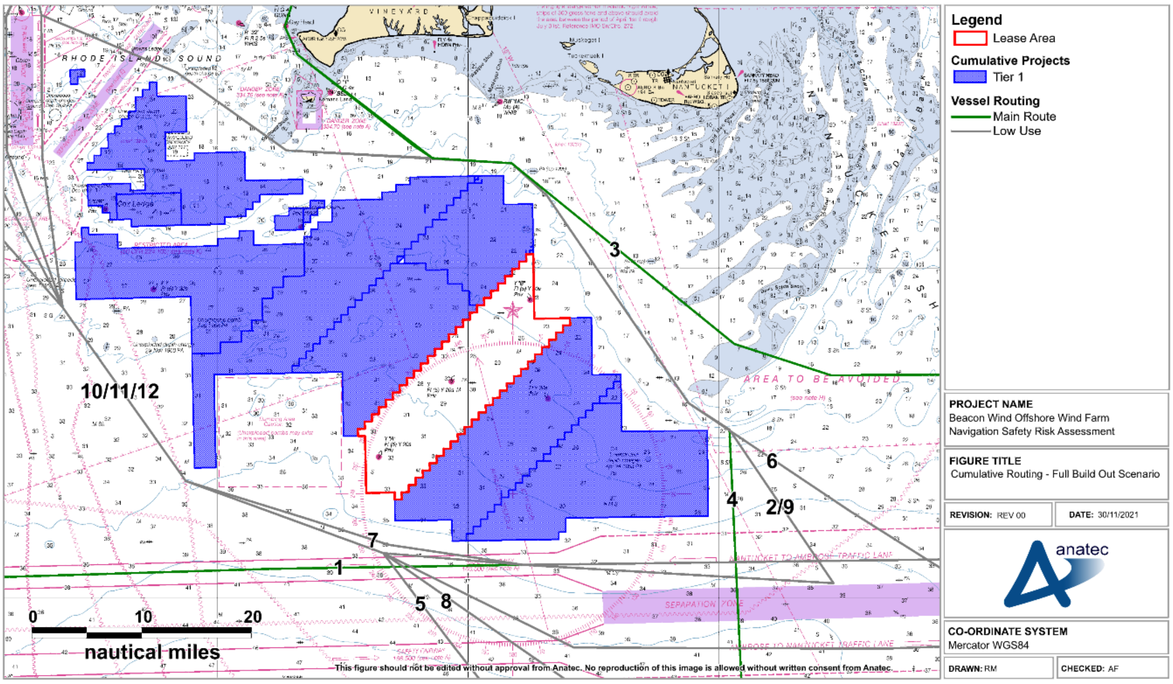

Figure 12.1 Cumulative Deviations – Scenario 1

12.2 Scenario 2 – Vineyard Wind Only

As per Section 2.2.1 and 10, Vineyard Wind and South Fork are classed as a Tier 1 development, and as such have been included within the cumulative routing assessment in Scenario 1 on a quantitative basis.

The anticipated cumulative deviations for Scenario 2 are shown in Figure 12.2.

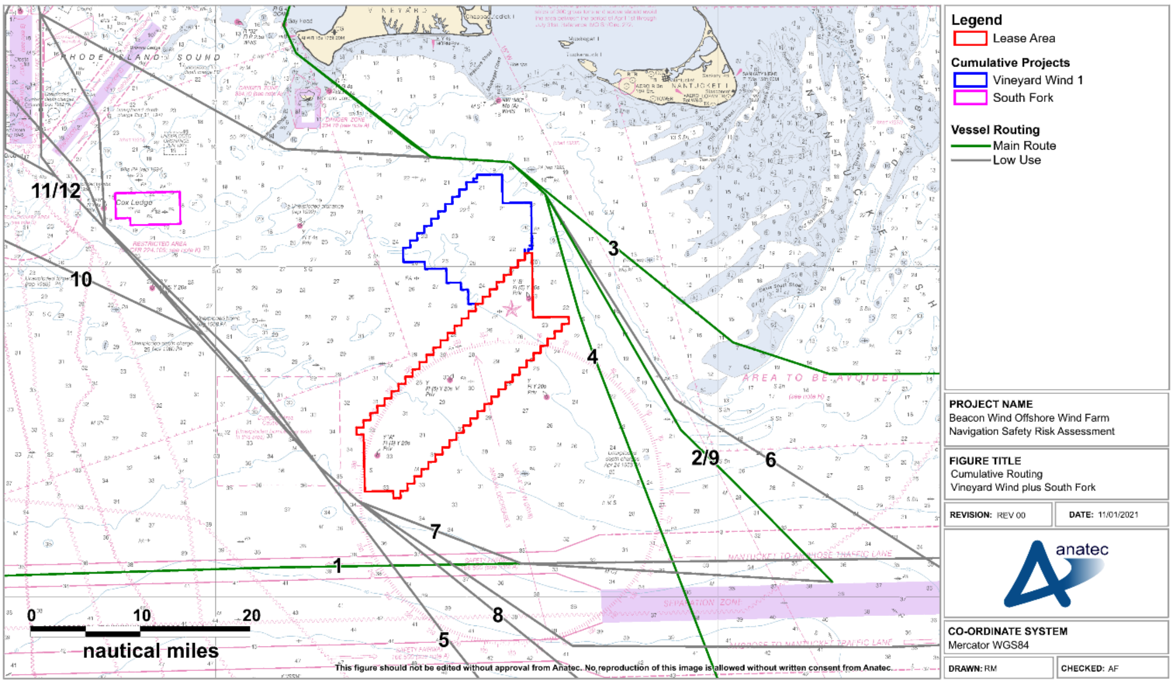

Figure 12.2 Cumulative Deviations – Scenario 2

12.3 Cumulative Deviation Summary

The changes in distance for each route are summarized in Table 12.1 for both Scenario 1 and 2.

Table 12.1 Cumulative Deviation Summary

Route Type	ID	Pre WF	Scenario 1			Scenario 2		
			Deviation	Change (nm)	Change (percent)	Deviation	Change (nm)	Change (percent)
Main Route	1	229.5	229.5	0.0	0.0	229.5	0.0	0.0
	2	87.4	90.1	2.7	3.1	90.2	2.7	3.1
	3	97.9	99.0	1.0	1.1	99.0	1.1	1.1
	4	113.6	121.7	8.1	7.1	118.8	5.2	4.6
Low Use	5	98.4	102.8	4.4	4.5	98.7	0.3	0.3
	6	129.2	133.8	4.6	3.5	133.9	4.7	3.6
	7	113.5	132.3	18.7	16.5	122.6	9.0	7.9
	8	130.1	141.3	11.2	8.6	132.7	2.7	2.1
	9	112.4	117.9	5.5	4.9	117.8	5.4	4.8

Route Type	ID	Pre WF	Scenario 1			Scenario 2		
			Deviation	Change (nm)	Change (percent)	Deviation	Change (nm)	Change (percent)
	10	201.1	203.0	1.9	1.0	203.8	2.7	1.3
	11	156.2	168.7	12.6	8.0	162.3	6.1	3.9
	12	161.8	168.7	6.9	4.3	162.3	0.5	0.3

For Scenario 1, the largest absolute increase in distance to a main route was 8.1 nm (15 km) to Route 4, which equates to an increase of 7.1 percent. The largest absolute increase in distance to a low use route was 18.7 nm (34.6 km) to Route 7, which equates to an increase of 16.5 percent.

For Scenario 2, the largest absolute increase in distance to a main route was 5.2 nm (9.6 km) to Route 4, which equates to an increase of 4.6 percent. The largest absolute increase in distance to a low use route was 9.0 nm (16.6 km) to Route 7, which equates to an increase of 7.9 percent.

13 MA/RI WEA Summary

As per Section 1.4, BOEM have publicized RODs for both Vineyard Wind 1 (BOEM 2021) and South Fork (BOEM 2021). This section summarizes the findings included within these RODs, noting the proximity of Vineyard Wind 1 and South Fork to the Lease Area. It should be considered that it is not necessarily appropriate to apply the content directly to the Project given the BOEM findings are based on the specific assessments undertaken for the individual projects. However, given they are all sited within the MA/RI WEA the summaries are considered of relevance and have therefore been included for reference.

13.1 Vineyard Wind 1

The Vineyard Wind 1 COP was approved by BOEM via the ROD for the Preferred Alternative, which included the application of a north/south and east/west 1x1nm (1.9x1.9km) grid layout in line with the MAIPARS Final Report (USCG 2020) recommendations.

The ROD reported that it is anticipated that the Vineyard Wind 1 project will have neutral impacts to navigation during construction and operation with the incorporation of mitigation.

The impacts (increased vessel traffic near the Project Area and local ports, increased possibility of fishing gear conflicts with the wind turbines, increased risk of collision occurring between project vessels and other vessels during cable laying, and increased risk of allision with structures) were considered to have been reduced to the greatest extent practicable with the selection of alternative D2 within the Preferred Alternative. In addition, Vineyard Wind 1 has proposed additional mitigation measures to reduce impacts to navigation and the majority of these mitigations are also anticipated to be in place for Beacon Wind. These include use of marine coordination, safe passing distances and safety zones, and PATONs to ensure that all structures (turbines and service platforms) are clearly marked for mariners and scheduling of vessel traffic to reduce navigational impacts to the relevant marine users.

13.2 South Fork

As was the case for Vineyard Wind 1 (see Section 13.1), the South Fork COP was approved by BOEM for the Preferred Alternative, which included the application of a north/south and east/west 1x1nm (1.9x1.9km) grid layout in line with the MAIPARS Final Report (USCG 2020) recommendations. The ROD stated that the 1x1nm (1.9x1.9km) uniform grid approach was sufficient to “mitigate potential impacts to navigation in the lease area.” Other mitigations of relevance include those similar to what is proposed for Beacon Wind (and also Vineyard Wind 1 as per Section 13.1), in particular use of marine coordination and implementation of PATONs.

14 Introduction to Impact Assessment

The following sections use the characteristics (waterway, maritime traffic and facility), quantitative assessment and the outputs of consultation to assess the impact of the major hazards associated with the development of the Project throughout the construction, operation and maintenance and decommissioning phases.

Each potential user is considered separately in the following sections to ensure that a specific assessment is undertaken for each specific user. The potential users considered are as follows:

- Commercial fishing vessels;
- Commercial vessels;
- Recreational vessels;
- Anchored vessels;
- Emergency responders; and
- Port access and services.

It is noted that military activity was observed to be limited. Given the very low frequency and relatively high level of awareness military vessels should have of ongoing developments, there are not considered to be any associated impacts.

It has been assumed that the embedded mitigation summarized in Section 23 and referenced within this impact assessment will be in place. On this basis, the significance of each impact (for each user) has been determined as either Broadly Acceptable, Tolerable or Unacceptable based on the definitions provided in Section 2.1.1. Where necessary, additional mitigation is then introduced to bring impacts to within ALARP parameters (see Section 2.1.2).

Each impact (for each user) includes a summary of the impact in *italic* text, prior to the main discussion of the impact. This is then followed (where appropriate) by a list of the relevant embedded mitigation before a final statement on the significance of the impact is given in **bold** text, with the significance ranking itself **highlighted**.

15 Impact Assessment for Fishing Vessels

It is noted that as per Section 2.1, commercial impacts and impacts associated with gear (e.g., snagging) are considered in Section 8.8 of the COP.

15.1 Vessel Deviations – Fishing Vessels

The presence of the Project may lead to commercial fishing vessels in transit deviating around the Lease Area resulting in increased journey times and distances.

15.1.1 Qualification of Risk

Based on the marine traffic data, the significant majority of traffic within the Lease Area was from fishing vessels, which accounted for 79 percent of the total. This aligned with the VMS data which also showed transit and fishing activity occurring within the Lease Area.

Operational experience indicates that fishing vessels are able to and do continue to transit through operational wind farms, including those with lower minimum spacing than would be the case for the Project. This aligns with the findings of the MARIPARS final report (USCG 2020) which indicated that the 1x1 nm (1.9×1.9 km) grid layout was sufficient to facilitate fishing vessel transits (see Section 6.7.5.1) such that additional formal routing measures/corridors were not necessary.

There will be no restrictions on commercial fishing vessel movements internally within the Lease Area other than the possible presence of active safety zones of 1,640 ft (500 m) radius around construction and decommissioning activities if applicable (see Section 4.5.3). Likewise, a minimum advisory safe passing distance from cable laying vessels will be implemented.

However, it should be considered that the decision whether to transit through will lie with individual vessel masters, and as such fishing vessels may still choose to deviate to avoid the wind farm structures.

Three main routes used by fishing vessels were identified, two of which may be deviated as a result of the Project, the largest of which was 2.4 nm (4.4 km), which equated to an increase of 2.1 percent over the pre wind farm distance. It is noted that larger deviations would be necessary for certain “low use” or seasonal routing.

There may be some displacement arising from the cable installation/maintenance works, however any impact will be temporary and spatially limited to the area where installation/maintenance is ongoing. There will be no displacement impact to fishing vessels in transit from the operational cables.

Fishing vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts. To ensure effective promulgation of information, relevant details should be promulgated to the fishing industry on a targeted basis.

15.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Use of PATON.

15.1.3 Impact Significance

There is the potential for large deviations if fishing vessels choose to not transit through the Lease Area, however the frequency of such an instance is low, with the majority of vessels requiring only small deviations. On this basis the impact is assessed to be Tolerable with Mitigation and within ALARP parameters, assuming targeted promulgation of information is undertaken.

15.2 Adverse Weather Deviations – Fishing Vessels

The presence of the Project may lead to commercial fishing vessels in transit deviating around the Lease Area resulting in increased journey times and distances during periods of adverse weather.

15.2.1 Qualification of Risk

During adverse weather conditions, or when such conditions are forecast, it may be necessary for commercial fishing vessels to seek safe refuge, either by returning to port or travelling to sheltered waters. The presence of the Lease Area may result in increased time required to perform this action, and therefore may result in the vessel being more exposed to the adverse weather conditions.

Based on NOAA data (see Section 5.3.5), a total of nine tropical cyclones tracks have intersected the Lease Area since 1900, with the most recent occurrence being in 2016. Adverse conditions to the extent of a tropical cyclone may therefore occur over the lifetime of the Project. However, as per the analysis in Section 5.3.5, at a local level the exposure is moderately low owing to the relatively sheltered location of the Lease Area when compared to areas further offshore.

Fishing vessel masters would assess the forecast in terms of severity and timeframe, and the distance to the nearest ports or areas of shelter before choosing a transit plan, which may involve the selection of an alternative port or sheltered location, or choosing to not make passage at all if the conditions were deemed too dangerous. This aligns with the findings of the MARIPARS final report (USCG 2020) which indicated that "proper voyage planning and access to relevant safety information should ensure that safety is not compromised" assuming the 1 × 1 nm (1.9 × 1.9 km) grid, noting the relevant passage planning considerations included "Weather conditions – both current and predicted including sea state and visibility".

As with commercial fishing vessel deviations in normal weather conditions, vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts.

15.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Use of PATON.

15.2.3 Impact Significance

Assuming the embedded mitigations of effective promulgation of information regarding the Project and compliance with international and flag state regulations (COLREGs i.e., Rule 6 safe speed and SOLAS i.e. V, effective passage planning for all vessels proceeding to sea), there is not considered to be any significant effect on the deviation of commercial fishing vessels when adverse weather is forecast. On this basis the impact is assessed to be Broadly Acceptable and within ALARP parameters.

15.3 Increased Vessel to Vessel Collision Risk – Fishing Vessels

The presence of the Project may lead to commercial fishing vessels in transit deviating or altering routing due to the Lease Area, potentially resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk.

15.3.1 Quantification and Qualification of Risk

Given the volume of fishing vessels within the Lease Area, it is likely that there will be additional encounters occurring once the wind farm structures are in place, either internally or externally to the Lease Area. However, should an encounter situation develop, it is considered unlikely that this would develop into a collision incident.

The quantitative assessment of collision risk post wind farm estimated a vessel would be involved in a collision once per 1,986 years assuming base case traffic levels and worst case deviations (noting this includes fishing vessels in transit). This represents a 32 percent increase in annual collision frequency compared to the pre wind farm scenario.

Given the minimum spacing between wind turbines (approximately 1 nm [1.9 km]) there are not expected to be any issues with wind farm structures blocking or hindering the view of other vessels underway, particularly given the limited anticipated impacts of the Project on communication and position fixing equipment (see Section 8). The wind turbine foundation dimensions at sea level are 112 × 112 ft (34 x 34 m), and as such small vessels at transit speeds would only be out of sight for a very short period of time (a matter of seconds) assuming they were in close proximity to the wind farm structure. Vessels further from the structures are unlikely to be obscured.

Fishing vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts.

Should an encounter develop into a collision incident, the most likely consequences would also be low based on historical collision consequences, with minor contact between the vessels resulting in minor damage and both vessels able to continue their respective passages. The worst case consequences are the foundering of one of the vessels, with pollution caused, but this is considered highly unlikely. Given the smaller size of commercial fishing vessels (in comparison to commercial vessels) they are more susceptible to material damage than commercial vessels in a collision incident, but the pollution effects from a commercial fishing vessel involved in a collision would likely be less substantial than for commercial vessels. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects.

15.3.1.1 Internal Array Navigation

For commercial fishing vessels choosing to navigate internally within the array, there is an additional collision risk associated with vessels associated with the Project, particularly during the construction and decommissioning phases involving vessels which are restricted in their ability to maneuver. The same risk also applies to any commercial fishing vessel navigating in proximity to a cable laying vessel. However, mitigation measures outlined for Project vessels will be implemented including marine coordination, compliance with international and flag state regulations and health and safety requirements, and operational procedures. Furthermore, safety zones around construction and decommissioning activities may be utilized if applicable (see Section 4.5.3) and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented. These measures minimize the collision risk associated with Project vessels.

It is noted that concern was raised during consultation on the MARIPARS final report (USCG 2020) on the "funneling" of traffic into specific corridors. However, given no specific transit corridors are anticipated to be defined based on latest understanding of the MARIPARS output and USCG recommendations, there will be numerous transit options facilitated by the uniform grid and as such no "funneling" is anticipated.

15.3.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Marine Coordination;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information; and
- Use of PATON.

15.3.3 Impact Significance

With these embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters. It is noted that a high consequence could occur but that the frequency of the impact (based on modelling parameters and incident statistics) mean that the risk can be considered within ALARP parameters.

15.4 Powered Vessel to Structure Allision Risk – Fishing Vessels

The presence of the Project may create a risk of a commercial fishing vessel under power experiencing an allision with a wind farm structure.

15.4.1 Quantification and Qualification of Risk

Commercial fishing vessels navigating externally to the array should have a high level of awareness of the Project given the promulgation of information and presence of infrastructure on relevant nautical and electronic charts. The Project would also be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), with PATONs also potentially deployed to mark any working areas (where deemed appropriate by risk assessment). This will maximize mariner awareness of the Lease Area when in proximity, both in day and night time conditions. Fishing vessels external to the array should therefore be able to passage plan accordingly to navigate in such a way that an allision incident is unlikely (i.e., keeping a safe distance from the array).

15.4.1.1 Internal Navigation

Based on the marine traffic data, the significant majority of traffic within the Lease Area was from fishing vessels, which accounted for 79 percent of the total. This aligned with the VMS data which also showed transit and fishing activity within the Lease Area. As per Section 15.1, there will be no restrictions on third party vessel access (other than through active safety zones if applicable, see Section 4.5.3), and as such fishing vessels may choose to continue to navigate through the Lease Area. Minimum spacing of 1 nm (1.9 km) is considered sufficient to safely facilitate internal navigation and this aligns with the findings of the MARIPARS final report (USCG 2020), however the allision risk is greater to internally navigating vessels given the greater exposure to surrounding wind farm structures.

A quantitative assessment of fishing vessel allision risk indicated a fishing vessel would allide with a wind farm structure once per 8.7 years. This assumes no change in baseline activity, and makes no distinction of consequence (i.e., low speed/impact contacts are included). It is noted that based on the publicly available information (see Section 1.4) this is similar to assessed risk levels of other projects in the MA/RI WEA.

Should a powered allision occur, it is anticipated that the impact energy would primarily be absorbed by the wind farm structure rather than the vessel. The most likely consequences would be low, with minor damage sustained by the vessel. Given the smaller size of commercial fishing vessels they are more susceptible to material damage than commercial vessels in an allision incident, however pollution effects from a commercial fishing vessel involved in an allision would likely be less substantial than for commercial vessels. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects.

Lighting and marking will include unique identification marking of individual structures which will minimize the risk of a commercial fishing vessel navigating internally becoming disoriented. Further, safety zones of 1,640 ft (500 m) may be implemented if applicable (see Section 4.5.3) which will reduce allision risk to partially complete structures. Promulgation of information will be undertaken; however this should be undertaken on a targeted fishing industry basis.

15.4.1.2 Lessons Learned

To date there have been ten reported powered allision incidents with a wind farm structure in the U.K., corresponding to 1,721 years per wind turbine allision incident, noting that one has involved a fishing vessel, with the cause being related to poor seamanship. Further details are provided in Section 9.2.1.

15.4.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Promulgation of information;
- Provision of self-help capability;
- Safety vessel where appropriate; and
- Use of PATON.

15.4.3 Impact Significance

On a quantitative basis potential frequency of an allision is high, however most likely consequences are low. With the embedded mitigation measures considered, the impact is assessed to be Tolerable with Mitigation and within ALARP parameters assuming targeted promulgation of information. It is noted that a high consequence could occur but that the frequency of the impact (based on incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

15.5 Drifting Vessel to Structure Allision Risk – Fishing Vessels

The presence of the Project may create a risk of a commercial fishing vessel NUC alliding with a wind farm structure in an emergency situation.

15.5.1 Quantification and Qualification of Risk

Based on the marine traffic data (see Section 6.2), fishing vessels comprised more than half of all traffic within the Study Area. This included vessels both within and outside of the Lease Area. In the event that a fishing vessel were to break down in or in proximity to the Lease Area, there is a risk that it may drift towards a wind farm structure and subsequently allide.

A quantitative assessment of fishing vessel allision risk indicated a fishing vessel would allide with a wind farm structure once per 8.7 years. This assumes no change in baseline activity, and makes no distinction of consequence (i.e., low speed/impact contacts at drift speeds are included).

15.5.1.1 Lessons Learned

Within the U.K. (which has a major commercial fishing industry), there have been no reported drifting allision incidents with a wind farm structure to date.

15.5.1.2 Weather and Tidal Effects

Should a commercial fishing vessel be adrift in proximity to the Lease Area, there is a possibility that the tidal and/or wind conditions may push the vessel away from the wind farm structures therein. However, in cases where the vessel does drift towards the Lease Area, or is already situated within the Lease Area, it is likely that the vessel will first initiate its own emergency plans that may include the use of anchors to prevent allision occurring (noting this will depend on water depths and size of vessel). Vessels associated with the Project would seek to assist and operational SAR procedures would be implemented, noting that given a drifting vessel would likely to be at low speed, preventative action is more likely to be successful than in a powered vessel scenario. The operational procedures will be discussed and agreed with the USCG in advance of construction and will be reviewed and updated as necessary in liaison with the USCG as the Project progresses.

Should a drifting allision incident occur, it is anticipated that the impact energy would primarily be absorbed by the wind farm structure rather than the vessel. The most likely consequences would be minor, with minor damage sustained by the vessel (noting this is likely to be low impact contact based on likely drift speeds). Given the smaller size of commercial fishing vessels, they are more susceptible to material damage than commercial vessels in an allision incident, however the pollution effects from a fishing vessel involved in an allision would likely be less substantial than for commercial vessels. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects.

15.5.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Operational SAR procedures;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information;
- Provision of self-help capability;
- Safety vessel where appropriate; and
- Use of PATON.

15.5.3 Impact Significance

On a quantitative basis potential frequency of an allision is high, however most likely consequences are low. With the embedded mitigation measures considered, the impact is assessed to be Tolerable with Mitigation and within ALARP parameters assuming targeted promulgation of information. It is noted that a high consequence could occur but that the frequency of the impact (based on incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

16 Impact Assessment for Commercial Vessels

For the purposes of this impact assessment, commercial vessels are considered to be dry bulk, wet bulk, vehicle carriers and containerized cargo vessels, passenger vessels, marine aggregate dredgers and push/pull (tug) vessels. They do not include commercial fishing vessels which are assessed separately in Section 15.

16.1 Vessel Deviations – Commercial Vessels

The presence of the Project may lead to commercial vessels deviating around the Lease Area resulting in increased journey times and distances.

16.1.1 Qualification of Risk

Based on experience of operational wind farms, it is considered likely that commercial vessels will not transit through the Lease Area, and will instead deviate to avoid the wind farm structures therein. This aligns with the findings of the MARIPARS final report (USCG 2020) which indicated that based on "early discussions with the pilots and industry trade groups", commercial vessels will likely "avoid the turbine arrays" (see Section 6.7.5.1).

It should be considered that transit through the Lease Area would not be prohibited for any vessel other than through any active safety zones (if applicable, see Section 4.5.3). However, as above and in line with worst case assumptions from a deviation perspective, it is considered likely that the majority of commercial vessels will not transit the Lease Area based on current information.

Regardless, the significant majority of commercial vessel routing in the study area was observed to be associated with the Nantucket to Ambrose safety fairway located in excess of 5 nm (9 km) to the south of the Lease Area and on this basis the associated traffic will be unaffected.

No commercial vessel main routes were identified intersecting the Lease Area, with any routing through considered to be "low use". It is anticipated that these vessels will pass south of the Lease Area post wind farm. This would not represent a large deviation, with the greatest deviation to the relevant commercial "low use" routes being an additional 3.9 percent over the pre wind farm scenario.

There may be some displacement arising from the cable installation/maintenance works, however any such impact will be temporary and spatially limited to the area where installation/maintenance is ongoing. There will be no displacement impact to vessels from the operational cables.

Details of the Project will be promulgated in advance meaning the low number of vessels that may need to deviate will be able to passage plan in advance to minimize any disruption.

16.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Lighting and Marking;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Use of PATON.

16.1.3 Impact Significance

A limited number of commercial vessels are anticipated to be required to deviate; however the significant majority of commercial traffic will be unaffected. Therefore, with the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters.

16.2 Increased Vessel to Vessel Collision Risk – Commercial Vessels

The presence of the Project may lead to commercial vessels deviating or altering routing due to the Lease Area, potentially resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk.

16.2.1 Quantification and Qualification of Risk

Noting the low numbers of commercial vessels that are likely to be affected in terms of deviations (see Section 16.1), it is not considered likely that there will be a large increase in encounter situations caused by the commercial vessel deviations, and should an encounter situation develop, it is considered unlikely that this would develop into a collision incident, with the most likely consequences being low, with collision avoidance action implemented and the vessels complying with international and flag state regulations (including the COLREGs and SOLAS).

The quantitative assessment of collision risk post wind farm of routed vessels estimated a vessel would be involved in a collision once per 1,986 years assuming base case traffic levels and worst case deviations. This represents a 32 percent increase in annual collision frequency compared to the pre wind farm scenario.

Although the quantitative assessment suggests that a collision incident may occur (noting anticipated frequency is low), the quantitative assessment is based on worst case deviations, and does not take account of the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical charts and electronic charts to assist with passage planning. This will reduce the likelihood of a collision incident.

Given the minimum spacing between wind farm structures (approximately 1 nm [1.9 km] center-to-center) there are not expected to be any issues with the structures blocking or hindering the view of other vessels underway, noting that worst case foundation dimensions are 34x34m at sea level (see Section 4.2.1), considerably less than the length of a typical commercial vessel. In this regard it is noted that the Project is anticipated to have limited impacts on communication and position fixing equipment (see Section 8).

In cases where vessels do pass in proximity to the Lease Area, the wind farm structures will be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), with PATONs also potentially deployed to mark any working areas (where deemed appropriate by risk assessment). This will maximize mariner awareness of the Project when in proximity in both day and night time conditions.

It should also be considered that no collision incidents involving a third party vessel as a result of the presence of an offshore wind farm have been reported in the U.K. to date, despite the U.K.'s status as the global leader in offshore wind production.

Should an encounter develop into a collision incident, based on historical collision consequences the most likely consequences would be low, with minor contact between the vessels resulting in minor damage and both vessels able to continue their respective passages. The worst case consequences are the foundering of one of the vessels, with pollution caused, but this is considered highly unlikely. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects, noting that laden tankers are equipped with additional safety features including double hulls.

16.2.1.1 Collision Risk associated with Project Vessels

It is noted that in addition to collisions between third party vessels, there is also a collision risk associated with vessels associated with the Project, particularly during the construction and decommissioning phases involving vessels which are restricted in their ability to maneuver. However, there will be marine coordination implemented for all Project vessels, consisting of a central coordination hub from which all Project vessel movements will be managed. There will also be monitoring of third party traffic, and all Project vessels will carry operational AIS in line with the USCG and AIS carriage requirements.

Project vessels will be compliant with international and flag state regulations (including the COLREGs and SOLAS), and follow operational procedures such as entry/exit points to/from the Lease Area and designated routes to/from port.

Safety zones of up to 1,640 ft (500 m) radius around construction and decommissioning activities may be applied for if applicable (see Section 4.5.3). Further, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented. These measures minimize the collision risk associated with Project vessels by making clear the areas that should be avoided by third party traffic.

16.2.1.2 Reduced Visibility

In conditions of reduced visibility the collision risk is likely to be greater, particularly with regard to Project vessels entering or exiting the Lease Area. However, the COLREGs regulates vessel movements in adverse weather conditions and requires all vessels operating in reduced visibility to reduce speed to allow more time for reacting to encounters, thus minimizing the collision risk.

16.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information; and
- Use of PATON.

16.2.3 Impact Significance

The low anticipated frequency of commercial vessel deviations means the potential for increased encounters is also considered to be low. Therefore, with the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters.

16.3 Powered Vessel to Structure Allision – Commercial Vessels

The presence of the Project may create a risk of a commercial vessel under power experiencing an allision with a wind farm structure.

16.3.1 Quantification and Qualification of Risk

The significant majority of commercial vessel routing in the study area was observed to be associated with the Nantucket to Ambrose safety fairway located in excess of 5 nm (9 km) to the south of the Lease Area and on this basis the associated traffic will be at very low risk of allision. Based on the marine traffic data (see Section 6.2.4.3), commercial traffic within the Lease Area is limited, and no commercial main routes were identified intersecting the Lease Area. On this basis the likelihood of a commercial vessel alliding with a wind farm structure under power is considered low. This aligns with the quantitative assessment of commercial vessel powered allision risk, which indicated the risk was negligible.

Details of the Project will be promulgated in advance, and the presence of infrastructure will be detailed on relevant nautical charts and electronic charts. Additionally, the Project will be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), with PATONs also potentially deployed to mark any working areas (where deemed appropriate by risk assessment). This will maximize mariner awareness of the Lease Area when in proximity, both in day and nighttime conditions.

Furthermore, safety zones of up to 1,640 ft (500 m) radius around construction and decommissioning activities may be applied for if applicable (see Section 4.5.3) and a safety vessel will be deployed during the construction and decommissioning phases (where deemed appropriate by risk assessment) and will be able to advise vessels on an allision course with a wind farm structure and contact the USCG on VHF-CH 16 if necessary.

Should a powered allision incident occur, it is anticipated that the impact energy would primarily be absorbed by the wind farm structure rather than the vessel, noting the high level of construction standards for commercial vessels operating at sea. Based on expert opinion, consideration of other types of historical incidents, operational speeds and impact energies the most likely consequences would be low with minor damage sustained by the vessel, i.e., hull damage. In the highly unlikely case of a powered allision incident resulting in pollution, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects, noting that laden tankers are equipped with additional safety features including double hulls.

16.3.1.1 Lessons Learned

To date there have been ten reported powered allision incidents with a wind farm structure in the U.K., corresponding to 1,721 years per wind turbine allision incident, but none have involved a third party commercial vessel (see Section 9.2.1). It is noted that this includes U.K. projects situated in closer proximity to busy IMO adopted routing measures than the Project is to the Nantucket to Ambrose safety fairway.

16.3.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;

- Project vessel operational procedures;
- Promulgation of information;
- Safety vessel where appropriate; and
- Use of PATON.

16.3.3 Impact Significance

With these embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters. It is noted that a high consequence allision could occur but that the frequency of the impact (based on the modelling, incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

16.4 Drifting Vessel to Structure Allision Risk – Commercial Vessels

The presence of the Project may create a risk of a commercial vessel NUC alliding with a wind farm structure in an emergency situation.

16.4.1 Quantification and Qualification of Risk

A total of 10 potential NUC vessel incidents were observed within 5 nm (9.3 km) of the Lease Area based on the USCG incident data (see Section 9.1.2.1), including three within the Lease Area itself. This corresponds to one per year. It should be considered that an NUC vessel may not inform the USCG of the incident, however the non-reporting would also indicate no dangerous situation has occurred and the vessel restored power without further incident. Further, these incidents occurred prior to the presence of the wind farm structures (i.e., the relevant vessels may have utilized different passage should there have been structures present).

Quantitative assessment of drifting allision risk estimated a drifting allision return period for commercial vessels of approximately one in 13,859 years assuming base case traffic levels. This is indicative of the significant majority of commercial vessels in the area utilizing the safety fairway to the south and as such remaining clear of the Lease Area.

Should a drifting allision incident occur, it is anticipated that the impact energy would primarily be absorbed by the wind farm structure rather than the vessel, noting the high level of construction standards for commercial vessels operating at sea. Based on expert opinion, consideration of other types of historical incidents, likely drifting speeds and impact energies the most likely consequences would be low with minor damage sustained by the vessel, i.e., hull damage. In the highly unlikely case of a drifting allision incident resulting in pollution, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects, noting that laden tankers are equipped with additional safety features including double hulls.

16.4.1.1 Lessons Learned

It is noted that there is precedent for operational wind farms to be sited in proximity to busy areas of shipping including routing measures and hence potential drifting risk. For example, Greater Gabbard and Galloper in the U.K. are located immediately adjacent to the Sunk TSS, as shown in Figure 16.1.

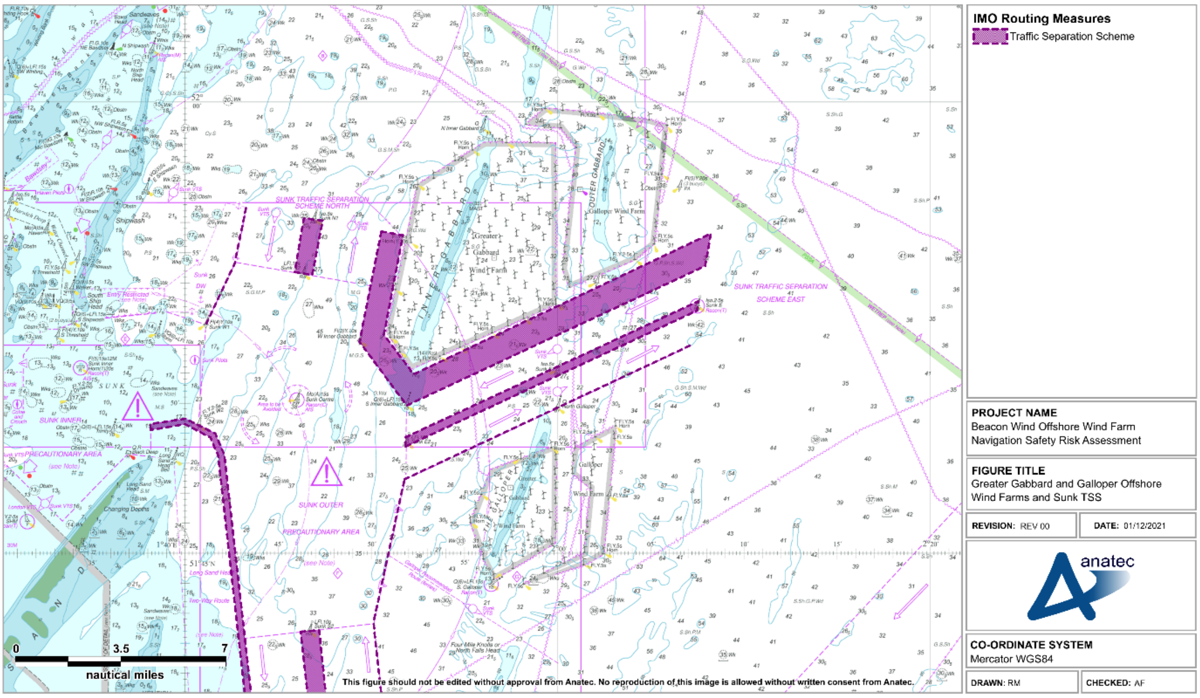

Figure 16.1 Greater Gabbard and Galloper Offshore Wind Farms and Sunk TSS

The Sunk TSS is a busy IMO routing measure (approximately four to five transits per day in each direction in the Sunk East TSS) and therefore is exposed to potential drifting allision risk. However, both developments were awarded consent and no drifting incidents have been reported in the nine years since Greater Gabbard was fully commissioned (noting that Galloper was fully commissioned later, in 2018).

Furthermore, it is also noted that there have been no drifting allision incidents with a wind farm structure reported in the U.K. to date, despite the operational projects in place including those in proximity to areas of busy traffic. Of the ten allision incidents reported in the U.K. to date (noting that these involved vessels under power), the worst consequences reported have been minor flooding of the vessel, with no life-threatening injuries to persons onboard reported - no material damage to wind turbines was reported in any of the incidents. Further details are provided in Section 9.2.1.

16.4.2 Weather or Tidal Effects

Should a vessel be adrift in proximity to the Lease Area, there is a possibility that the tidal and/or wind conditions may push the vessel towards the wind farm structures. However, in such a scenario, it is likely that the vessel will first initiate its own emergency plans that may include the use of thrusters (depending on availability and power supply) and anchors to prevent an allision occurring. Vessels associated with the Project would seek to assist, and operational SAR procedures would be implemented. The operational procedures will be discussed and agreed with the USCG in advance of construction and will be reviewed and updated as necessary in liaison with the USCG as the Project progresses.

Taking these mitigation measures into account, the likelihood of an allision incident occurring is considered very low, particularly given that a drifting vessel is likely to be drifting at low speeds and therefore preventative action is more likely to be successful.

16.4.3 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Operational SAR procedures;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information;
- Provision of self-help capability;
- Safety vessel where appropriate; and
- Use of PATON.

16.4.4 Impact Significance

With these embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters. It is noted that a high consequence allision could occur but that the frequency of the impact (based on the modelling, incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

17 Impact Assessment for Recreational Vessels

17.1 Vessel Deviations – Recreational Vessels

The presence of the Project may lead to recreational vessels deviating around the Lease Area resulting in increased journey times and distances.

17.1.1 Qualification of Risk

The marine traffic data recorded indicates recreational vessels do transit through the Lease Area (see Section 6.2.4.4). The assessment is AIS based and therefore is likely to underrepresent overall recreational activity, however it is considered as providing indication of where recreational activity may occur. It is also noted that given the distance offshore, it is likely that levels of non-AIS recreational vessels will be less than areas nearer shore. Based on visual survey data collected on site, an estimated 50 percent of recreational vessels do not transmit via AIS within the Lease Area.

Safety zones may be utilized around structures where active construction or maintenance works are ongoing if applicable (see Section 4.5.3). However, any such areas would be temporary and spatially limited. Other than these areas, no restrictions on transit will be implemented. Minimum spacing of 1 nm (1.9 km) and alignment of wind turbines is considered as sufficient to facilitate such recreational transit through the Lease Area, should the vessels choose to do so, noting this aligns with the general findings of the MARIARS final report (USCG 2020). It is also noted that minimum blade tip height of 26m above HAT reduces allision risk and therefore further facilitating recreational transits.

There may be some displacement arising from the cable installation/maintenance works, however any such impact will be temporary and spatially limited to the area where installation/maintenance is ongoing. There will be no displacement impact to vessels from the operational cables.

Recreational vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts.

17.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Minimum blade clearance;
- Ongoing engagement with stakeholders;

- Promulgation of information; and
- Use of PATON.

17.1.3 Impact Significance

Given the layout is anticipated to facilitate recreational vessel transits, any deviation is considered to be low frequency. Therefore, with the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters.

17.2 Adverse Weather Deviations – Recreational Vessels

The presence of the Project may lead to recreational vessels deviating around the Lease Area resulting in increased journey times and distances during periods of adverse weather.

17.2.1 Qualification of Risk

During adverse weather conditions, or when such conditions are forecast, it may be necessary for recreational vessels to seek safe refuge, either by returning to port or travelling to sheltered waters. The presence of the Lease Area may result in increased time required to perform this action, and therefore may result in the vessel being more exposed to the adverse weather conditions.

Based on NOAA data (see Section 5.3.5), a total of nine tropical cyclones tracks have intersected the Lease Area since 1900, with the most recent occurrence being in 2016. Adverse conditions to the extent of a tropical cyclone may therefore occur over the lifetime of the Project. However, as per the analysis in Section 5.3.5, at a local level the exposure is moderately low owing to the relatively sheltered location of the Lease Area when compared to areas further offshore.

The marine traffic data recorded indicates recreational vessels do transit through the Lease Area (see Section 6.2.4.4). The assessment is AIS based and therefore is likely to underrepresent overall recreational activity, however it is considered as providing indication of where recreational activity may occur. It is also noted that given the distance offshore, it is likely that levels of non-AIS recreational vessels will be less than areas nearer shore.

As with recreational vessel deviations in normal weather conditions, recreational vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts. Recreational vessel masters would assess the forecast in terms of severity and timeframe, and the distance to the nearest ports or areas of shelter before choosing a transit plan, which may involve the selection of an alternative port or sheltered location, or choosing to not make passage at all if the conditions were deemed too dangerous.

This aligns with the findings of the MARIPARS final report (USCG 2020) which indicated that "proper voyage planning and access to relevant safety information should ensure that safety is not compromised" assuming the 1x1 nm (1.9×1.9 km) grid, noting the relevant passage planning considerations included "Weather conditions – both current and predicted including sea state and visibility".

17.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Minimum blade clearance;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Use of PATON.

17.2.3 Impact Significance

Assuming the embedded mitigations of effective promulgation of information regarding the Project and compliance with international and flag state regulations (COLREGs i.e., Rule 6 safe speed and SOLAS i.e. V, effective passage planning for all vessels proceeding to sea), there is not considered to be any significant effect on the deviation of recreational vessels when adverse weather is forecast. On this basis the impact is assessed to be Broadly Acceptable and within ALARP parameters.

17.3 Increased Vessel to Vessel Collision Risk – Recreational Vessels

The presence of the Project may lead to recreational vessels deviating or altering routing due to the Lease Area, potentially resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk.

17.3.1 Qualification of Risk

As per Section 17.1, there will be no restrictions on vessels transiting through the Lease Area other than through any active safety zones if applicable (see Section 4.5.3), and based on operational experience, recreational vessels do continue to transit through operational wind farms. However, the decision as to whether to transit through will lie with individual vessel masters. Should recreational vessels deviate, this may lead to increased encounter situations around the Lease Area. However, should an encounter situation develop, it is considered unlikely that this would develop into a collision incident with the most likely consequences being low, with collision avoidance action implemented and the vessels complying with international and flag state regulations (including the COLREGs and SOLAS).

Given the minimum spacing between wind turbines (approximately 1 nm [1.9 km]) there are not expected to be any issues with wind farm structures blocking or hindering the view of other vessels underway, particularly given the limited anticipated impacts of the Project on communication and position fixing equipment (see Section 8). wind turbine foundation dimensions at sea level are 112 × 112 ft (34 × 34 m), and as such small vessels at transit speeds would only be out of sight for a very short period of time (a matter of seconds) assuming they were in close proximity to the wind farm structure. Vessels further from the structures are unlikely to be obscured.

Recreational vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the presence of infrastructure on relevant nautical and electronic charts.

17.3.1.1 Internal Array Navigation

For recreational vessels choosing to navigate internally within the array, there is an additional collision risk associated with vessels associated with the Project, particularly during the construction and decommissioning phases involving vessels which are restricted in their ability to maneuver. The same risk also applies to recreational vessel navigating in proximity to a cable laying vessel. However, mitigation measures outlined for Project vessels will be implemented including marine coordination, compliance with international and flag state regulations and health and safety requirements, and operational procedures. Furthermore, safety zones around construction and decommissioning activities may be utilized if applicable (see Section 4.5.3) and, where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented. These measures minimize the collision risk associated with Project vessels.

It is noted that concern was raised during consultation on the MARIPARS report (USCG 2020) on the "funneling" of traffic into specific corridors. However, given no specific transit corridors are anticipated to be defined based on latest understanding of the MARIPARS output, there will be numerous transit options for recreational vessels facilitated by the uniform grid and as such no "funneling" is anticipated.

It should be considered that there is the potential for an increase in recreational fishing vessels associated with fish aggregation at the wind farm structures, particularly during any peak seasonal recreational periods (i.e., fair weather periods). Regardless, these vessels are not anticipated to be a significant contributor to collision risk in the area.

17.3.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Marine Coordination;
- Minimum advisory safe passing distance;

- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information; and
- Use of PATON.

17.3.3 Impact Significance

With the embedded mitigation measures considered and noting compliance with COLREGs and SOLAS, the impact is considered to be Broadly Acceptable and within ALARP parameters given the low frequency and most likely consequences (low).

17.4 Powered Vessel to Structure Allision – Recreational Vessels

The presence of the Project may create a risk of a recreational vessel under power experiencing an allision with a wind farm structure.

17.4.1 Qualification of Risk

As shown in the assessment of marine traffic data (see Section 6.2.4.4), recreational activity is present within and near the Lease Area and as such there is an allision risk from a vessel under power (including under sail). The assessment is AIS based and therefore is likely to underrepresent overall recreational activity, however it is considered as providing indication of where recreational activity may occur. It is also noted that given the distance offshore, it is likely that levels of non-AIS recreational vessels will be less than areas nearer shore.

Promulgation of information and presence of infrastructure on relevant nautical and electronic charts will ensure recreational vessels navigating externally to the array should have a high level of awareness of the Project. The Project would also be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), with PATONs also potentially deployed to mark any working areas (where deemed appropriate by risk assessment). Such vessels will therefore be able to passage plan accordingly to navigate in such a way that an allision incident is unlikely (i.e., keeping a safe distance from the Lease Area).

The most likely consequences would be minor, with minor damage sustained by the vessel, noting minimum blade clearance of 26m above HAT. Given the smaller size of recreational vessels they are more susceptible to material damage than commercial vessels in an allision incident, however the pollution effects from a recreational vessel involved in an allision would likely be less substantial than for commercial vessels. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects.

17.4.1.1 Internal Array Navigation

There is potential for recreational vessels to navigate internally within the array, including recreational fishing given the potential aggregation around the foundations. Any additional recreational fishing is not expected to reach a level at which additional assessment is required given that overall it is likely to be a negligible increase against total vessel numbers, particularly given that the distance offshore of the Lease Area makes it unfavorable to most day cruisers.

For any recreational vessels navigating internally within the array, the powered allision risk is greater given the greater exposure to surrounding wind farm structures. In line with the findings of the MARIPARS final report (USCG 2020), the uniform nature layout includes multiple lines of orientation consistent across all internal wind turbines which will assist with ensuring recreational vessels are able to safely navigate from one side of the Lease Area to the other. The minimum spacing center-to-center between wind turbines is 1 nm (1.9 km), which is considered sufficient for safe navigation based on both Anatec's experience of existing offshore wind developments in the U.K. (where recreational vessels have been observed to safely adapt to the presence of wind farm structures with much lower spacing) and the MARIPARS final report (USCG 2020).

Should a recreational vessel with a mast enter the proximity of a wind turbine, there is not only an allision risk associated with the wind turbine tower but also the wind turbine blades. NVIC No. 01-19 (USCG 2019) does not suggest a minimum safe clearance, and so the 72 ft (22 m) above MHWS requirement defined in MGN 654 (MCA 2021) has been considered. The minimum wind turbine blade clearance above HAT for the Project is 85 ft (26 m), and therefore there is considered to be sufficient air clearance for the majority of recreational vessels with a mast navigating in proximity to a wind turbine to avoid mast contact.

Should a recreational vessel under sail enter the proximity of a wind turbine, 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 wind turbines do reduce wind velocity downwind of a wind turbine but that no negative effects on recreational craft have been reported given the limited spatial extent of the effect is not considered to be significant, and similar to that experienced when passing a large vessel or close to other large structures (e.g., 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.

The Project would also be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), with PATONs also potentially deployed to mark any working areas (where deemed appropriate by risk assessment). The marking will also include unique identification marking of individual structures which will minimize the risk of a recreational vessel navigating internally becoming disoriented.

17.4.1.2 Lessons Learned

As discussed in Section 9.2.1, to date there have been ten powered allision incidents with a wind farm structure reported in the U.K. to date, corresponding to 1,721 years per wind turbine allision incident, but none have involved a recreational vessel.

17.4.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Safety zones (if applicable);
- Charting of infrastructure;
- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Minimum blade clearance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Use of PATON.

17.4.3 Impact Significance

With the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters. It is noted that a high consequence could occur but that the frequency of the impact (based on incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

17.5 Drifting Vessel to Structure Allision Risk – Recreational Vessels

The presence of the Project may create a risk of a recreational vessel NUC alliding with a wind farm structure in an emergency situation.

17.5.1 Qualification of Risk

As shown in the assessment of marine traffic data (see Section 6.2.4.4), recreational activity is present within and near the Lease Area and as such there is a drifting allision risk to recreational vessels.

17.5.1.1 Lessons Learned

Within the U.K. there have been no reported drifting allision incidents with a wind farm structure to date (see Section 9.2.1).

17.5.1.2 Weather and Tidal Effects

Should a recreational vessel be adrift in proximity to the Lease Area, there is a possibility that the tidal and/or wind conditions may push the vessel away from the wind farm structures therein. However, in cases where the vessel does drift towards the Lease Area, or is already situated within the array, it is likely that the vessel will first initiate its own emergency plans that may include the use of anchors to prevent allision occurring (noting this will depend on water depths and size of vessel). Vessels associated with the Project would seek to assist and operational SAR procedures would be implemented, noting that given a drifting vessel would likely to be at low speed, preventative action is more likely to be successful. The operational procedures will be discussed and agreed with the USCG in advance of construction and will be reviewed and updated as necessary in liaison with the USCG as the Project progresses.

As with risk of a powered allision for a recreational vessel with a mast, there is not only an allision risk associated with the wind turbine tower but also the wind turbine blades. The minimum wind turbine blade clearance above HAT for the Project is 85 ft (26 m), and this is considered to be a sufficient air clearance for the majority of drifting recreational vessels with a mast to avoid a contact involving its mast (see Section 17.4).

The most likely consequences would be minor, with minor damage sustained by the vessel (noting the blade clearance). Given the smaller size of recreational vessels they are more susceptible to material damage than commercial vessels in an allision incident, however the pollution effects from a recreational vessel involved in an allision would likely be less substantial than for commercial vessels. If pollution were to occur, there will be pollution contingency plans set in place by the Project which would be implemented to minimize the environmental effects.

17.5.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Charting of infrastructure;
- Lighting and Marking;
- Minimum advisory safe passing distance;
- Minimum blade clearance;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Operational SAR procedures;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information;
- Provision of self-help capability;
- Safety vessel where appropriate; and
- Use of PATON.

17.5.3 Impact Significance

With the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters. It is noted that a high consequence could occur

but that the frequency of the impact (based on incident statistics and lessons learned) mean that the risk can be considered within ALARP parameters.

18 Impact Assessment for Anchored Vessels

18.1 Displacement of Anchoring

The presence of wind farm structures and subsea cables or the associated works may displace existing anchoring activity.

18.1.1 Qualification of Risk

A behavioral assessment of the marine traffic data indicated that an average of three vessels per day were at anchor within the Submarine Export Cable Route Study Area. The significant majority of this activity was observed to occur near the mouth of the East River, noting this included vessels at anchor over the indicative submarine export cable route. Lower levels of anchoring were also recorded within the vicinity of the Niantic Bay, Connecticut landfall noting that this included anchoring in close proximity to the cable.

These findings aligns with the navigational features assessment, which identified a total of 22 anchorage areas in the Submarine Export Cable Route Study Area, the majority of which were within the East River or its approaches.

During installation of the cables, the associated vessel activity may displace these anchored vessels. Furthermore, once the cables are installed and operational, their presence may discourage vessels from anchoring within close proximity to their charted positions, and instead seeking anchorage in a nearby suitable location, if available. Similar displacement may occur from any maintenance works.

Any impact from the installation process or maintenance will be temporary and spatially limited to the area where work is currently active. Regardless, given the length of submarine export cable route and noting levels of anchoring activity in and around the East River, consultation and liaison with PANYNJ in particular is considered crucial.

Therefore, the relevant anchoring activity will be discussed with the PANYNJ as part of the Cable Burial Risk Assessment process and Cable Installation Plan. Details of the installation works will also be promulgated in advance to stakeholders including the USCG and PANYNJ to ensure any disruption is minimal. Based on a review of relevant navigational features including anchorages (see Section 5.1.3) in proximity to the submarine export cable route, there are designated “unrestricted” anchorage areas in and in proximity to the East River that do not intersect the submarine export cable route. The anchoring assessment of 2019 marine traffic data (see Section 6.2.4.5) indicated existing use of these anchorages was such that further vessels could be accommodated, and such it is considered likely that any displaced anchoring activity would move into the designated areas, however this will be discussed with PANYNJ.

Cable burial depths and protection measures will be determined via the Cable Burial Risk Assessment and in consultation with the U.S. Army Corps of Engineers and the USCG. Burial depths and protection measures will consider baseline anchoring activity, however any impacts on existing anchoring activity or defined anchorage areas from the operational cables in or near the East River will be discussed with the PANYNJ.

Given limited levels of anchoring in proximity to the landfall at Niantic Bay, Connecticut, any displacement impact will be notably lower than that for the East River vessels. It will be ensured that promulgation of information will include local users of the area to ensure awareness of the cables is maximized, and liaison will be ongoing with the USCG to ensure relevant marine activity is considered and relevant ports are consulted.

It is noted that no anchoring activity was identified within the Study Area or the Lease Area itself. This aligns with the navigational features assessment which showed the nearest anchorage was in excess of 7 nm (13 km) to the north. There would be no restrictions on anchoring activity other than in active safety zones if applicable (see Section 4.5.3), however it is considered unlikely that vessels would seek to anchor within the Lease Area once the wind farm structures are in place. Given baseline anchoring activity is low no notable impact is expected from the wind farm structures.

18.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Cable Burial Risk Assessment;
- Cable Installation Plan;
- Charting of infrastructure;
- Monitoring of cables and associated protection;
- Ongoing engagement with stakeholders;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures; and
- Promulgation of information.

18.1.3 Impact Significance

Given the potential for displacement of anchoring, with the embedded mitigation measures considered, the impact is assessed to be Tolerable with Mitigation and within ALARP parameters, assuming consultation is undertaken with PANYNJ, the USCG and the U.S. Army Corps of Engineer as part of the Cable Burial Risk Assessment and Cable Installation Plan processes for the extents of both the BW1 and BW2 cables. It is noted that there are not assessed to be any navigational safety impacts remaining once the mitigations are in place/completed i.e., Cable Burial Risk Assessment.

18.2 Anchor Interaction with Subsea Cables

The installed cables or structures create an underwater snagging or contact risk to vessels anchoring within close proximity.

18.2.1 Qualification of Risk

There is potential that a vessel may interact with the submarine export cable route via its anchor, for example in one of the following scenarios:

- A vessel deliberately drops anchor over the cables in an emergency;
- The deployed anchor of a vessel fails, and the vessel subsequently drags anchor over the cables;
- A vessel departs an anchorage but neglects to raise anchor, subsequently dragging the anchor over the cables;
- The anchor is deployed over the cable unintentionally, with the vessel unaware of the cable's presence, or the vessel incorrectly judging the position/location of the cable; or
- The anchor is deployed over the cables accidently via human error or mechanical failure.

Should the anchor of a large commercial vessel make contact with a cable, it is likely that this would only result in damage to the cable. However, should the anchor of a smaller vessel (e.g., fishing, recreation) make contact, there is the risk of snagging. As a worst case this may lead to loss of stability of the vessel and capsize, with loss of life as a worst-case consequence.

As discussed in Section 18.1, an average of three vessels per day were identified as being at anchor within the Submarine Export Cable Route Study Area. The significant majority of this activity was observed to occur near the mouth of the East River, noting this included vessels at anchor over the indicative submarine export cable route. This aligned with the navigational features assessment which showed a total of 22 anchorage areas in the Submarine Export Cable Route Study Area, with the majority of these being in the East River and its approach. Anchoring activity was also recorded in Niantic Bay in proximity to the second landfall location, albeit at much lower levels than in the East River.

Cable burial depths and protection measures will be determined via the Cable Burial Risk Assessment and in consultation with the U.S. Army Corps of Engineers and the USCG. Any impacts on existing anchoring activity in or near the East River will be discussed with the PANYNJ and local USCG sectors. The locations and levels of anchoring activity and/or anchorage areas will be taken into account when defining the necessary cable protection as part of the Cable Burial Risk Assessment process, as will the vessel types/sizes of the relevant vessels.

As per the marine traffic and navigational features assessments, it is likely that protection measures will be necessary within the East River and its approach, however this will be assessed via the Cable Burial Risk Assessment. Any impact to vessels anchoring within Niantic Bay will also be considered in consultation with USCG and the U.S. Army Corps of Engineers with appropriate protection applied.

Burial will form the primary method of protection where feasible, noting that additional protection may be also be utilized where identified as necessary via the Cable Burial Risk

Assessment. Cable protection monitoring approach will be agreed as part of the Cable Burial Risk Assessment process in consultation with the USCG and the U.S. Army Corps of Engineers.

It is noted that no anchoring activity was identified within the Study Area or the Lease Area itself, and the nearest anchorage was located in excess of 7 nm (13 km) to the north. There would be no restrictions on such activity other than in active safety zones if applicable (see Section 4.5.3), however it is considered unlikely that vessels would seek to anchor within the Lease Area once the wind farm structures are in place. Given baseline anchoring activity is low no notable anchor interaction risk is anticipated from the inter array cables or wind farm structures.

18.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Cable Burial Risk Assessment;
- Cable Installation Plan;
- Charting of infrastructure;
- Monitoring of cables and associated protection;
- Ongoing engagement with stakeholders;
- Promulgation of information; and
- Safety vessel where appropriate.

18.2.3 Impact Significance

Given the proximity of the submarine export cable route to known anchorages and anchoring activity, with the embedded mitigation measures considered, the impact is assessed to be Tolerable with Mitigation and within ALARP parameters. It should be considered that the assessment is related to the moderate frequency of occurrence and consequences are still expected to be low for the vessels. i.e., unlikely to be any damage to a vessel or injury to personnel.

19 Impact Assessment for Emergency Responders

19.1 Reduction of Emergency Response Resource Capability

The increased number of vessels and personnel undertaking activities associated with the Project will increase the likelihood of an incident requiring emergency response, and consequently diminish emergency response capability for the region, including SAR services.

19.1.1 Qualification of Risk

Based on the USCG incident data studied (see Section 9.1.2), a total of 73 SAR incidents were recorded within the Study Area, corresponding to an average of seven per year. Of these, 11 occurred within the Lease Area itself. An average of one pollution incident per year was estimated.

These rates indicate the likelihood of an incident requiring an emergency response in proximity to the Lease Area is low. These rates are not considered likely to increase markedly due to the presence of the Project, noting the range of preventative embedded mitigation measures (see Section 22) designed to minimize the risk of an incident associated with the Project occurring. This aligns with the findings of the consequences assessment (see Section 11.5.1) and experience of operational wind farms (see Section 9.2.1).

It should be considered that incident rates were significantly higher in the Submarine Export Cable Route Study Area, with an estimated average of 73 per year based on the USCG data. However, there is not expected to be a significant increase in incidents associated with the submarine export cable route noting the Cable Burial Risk Assessment will be in place (see Section 22).

COMDTINST M16130.2F (USCG 2013) states that USCG units “with SAR readiness responsibility shall maintain a B-0 (have a suitable SAR resource ready to proceed within 30 minutes of notification of a distress) readiness”. Furthermore, USCG units “should provide for no greater than a two-hour total response time” within their area of responsibility (inclusive of the 30 minutes preparation time).

As per Section 9.1.1, there are various active USCG stations in proximity from which assets could be mobilized in the event of an incident. This includes Air Station Cape Cod, located 40 nm (74 km) to the north of the Lease Area. The USCG stated in the MARIPARS final report (USCG 2020) that it is likely that airborne assets would likely be relied upon for incidents in the MA/RI WEA given the distance offshore, and therefore it is likely that Air Station Cape Cod would be used for mobilization based on its location relative to the Lease Area. Based on the USCG incident response data (see Section 9.1.2), approximately half of all incidents in the Lease Area were responded to by an airborne asset.

Air Station Cape Cod operates assets including the MH-60T Jayhawk helicopter (operates at maximum speeds of between 125 and 150 knots and has an operational range of 300 nm

[556 km]), and as such it is anticipated that there will be no effect on the USCG target of two-hour response time including preparation.

The USCG set out recommendations for SAR access within the MA/RI WEA layouts in the MARIPARS final report (USCG 2020), stating that two lines of orientation in north/south and east/west orientations were sufficient assuming a 1 × 1 nm (1.9 × 1.9 km) uniform grid. As per Section 4.2 the current layout facilitates these requirements and as such is considered as ensuring SAR operations will be able to continue in the Lease Area once the wind farm structures are in place.

It is noted that the Project will have an Emergency Response Plan in place, and that this will include shut down procedures for the wind turbines to reduce visual distraction, physical collision and turbulence risk to SAR helicopters and/or rescue boats during SAR operations. Further, any vessels on-site associated with the Project may be able to assist if required (in liaison with the USCG), noting such vessels will likely have an increased level of response equipment onboard over that of a typical third party vessel.

It is also noted that the marine coordination and monitoring associated with the Project is anticipated to have a positive and beneficial effect on emergency response in the area. This will include facilitation of the USCG to undertake SAR trials within and in proximity to the Lease Area to aid effectiveness of operations in an actual SAR scenario. The wind farm structures themselves may provide a place of refuge if needed during an incident, and would be marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021), thus enhancing SAR operation capability.

19.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Layout design (1x1nm (1.9x1.9km) grid);
- Lighting and Marking;
- Marine Coordination;
- Marine pollution contingency plans;
- Ongoing engagement with stakeholders;
- Ongoing engagement with the USCG with regards to layout and SAR operations;
- Operational SAR procedures;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures;
- Promulgation of information;
- Provision of self-help capability;
- SMS;
- USCG SAR trials;

- Safety vessel where appropriate; and
- Wind turbine shut down procedures.

19.1.3 Impact Significance

Given the layout will facilitate SAR access in line with the MARIPARS output and considering the Project resources available in an emergency incident situation, with the embedded mitigation measures considered, the impact is assessed to be Broadly Acceptable and within ALARP parameters.

20 Impacts on Ports

20.1 Port Access – Project Vessels

The construction, maintenance and decommissioning activities associated with the Project may result in restricted access at ports, including those used as base ports by the Project.

20.1.1 Qualification of Risk

Given that the Lease Area is located in excess of 20 nm (37 km) from shore, the wind farm structures are not expected to have any notable effect on access to ports in the area (see Section 20.2 for impacts from cable installation). However, the presence of vessel traffic associated with the Project has a low potential to impact on port access.

Levels of construction vessel traffic will depend on the construction methods chosen and will include both smaller vessels (e.g., crew transfer vessels (CTV)) and larger vessels (e.g., jack ups). Regardless, given the existing traffic levels, any disruption caused by construction vessels is anticipated to be minimal given they are unlikely to represent a significant increase in commercial traffic in the area.

Throughout all phases, Project vessel movements will be managed through marine coordination to minimize disruption (as far as is feasible) to third party traffic, and Project vessels will comply with international and flag state regulations (including the COLREGs and SOLAS).

Precise base ports to be utilized during the construction and operational phases are yet to be determined. Regardless, to ensure third party vessels and relevant ports are aware of likely Project vessel movements, operational procedures such as designated routes to/from the chosen ports will be established for Project vessels. These procedures will be determined in consultation with key stakeholders, including relevant ports and the USCG. Details of the agreed procedures would then be promulgated to relevant parties.

20.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Marine Coordination;
- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures; and
- Promulgation of information.

20.1.3 Impact Significance

With the embedded mitigation measures considered in particular marine coordination and vessel procedures, the impact is assessed to be Broadly Acceptable and within ALARP parameters.

20.2 Port Access – Cable Installation

Cable installation/maintenance activities associated with the Project may result in restricted access at local ports.

20.2.1 Qualification of Risk

The current submarine export cable route passes through Long Island South and into the East River, making landfall at initially at Astoria (noting a second landfall in Niantic Bay, Connecticut is under consideration for BW2). Given available channel width in the East River and its approaches, there is likely to be impact from the installation process to existing users in terms of port access. Based on the 2019 marine traffic data, it is estimated that average vessel numbers over the East River mouth are in excess of 25 per day, noting that is AIS only. This is therefore a busy area in terms of traffic.

Channel width at the narrowest point at the East River mouth is 0.5 nm (0.9 km), and therefore noting the traffic levels, consultation and liaison with PANYNJ is considered crucial to ensure any disruption is minimal. Measures and procedures associated with the installation of the submarine export cable route will be detailed in a Cable Installation Plan, which will be produced in consultation with the U.S Army Corps of Engineers and the USCG and via PANYNJ liaison. The agreed measures will include details as to how details of the installation process will be promulgated.

Space available within Niantic Bay is such that there are unlikely to be any notable impacts on port access associated with installation of the associated cables, however this will be considered within the Cable Installation Plan. Details of cable installation would be promulgated to relevant users in advance to maximize awareness of the works.

It should be considered that there may be further impact arising post installation from any required cable maintenance. However, any such work is likely to be an infrequent event, and would be spatially limited to the area requiring maintenance. The impact would also be managed in the same manner as for the construction phase, with the same agreed measures and procedures applied.

There are two pilot boarding areas within the Submarine Export Cable Route Study Area, located at Montauk Point and New York Harbor off Execution Rocks. The cable installation works have the potential to interact with pilot operations at these locations. Montauk Point is a “secondary” pilot boarding location (NOAA 2021); however the New York Harbor point is used by vessels accessing both New York and New Jersey from the Long Island Sound and as such is an important location. Any impact will be temporary and spatially limited to the area where work was ongoing, however consultation will be undertaken in advance with PANYNJ as part of the Cable Installation Plan to ensure any disruption is minimal.

20.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation measures which have been identified are as follows (further detail on mitigation is included in Section 22):

- Cable Burial Risk Assessment;
- Cable Installation Plan;
- Marine Coordination;
- Ongoing engagement with stakeholders;
- Project Vessel AIS Carriage;
- Project vessel compliance with international and flag state regulations;
- Project vessel operational procedures; and
- Promulgation of information.

20.2.3 Impact Significance

Given the high levels of traffic and available channel width, the impact is assessed to be Tolerable with Mitigation and within ALARP parameters, noting the associated mitigations require extensive planning, promulgation of information and consultation with PANYNJ, the USCG and the U.S Army Corps of Engineers.

21 Cumulative Impact Assessment

This section assesses relevant impacts on a cumulative basis as per the methodology detailed in Section 2.2. It is noted that the cumulative routing assessment (see Section 12) has assessed two scenarios. The worst case of these (full build out of the entire MA/RI WEA as per Section 12.1) has been assumed for the purposes of cumulative impact assessment to ensure a worst case has been assessed.

21.1 Deviations

The presence of cumulative developments may lead to vessels deviating around the multiple Lease Areas resulting in increased journey times and distances.

The significant majority of commercial vessel traffic in the area utilizes the safety fairways to the south, and as such are unaffected by both the Project and other cumulative developments. This aligns with the commercial vessel routing assessment, with no commercial vessel main routes identified in the Study Area intersecting the Lease Area or other cumulative developments. It is noted that there would be no restrictions on passage through the Lease Area other than through active safety zones if applicable (see Section 4.5.3), and it is assumed the same will apply for the other MA/RI projects. However, operational experience indicates commercial vessels will deviate rather than transit through constructing or operational wind farm structures. If they do so in this case, there will be deviations required for limited volumes of commercial traffic in the study area, and it is anticipated that these vessels will pass west of the MA/RI WEA.

Fishing vessels accounted for the majority of vessels in the Lease Area, comprising 79 percent of the total. As for commercial vessels there would be no restrictions on transit through the Lease Area other than through active safety zones if applicable (see Section 4.5.3), and it is assumed the same will apply for the other MA/RI projects. The MARIPARS final report (USCG 2020) recommended uniform 1 × 1 nm (1.9 × 1.9 km) grids throughout the MA/RI WEA, including east/west and north west/south east lines of orientation to facilitate known fishing vessel transits (with which the current Project layout complies as per Section 4.2). Based on operational experience, 1 nm (1.9 km) minimum spacing is sufficient to accommodate fishing vessel transits, with such vessels transiting through U.K. developments (for example) with much smaller minimum spacing. The same is considered as applying for other small vessels (e.g., recreational), noting again this aligns with experience of operational wind farms.

However, the decision to transit through will lie with each individual vessel master and will be based on various factors including final layouts, weather conditions and other traffic. It should therefore be considered that fishing vessels may still choose to deviate around the MA/RI WEA rather than transit through. A total of three fishing vessel main routes were identified as potentially deviating on a cumulative basis assuming full build out of the MA/RI WEA, with the maximum deviation being 8.1 nm (15 km), representing a 7.1 percent increase in transit distance.

Should vessels choose to deviate, the charted locations, promulgation of information, and lighting and marking of the MA/RI WEA projects at a cumulative level will ensure third party traffic is able to passage plan in advance to ensure any deviation is minimal.

Mitigation measures associated with the equivalent impacts for the assessment of the Project in isolation are also applicable for this cumulative impact. In particular all developments will have infrastructure charted and information promulgated.

With these embedded mitigation measures considered, the impact is assessed to be **Tolerable with Mitigation** and within ALARP parameters.

21.2 Adverse Weather Deviations

The presence of cumulative developments may lead to commercial fishing or recreational vessels deviating around the Lease Areas while in transit resulting in increased journey times and passage distances during periods of adverse weather.

As for the in isolation assessment of adverse weather deviations (see Sections 15.2 and 17.2), deviations may be necessary in certain adverse weather conditions around the cumulative developments, which is a worst case would be full build out of the MA/RI WEA.

The in isolation assessment of NOAA weather data focused on the Project, but is considered as being reflective of local conditions on a general basis including the MA/RI WEA given the spatial area assessed (see Section 5.3.5). On this basis, adverse conditions to the extent of a tropical cyclone affecting the MA/RI WEA may occur over the lifetime of the relevant developments. However, as per the analysis in Section 5.3.5, at a local level the exposure is moderately low owing to the relatively sheltered location when compared to areas further offshore.

Vessel masters would assess the forecast in terms of severity and timeframe, and the distance to the nearest ports or areas of shelter before choosing a transit plan, which may involve the selection of an alternative port or sheltered location, or choosing to not make passage at all if the conditions were deemed too dangerous. This passage planning should include consideration of the location and status of all relevant wind farm developments.

This aligns with the findings of the MARIPARS report (USCG 2020) which indicated that “proper voyage planning and access to relevant safety information should ensure that safety is not compromised” assuming the 1 × 1 nm (1.9 × 1.9 km) grid across the MA/RI WEA as a whole, noting the relevant passage planning considerations included “Weather conditions – both current and predicted including sea state and visibility”.

As with commercial vessel deviations in normal weather conditions and as noted in the in isolation assessments, vessels are expected to comply with international and flag state regulations (including the COLREGs and SOLAS) and will be able to passage plan in advance given the promulgation of information relating to the Project and the MA/RI WEA as a whole including the presence of infrastructure on relevant nautical and electronic charts.

Mitigation measures associated with the equivalent impacts for the assessment of the Project in isolation are also applicable for this cumulative impact. In particular all developments will have infrastructure charted and information promulgated.

With these embedded mitigation measures considered, the impact is assessed to be **Broadly Acceptable** and within ALARP parameters.

21.3 Increased Vessel to Vessel Collision Risk

The presence of cumulative developments may lead to vessels deviating or altering routing around the multiple Lease Areas, potentially resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk.

Given that the majority of commercial traffic in the area utilizes the safety fairways to the south, and as discussed in Section 21.1, there is not anticipated to be significant displacement of commercial vessel routing including on a cumulative level. On this basis there is not likely to be a significant increase in cumulative collision risk associated with commercial vessel deviations.

Smaller vessels (e.g., fishing, recreation), may still choose to transit through the MA/RI WEA, though they may also deviate. On the basis that the MARIPARS final report (UCSG 2020) did not recommend dedicated transit corridors through the MA/RI WEA, there is not considered likely to be a "funneling" effect of traffic choosing to transit through, given there will be multiple transit options available assuming uniform 1 × 1 nm (1.9 × 1.9 km) grids. However, noting the decision to transit through will be dependent on various factors including the final layouts (which will be defined and approved via BOEM), it should be considered that there may be small increases of vessel density around the periphery of the MA/RI WEA.

All vessels (third party and project vessels associated with MA/RI WEA developments) are expected to comply with international and flag state regulations (including the COLREGs and SOLAS). This will include requirements to passage plan in advance, which will be facilitated by the promulgation of information relating to the Project and the other MA/RI WEA developments including the presence of infrastructure on relevant nautical and electronic charts.

Mitigation measures associated with the equivalent impacts for the assessment of the Project in isolation are also applicable for this cumulative impact; in particular all developments will have infrastructure charted and information promulgated, and marine coordination will be in place for Project vessels.

With these embedded mitigation measures considered, the impact is assessed to be **Broadly Acceptable** and within ALARP parameters.

21.4 Vessel to Vessel Allision Risk (Powered and Drifting)

The presence of cumulative developments may create a risk of a vessel under power or NUC experiencing an allision with a structure within one of the Lease Areas.

Assuming full build out of the MA/RI WEA there will be a significant number of new structures that will pose an allision risk to vessels NUC or under power. In terms of commercial vessel traffic, based on experience of operational wind farms, it is anticipated that these vessels will deviate around the MA/RI WEA, and as such it will be the periphery structures causing the majority of the risk. However, as is the case for the in isolation assessment, there is considered to be suitable sea room available for commercial vessels to pass a safe distance from the MA/RI WEA periphery to minimize any cumulative allision risk.

As per Section 21.1, smaller vessels may choose to transit through the MA/RI WEA, and as such are at risk of allision with internal structures. However, based on the findings of the MARIPARS final report (USCG 2020), and in line with experience of operational wind farms, assuming 1 × 1 nm (1.9 × 1.9 km) uniform grids, there is considered to be sufficient spacing within the MA/RI WEA to accommodate fishing vessel transits (or transits from other small vessels, e.g., recreational). It should be considered that in isolation allision risk to fishing vessels from the Project was assessed as being high on a quantitative basis, however this was inclusive of all incident consequence levels including low energy/impact contacts which are considered the most likely scenario. As per Section 9.2.1, there has only been one reported fishing vessel allision to date in a U.K. wind farm, despite a significant volume of operational hours.

All MA/RI WEA projects will be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021). It should also be considered that the projects within the MA/RI WEA will have resources available to assist in an emergency situation (e.g., drifting vessel), noting this would be in liaison with the USCG.

Mitigation measures associated with the equivalent impacts for the assessment of the Project in isolation are also applicable for this cumulative impact; in particular, lighting and marking to ensure vessels are aware of the presence of the structures.

With these embedded mitigation measures considered, the impact is assessed to be **Tolerable with Mitigation** and within ALARP parameters.

22 Embedded Mitigation Measures

As referenced throughout Sections 15 through 21, there are a range of embedded mitigation measures which have been assumed within the impact assessment undertaken within this NSRA. These measures are summarized in Table 22.1 for ease of reference and completeness. This includes a summary of how each measure manages the relevant risk.

Table 22.1 Embedded Mitigation

Measure	Description	Relevance to Risk Management
Application and use of safety zones up to 1,640 ft (500 m) radius during construction and decommissioning	Where applicable, safety zones will be established around the structures where works are ongoing. Where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented, as per the COLREGs. Where safety zones are not applicable, on-site vessels will promote awareness of the relevant activities, highlighting the areas where sensitive operations are ongoing to ensure the safety of the third party vessels and construction equipment/personnel.	Protects Project vessels from passing third party vessels, minimizing collision risk. Protects third party vessels from wind farm structures under construction (and prior to operational lighting/marking), minimizing powered allision risk.
Cable Burial Risk Assessment	A Cable Burial Risk Assessment will be undertaken prior to the commencement of construction to determine cable protection methods. This will take into account locations of existing anchoring and fishing activity, and will be in compliance with burial requirements in federally maintained areas where applicable. The process will also include further consultation with stakeholders most notably the USCG and U.S. Army Corps of Engineers.	Will ensure target burial depths and external protection are sufficient to minimize cable interaction risk from anchors and fishing gear.
Cable Installation Plan	A Cable Installation Plan will be produced in consultation with the U.S. Army Corps of Engineers, the USCG and PANYNJ detailing how cable installation will be managed to ensure disruption is minimized, in particular in approaches to ports.	Will ensure any disruption associated with cable installation works/vessels is minimized, including consideration of ports with which Project vessels are associated.

Measure	Description	Relevance to Risk Management
Charting of infrastructure	All wind farm structures and cables (i.e., offshore infrastructure associated with the Project) will be charted on the relevant nautical and electronic charts in conjunction with NOAA. Beacon Wind will provide this information in advance of construction.	Facilitates passage planning in advance, thus minimizing deviations, collision risk and powered allision risk. Facilitates third party vessels in determining suitable anchoring locations, which minimizes anchor snagging and contact risk.
Layout Design aligning with USCG recommendations under MARIPARS (1x1nm (1.9x1.9km) grid)	Application of a 1x1nm (1.9x1.9km) grid in line with USCG recommendations under the MARIPARS final report.	Facilitates internal vessel transit and SAR operations.
Lighting and Marking	The array will be lit and marked in compliance with COMDTINST M16500.7A (USCG 2015), USCG D1 LNM guidance on Lighting and Marking (2020), and the Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (BOEM 2021). Additionally, Federal Aviation Administration requirements for the lighting of structures over 200 ft (60.1 m) will be adhered to. Structures will show unique identifiers that have been predetermined by the USCG. The ID system will be standardized and consistent across the MA/RI WEA projects to facilitate internal navigation and SAR.	Facilitates third party vessel awareness of the Project, to minimize collision risk and powered allision risk. Facilitates emergency response, ensuring SAR operations can be undertaken as efficiently as possible.
Marine Coordination	Marine coordination will be implemented for all vessels associated with the Project, i.e., a central coordination hub from which all Project vessel movements will be managed and third-party vessel traffic monitored. This will include a construction vessel and schedule notification system.	Minimizes collision risk and assists emergency responders to undertake SAR operations as efficiently as possible. Ensures disruption is minimized, including access to ports used for operations relating to the Project.
Minimum advisory safe passing distance	Where feasible, a minimum advisory safe passing distance for cable laying vessels will be implemented.	Protects Project vessels undertaking sensitive works associated with cables from passing third party vessels, minimizing collision risk.

Measure	Description	Relevance to Risk Management
Minimum blade clearance	The minimum blade clearance for wind turbine blades will be 85 ft (26 m) above HAT.	Minimizes powered and drifting allision risk for recreational vessels with a mast.
Monitoring of cables and associated protection	Cable burial and protection measures will be periodically monitored to ensure they remain effective, with regular monitoring of protection in the vicinity of any areas of existing anchoring as identified within the Cable Burial Risk Assessment.	Minimizes anchor snagging and contact risk.
Marine pollution contingency plans	Appropriate marine pollution contingency planning will be undertaken.	Minimizes environmental effects should an incident occur, including a collision or allision incident.
Ongoing engagement with stakeholders	Consultation and stakeholder engagement will be ongoing throughout and beyond the NSRA process, and continue through the construction of the Project. This will include use of a Fisheries Liaison Officer for discussions with commercial fishing stakeholders.	Assists dynamic risk assessment to minimize collision and allision risk to vessels operating in the area. Ensures disruption is minimized, including access to ports used for operations relating to the Project.
Ongoing engagement with the USCG including in relation to SAR operations	Consultation and stakeholder engagement will be ongoing with the USCG throughout and beyond the NSRA process with regards to facilitation of SAR operations.	Facilitates emergency response, ensuring SAR operations can be undertaken as efficiently as possible.
Operational SAR procedures	Operational SAR procedures will be put in place to detail how Beacon Wind will cooperate with the USCG in the event of an emergency situation e.g., on site vessels role as first responders/self help capability. These will be discussed and agreed with the USCG in advance of construction and will be reviewed and updated in liaison with the USCG as necessary as the Project progresses.	Facilitates emergency response, ensuring SAR operations can be undertaken as efficiently as possible.
Project Vessel AIS Carriage	All vessels associated with the Project will carry operational AIS, pursuant to the USCG and AIS carriage requirements, to monitor the number of vessels and traffic patterns.	Assists third party vessel awareness of Project vessel movements to minimize collision risk.

Measure	Description	Relevance to Risk Management
Project vessel compliance with international and flag state regulations	All vessels associated with the Project will be compliant with international and flag state regulations including the COLREGs and SOLAS and other health and safety requirements.	Minimizes collision risk for Project vessels. Ensures disruption is minimized, including access to ports used for operations relating to the Project.
Project vessel operational procedures	All vessels associated with the Project will follow operational procedures such as entry/exit points to/from the array and designated routes to/from port.	Minimizes collision risk for Project vessels. Ensures disruption is minimized, including access to ports used for operations relating to the Project.
Promulgation of information	Information relating to the Project and associated activities will be promulgated via Notices to Mariners and other appropriate means.	Assists third party vessels to passage plan in advance, thus minimizing deviations, collision risk and powered allision risk. Ensures disruption is minimized, including access to ports used for operations relating to the Project.
Provision of self-help capability	In the event of an emergency, vessel and/or structure based resources or facilities relating to the Project may be able to assist.	Minimizes drifting allision risk and assists in limiting the effects of the Project on emergency response capability.
SMS	An SMS will be created and implemented and will include an Emergency Response Plan outlining procedures in an emergency situation.	Details approach to be followed by the Project to manage safety risks, assisting in limiting the effects of the Project on emergency response capability.
USCG SAR trials	Facilitation of USCG SAR trials within and in proximity to the Lease Area.	Assists emergency responders to undertake SAR operations as efficiently as possible.
Safety vessel where appropriate	Use of safety vessel during the construction and decommissioning phases, where deemed appropriate via risk assessment. It is noted that safety vessels will have no law enforcement authority and will contact the USCG on VHF-CH 16 if necessary.	Minimizes powered and drifting allision risk.

Measure	Description	Relevance to Risk Management
Use of PATON	PATON may be deployed during the construction, operation and maintenance, and decommissioning phases to mark the working area or Lease Area (where deemed appropriate by risk assessment).	Assists third party vessel awareness of the Project to minimize collision risk and powered allision risk.
Wind turbine shut down procedures	It will be possible for the wind turbines to be remotely shut down, either individually, in a row or across the complete array.	Assists emergency responders to undertake SAR operations as efficiently as possible.

23 Conclusion

This NSRA has assessed the impact of the major hazards associated with the development of the Beacon Wind Project based on waterway, maritime traffic, and vessel characteristics, lessons learned from trials and existing offshore wind farms, and collision, allision, and grounding risk modelling.

Table 23.1 summarizes the potential impacts identified for shipping and navigation which were assessed in the NSRA. It is noted that impacts, such as those relating to navigation and communication position fixing equipment, tropical cyclones, and ice, which were not deemed significant enough to be considered fully in the impact assessment have not been included in Table 23.1.

Table 23.1 FSA Summary

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
Commercial fishing vessels	Deviations	Tolerable with Mitigation	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	The FSA identified that targeted promulgation of information to fishing users was necessary for the risk to be ALARP.
	Adverse weather deviations	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Increased vessel to vessel collision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Marine Coordination; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
	Powered vessel to structure allision risk	Tolerable with Mitigation	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; ▪ Provision of self-help capability; ▪ Safety vessel where appropriate; and ▪ Use of PATON.	The FSA identified that targeted promulgation of information to fishing users was necessary for the risk to be ALARP.
	Drifting vessel to structure allision risk	Tolerable with Mitigation	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Operational SAR procedures; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; ▪ Provision of self-help capability; ▪ Safety vessel where appropriate; and ▪ Use of PATON.	The FSA identified that targeted promulgation of information to fishing users was necessary for the risk to be ALARP.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
Commercial vessels	Deviations	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Increased vessel to vessel collision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
	Powered vessel to structure allision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; ▪ Safety vessel where appropriate; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Drifting vessel to structure allision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Operational SAR procedures; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; ▪ Provision of self-help capability; ▪ Safety vessel where appropriate; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
Recreational vessels	Deviations	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum blade clearance; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Adverse weather deviations	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum blade clearance; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Increased vessel to vessel collision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Marine Coordination; ▪ Minimum advisory safe passing distance; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
	Powered vessel to structure allision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Minimum blade clearance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Drifting vessel to structure allision risk	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Minimum blade clearance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Operational SAR procedures; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; ▪ Provision of self-help capability; ▪ Safety vessel where appropriate; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
Anchored vessels	Displacement of Anchoring	Tolerable with Mitigation	▪ Cable Burial Risk Assessment; ▪ Cable Installation Plan; ▪ Charting of infrastructure; ▪ Monitoring of cables and associated protection; ▪ Ongoing engagement with stakeholders; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; and ▪ Promulgation of information.	The FSA identified that consultation and liaison with PANYNJ, the USCG and U.S. Army Corps of Engineers is crucial.
	Underwater snagging or contact risk	Tolerable with Mitigation	▪ Cable Burial Risk Assessment; ▪ Cable Installation Plan; ▪ Charting of infrastructure; ▪ Monitoring of cables and associated protection; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Safety vessel where appropriate.	The FSA identified that consultation and liaison with PANYNJ, the USCG and U.S. Army Corps of Engineers is crucial.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
Emergency responders	Emergency response capability	Broadly Acceptable	▪ Lighting and Marking; ▪ Marine Coordination; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Ongoing engagement with the USCG with regards to layout and SAR operations; ▪ Operational SAR procedures; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; ▪ Provision of self-help capability; ▪ SMS; ▪ USCG SAR trials; ▪ Safety vessel where appropriate; and ▪ Wind turbine shut down procedures.	Risk level has been reduced to ALARP and no further mitigation is required.
Ports and services	Restricted access at ports – Project Vessels	Broadly Acceptable	▪ Marine Coordination; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; and ▪ Promulgation of information.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
	Restricted access at ports – Cable Installation	Tolerable with Mitigation	▪ Cable Burial Risk Assessment; ▪ Cable Installation Plan; ▪ Marine Coordination; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; and ▪ Promulgation of information.	The FSA identified that consultation and liaison with PANYNJ, the USCG and U.S. Army Corps of Engineers is crucial.
All users (cumulative)	Deviations	Tolerable with Mitigation	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	The FSA identified that targeted promulgation of information to fishing users was necessary for the risk to be ALARP.
	Adverse weather deviations	Broadly Acceptable	▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum blade clearance; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.

User	Impact	ALARP Risk Level	Embedded Mitigation Measures	Additional Mitigation Measures
	Increased vessel to vessel collision risk	Broadly Acceptable	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Marine Coordination; ▪ Minimum advisory safe passing distance; ▪ Ongoing engagement with stakeholders; ▪ Project Vessel AIS Carriage; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Promulgation of information; and ▪ Use of PATON.	Risk level has been reduced to ALARP and no further mitigation is required.
	Powered and drifting vessel to structure allision risk	Tolerable with Mitigation	▪ Safety zones (if applicable); ▪ Charting of infrastructure; ▪ Lighting and Marking; ▪ Minimum advisory safe passing distance; ▪ Minimum blade clearance; ▪ Marine pollution contingency plans; ▪ Ongoing engagement with stakeholders; ▪ Promulgation of information; ▪ Use of PATON. ▪ Operational SAR procedures; ▪ Project vessel compliance with international and flag state regulations; ▪ Project vessel operational procedures; ▪ Provision of self-help capability; and ▪ Safety vessel where appropriate.	Risk level has been reduced to ALARP and no further mitigation is required.

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Attachment A NVIC Checklist

Table A.1 provides the completed NVIC No. 01-19 checklist with comments included for each entry. Where appropriate, comments include references to where each respective issue has been addressed within this NSRA.

Table A.1 NVIC 01-19 Checklist

Issue	Yes/ No	Comments
1. Site and installation coordinate		
Has the developer ensured that coordinates and subsequent variations of site parameters and individual structures are made available, upon request, to interested parties at all, relevant project stages?	Yes	Coordinates for the Lease Area are provided in Section 4.1. The location of individual structures will not be finalized until acceptance of the COP but will be provided once available.
Has the coordinate data been supplied as authoritative Geographical Information System data, preferably in Environmental Systems Research Institute 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 World Geodetic System 1984 datum.	Yes	Coordinates for the Lease Area are provided in Section 4.1. Geographical Information System data will be provided to the USCG.
2. Traffic survey		
Was the traffic survey conducted within 12 months of the NSRA?	Yes	As agreed with the USCG (see Section 3), pre Covid data has been used. This covers the most recent unaffected year of data (2019) as per Section 6.1.
Does the survey include all vessel types?	Yes	Vessels determined to be engaged in works considered as temporary have been excluded but all other vessel types have been included as noted in Section 6.1. Detailed analysis of the main vessel types is provided in Section 6.2.4.
Is the time period of the survey at least 28 days duration?	Yes	A year of data (2019) has been assessed as per Section 6.1.
Does the survey include consultation with recreational vessel organizations?	Yes	See Section 3.2.
Does the survey include consultation with fishing vessel organizations?	Yes	See Section 3.2.
Does the survey include consultation with pilot organizations?	Yes	See Section 3.2.
Does the survey include consultation with commercial vessel organizations?	Yes	See Section 3.2.

Issue	Yes/ No	Comments
Does the survey include consultation with port authorities?	Yes	See Section 3.2.
Does the survey include proposed structure location relative to areas used by any type of vessel?	Yes	The marine traffic data has been shown relative to the Lease Area and the submarine export cable route in Section 5.3.5.
Does the survey include numbers, types, sizes and other characteristics of vessels presently using such areas?	Yes	Vessel numbers are assessed within Section 6.2.1, sizes in Section 6.2.2, and types in Section 6.2.4.
Does the survey include types of cargo carried by vessels presently using such areas?	Yes	Commercial cargo vessels and tankers have been subcategorized in Section 6.2.4.3.
Does the survey identify non-transit uses of the areas (for example, fishing, day cruising of leisure craft, racing, marine regattas and parades, aggregate mining)?	Yes	Fishing vessels are assessed within Section 6.2.4.2 and recreational vessels are assessed within Section 6.2.4.4. It is noted that fishing vessels engaged in fishing activities have not been considered within the assessment, but rather have been assessed as part of the commercial fisheries assessment (Section 8.8 of the COP).
Does the survey include whether these areas contain transit routes used by coastal or deep-draft vessels, ferry routes, and fishing vessel routes?	Yes	Vessel draft is assessed within Section 6.2.2.2, and commercial vessel routing is assessed within Section 6.3. Fishing vessel activity is assessed within Section 6.2.4.2.
Does the survey include alignment and proximity of the site relative to adjacent shipping routes?	Yes	Commercial vessel routing is assessed within Section 6.3. Relevant routing measures are presented in Section 5.1.1.
Does the survey include whether the nearby area contains prescribed or recommended routing measures or precautionary areas?	Yes	Relevant routing measures are presented in Section 5.1.1.
Does the survey include whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes or TSS?	Yes	Relevant routing measures are presented in Section 5.1.1.
Does the survey include the proximity of the site to anchorage grounds or areas, safe haven, port approaches, and pilot boarding or landing areas?	Yes	Relevant navigational features are presented within Section 5.1.
Does the survey include the feasibility of allowing vessels to anchor within the vicinity of the structure field?	Yes	Existing anchoring activity is assessed within Section 6.2.4.5 and 6.6.3. Feasibility of anchoring is assessed within Section 18.
Does the survey include the proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds?	Yes	Fishing vessel activity is assessed within Section 6.2.4.2, noting that additional assessment is available within Section 8.8 of the COP.

Issue	Yes/ No	Comments
Does the survey include whether the site lies within the limits of jurisdiction of a port and/or navigation authority?	Yes	Local ports are presented in Section 5.1.12.
Does the survey include the proximity of the site to offshore firing/bombing ranges and areas used for any marine or airborne military purposes?	Yes	See Section 5.1.9.
Does the survey include the proximity of the site to existing or proposed offshore OREI/gas platform or marine aggregate mining?	Yes	Proposed offshore wind farms developments have been considered in Section 10. No relevant marine aggregate dredging areas or gas platforms have been identified.
Does the survey include the proximity of the site to existing or proposed structure developments?	Yes	Proposed offshore wind farms developments have been considered in Section 10. There are no existing structures in proximity.
Does the survey include the proximity of the site relative to any designated areas for the disposal of dredging material or ocean disposal site?	Yes	See Section 5.1.7.
Does the survey include the proximity of the site to aids to navigation and/or VTS in or adjacent to the area and any impact thereon?	Yes	Aids to Navigation are presented in Section 5.1.5. The Lease Area does not fall under the jurisdiction of any port.
Does the survey include a researched opinion using computer simulation techniques with respect to the displacement of traffic, mixing of vessel types that were previously segregated; changes in traffic density and resultant change in vessels encounters; and, in particular, the creation of 'choke points' in areas of high traffic density?	Yes	Post wind farm routing based on the main vessel traffic dataset (and therefore considering multiple vessel types) is provided in Section 11.3.1. Changes in traffic density and vessel to vessel collision risk including choke points have been assessed on a quantitative basis in Section 11.3.3.
Does the survey include whether the site is in or near areas that will be affected by variations in traffic patterns as a result of changes to vessel emission requirements?	Yes	No changes are expected in relation to changes to vessel emission requirements as per Section 6.7.4.
Does the survey include seasonal variations in traffic?	Yes	A year of data (2019) has been assessed as per Section 6.1, and as such is considered to capture seasonal variations.
3. Offshore above water structure		

Issue	Yes/ No	Comments
Does the NSRA denote whether any features of the offshore above water structure, including auxiliary platforms outside of the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring? Such dangers would include clearances of wind turbine blades above the sea surface, the burial depth of cabling and lateral movement of floating wind turbines.	Yes	Impacts relating to the interaction of vessels with wind farm structures have been assessed (allision risk) (Sections 15, 16, and 17) and cables (underwater snagging or contact risk) (Section 18) have been assessed. The wind turbine blade clearance has been considered in the assessment of allision risk to recreational vessels in Section 17. The burial depth of cables has been considered in the assessment of underwater snagging or contact risk in Section 18. Floating foundations are not under consideration as per Section 4.2.1.
Does the NSRA denote whether minimum safe (air) clearances between sea level conditions at Mean Higher High Water (MHHW) and wind turbine rotors are suitable for the vessel types identified in the traffic survey? Depths, clearances and similar features of other structure types which might affect navigation safety and other Coast Guard missions should be determined on a case by case basis.	Yes	The wind turbine blade clearance has been considered in the assessment of allision risk to recreational vessels in Section 17. No characteristics of individual structures have been identified as potentially affecting navigational safety in relation to the USCG missions.
Does the NSRA denote whether any feature of the installation could impede emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels?	Yes	The impact on emergency response capability has been assessed in Section 19.
Does the NSRA denote how the rotor blade rotation and power transmission, etc. will be controlled by the designated services when this is required in an emergency?	Yes	Wind turbine shut down procedures have been outlined in Section 4.2.2. Further details will be outlined within the SMS.
Does the NSRA denote whether any noise or vibrations generated by a structure above and below the water column would impact navigation safety or affect other Coast Guard missions?	Yes	Impacts due to surface and underwater noise have been assessed in Section 8.11.
Does the NSRA denote the ability of a structure to withstand collision damage by vessels without toppling for a range of vessel types, speeds and sizes?	Yes	Structure integrity post allision is considered in Section 11.5.2.

Issue	Yes/ No	Comments
4. Offshore under water structure		
Does the NSRA denote whether minimum safe clearance over underwater devices has been determined for the deepest draft of vessels that could transit the area?	Yes	There are no underwater devices planned (other than subsea cables) but a partially quantitative assessment has been applied with respect to vessel grounding risk in Section 11.3.6.
Has the developer demonstrated an evidence-based, case-by-case approach which will include dynamic draft modelling in relation to charted water depth to ascertain the safe clearance over a device?	Yes	There are no underwater devices planned (other than subsea cables) but a partially quantitative assessment has been applied with respect to vessel grounding risk in Section 11.3.6.
To establish a minimum clearance depth over devices, has the developer identified from the traffic survey the deepest draft of observed traffic? This will then require modelling to assess impacts of all external dynamic influences giving a calculated figure for dynamic draft. A 30 percent factor of safety for under keel clearance should then be applied to the dynamic draft, giving an overall calculated safe clearance depth to be used in calculations.	Yes	There are no underwater devices planned (other than subsea cables) but a partially quantitative assessment has been applied with respect to vessel grounding risk in Section 11.3.6, which includes consideration of the maximum vessel drafts recorded.
5. Assessment of access to and navigation within, or close to, a structure. Has the developer determined the extent to which navigation would be feasible within the structure site itself by assessing whether:		
Navigation within the site would be safe? ▪ By all vessels or ▪ By specified vessel types, operations and/or sizes? ▪ In all directions or areas; or ▪ In specified directions or areas? ▪ In specified tidal, weather or other conditions; and ▪ At any time, day or night?	Yes	Navigation relative to the site (including internal navigation where appropriate) is assessed for key vessel types in Sections 15 through 17. Adverse weather transits have also been considered where appropriate within these sections. Weather and tidal conditions have been accounted for in drifting allision risk modelling in Section 11.3.4.2. The above assessments have been qualified with Project characteristics applied which include suitable lighting and marking in both day and night conditions as considered in Section 7.
Does the NSRA contain enough information for the Coast Guard to determine whether or not exclusion from the site could cause navigation, safety or transiting problems for vessels operating in the area?	Yes	Post wind farm routing is assessed within Section 11.3.1, and assumes in line with experience of other operational wind farms that commercial vessels will avoid the Lease Area. The effects of this post wind farm routing on collision risk are assessed in 11.3.3.

Issue	Yes/ No	Comments
6. The effect of tides, tidal streams, and currents. Does the NSRA contain enough information for the Coast Guard to determine whether or not:		
Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed structure is situated at various states of the tide, that is, whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as noted in Section 5.3.4.
Current maritime traffic flows and operations in the general area are affected by existing currents in the area in which the proposed structure is situated?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as per Section 5.3.4.
The set and rate of the tidal stream, at any state of the tide, would have a significant effect on vessels in the area of the structure site?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as noted in Section 5.3.4. Drifting risk is assessed in Section 11.3.4.2.
Current directions/velocities might aggravate or mitigate the likelihood of allision with the structure?	Yes	The drifting vessel to structure allision risk modelling has taken into consideration the speed and direction of the tide as noted in Section 11.3.4.2.
The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as noted in Section 5.3.4.
The set is across the major axis of the layout at any time, and, if so, at what rate?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as noted in Section 5.3.4.
In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream or currents?	Yes	The drifting vessel to structure allision risk modelling accounts for likely engine breakdown rates, including consideration for the potential for vessels to have multiple engines as noted in Section 11.3.4.2.
Structures in the tidal stream could produce siltation, deposition of sediment or scouring, any other suction or discharge aspects, which could affect navigable water depths in the structure area or adjacent to the area?	Yes	Based on the available data and distance offshore no impacts relating to tidal streams are anticipated as noted in Section 5.3.4. Grounding risk is assessed within Section 11.3.6, noting that any change in risk is only considered likely to be associated with subsea cables.
Structures would cause danger and/or severely affect the air column, water column, seabed and sub-seabed in the general vicinity of the structure?	Yes	Addressed in Section 4.0 of the COP (Physical Resources).

Issue	Yes/ No	Comments
7. Weather. Does the NSRA contain a sufficient analysis of expected weather conditions, water depths and sea states that might aggravate or mitigate the likelihood of allision with the structure, so that the Coast Guard can properly assess the applicant's determination of whether:		
The site, in all weather conditions, could present difficulties or dangers to vessels, which might pass in close proximity to the structure?	Yes	Visibility, tidal streams, wind direction, and sea state are considered within the allision and collision modelling undertaken as per Section 11. Adverse weather transits have been considered for fishing vessels (Section 15) and recreational vessels (Section 17).
The structures could create problems in the area for vessels under sail, such as wind masking, turbulence, or sheer?	Yes	The potential for effects such as wind shear, masking and turbulence to occur has been assessed for recreational vessels under sail in Section 17.
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 above?	Yes	The drifting vessel to structure allision risk modelling accounts for local wind direction probabilities and likely engine breakdown rates, including consideration for the potential for vessels to have multiple engines, as noted in Section 11.3.4.2.
Depending on the location of the structure and the presence of cold weather, sea ice and/or icing of the structure may cause problems? A thorough analysis of how the presence of the structure would mitigate or exacerbate icing?	Yes	The presence of sea ice and icing of the Wind turbine blades has been considered in Section 5.3.6.
An analysis of the ability for structures to withstand anticipated ice floes should be conducted by the applicant?	Yes	The presence of sea ice and icing of the wind turbine blades has been considered in Section 5.3.6.
An analysis of the likelihood that ice may form on the structure, especially those types that have rotating blades such as a wind turbine, should be conducted by the applicant, and should include an analysis of the ability of the structure to withstand anticipated ice accumulation on the structures, and potential for ice to be thrown from the blades, and the likely consequences of that happening and possible actions to mitigate that occurrence?	Yes	The presence of sea ice and icing of the wind turbine blades has been considered in Section 5.3.6.

Issue	Yes/ No	Comments
8. Configuration and collision avoidance		
The Coast Guard will provide SAR services in and around OREIs in U.S. waters. Layout designs should allow for safe transit by SAR helicopters operating at low altitude in bad weather, and those vessels (including rescue craft) that decide to transit through them. Has the developer conducted additional site specific assessments, if necessary, to build on any previous assessments to assess the proposed locations of individual turbine devices, substations, platforms and any other structure within OREI such as a wind farm or tidal/wave array? Any assessment should include the potential impacts the site may have on navigation and SAR activities. Liaison with the USCG is encouraged as early as possible following this assessment which should aim to show that risks to vessels and/or SAR helicopters are minimized and include proposed mitigation measures.	Yes	The impact on emergency response capability including SAR services has been assessed in Section 19.
Each OREI layout design will be assessed on a case-by-case basis.	Yes	The layout assessed is considered the maximum design scenario for shipping and navigation as noted in Section 4.5.3. The final layout will be agreed following acceptance of the COP, noting the current layout aligns with the output of the MARIPARS (USCG 2020).
Risk assessments should build on any earlier work conducted as part of the NSRA and the mitigations identified as part of that process. Where possible, an original assessment should be referenced to confirm where the information or the assessment remains the same or can be further refined due to the later stages of project development. Risk assessments should present information to enable the USCG to adequately understand how the risks associated with the proposed layout have been reduced to ALARP.	Yes	A maximum design scenario approach has been taken within the NSRA (see Section 4.5.3), which ensures any refinement to the PDE will not increase the significance of the impacts identified The risk assessment uses an RBDM approach (Section 2.1.1) with the ALARP principle applied (Section 2.1.2) and is presented with a consistent structure applied to each user and impact in turn (summary of the impact, main discussion of the impact, list of relevant embedded mitigation and final significance ranking) (see Section 13).

Issue	Yes/ No	Comments
In order to minimize risks to surface vessels and/or SAR helicopters transiting through an OREI, structures (turbines, substations) should be aligned and in straight rows or columns. Multiple lines of orientation may provide alternative options for passage planning and for vessels and aircraft to counter the environmental effects on handling, i.e., sea state, tides, current, weather, visibility. Developers should plan for at least two lines of orientation unless they can demonstrate that fewer are acceptable.	Yes	As per Section 4.2, the wind turbines and offshore substation facilities are arranged in strict rows and columns providing multiple lines of orientation. The layout aligns with the outputs and recommendations of the MARIPARS (USCG 2020).
Packed boundaries will be considered on a case-by-case basis as part of the risk assessment process. For opposite boundaries of adjacent sites due consideration should be given to the requirement for lines of orientation which allow a continuous passage of vessels and/or SAR helicopters through both sites. Where there are packed boundaries this will affect layout decisions for any possible future adjacent sites. The definition of ‘adjacent’ will be assessed on a case-by-case basis.	Yes	The preferred base case layout is grid based and therefore does not include a packed boundary as per Section 4.2.
9. Visual navigation. Does the NSRA contain an assessment of the extent to which:		
Structures could block or hinder the view of other vessels underway on any route?	Yes	The potential blocking or hindering of the view of other vessels in relation to increased collision risk has been assessed in Sections 15, 16, and 17.
Structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories?	Yes	The impact on existing aids to navigation has been assessed in Section 8.12.
Structures and locations could limit the ability of vessels to maneuver in order to avoid collisions?	Yes	Collision risk including the available sea room for safe re-routing has been assessed in Section 11.3.3.
10. Communications, Radar and positioning systems. Does the NSRA provide researched opinion of a generic and, where appropriate, site specific nature concerning whether or not:		
Structures could produce interference such as shadowing, reflections or phase changes, with marine positioning, navigation, or communications, including AIS, whether shipborne ashore, or fitted to any of the proposed structures?	Yes	Impacts relating to VHF (Section 8.1 and 8.2), AIS (Section 8.4), NAVTEX (Section 8.5), GPS (Section 8.6) and Loran-C (Section 8.7) have been assessed.

Issue	Yes/ No	Comments
Structures could produce Radar reflections, blind spots, shadow areas or other adverse effects in the following interrelationships: ▪ Vessel to vessel; ▪ Vessel to shore; ▪ VTS Radar to vessel; ▪ Racon to/from vessel; and ▪ Aircraft and Air Traffic Control.	Yes	Impacts on marine Radar are assessed in Section 8.9.
Structures, in general, would comply with current recommendations concerning electromagnetic interference?	Yes	Impacts relating to electromagnetic interference have been assessed in Section 8.8.
Structures might produce acoustic noise or noise absorption or reflections which could mask or interfere with prescribed sound signals from other vessels or aids to navigation?	Yes	Impacts that may arise from the offshore wind infrastructure relating to noise have been assessed in Section 8.11.
Structures, generators, and the seabed cabling within the site and onshore might produce electromagnetic fields affecting compasses and other navigation systems?	Yes	Impacts relating to electromagnetic interference have been assessed in Section 8.8.
The power and noise generated by structures above or below the water would create physical risks that would affect the health of vessel crews?	Yes	Impacts that may arise from the offshore wind infrastructure relating to noise have been assessed in Section 8.11.
11. Risk of collision, allision, or grounding. Does the NSRA, based on the data collected per Paragraph 2 above, provide an evaluation that was conducted to determine the risk of collision between vessels, risk of allisions with structures, or grounding because of the establishment of a structure, including, but not limited to:		
▪ Likely frequency of collision (vessel to vessel); ▪ Likely consequences of collision (“What if” analysis); ▪ Likely location of collision; ▪ Likely type of collision; ▪ Likely vessel type involved in collision; ▪ Likely frequency of allision (vessel to structure); ▪ Likely consequences of allision (“What if” analysis); ▪ Likely location of allision; ▪ Likely vessel type involved in allision; ▪ Likely frequency of grounding; ▪ Likely consequences of grounding (“What if” analysis); ▪ Likely location of grounding; and ▪ Likely vessel type involved in grounding?	Yes	Collision risk has been assessed on a quantitative basis within Section 11.3.3, with associated impact assessment then undertaken for key vessel types in Sections 15 through 17. Allision risk has been assessed on a quantitative basis within Section 11.3.4 and 11.3.5, with associated impact assessment then undertaken for key vessel types in Sections 15 through 17. Grounding risk is considered in Section 11.3.6.

Issue	Yes/ No	Comments
12. Emergency response considerations. In order to determine the impact on Coast Guard and other emergency responder missions, has the developer conducted assessments on the SAR and the Marine Environmental Protection emergency response missions?		
For SAR, the Coast Guard will assist in gathering and providing the following information: ▪ The number of SAR cases the USCG has conducted in the proposed structure region over the last 10 years. ▪ The number of cases involving helicopter hoists. ▪ The number of cases performed at night or in poor visibility/low ceiling. ▪ The number of cases involving aircraft (helicopter, fixed-wing) searches. ▪ The number of cases performed by commercial salvors (for example, BOAT US, SEATOW, commercial tugs) responding to assist vessels in the proposed structure region over the last 10 years. ▪ Has the developer provided an estimate of the number of additional SAR cases projected due to allisions with the structures? ▪ Will the structure enhance SAR such as by providing a place of refuge or easily identifiable markings to direct SAR units?	Yes	SAR data provided by the USCG has been assessed in Section 9.1. Effects of the Project on emergency response are assessed in Section 19. This includes likely effects on incident rates, and the potential for the wind farm structures to provide places of refuge. As per Section 7, all wind farm structures will be marked with clearly visible alphanumeric identifiers.
For marine environmental protection/response: ▪ How many marine environmental/pollution response cases has the USCG conducted in the proposed structure region over the last 10 years? ▪ What type of pollution cases were they? ▪ What type and how many assets responded? ▪ How many additional pollution cases are projected due to allisions with the structures?	Yes	SAR and pollution data provided by the USCG has been assessed in Section 9.1.
13. Facility characteristics. In addition to addressing the risk factors detailed above, does the developer's NSRA include a description of the following characteristics related to the proposed structure:		
Marine navigation marking?	Yes	Proposed lighting and marking for the purposes of marine navigation has been outlined in Section 7.
How the overall site would be marked by day and by night, taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances?	Yes	Proposed lighting and marking for the purposes of marine navigation has been outlined in Section 7. This includes consideration for both day and night conditions.

Issue	Yes/ No	Comments
How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night?	Yes	Proposed lighting and marking for the purposes of marine navigation has been outlined in Section 7. This includes consideration for both day and night conditions.
If the site would be marked by one or more Racons or, an AIS transceiver, or both and if so, the AIS data it would transmit?	Yes	As per Section 7, the use of AIS will be considered in consultation with the USCG. Any structures from which AIS will be transmitted (and the information transmitted) will be confirmed following finalization of the layout post acceptance of the COP.
If the site would be fitted with a sound signal, the characteristics of the sound signal, and where the signal or signals would be sited?	Yes	Sound signals will be utilized as appropriate as per Section 7, noting that the structures on which sound signals will be deployed will be confirmed following finalization of the layout post acceptance of the COP.
If the structure(s) are to be fitted with aviation marks, how would they be screened from mariners or potential confusion with other navigational marks and lights be resolved?	Yes	Proposed aviation lighting including screening from mariners has been outlined in Section 7.
Whether the proposed site and/or its individual generators would comply in general with markings for such structures, as required by the Coast Guard?	Yes	Proposed lighting and marking is in line with the relevant guidance provided by the USCG, IALA and BOEM as noted in Section 7.
Whether its plans to maintain its aids to navigation are such that the Coast Guard's availability standards are met at all times. Separate detailed guidance to meet any unique characteristics of a particular structure proposal should be addressed by the respective District Waterways Management Branch?	Yes	Proposed lighting and marking is in line with guidance provided by the USCG, IALA and BOEM (Section 7) and the availability of aids to navigation has been outlined.
The procedures that need to be put in place to respond to and correct discrepancies to the aids to navigation, within the timeframes specified by the Coast Guard?	Yes	Proposed action should any aid to navigation experience a discrepancy has been outlined in Section 7.
How the marking of the structure will impact existing Federal aids to navigation in the vicinity of the structure?	Yes	The impact on existing aids to navigation has been assessed in Section 8.12.

Issue	Yes/ No	Comments
14. Design requirements. Is the structure designed and constructed to satisfy the following recommended design requirements for emergency shutdown in the event of a search and rescue, pollution response, or salvage operation in or around a structure?		
All above surface structure individual structures should be marked with clearly visible unique identification characters (for example, alpha-numeric labels such as 'A1', 'B2'). The identification characters should each be illuminated by a low-intensity light visible from a vessel, or be coated with a phosphorescent material, thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting or phosphorescence should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, and at a distance of at least 150 yards from the structure. It is recommended that, if lighted, the lighting for this purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation aids. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers).	Yes	Proposed marking in terms of unique alphanumeric marking has been outlined in Section 7, noting that the label system has been predetermined by USCG.
All generators and transmission systems should be equipped with control mechanisms that can be operated from an operations center of the installation.	Yes	Wind turbine shut down procedures have been outlined in Section 4.2.2. Further details will be outlined within the SMS.
Throughout the design process, appropriate assessments and methods for safe shutdown should be established and agreed to through consultation with the Coast Guard and other emergency support services.	Yes	Wind turbine shut down procedures have been outlined in Section 4.2.2. Further details will be outlined within the SMS.
The control mechanisms should allow the operations center personnel to fix and maintain the position of the wind turbine blades, nacelles and other appropriate moving parts as determined by the applicable Coast Guard command center. Enclosed spaces such as nacelle hatches in which personnel are working should be capable of being opened from the outside. This would allow rescuers (for example, helicopter winch-man) to gain access if occupants are unable to assist or when sea-borne approach is not possible.	Yes	Remote positioning of the nacelle and the blades will be possible. Further wind turbine shut down procedures have been outlined in Section 4.2.2, and full details will be outlined within the SMS. The nacelle exterior hatch will be capable of being opened from the exterior roof.

Issue	Yes/ No	Comments
Access ladders, although designed for entry by trained personnel using specialized equipment and procedures for maintenance in calm weather, could conceivably be used in an emergency situation to provide refuge on the structure for distressed mariners. This scenario should therefore be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions.	Yes	Emergency access requirements will be discussed and agreed with USCG.
15. Operational requirements. Will the operations be continuously monitored by the facility's owners or operators, ostensibly in an operations center? Does the NSRA identify recommended minimum requirements for an operations center such as:		
The operations center should be manned 24 hours a day?	Yes	Operations center will be manned 24 hours a day.
The operations center personnel should have a chart indicating the GPS position and unique identification numbers of each of the structures?	Yes	The operations center personnel will have a chart indicating the GPS position and unique identification numbers of each of the structures.
All applicable Coast Guard command centers (District and Sector) will be advised of the contact telephone number of the operations center?	Yes	All applicable Coast Guard command centers (District and Sector) will be advised of the contact telephone number of the operations center.
All applicable Coast Guard command centers will have a chart indicating the position and unique identification number of each of the structures?	Yes	As per Section 22, structure positions will be provided to NOAA for display on relevant nautical charts.
16. Operational procedures. Does the NSRA provide for the following operational procedures?		
Upon receiving a distress call or other emergency alert from a vessel that is concerned about a possible allision with a structure or is already close to or within the installation, the Coast Guard Search and Rescue Mission Coordinator (SMC) will establish the position of the vessel and identification numbers of any structures visible to the vessel. The position of the vessel and identification numbers of the structures will be passed immediately to the operations center by the SMC.	N/A	Noted.
The operations center should immediately initiate the shut-down procedure for those structures as requested by the SMC, and maintain the structure in the appropriate shut-down position, again as requested by the SMC, until receiving notification from the SMC that it is safe to restart the structure.	Yes	This will be in built into procedures to be followed as part of emergency operation plans. Additional details of wind turbine shut down procedures have been outlined in Section 4.2.2. Further details will be outlined within the SMS.

Issue	Yes/ No	Comments
Communication and shutdown procedures should be tested satisfactorily at least twice each year.	Yes	Communication and shutdown procedures can be tested at least twice each year. Further discussion will be required with regards to requirements of any testing i.e., which specific elements require testing and which parts of the field need testing.
After an allision, the applicant should submit documentation that verifies the structural integrity of the structure.	Yes	Per NVIC 01-19 (16d), after an allision Empire will advise the USCG if a structure is deemed a hazard to navigation.

Attachment B Consequences

This attachment presents an assessment of the consequences of collision and allision incidents, in terms of risk to people and the environment, due to the impact of the wind farm structures.

B.1 Risk Evaluation Criteria

B.1.1 Risk to People

With regard to the assessment of risk to people two measures are considered, namely:

- Individual risk; and
- Societal risk.

B.1.2 Individual Risk (per year)

This measure considers whether the risk from an accident to a particular individual changes significantly due to the presence of the wind farm structures. Individual risk considers not only the frequency of the accident and the consequences (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 accident.

The purpose of estimating the individual risk is to ensure that individuals who may be affected by the presence of the wind farm structures are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of the wind farm structures relative to the background individual risks.

Annual individual risk levels to crew (the annual risk to an average crew member) for different vessel types are presented in Figure B.1, which also includes the upper and lower bounds for risk acceptance criteria as suggested in IMO Maritime Safety Committee 72/16 (IMO, 2000). The annual individual risk to crew falls within the ALARP region for each of the vessel types presented.

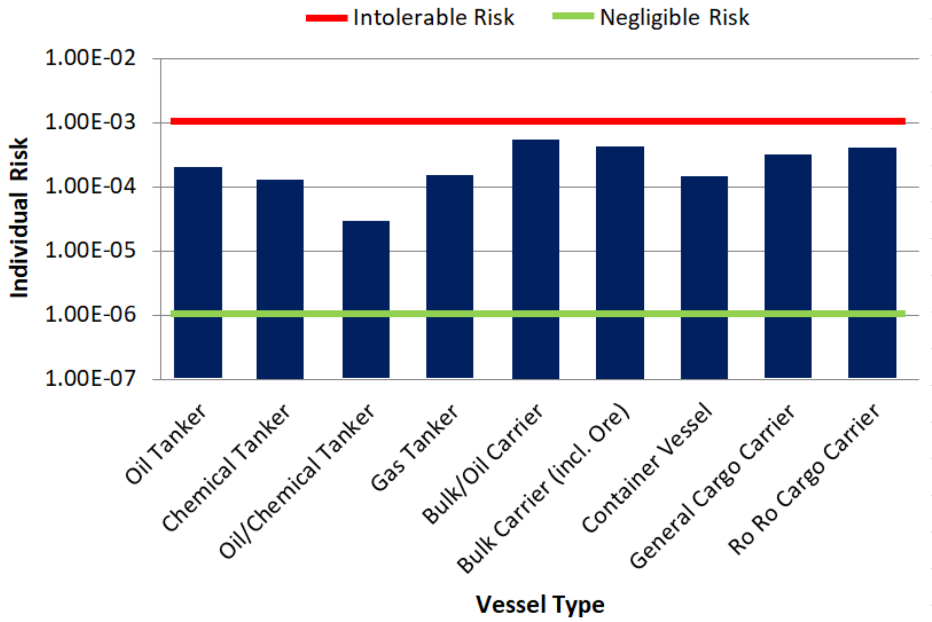

Figure B.1 Individual risk levels and acceptance criteria per vessel type (IMO, 2000)

Typical bounds defining the ALARP regions for RBDM within shipping are presented in Table B.1.

Table B.1 Individual risk ALARP criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
Crew members	10^{-6}	10^{-3}
Passenger	10^{-6}	10^{-4}
Third party	10^{-6}	10^{-4}
New vessel target	10^{-6}	Above values reduced by one order of magnitude

B.1.3 Societal Risk

Societal risk is used to estimate the risk of an accident affecting many persons, e.g., catastrophes, and acknowledging risk averse or neutral attitudes. Societal risk includes the risk to every person, even if a person is only exposed on one brief occasion to that risk. 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.

Within this assessment societal risk (navigational based) can be assessed for the Project, giving account to the change in risk associated with each accident 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
- FN-diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident.

B.1.4 Risk to the Environment

For risk to the environment the key criteria considered in terms of the effect of the Project is the potential amount of oil spilled from the vessel involved in an accident.

It is recognized that there will be other potential pollutions, e.g., hazardous containerized 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 the Project.

B.2 Fatality Risk

This section uses incident data along with information on average manning levels per vessel type to estimate the probability of fatality in a marine incident associated with the Project.

The development is assessed to have the potential to affect the following incidents:

- Vessel to vessel collision;
- Powered vessel to structure allision; and
- Drifting vessel to structure allision.

B.2.1 Incident Data

UK flagged commercial vessels are required to report accidents to the MAIB. Non-UK flagged vessels do not have to report unless they are at a UK port or within 12 nm (22 km) territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to MAIB; however, a significant proportion of these incidents are reported to and investigated by the MAIB. The MCA, harbor authorities and inland waterway authorities also have a duty to report accidents to the MAIB. Therefore, while there may be a degree of underreporting of accidents with minor consequences, those resulting in more serious consequences, such as fatalities, are likely to be reported.

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/harbors and rivers/canals have been excluded since the causes and consequences may differ from an accident occurring offshore, which is the location of most relevance to the Project.

Taking into account these criteria, approximately 12,093 accidents, injuries and hazardous incidents were reported to the MAIB between 2000 and 2019 involving approximately 13,965 vessels (some incidents such as collisions involved more than one vessel).

A plot of the locations of incidents reported in proximity to the UK is presented in Figure B.2, color-coded by incident type[12]. This appendix uses this data, and in particular the data for collision and allision incidents to determine the fatality probability for different vessel categories.

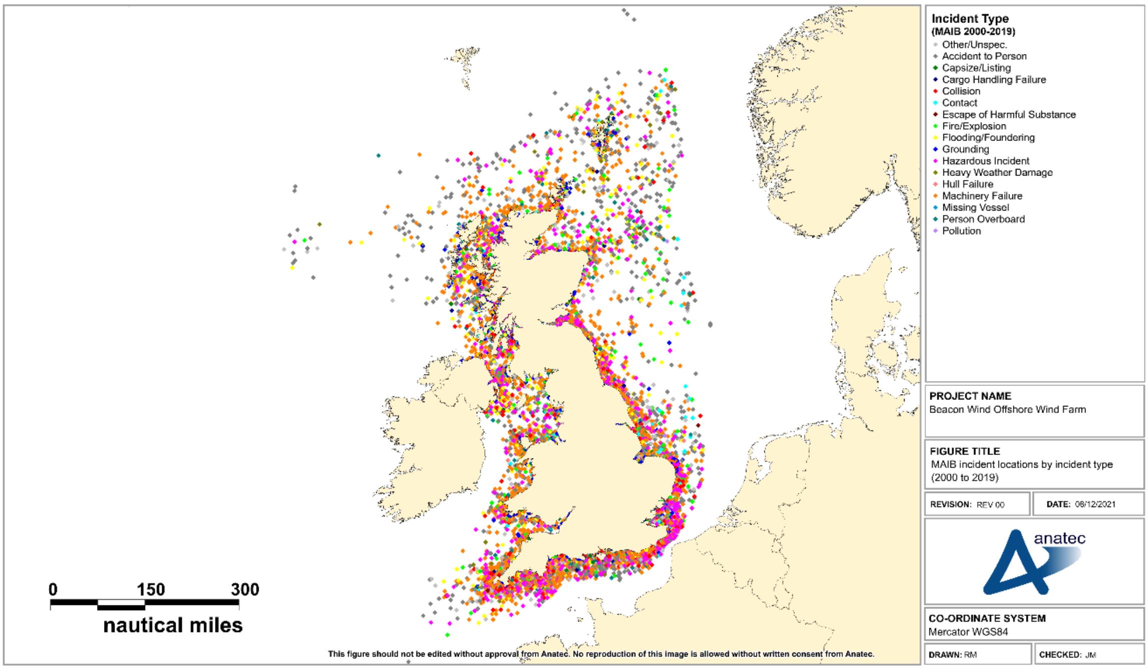

Figure B.2 MAIB incident locations by incident type (2000 to 2019)

B.2.2 Fatality Probability

Using collision and allision incident data from the MAIB spanning a 20-year period, the number of fatalities, number of people involved in incidents and thus the fatality probabilities have been computed. Given that the fatality probability associated with smaller craft is higher this analysis has been divided into three categories of vessel, as shown in Table B.2.

Table B.2 MAIB fatality probability per collision per vessel category[13]

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	1	16,256	6.2×10^{-5}

[12] The MAIB aim for 97% accuracy in reporting the location of incidents.

[13] Note this data has been used for the purpose of calibrating Anatec's collision and allision risk models. The data is UK based, however is considered as being representative of worldwide incident rates, and therefore fit for the purposes of model calibrations within this NSRA.

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Fishing	Trawler, potter, dredger, etc.	2	880	2.3×10^{-3}
Pleasure craft	Yacht, small commercial motor vessel, etc.	3	713	4.2×10^{-3}

It can be seen that the risk is notably higher for people onboard small craft compared to larger commercial vessels.

B.2.3 Fatality Risk due to the Project

The base and future-case annual collision and allision frequency levels without and with the development are summarized in Table B.3. Background into the methodology by which these values were calculated is provided in Section 11.

Table B.3 Summary of annual collision and allision frequency results

Table Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
Vessel to vessel collision	Base case	3.82×10^{-4} (2,620 years)	5.03×10^{-4} (1,986 years)	1.22×10^{-4}
	Future case (10 percent)	4.62×10^{-4} (2,165 years)	6.09×10^{-4} (1,642 years)	1.47×10^{-4}
	Future case (20 percent)	5.50×10^{-4} (1,819 years)	7.25×10^{-4} (1,379 years)	1.75×10^{-4}
Powered vessel to structure allision	Base case	N/A	2.45×10^{-9} (Negligible)	2.45×10^{-9}
	Future case (10 percent)	N/A	2.70×10^{-9} (Negligible)	2.70×10^{-9}
	Future case (20 percent)	N/A	2.94×10^{-9} (Negligible)	2.94×10^{-9}
Drifting vessel to structure allision	Base case	N/A	7.22×10^{-5} (13,859 years)	7.22×10^{-5}
	Future case (10 percent)	N/A	7.94×10^{-5} (12,599 years)	7.94×10^{-5}
	Future case (20 percent)	N/A	8.66×10^{-5} (11,549 years)	8.66×10^{-5}
Fishing vessel to structure allision	Base case	N/A	1.15×10^{-1} (8.7 years)	1.15×10^{-1}
	Future case (10 percent)	N/A	1.23×10^{-1} (8.1 years)	1.23×10^{-1}

Table Risk	Scenario	Annual Frequency (Return Period)		
		Pre Wind Farm	Post Wind Farm	Change
	Future case (20 percent)	N/A	1.31×10^{-1} (7.7 years)	1.31×10^{-1}
Total	**Base case**	**3.82×10^{-4} (2,620 years)**	**1.16×10^{-1} (8.6 years)**	**1.16×10^{-1}**
	Future case (10 percent)	**4.62×10^{-4} (2,165 years)**	**1.24×10^{-1} (8.1 years)**	**1.23×10^{-1}**
	Future case (20 percent)	**5.50×10^{-4} (1,819 years)**	**1.31×10^{-1} (7.6 years)**	**1.31×10^{-1}**

Table B.4 presents the estimated average number of people on board (POB) for the local vessels operating in the region. The POB for passenger vessels is based on the combined crew and passenger capacities of passenger vessels identified within the vessel traffic data, given that this information is readily available for the majority of passenger vessels. POB information for specific cases of the other vessel types is not as readily available, and as such these have been estimated on a conservative basis.

Table B.4 Vessel types, incidents and average number of POB

Vessel Type	Collision/Allision Incidents	Average Number of POB
Cargo vessel	▪ Vessel to vessel collision; ▪ Powered vessel to structure allision; and ▪ Drifting vessel to structure allision.	15
Tanker		22
Passenger vessel		3,864
Fishing vessel		3
Recreational vessel	▪ Vessel to vessel collision	3

From the detailed results of the collision and allision frequency modelling, the distribution of the predicted change in annual collision and allision frequency by vessel type due to the Project for the base case (0% increase in traffic), future case (10% increase in traffic), and future case (20% increase in traffic) are presented in Figure B.3.

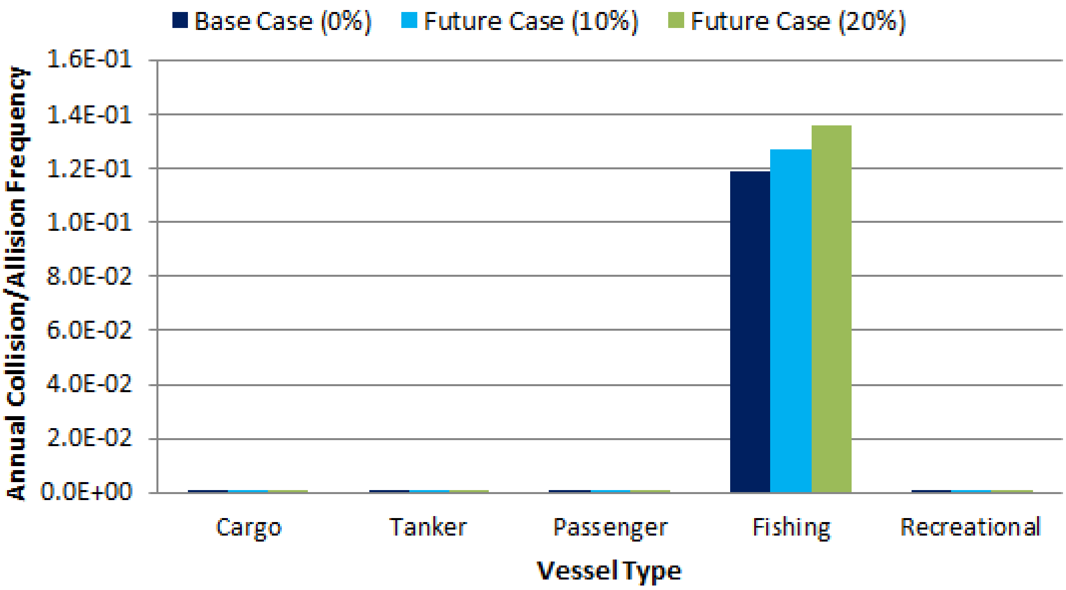

Figure B.3 Change in annual collision and allision frequency by vessel type

The majority of change in allision and collision risk is associated fishing vessels owing to the volume of this vessel type in the area and the associated allision risk.

Combining the annual collision and allision frequency (Table B.3), estimated POB each vessel type (Table B.4) and the estimated fatality probability for each vessel category (Table B.2), the annual increase in PLL due to the impact of the Project for the base case is approximately 8.26×10^{-4}, which equates to one additional fatality in approximately 1,200 years. The annual increase in PLL due to the impact of the development for the future case (10% increase in traffic) is estimated to be approximately 8.88×10^{-4}, which equates to one additional fatality in approximately 1,100 years. The annual increase in PLL due to the impact of the development for the future case (20% increase in traffic) is estimated to be 9.52×10^{-4}, which equates to one additional fatality in approximately 1,000 years.

The estimated incremental changes in PLL due to the development, distributed by vessel type for the base and future cases, are presented in Figure B.4.

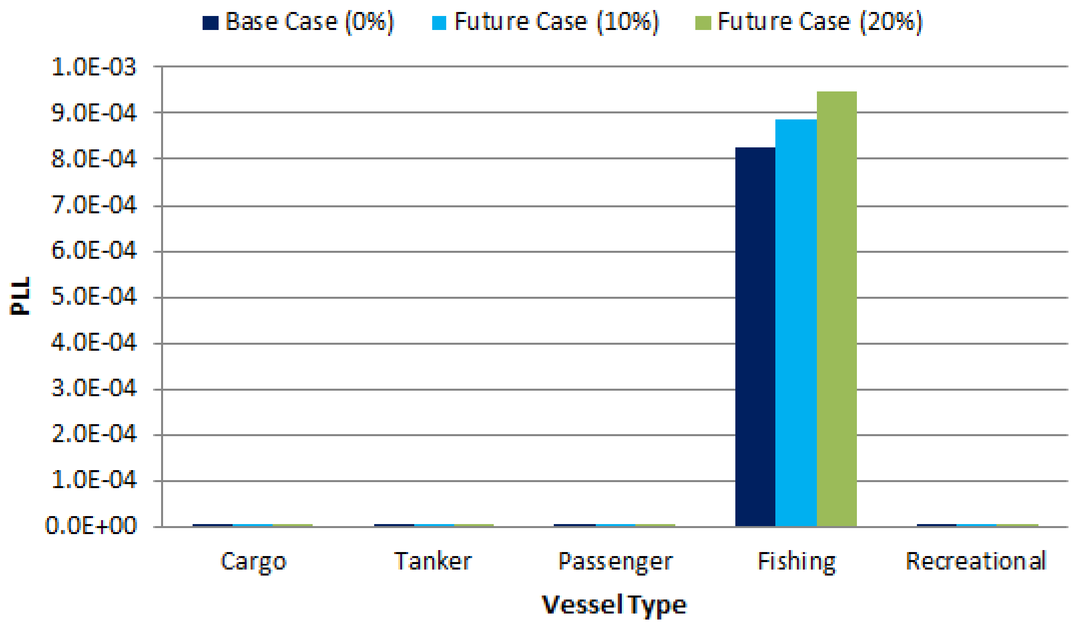

Figure B.4 Estimated change in annual PLL by vessel type

The majority of increase in PLL was observed to be associated with fishing vessels, largely as a result of the associated allision risk.

Converting the PLL to individual risk per annum (IRPA) based upon the average number of people exposed by vessel type per year, the results are presented in Figure B.5. This calculation assumes that the risk is shared between 10 vessels of each type, which is considered to be conservative based upon the number of different vessels operating in the vicinity of the Lease Area.

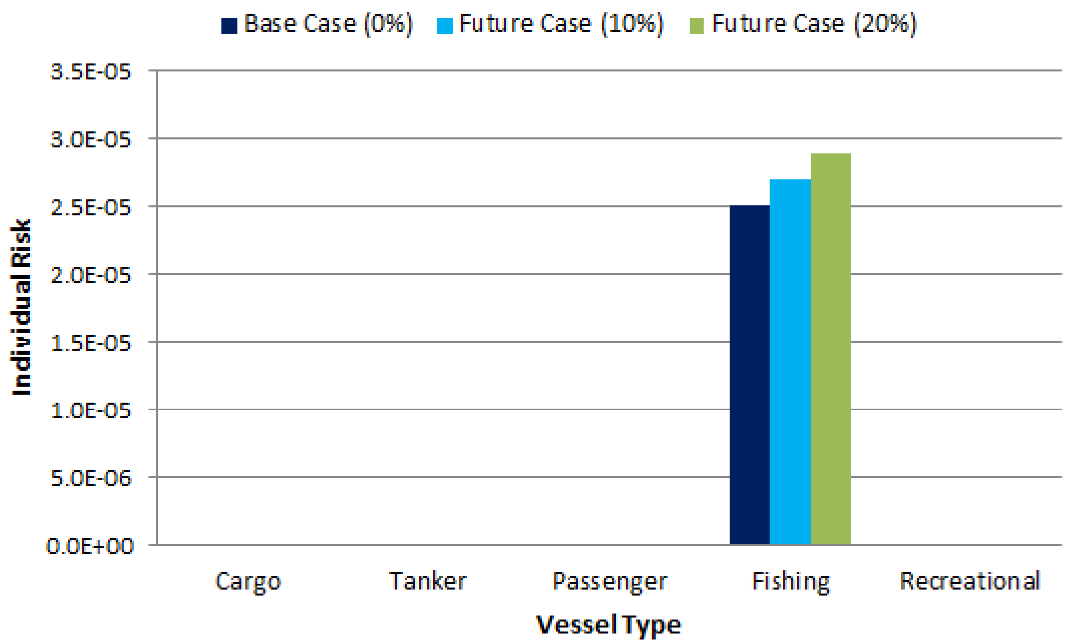

Figure B.5 Estimated change in individual risk by vessel type

IRPA was observed to be greatest to fishing vessels owing to the high volume of this vessel type and higher probability of fatality per incident compared to other vessel types. IRPA for passenger vessels is lowest owing to the high average number of POB, therefore distributing the risk among many more individuals.

B.2.4 Significance of Increase in Fatality Risk

The overall increase in PLL and individual risk post offshore wind project is summarized in Table B.5. PLL refers to the potential increase in lives lost per year as a result of the Project, and individual risk refers to the probability of fatality to an individual. The changes in frequency are presented for the base case, 10% future case and 20% future case scenarios.

Table B.5 Summary of fatality risk for future cases

Fatality Risk	Change in Frequency		
	Base Case	10% Increase	20% Increase
PLL	8.26×10^{-4} (0.000826)	8.88×10^{-4} (0.000888)	9.52×10^{-4} (0.000952)
IRPA	2.51×10^{-5} (0.0000251)	2.70×10^{-5} (0.0000270)	2.89×10^{-5} (0.0000289)

The frequency changes outlined in Figure B.5 indicate that IRPA is low.

B.3 Pollution Risk

B.3.1 Historical Analysis

The pollution consequences of a collision in terms of oil spill depend upon the following:

- Spill probability (i.e., likelihood of outflow following an accident); and
- Spill size (amount of oil).

Two types of oil spill are considered in this assessment:

- Fuel oil spills from bunkers (all vessel types); and
- Cargo oil spills (laden tankers).

The research undertaken as part of the Department for Transport's Marine Environmental High Risk Areas project (Department for Transport, 2001) has been used as it was comprehensive and based upon worldwide marine spill data analysis.

From this research, the overall probability of a spill per accident was calculated based upon historical accident data for each accident type as presented in Figure B.6.

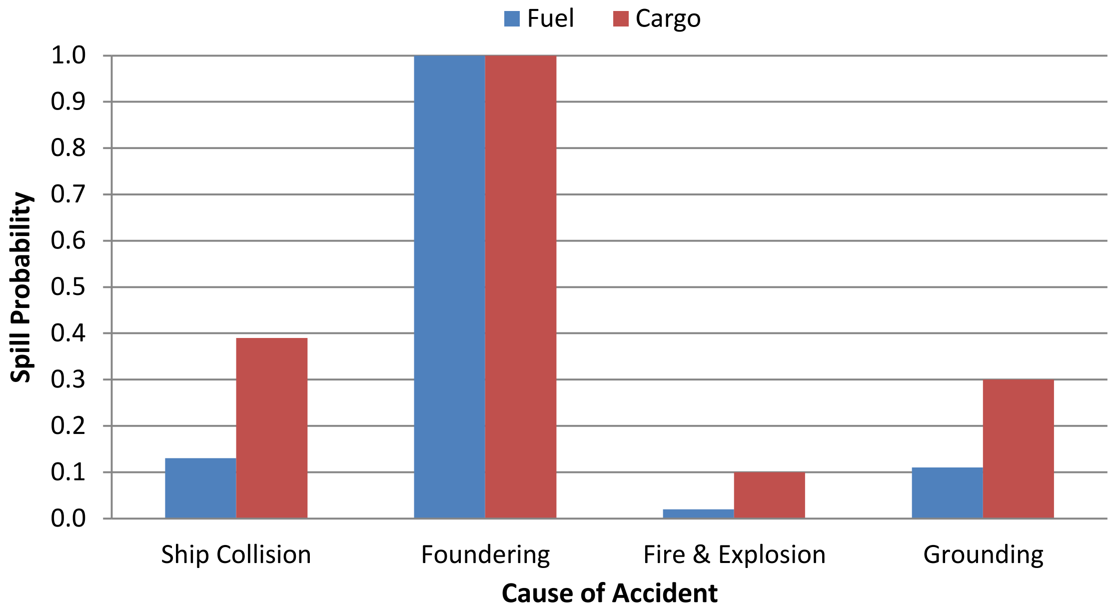

Figure B.6 Probability of an oil spill resulting from an accident

Based on this data, 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.

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 of below 50% of the bunker capacity, and in most incidents much lower. For the types and sizes of vessels exposed to the Project, an average spill size of 100 tons (30,467 gallons) of fuel oil is considered to be a conservative assumption.

For cargo spills from laden tankers, the spill size can vary significantly. The International Tanker Owners Pollution Federation report the following spill size distribution for tanker collisions between 1974 and 2004:

- 31% of spills below seven tons (2,100 gallons);
- 52% of spills between seven and 700 tons (2,100 and 213,000 gallons); and
- 17% of spills greater than 700 tons (213,000 gallons).

For fishing vessel collisions, comprehensive statistical analysis is not available. Consequently, it is conservatively assumed that 50% of all collisions involving fishing vessels will lead to an oil spill with the quantity spilled being on average five tons (1,500 gallons). Similarly, for recreational vessels, due to a lack of data 50% of collisions are assumed to lead to a spill with an average size of one ton (300 gallons).

B.3.2 Pollution Risk due to the Project

Applying the probabilities from Section B.3.1 to the annual collision and allision frequency by vessel type presented in Figure B.3 and the average spill size per vessel, the amount of oil spilled per year due to the impact of the Project is estimated to be approximately 93 gallons per year for the base case, approximately 102 gallons per year for the future case (10% increase in traffic), and approximately 109 gallons per year for the future case (20% increase in traffic).

The estimated increase in gallons of oil spilled distributed by vessel type for the base case, future case (10% increase in traffic), and future case (20% increase in traffic) are presented in Figure B.7.

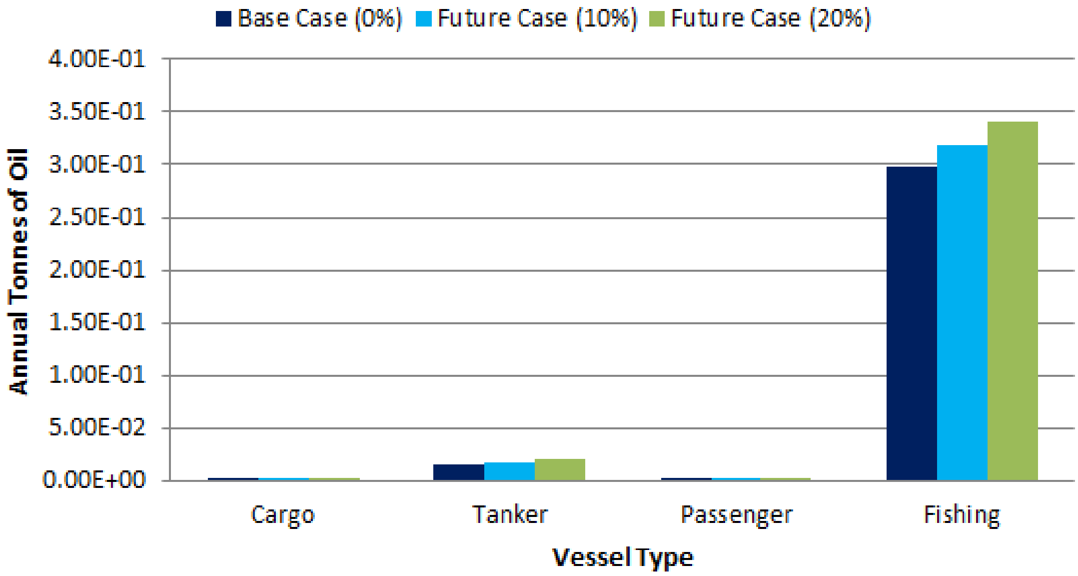

Figure B.7 Estimated change in pollution by vessel type

The majority of increase in oil spilled was observed to be associated with fishing vessels, owing to the volume of this type of vessel in the area. Tankers contributed the most risk after fishing vessels, owing to the higher volume of oil spilled in incidents involving this vessel type relative to other types.

B.3.3 Significance of Increase in Pollution Risk

Based upon data available from the BTS (BTS, 2019), the annual average volume of petroleum oil spilled from all vessels impacting navigable U.S. waterways between 1995 and 2018 was approximately 600,000 gallons. During this period, the annual average number of oil spill incidents from all vessels impacting navigable U.S. waterways was 2,790.

The overall change in pollution estimated due to the Project (approximately 93 gallons per year for the base case) represents a negligible increase (< 0.02%) in the total annual average gallons of oil spilled which impact navigable U.S. waterways. This indicates that the increase in pollution risk resulting from the Project is low.

Photo credit: Matt Goldsmith, Equinor