The latest revision date of Appendix DD to the Empire Offshore Wind COP is March 2023. This appendix was not revised as part of the November 2023 submittal; therefore, the date on the Appendix DD cover sheet remains as March 2023.

Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2)
Construction and Operations Plan

APPENDIX DD

Navigation Safety Risk Assessment

Prepared for
equinor

TETRA TECH

MARCH 2023

Empire Offshore Wind: Empire Wind Project (EW 1 and EW 2)

Navigation Safety Risk Assessment

Prepared by	Anatec Limited
Presented to	Tetra Tech, Inc. and Empire Offshore Wind LLC
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Revision Number	Date	Summary of Change
00	January 21, 2019	Initial Draft
01	March 20, 2019	Updates following first internal review
02	May 01, 2019	Updates following USCG consultation
03	August 05, 2019	Further USCG comments
04	October 25, 2019	Updated following consultee comments
05	December 20, 2019	Final for Review
06	April 13, 2020	Update following BOEM/USCG Comments
07	June 12, 2020	Updates following BOEM/USCG Comments
08	August 05, 2020	Updated export cable route
09	August 13, 2020	Additional updates addressing consultation
10	September 16, 2020	Final for Review
11	April 9, 2021	Updates following BOEM/USCG Comments
12	September 29, 2021	Refined PDE
13	March 4, 2022	Refined PDE
14	May 6, 2022	Updated export cable route
15	May 17, 2022	Additional internal updates
16	January 9, 2023	Added Appendix I

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Abbreviations Table

Abbreviation	Definition
ACPARS	Atlantic Coast Port Access Route Study
AIS	Automatic Identification System
ALARP	As Low As Reasonably Practicable
ARPA	Automatic Radar Plotting Aid
ATB	Articulated Tug Barge
AtoN	Aid to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BEIS	Department of Business, Energy, and Industrial Strategy
BOEM	Bureau of Ocean Energy Management
BTS	Bureau of Transportation Statistics
BWEA	British Wind Energy Association
CFR	Code of Federal Regulations
CHIRP	Confidential Reporting Program for Aviation and Maritime
COLREGs	International Regulations for Preventing Collisions at Sea
COMDTINST	Commandant Instruction
COTP	Captain of the Port
CTV	Crew Transfer Vessel
dB	Decibel
DfT	Department for Transport
DSC	Digital Selective Calling
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
Empire	Empire Wind Offshore LLC
ERP	Emergency Response Plan
FAA	Federal Aviation Administration
ft	Feet
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HP	Horsepower

Abbreviation	Definition
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IOGP	International Association of Oil and Gas
IPS	Intermediate Peripheral Structure
IRPA	Individual Risk per Annum
ITAP	Institut für technische und angewandte Physik
ITOPF	International Tanker Owners Pollution Federation
kHz	Kilo Hertz
kn	Knots
m	Meter (1 meter = 3.28 feet)
MA	Massachusetts
MAIB	Marine Accident Investigation Branch
MCA	Maritime and Coastguard Agency
MD	Maryland
MEHRA	Marine Environmental High-Risk Area
MGN	Marine Guidance Note
MHHW	Mean Higher High Water
MISLE	Marine Information for Safety and Law Enforcement
MLLW	Mean Lower Low Water
MMC	Multipurpose Marine Cadastre
MSC	Maritime Safety Committee
MW	Mega Watt
N	North
NAVTEX	Navigational Telex
NJ	New Jersey
nm	Nautical Mile (1 nautical mile = 6,076 feet)
NNYBPARS	Northern New York Bight Port Access Route Study
NOAA	National Oceanic and Atmospheric Administration
NSRA	Navigation Safety Risk Assessment

Abbreviation	Definition
NUC	Not Under Command
NVIC	Navigation and Vessel Inspection Circular
NY	New York
OCS	Outer Continental Shelf
ODAS	Ocean Data Acquisition Systems
OPAREA	Operating Area
OREI	Offshore Renewable Energy Installation
PA	Pennsylvania
PDE	Project Design Envelope
PANYNJ	Port Authority of New York and New Jersey
PLA	Port of London Authority
PLL	Potential Loss of Life
POB	People on Board
RAM	Restricted in Ability to Maneuver
RBDM	Risk Based Decision Making
REZ	Renewable Energy Zone
RI	Rhode Island
RUK	Renewables UK
SAR	Search and Rescue
SMA	Seasonal Management Area
SMS	Safety Management System
SOLAS	Safety of Life at Sea
SOV	Service Operations Vessel
SPS	Significant Peripheral Structure
SWH	Significant Wave Height
TCE	The Crown Estate
TSS	Traffic Separation Scheme
UK	United Kingdom
UKHO	United Kingdom Hydrographic Office
USCG	United States Coast Guard

Abbreviation	Definition
UTM	Universal Transverse Mercator
VA	Virginia
VHF	Very High Frequency
VMRS	Vessel Movement Reporting System
VTS	Vessel Traffic Service
WEAs	Wind Energy Areas
WFDA	Wind Farm Development Area
WG	Working Group
WGS84	World Geodetic System 1984
yd	Yard

Glossary

Term	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.
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 risk modelling software, recommended as best practice by the International Association of Oil & Gas Producers (IOGP).
Commercial Fishing Vessels	Fishing vessels engaged in commercial fishing activity, where that activity forms the primary commercial means of those vessels.
Project Design Envelope	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 Environmental Impact Statement (EIS) inadequate.
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 1 nm within the same minute.

Term	Definition
Environmental Impact Statement (EIS)	A publicly available document that provides information on a project, including its environmental impacts and mitigation measures, and is used to inform development consent decisions.
Export Cable Study Area	A 2 nm area applied around the Export Cable Corridor in order to ensure that focus is placed upon the vessel traffic relevant to the 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	Internationally recognized shipping routes established by the International Maritime Organization (IMO).
Layout Rules	A set of rules in relation to layout parameters that have been voluntarily defined in order that generation capacity optimization can be balanced against risk.
Main Routes	Defined transit routes (mean position) of commercial vessels identified within the region.
Marine Guidance Note (MGN)	A system of guidance notes issued by the UK Maritime and Coastguard Agency (MCA) 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.
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).
Navigational Safety Risk Assessment (NSRA)	A document which assesses the overall impact to shipping and navigation of a proposed Offshore Renewable Energy Installation (OREI) based upon formal risk assessment (also known as Navigational Risk Assessment, NRA).
Not Under Command (NUC)	Under Part A of the International Regulations for Preventing Collisions at Sea (COLREGs), 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 (US) that creates electricity by using sources other than oil or gas.
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 Fairway	Area within which no artificial island or fixed structures are permitted. Their use is not mandatory for vessels but is recommended. Traffic direction is dictated. They are regulated by 33 Code of Federal Regulations (CFR) § 166.

Term	Definition
Safety Zone	An area around facilities within 12 nautical miles (22.2 kilometers) which are being constructed maintained or operated. Safety zones may be established to prevent or control specific activities and access by vessels or persons, and include measures to protect the living resources of the sea from harmful agents. See also Section 14 item 1. Defined by USCG under 33 CFR Part 147.
Study Area	An area of 15 nautical mile (nm) (27.8 kilometers) radius 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 (COLREGs). Traffic direction is dictated. The TSS of relevance to the Project are regulated by 33 CFR § 167.1.
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

This Navigation Safety Risk Assessment (NSRA) contains an assessment of the impact of the major navigational hazards associated with the development of the Empire Offshore Wind LLC (Empire) Offshore Wind Farm (hereby referred to as 'the Project') within the Bureau of Ocean Energy Management's (BOEM) offshore lease area OCS-A 0512 (Lease Area). Aspects of the development relevant to shipping and navigation have been described and the maximum design scenario from a shipping and navigation perspective has been outlined. The key guidance considered throughout is the Navigation and Vessel Inspection Circular (NVIC) 01-19 (USCG, 2019).

To ensure the impact assessment is properly informed, a range of information has been gathered and processed and is presented within this NSRA. This includes waterway, maritime traffic, and vessel and facility characteristics, as well as key responses received during consultation with stakeholders. Lessons learned from trials and existing offshore wind farm developments have been considered, and collision and allision risk modelling has been undertaken in order to provide an assessment of the relevant impacts, on both a qualitative and (where appropriate) quantitative basis. Historical United States Coast Guard (USCG) incident response data has also been considered.

Vessel traffic data has been collected over a period of 12 months via satellite and coastal Automatic Identification System (AIS) data. This data has been used to establish the existing maritime traffic behavior and patterns within and surrounding the Lease Area.

The key features in terms of maritime traffic are considered to be the International Maritime Organization (IMO) adopted Traffic Separation Scheme (TSS) lanes. Based on the AIS data studied, no main vessel routes intersect the Lease Area, with the majority of vessel traffic instead utilizing the TSS lanes for access to/from New York, NY. Approximately one unique vessel per day was recorded within the Lease Area. However, the components of this traffic observed to be in transit (rather than engaged in a third-party activity, i.e. fishing) were not observed to be frequent enough to constitute a main route.

Using the information gathered, the assessment of shipping and navigation impacts (both for the Project in isolation, and the cumulative offshore wind farm developments in the region) was undertaken using Risk Based Decision Making (RBDM) and determined that all impacts were considered to be within (at most) tolerable limits when assessed to be As Low As Reasonably Practicable (ALARP) using a range of embedded mitigation.

Based on the proposed development, which includes a 1 nm (1.9 km) setback from wind farm structures to the edge of the TSS, impacts associated with commercial vessel allision under power, displacement of anchoring activity, anchor snagging, and restricted port access were assessed to be of **tolerable significance**, with all other impacts (deviations, encounters and collision risk) deemed to be **broadly acceptable**. Under the NSRA methodology, it has been ensured that the risks associated with the tolerable impacts are **As Low As Reasonably Practicable (ALARP), with additional mitigation** over that considered embedded added where necessary.

1 Introduction

1.1 Design Evolution

The design of the Project has been informed by consultation and assessment undertaken prior to the commencement of the overarching Navigation Safety Risk Assessment (NSRA) process. Details of this work and how it has influenced design decisions of relevance to the NSRA are included in Section 5.3. The As Low as Reasonably Practicable (ALARP) statement made within the NSRA is based upon assessment of a Maximum Design Scenario defined by those design decisions (see Section 4.6). Therefore, this work is considered as representing an important assessment for the purposes of setting the context of the NSRA process.

1.2 Guidance and Data Sources

This NSRA complies with the requirements set out in the Navigation and Vessel Inspection Circular (NVIC) 01-19 (USCG, 2019). A checklist is contained in Attachment B to show how each element of the NVIC has been covered, either directly within the NSRA, or a description of how / where the element is addressed if outside of the NSRA.

The NVIC (USCG, 2019) provides guidance on information and factors the USCG will consider when reviewing an application for a permit to build and operate an Offshore Renewable Energy Installation (OREI) in United States (U.S.) navigable waters.

1.2.1 Other US Guidance Documents – Summary

The other guidance documents considered during the NSRA are as follows:

- *Commandant Instruction (COMDTINST) 16003.2A* (USCG, 2016a):
  - Outlines topics which should be covered in the formal assessment for developments and provides the methodology by which traffic routing measures should be determined.
- *Atlantic Coast Port Access Route Study (ACPARS) Final Report* (USCG, 2016b):
  - The ACPARS Working Group (WG) was given three objectives to complete within the limits of available resources (see Section 1.2.2 for further details):
    1) Determine whether the USCG should initiate actions to modify or create safety fairways, TSS lanes, or other routing measures;
    2) Provide data, tools, and/or methodology to assist in future determinations of waterways suitability for proposed projects; and
    3) Develop, in the near term, AIS products and provide other support as necessary to assist USCG Districts (Districts) with all emerging coastal and offshore energy projects.
- *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.

- *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 NY Bight.

1.2.2 Further information on PARS

The USCG has acknowledged the risks to safe navigation posed by the increasing diversity of maritime uses in areas where vessel traffic is prevalent, and is committed to assisting with the identification of navigation and routing conflicts arising from offshore development.

As part of this effort, the USCG plans to investigate the development of a network of shipping safety fairways along the Atlantic coast. The definition used for a fairway (as per 33 CFR § 166.105) is as follows: "a lane or corridor in which no artificial island or fixed structure, whether temporary or permanent, will be permitted".

Prior to establishing or adjusting any such fairway, the USCG is required by the Ports and Waterways Safety Act (PWSA) to conduct a Port Access Route Study (PARS).

The ACPARS WG was initially established in 2011, and was tasked with identifying historical transit routes, by vessel class, focusing on transits occurring in the north-south/south-north direction along the Atlantic coast. The ACPARS report was completed in 2017 and included the identification of suitable navigation corridors and recommendations to develop fairway regulations, using the navigation corridors as a starting point.

The ACPARS study (USCG, 2016b) (Enclosure 2) included the Marine Planning Guidelines which were provided to assist offshore developers and marine planners with their evaluation of the navigational impacts of any projects with multiple permanent fixed structures. It notes that the 'guidelines are not regulatory' and that they do not impact the boundaries of any existing leases for site characterization and site assessment activities, but they do inform suitability of siting structures within a lease area. These guidelines were considered within the preliminary assessment undertaken and consulted with the USCG prior to the NSRA with regards to an appropriate and safe setback distance (see Section 5.3).

It is noted that the USCG has also 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 have been considered qualitatively within the cumulative assessment (see Section 10.5).

1.2.3 MGN 543 and SAR Annex

Given that the wind farm consent (permitting) process is now well established within the UK, it has been considered appropriate to consider the corresponding key guidance, namely Marine Guidance Note (MGN) 543[1] (Maritime and Coastguard Agency (MCA), 2016). It is noted that COMDTINST 16003.2A references MGN 371. However, this document was superseded by MGN 543 in 2016. MGN 543 has therefore been considered within this NSRA, rather than MGN 371.

Unlike its predecessor, MGN 543 no longer includes specific recommendation for siting in proximity to a TSS boundary or 5 nm (9.3 km) area around TSS terminus points. It is likely that the difference in guidance largely relates to a precautionary approach originally taken (pre any large offshore developments) within MGN 371. This was eventually eased (within MGN 543) due to the assessment of consented, planned and constructed developments, which showed vessels comfortably navigating as close as 1 nm (1.9 km) (closest point of approach) from offshore structures.

Of note is the MGN 543 SAR Annex (MCA, 2018), which provides details of MCA policy, guidance, advice and specific requirements (where seen as necessary) to assist and enable search and rescue (SAR), and other emergency response (e.g. counter pollution operations) to, within, and in the vicinity of OREI in UK waters. This includes MCA guidance on how wind farm structures should be lit and marked to facilitate SAR operations, and guidance around layout design.

1.2.4 Consultees and Stakeholders

A number of key marine and navigation stakeholders have been consulted during the NSRA process. Further details of shipping and navigation meetings are provided in Attachment E. A summary of engagement with agencies is available in Appendix B of the COP. In summary, these stakeholders include, but are not limited to, the following:

- New York Harbor Operations Committee Meeting including shipping, port and regulator representatives;
- New York Harbor Operations Steering Committee;
- Port Authority of New York and New Jersey (PANYNJ);
- USCG;
- New York Vessel Traffic Services (VTS [Part of USCG]);
- Commercial and recreational fisheries (see below);
- McAllister Towing of New York;
- Sandy Hook Pilots;
- Hudson River Safety, Navigation, and Operations Committee; and
- Regular operators.

[1] Latest MGN available at the time of the NSRA process.

Note: Some information relating to the consultation process has been redacted to protect third parties' personal details.

Regular operators of the area have been identified via marine traffic survey data, and have subsequently been sent details of the Project along with a request for a consultation response.

Equinor Wind also participates in the New York State Fisheries and Maritime Technical Working Groups which are comprised of commercial fisheries representatives, maritime stakeholders, and offshore wind energy developers who provide guidance and advice on how to responsibly implement New York State's efforts to advance offshore wind energy development. State and federal fisheries managers, regional shipping and navigation stakeholders, as well as USCG, U.S. Army Corps of Engineers, and other federal and state regulators and stakeholders are engaged in these groups to provide technical expertise and assist with coordination. Members come from a regional geography, with fishing community representatives from both New England and the Mid-Atlantic states.

A separate section of the COP, specific to impacts on commercial fisheries, is available in Section 8.8 (Commercial and Recreational Fishing). The NSRA only covers fishing vessels from a navigational perspective (e.g. in transit). This is due to the commercial issues related to vessels engaged in fishing. Noting that the mitigation-to-risk of vessels engaged in fishing could, for example, be displacement from the area which then has commercial consequence. As this cannot be effectively assessed within a risk assessment based primarily on navigation safety, it is therefore assessed separately within the COP.

1.3 Data Sources

This subsection summarizes the main data sources used to assess the existing environment in terms of waterway characteristics (Section 6) and baseline shipping activities (Section 7) relative to the Project. These are as follows:

- Vessel traffic data:
  - AIS data recorded via satellite receivers between August 2017 and July 2018;
  - AIS data recorded via coastal receivers between August 2017 and July 2018; and
  - Visual observation and AIS data recorded from the survey vessel *Ocean Researcher* during 2018.
- Fishing-specific data:
  - National Oceanic and Atmospheric Administration (NOAA) Vessel Monitoring System (VMS) data, 2015 to 2016 - Northeast Ocean Data Portal (NEODP, 2018).
- Maritime incident data:
  - USCG Marine Information for Safety and Law Enforcement (MISLE) database (2008 to 2017); and

    - Marine Accident Investigation Branch (MAIB) collision and allision incident data (1995 to 2014)[2].
- Navigational features:
    - NOAA Nautical Charts 12300, 12326, 12327, 12402, and 13003 (accessed February 2018);
    - United Kingdom Hydrographic Office (UKHO) Admiralty Charts 3204 and 2860;
    - United States Coast Pilot 2 – 47th Edition (NOAA, 2018);
    - UKHO Pilot NP68 (UKHO, 2016);
    - Multipurpose Marine Cadastre (MMC) US Navy Military Operating Area Boundaries: Atlantic/Gulf of Mexico (accessed June 2018); and
    - MMC US Navy Military Submarine Transit Lanes: Atlantic/Gulf of Mexico (accessed June 2018).
- Meteorological & Oceanographic (Metocean) data:
    - Equinor Wind (OCS-A 0512) Metocean Design Basis (Equinor Wind, 2018);
    - Wave height data collected from Ocean Data Acquisition Systems (ODAS) Buoy 44025 (NOAA, 2018); and
    - Tidal stream data taken from UKHO chart 3204.
- Use of Marine Radar:
    - *Report of the Effect on Radar Performance of the Proposed Cape Wind Project and Advance Copy of USCG Findings and Mitigation* (USCG, 2008; Cape Wind Associates, 2008).

1.4 Other Applicable Research Papers and Data Sources

Due to the early stage of offshore wind farm development in the US, the domestic lessons learned to date are limited. Therefore, given its status as the leading producer of offshore wind power, a number of UK based research papers or data sources have been considered in addition to the US sources available. Where used, these papers or data sources have been clearly referenced. They include:

- *Results of the Electromagnetic Investigations 2nd Edition* (MCA and QinetiQ, 2004);
- *Guidelines for Health and Safety in the Wind Energy Industry* (Renewables UK (RUK), 2014 issue 2);
- *Offshore Wind Farm Helicopter Search and Rescue – Trials Undertaken at the North Hoyle Wind Farm Report of Helicopter Search and Rescue (SAR) Trials Undertaken with Royal Air Force (RAF) Valley "C" Flight 22 Squadron on March 22, 2005* (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)* (The Crown Estate (TCE) and Anatec, 2012);

[2] Historical incident data provided by the MAIB under the Freedom of Information Act. This data is used by Anatec for the purpose of comprehensive calibration of the CollRisk allision and collision models and has therefore not been presented directly within this NSRA. See Attachment A.

- *Influence of UK Offshore Wind Farm Installation on Commercial Vessel Navigation: A Review of Evidence* (Anatec, 2016); and
- *Historical UK offshore wind farm allision incidents from MAIB, UK Confidential Reporting Programme for Aviation and Maritime (CHIRP), International Marine Contractors Association (IMCA) and basic web searches.*

Wind farm technology has advanced significantly since many of the sources above were published. In particular, foundation and turbine technology has allowed for much larger turbines, which in turn means greater minimum spacing is able to be utilized when defining wind farm layouts, this has had a beneficial effect in terms of reducing impacts on communications and position fixing equipment. This is discussed further in Section 9.

2 NSRA Methodology

2.1 Risk Assessment Requirements of NVIC 01-19

The NSRA has been completed in line with NVIC 01-19, which requires the developer to undertake an NSRA that includes a *"change analysis" whereby the potential impacts of the structures can be considered and compared to the baseline situation. The risks associated with the proposed structures should be assessed and appropriate risk mitigation strategies developed and evaluated* (section 5b(4) of NVIC 01-19).

No defined methodology is provided; therefore, in order to undertake a Risk Based Decision Making (RBDM) process, this NSRA has considered the principles of the International Maritime Organization's (IMO) Formal Safety Assessment (FSA) (2018) as its risk assessment process. Further information is provided in the following sections[3].

A summary of the risk assessment requirements of NVIC 01-19 are shown in Table 2-1 below, then showing where within this assessment they are undertaken.

Table 2-1 NVIC 01-19 Risk Assessment Requirements

NVIC 01-19 Requirement	Where addressed within NSRA
In order to assess the impact on navigation safety, the developer should perform a systematic assessment of the risks to navigation safety associated with the proposed project leveraging existing studies, standard industry practices, or guidelines from other recognized sources such as governmental agencies or classification societies that may be applicable to their specific structure or the characteristics of the waterway (Enclosure 2).	The risk assessment follows the FSA's 'five step risk assessment process' as detailed in section 2.1 Sections 2.5, 2.6 and 9.9 (marine Radar) detail additional guidance and other studies considered.
The risk assessment should identify and evaluate potential measures that could be implemented to mitigate increased risks associated with the proposed project (Enclosure 2).	Each impact detailed in section 12 notes mitigation required to reduce the impact to ALARP. The mitigations are then summarized in section 14.
At a minimum, the risk assessment should consider the impact and significance of the appropriate factors (for example, vessel, waterway, environmental factors and traffic characteristics) as described in Enclosure 2.	All required factors have been considered as noted in Attachment B (NVIC checklist).

[3] It is noted that the IMO FSA is intended to assist maritime authority rule makers in their decision making process; however, it has been selected for the NSRA a systematic approach to risk assessment in a marine environment.

NVIC 01-19 Requirement	Where addressed within NSRA
Risk assessments should present information to enable the USCG to adequately understand how the risks associated with the proposed layout have been reduced to As Low as Reasonably Practicable (ALARP) (Enclosure 2).	Sections 3 to 11 summarize the base case and future case information (including consultation) that has been used to inform the risk assessment process. This process is then summarized in section 12, with the reader being walked through how the ALARP assessment has been drawn.
The risk assessment approach should include a "change analysis" whereby the potential impacts of the structure can be considered and compared to the baseline situation (Section 5).	Pre and post wind farm quantification assessments are considered in section 10. Section 12 then summarizes textually.
The risks associated with the proposed structures should be assessed and appropriate risk mitigation strategies developed and evaluated (Section 5).	The NSRA is the risk assessment process; the gathering of data, quantification, consultation and desktop resources have been considered within a five step process in order to determine a risk level. This is summarized in section 12.

2.2 Methodology for Assessing the Project in Isolation

2.2.1 Summary of Project Phases

Using a RBDM approach, this NSRA identifies the impacts to shipping and navigation users that may arise from the construction, operation, and decommissioning of the Project. Given that the construction of the Project will represent a similar scenario to that of decommissioning (e.g., increased Project vessel presence on-site, partially complete structures), impacts have only been assessed for the construction phase. However, a separate NSRA specific to decommissioning will be produced prior to the start of the decommissioning phase to consider any change in baseline conditions that may have occurred.

2.2.2 Scope of NSRA

It is important to note that the NSRA is primarily concerned with safety-based impacts to third party vessels and operators, rather than any impacts to the Project itself. Shipping and navigation users that may be affected by the Project (and thus considered within the impact assessment in Section 14) have been identified on this basis. Impacts from Project vessels will be mitigated by the marine coordination processes put in place to control transits to / from the Lease Area and entry / exit to ensure that they do not pose an increased allision or collision risk to third party vessels. These are described in more detail throughout the NSRA where applicable.

With regards to potential construction ports, the NSRA includes preliminary consideration of anticipated transport configuration, anticipated transport schedule, representative increase to existing traffic levels, and relevant stakeholder engagement for ports under consideration. This content is provided in Attachment H. As per Section 14, once there is further clarity around which ports will be utilized, Empire will also provide a Construction Method Statement separate to the NSRA which will contain additional detail of specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.

2.2.3 IMO Formal Safety Assessment Process

Impact assessments have been undertaken with consideration to internationally recognized standards and best practices for marine risk assessment methods, namely the IMO FSA approach as detailed under their relevant guidance - MSC-MEPC.2/Circ.12/Rev.2 (IMO, 2018). The FSA process requires a systematic review of risks, applying mitigations until they are brought within ALARP levels. Therefore, the approach used within this assessment is aligned with this process.

MSC-MEPC.2/Circ.12/Rev.2 (IMO, 2018) notes any FSA should include the steps listed below and subsequently illustrated in Figure 2.1:

1. **Identification of hazards** - the Hazard is the potential threat posed. Therefore, this NSRA identifies the hazards (summarized in section 2.2.5) and assesses the impact.
2. **Risk analysis** – the Risk is the combination of the frequency and the severity of the consequence; this is considered throughout the NSRA but is summarized within the impact assessment.
3. **Risk control options** - referred to as mitigations (within section 12, whereby they are linked to the hazards and associated risks they are mitigating but also summarized in section 14).
4. **Cost-benefit assessment** - as per the FSA this step is only required if a mitigation (risk control option) is expensive and outweighs the benefits it provides. *there are no mitigations identified in this NSRA as requiring a cost-benefit assessment.
5. **Recommendations for decision-making** - recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control options if provided) is contained within the impact assessment in section 12. An ALARP statement is made per user group to summarize the five step process that has occurred.

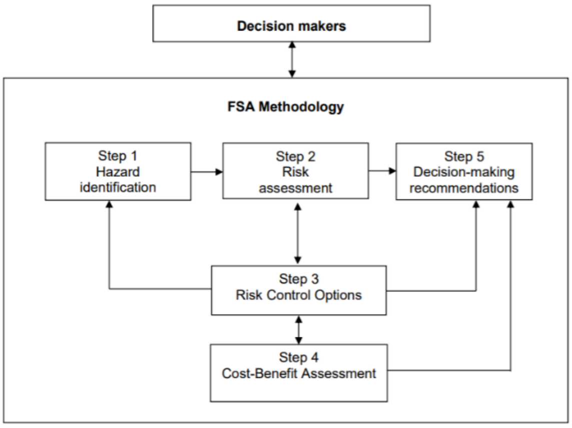

Figure 2.1 Flow Chart of the FSA Methodology

2.2.4 Hazard Identification

Hazards have been identified via the results of the baseline characteristic assessment of waterway and maritime characteristics, and the outputs of the consultation process, including preliminary hazard identification meetings noted in Section 3. At these meetings (undertaken in 2018) users of the area and regulators were directly questioned as to likely impacts associated with a development of the Project. Consultation also included the Harbor Operations meeting where a wide range of users were presented to, and feedback requested. A summary of the output of this process in relation to Hazard Identification is provided in Table 2-2.

The hazards identified were then taken forward as part of the risk assessment process and summarized within the Impact Assessment contained in Section 12.

Table 2-2 Hazard and Impact Identification

User Group	Hazards Identified (what is causing the danger)	Risk Assessed within the Impact Assessment (section 12)	Project Phase
Commercial Vessels	▪ Presence of surface piercing structures both partially and fully constructed. ▪ Presence of displaced vessel from the array area. ▪ Construction and operational traffic associated with the Project.	Deviations	Construction and Operation
		Increased vessel to vessel encounters and collision risk	Construction and Operation
		Powered vessel to structure allision risk	Construction and Operation
		Drifting vessel to structure allision risk	Construction and Operation

User Group	Hazards Identified (what is causing the danger)	Risk Assessed within the Impact Assessment (section 12)	Project Phase
Commercial Fishing Vessels	▪ Presence of surface piercing and sub surface structures both partially and fully constructed. ▪ Construction and operational traffic associated with the Project. ▪ Presence of export and inter-array cables.	Deviations	Construction and Operation
		Increased vessel to vessel encounters and collision risk	Construction and Operation
		Powered vessel to structure allision risk	Construction and Operation
		Drifting vessel to structure allision risk	Construction and Operation
		Restricted fisheries operation (assessed in COP Section 8.8)	n/a
Recreational Vessels	▪ Presence of surface piercing structures both partially and full constructed. ▪ Construction and operational traffic associated with the Project.	Deviations	Construction and Operation
		Increased vessel to vessel encounters and collision risk	Construction and Operation
		Powered vessel to structure allision risk	Construction and Operation
		Drifting vessel to structure allision risk	Construction and Operation
Military Vessels	▪ Presence of surface piercing structures both partially and fully constructed. ▪ Presence of displaced vessel from the array area. ▪ Construction and operational traffic associated with the Project.	Displacement and collision risk	Construction and Operation
		Vessel to structure allision risk (powered and drifting)	Construction and Operation
		Emergency response resource capability	Construction and Operation
Anchoring	▪ Presence of export and inter-array cables.	Displacement of anchoring activity	Installation and Operation
		Anchor snagging	Installation and Operation

User Group	Hazards Identified (what is causing the danger)	Risk Assessed within the Impact Assessment (section 12)	Project Phase
Ports	▪ Presence of surface piercing structures both partially and full constructed.	Restricted port access[4] by increased levels of Project vessels	Construction and Operation
		Restricted port access by cable installation	Construction and Operation

2.2.5 Ranking within the Impact Assessment

The risk assessment process is undertaken using both qualitative[5] and quantitative sources and results in order that an ALARP statement can be concluded within the impact assessment. The ALARP statements have been determined using the following sources and analysis.

- Baseline data and statistical analysis;
- Expert opinion;
- Level of stakeholder concern and any feedback;
- Number of transits of a specific vessel and/or type;
- Magnitude of any vessel deviation;
- Outputs of collision and allision risk modelling;
- Lessons learned from existing offshore developments (primarily UK); and
- Consequence and frequency – whereby a risk may be high consequence but the frequency or potential of it occurring is low enough that the risk is deemed ALARP.

The impact assessment takes account of the embedded mitigation implemented for the Project (Section 14) and using the analysis and sources listed above determines the significance of each individual impact reviewed as having (a) broadly acceptable, (b) tolerable, or (c) unacceptable parameters.

The definitions of each significance ranking are given in Table 2.1. These significance terms are based on the IMO FSA process (IMO, 2018) for the qualification of ALARP. Neither the NVIC 01-19 nor the IMO FSA include quantification of safe distances, given that each scenario will need to be on a case by case basis. This terminology is used throughout the NSRA to identify to the reader where impacts are considered ALARP or where they would require further mitigation based on the risk assessment process undertaken.

[4] Vessels normal transits into a port area, restricted or prevented by the presence of structures or construction/installation activities.
[5] Qualitative methods of assessment are ways of gathering information that yield results that can't easily be measured by or translated into numbers, as opposed to quantitative which are results based on the numerical processing of data.

Table 2-3 Significance Ranking Definitions

Significance	Definition
Broadly Acceptable	A level of risk that is managed by standard mitigations in place for offshore wind farm developments. No further assessment required. These risks are likely low consequence and low frequency or high frequency and low consequence with embedded (industry standard) mitigations in place.
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 farm developments. Further assessment has identified that risk is As Low as Reasonably Practicable (ALARP) with this mitigation and can then be reduced to broadly acceptable. The mitigations must be secured; if they are not secured then the impact remains as Tolerable with Mitigation. These risks are of higher frequency or consequence until additional mitigation is identified to bring them into ALARP parameters by reducing the frequency or the consequences.
Unacceptable	Risks cannot be managed through mitigation (modification, control measures or monitoring) and the wind farm requires significant changes and then re assessment to bring into As Low as Reasonably Practicable parameters. This risk are high frequency and consequence, meaning they cannot be bought into ALARP parameters and further reassessment and consideration of mitigations is required.

Any impact qualitatively considered to have an unacceptable level of tolerability will require further mitigation in order to reduce the risk to within ALARP parameters.

Figure 2.2 is taken directly from the MSC-MEPC.2/Circ.12/Rev.2 – Figure 2. The figure is intended to aid the reader of this NSRA to visualize the ALARP process and shows that there is a risk level that is intolerable above an upper bound[6]. In this region of the figure, risk cannot be justified and must be reduced, irrespective of cost of mitigations. The principle also states that there is a risk level that is "broadly acceptable" below a lower bound. In this region of the figure, risk is negligible (as Table 2.3 low consequence and frequency), and no further risk

[6] The bound is not a numerical value.

reduction (mitigation) required. If the risk level is in between the two bounds, the ALARP region, risk should be reduced to meet economic responsibility: Risk is to be reduced to a level as low as is reasonably practicable. The term reasonable is interpreted to mean cost-effective. Risk reduction measures should be technically practicable, and the associated costs should not be disproportionate to the benefits gained.

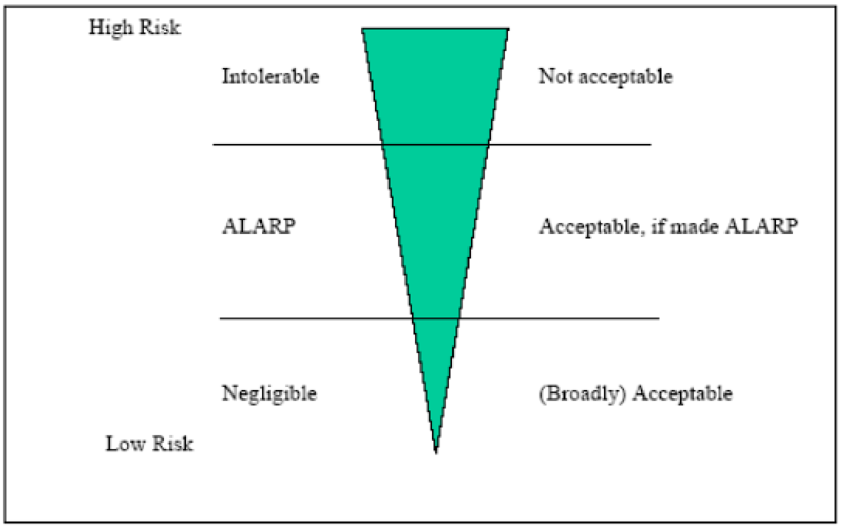

Figure 2.2 The ALARP Principle (Source: MSC-MEPC.2/Circ.12/Rev.2 – Figure 2)

In addition to assessing the tolerability of impacts qualitatively, a risk evaluation with regard to people and the environment has been undertaken. In the case of risk to people, this involves determining the annual fatality rate when frequency and fatality are combined into a one-dimensional measure of societal risk known as Potential Loss of Life (PLL) (Attachment A). In the case of risk to the environment, this involves a numerical estimate of the amount of oil spilled from a vessel involved in an incident relating to the development based upon historical data. It is recognized that there are other potential sources of pollution (e.g. hazardous containerized cargoes) but oil is considered to be the most likely pollutant. The output of this assessment is summarized within this NSRA, with further details provided in Attachment A.

2.2.6 Software Modelling

The risks associated with the wind farm have been assessed on a qualitative basis in Section 12; however, the assessment has been informed via a comprehensive quantitative assessment undertaken using Anatec's suite of collision and allision models. These models have each been used in multiple successful wind farm applications within the UK, and are refined and improved on a continuous basis, as stated in Attachment D. Key models include:

- **Encounters**: identifies instances of vessel encounters[7] within an AIS data set;

[7] As per glossary, one encounter defined as period where two or more vessels are all within 1 nm (1.9 km) of each other.

- **COLLRISK Vessel to Vessel Collision**: estimates vessel to vessel collision risk within a given area;
- **COLLRISK Vessel to Structure Allision (Powered):** estimates frequency at which a vessel will allide with a structure whilst under power; and
- **COLLRISK Vessel to Structure Allision (Drifting):** estimates frequency at which a vessel will allide with a structure whilst Not Under Command (NUC).

Where appropriate, further details on the methodology of the models used are provided in Section 10.

2.3 Methodology for Assessing Cumulative Effects

2.3.1 Other Wind Farm Projects

The identified impacts (identified as per Section 2.1) are also assessed for cumulative effects with the inclusion of other planned developments in the area. Given the varying development status of current U.S. renewables projects, a tiered approach to cumulative assessment has been undertaken, which splits projects into Tiers depending on status[8], data confidence levels, proximity to the Project, and the level to which they are anticipated to cumulatively impact relevant users.

The Tiers are summarized in Table 2.2, which includes a list of the projects considered, and which tier each falls into. The level of assessment undertaken for each Tier is then stated. Following this, the projects are presented by Tier relative to the Lease Area in Figure 2.3.

Table 2-4 Cumulative Project Screening Summary

Tier	Status of Lease Area	Status of Project	Description (specific to Shipping and Navigation)	Lease Areas / Projects	Data Confidence Level	Proposed Assessment with NSRA
1a	Active prior to Feb 2022	Approved, submitted or not submitted	Within 100 nm (185 km) of the Lease Area **and** that may impact a main route which transits through or within 1 nm (1.9 km) of either Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area.	• New Jersey (Ocean Wind), OCS-A 0498 / 0532 • Atlantic Shores, OCS-A 0499 / 0549	High or Medium	• Quantitative[9] cumulative re-routing of main routes
1b	Active as of Feb 2022[10]	Not submitted	Within 100 nm (185 km) of the Lease Area **and** that may impact a main route which transits through or within 1 nm (1.9 km) of either Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area.	• OCS-A 0537 • OCS-A 0538 • OCS-A 0539 • OCS-A 0541 • OCS-A 0542 • OCS-A 0544	Low	• Qualitative cumulative re-routing of main routes

[8] Status as of May 17, 2022
[9] Diagrammatic re-routing will be undertaken.
[10] Areas successfully auctioned under the New York Bight offshore wind sale (Feb 23, 2022).

Tier	Status of Lease Area	Status of Project	Description (specific to Shipping and Navigation)	Lease Areas / Projects	Data Confidence Level	Proposed Assessment with NSRA
2	Active	Submitted or not submitted	Within 150 nm (278 km) of the Lease Area **and** that may impact a main route which transits through or within 1 nm (1.9 km) of either Lease Area and/or interacts with traffic that may be directly displaced by the Lease Area	• Revolution Wind, OCS-A 0486 • OCS-A 0522	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 that may impact a main route which transits through or within 1 nm (1.9 km) of either Lease Area and/or interacts with traffic that may be directly displaced by Lease Area	• Central Atlantic Call Areas A and B	Low	• Qualitative assumptions of routing only given low confidence in future definition of planning areas
Screened Out	Any status	Any status	Over 150 nm (278 km) from Lease Area **or** Within 150 nm (278 km) but does not impact a main route which transits through or within 1 nm (1.9 km) of Lease Area and/or interacts with traffic that may be directly displaced by Lease Area	• Bay State Wind • Block Island • Garden State Offshore Energy • Maryland (US Wind) • Mayflower • Skipjack • Vineyard Wind • Beacon Wind • Central Atlantic Call Areas (excluding A and B) **Note projects further than 150nm not listed or shown in figure.**	High, Medium or Low – outside screened area	N/A

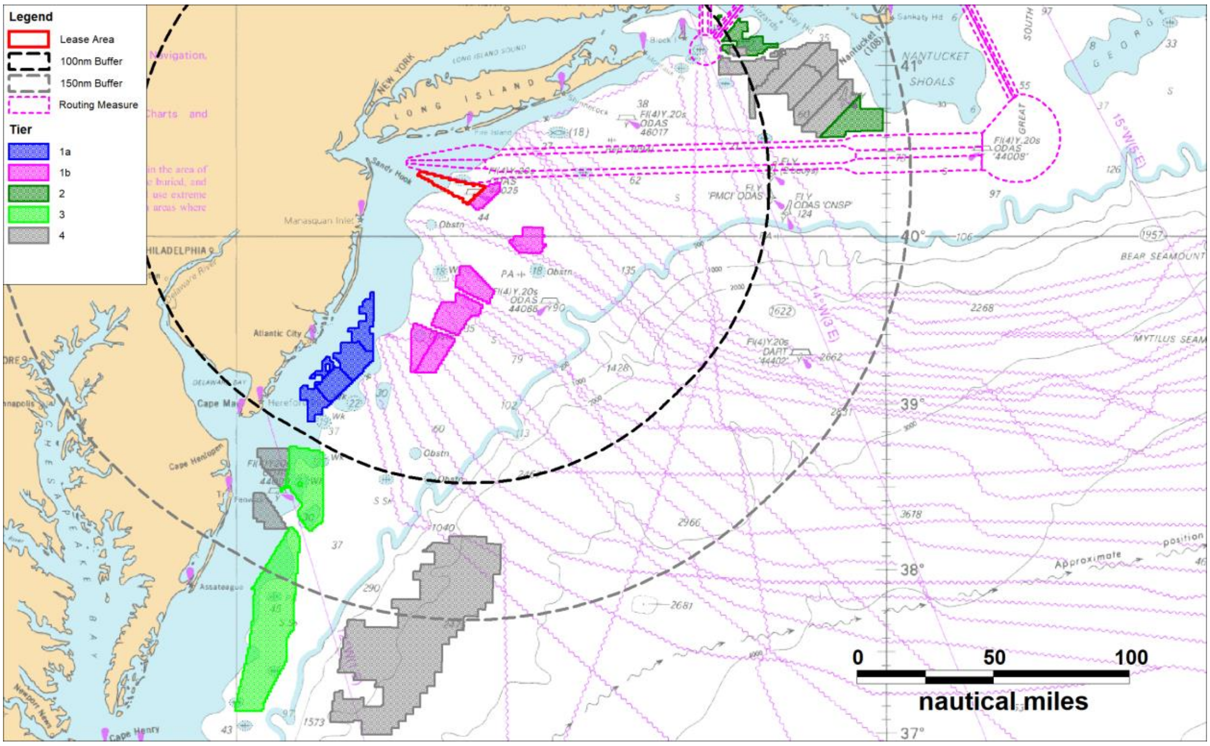

Figure 2.3 Projects by Tier

2.3.2 Routing Measures

All established routing measures (see Section 6.1.1 for those local to the Port of NY/NJ) have been considered during the cumulative routing assessment. It should be noted that the draft fairways proposed under the findings of the ACPARS (USCG, 2016b) and the NNYBPARS (USCG, 2021) have not been considered beyond qualitative discussion, given such measures are yet to be applied for and will be subject to further assessment and consultation.

2.3.3 Third Party Activities (non-transit)

Vessel tracks relating to commercial fishing vessels, recreational vessels and marine aggregate dredgers, are considered within the baseline assessment in Section 7.

2.4 Study Areas

Assessment within this NSRA has primarily been undertaken within 15 nm (27.8 km) of the Lease Area, which is hereafter referred to as the 'Study Area'. This 15 nm (27.8 km) area has been chosen to ensure that all passing vessel traffic relevant to the Lease Area is captured. In particular, capturing traffic within the nearby TSS lanes, while still ensuring the assessment remains site-specific to the Project. The Study Area is shown in Figure 2.4.

It is noted that the Study Area includes part of the Hempstead Bay (NY) waters. To ensure this NSRA is site-specific, marine traffic transiting purely within the Hempstead Bay has been excluded from the assessment.

To ensure appropriate impact assessment is included for the export cables within this NSRA, additional assessment at a high level has been undertaken within an area constituting an approximate 2 nm (3.7 km) buffer of the export cables. This area (hereafter referred to as the 'export cable Study Area') is illustrated in Figure 2.4.

It is noted that the 2nm (3.7 km) buffer is based on a previous iteration of the export cables, however is still considered suitable for the purposes of the current routes.

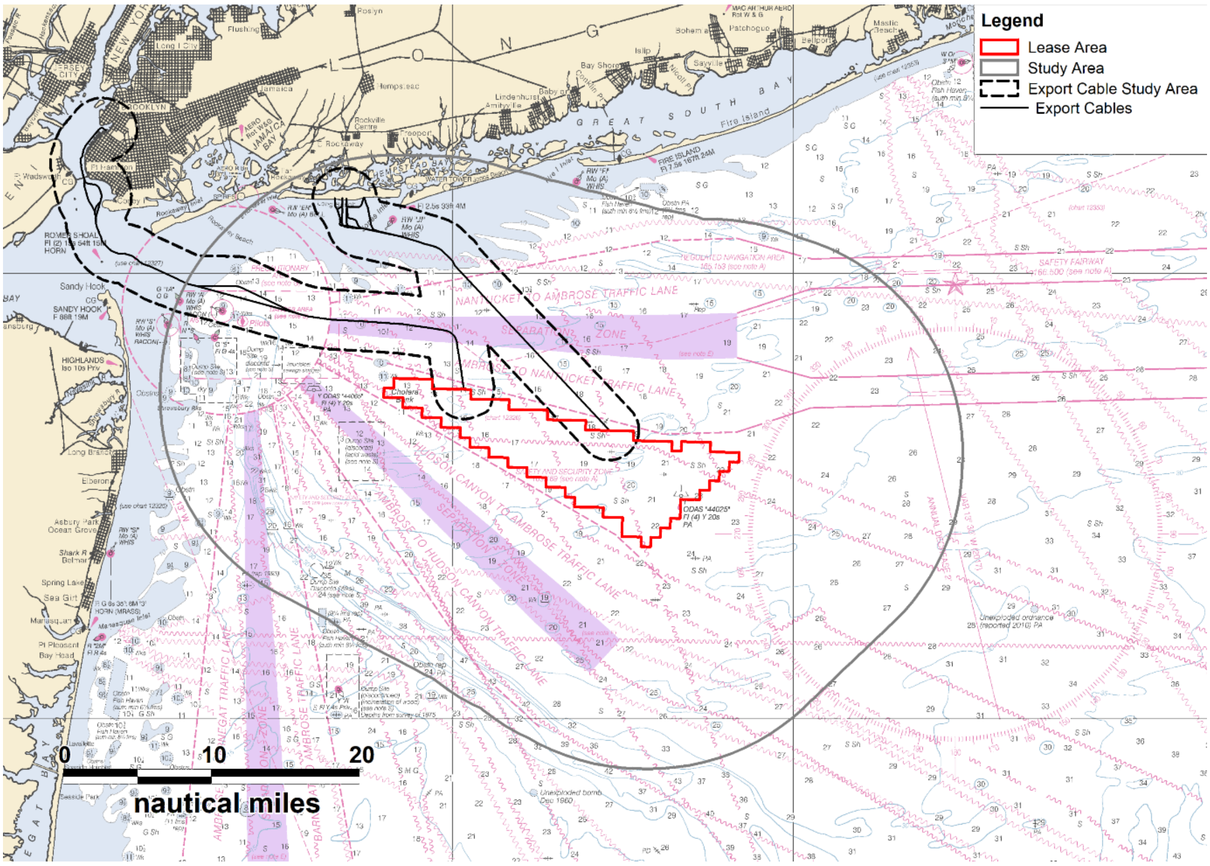

Figure 2.4 Study Areas

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, noting that the final location of structures will not be finalized until acceptance of the COP, but should still fall within the Project Design Envelope and maximum design scenario as assessed. The maximum design scenario assessed within this NSRA is discussed in detail in Section 4.6.

It is assumed that any notable changes to the baseline (e.g., changes in traffic patterns) 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.

2.6 Lessons Learned from Other Projects

2.6.1 Consideration of Other Guidance

As noted in section 1.2, this NSRA has complied with the requirements set out in NVIC 01-19 (USCG, 2019), the following guidance has been considered within this NSRA where U.S. guidance does not provide a standard. Where this guidance has been considered, a clear reference will be made within the NSRA.

2.6.1.1 MGN 543 and SAR Annex

The UK renewables industry is required to comply with the relevant active MCA MGN guidance. At the time of the NSRA this was MGN 543 (Merchant & Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on United Kingdom (UK) Navigational Practice, Safety and Emergency Responses (MCA, 2016). It highlights issues which should be considered when assessing navigational safety and emergency response impacts caused by OREIs. This superseded the previous corresponding guidance (MGN 371) in 2016, as detailed in Section 1.2.3 Given that the wind farm consent (permitting) process is now well established within the UK, it has been considered appropriate to consider the corresponding key guidance, namely MGN 543 (MCA, 2016) as per Section 1.2.3.

It is noted that COMDTINST 16003.2A references MGN 371, however this document has since been superseded by MGN 543. MGN 543 has therefore been considered within this NSRA, rather than MGN 371.

Unlike its predecessor, MGN 543 no longer includes specific recommendation for siting in proximity to a TSS boundary or 5 nm (9.3 km) area around TSS terminus points. It is likely that the difference in guidance largely relates to a precautionary approach originally taken (pre any large offshore developments) within MGN 371, which was eventually eased (within MGN 543) due to assessment of consented, planned and constructed developments which showed vessels comfortably navigating as close as 1 nm (1.9 km) (closest point of approach) from offshore structures.

2.7 Experience from Existing Sites

The following section details the lessons learned from existing offshore windfarm developments. This information has been used in both the sensitivity allision assessment (see Section 5.3) and in response to outputs of the consultation process.

2.7.1 Greater Gabbard and Galloper Offshore Windfarm– UK

The following section details the Gabbard and Galloper offshore windfarm developments located within the outer Thames Estuary in the UK. Figure 2.5 shows the location of the wind farm in proximity to the IMO routing measure, which includes a TSS lane passing between the developments.

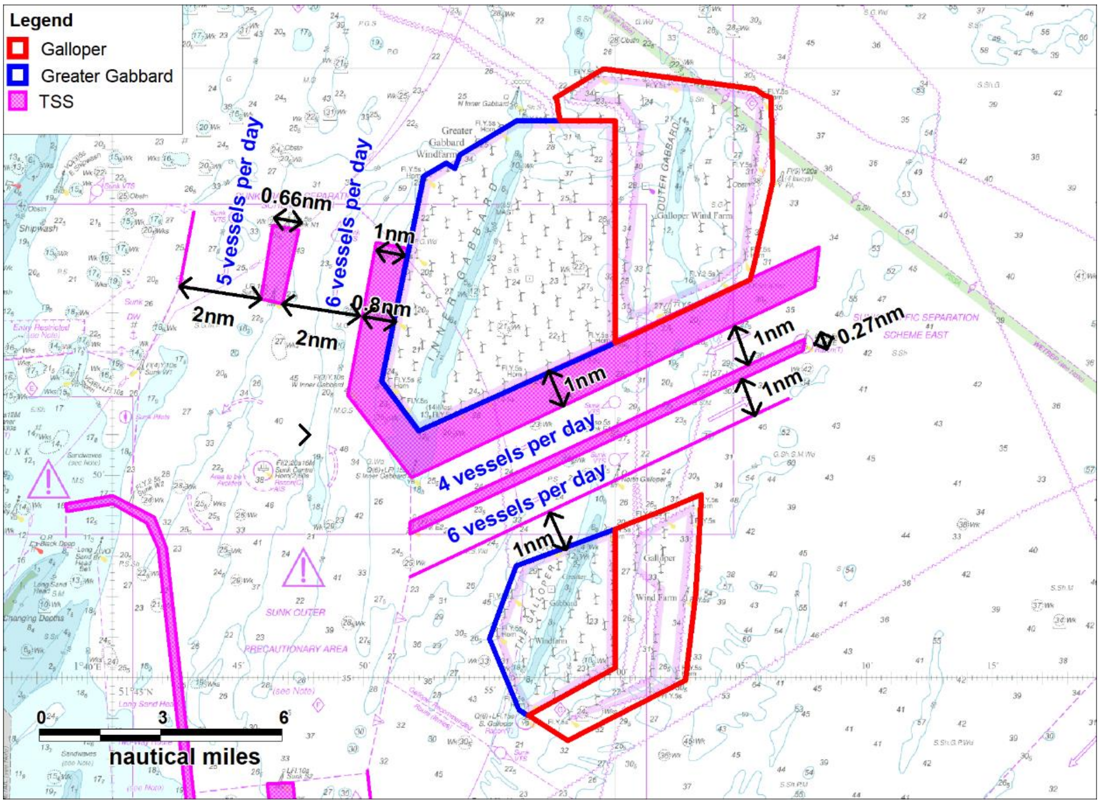

Figure 2.5 Greater Gabbard and Galloper Wind Farms (UK, both sites operational)

AIS analysis undertaken for the area around the Greater Gabbard Wind Farm as part of the Influence of UK Offshore Wind Farm Installation on Commercial Vessel Navigation: A Review of Evidence report (Anatec, 2016) is shown in Figure 2.6 and Figure 2.7. The former shows data collected during 2004, before the Project was constructed. While the latter shows established traffic patterns in 2015, once the Project was operational.

It should be considered that the 2004 AIS data (Figure 2.4) does not provide comprehensive coverage of the area around Greater Gabbard However, the coverage is sufficient to demonstrate how vessels adapted once the wind farm was operational.

The UK's SUNK Routeing Measure is considered to be an appropriate example for comparison to the Lease Area given the comparability between traffic in the two areas, demonstrated in Table 2-5, that shows the results of a recent assessment undertaken using AIS data from 2017 through 2018. It is also noted that some vessels were identified operating in both US and UK data sets. This demonstrates that traffic transiting to the PANYNJ is on route from the Thames Estuary and therefore would be familiar with navigating in the vicinity of offshore wind farms.

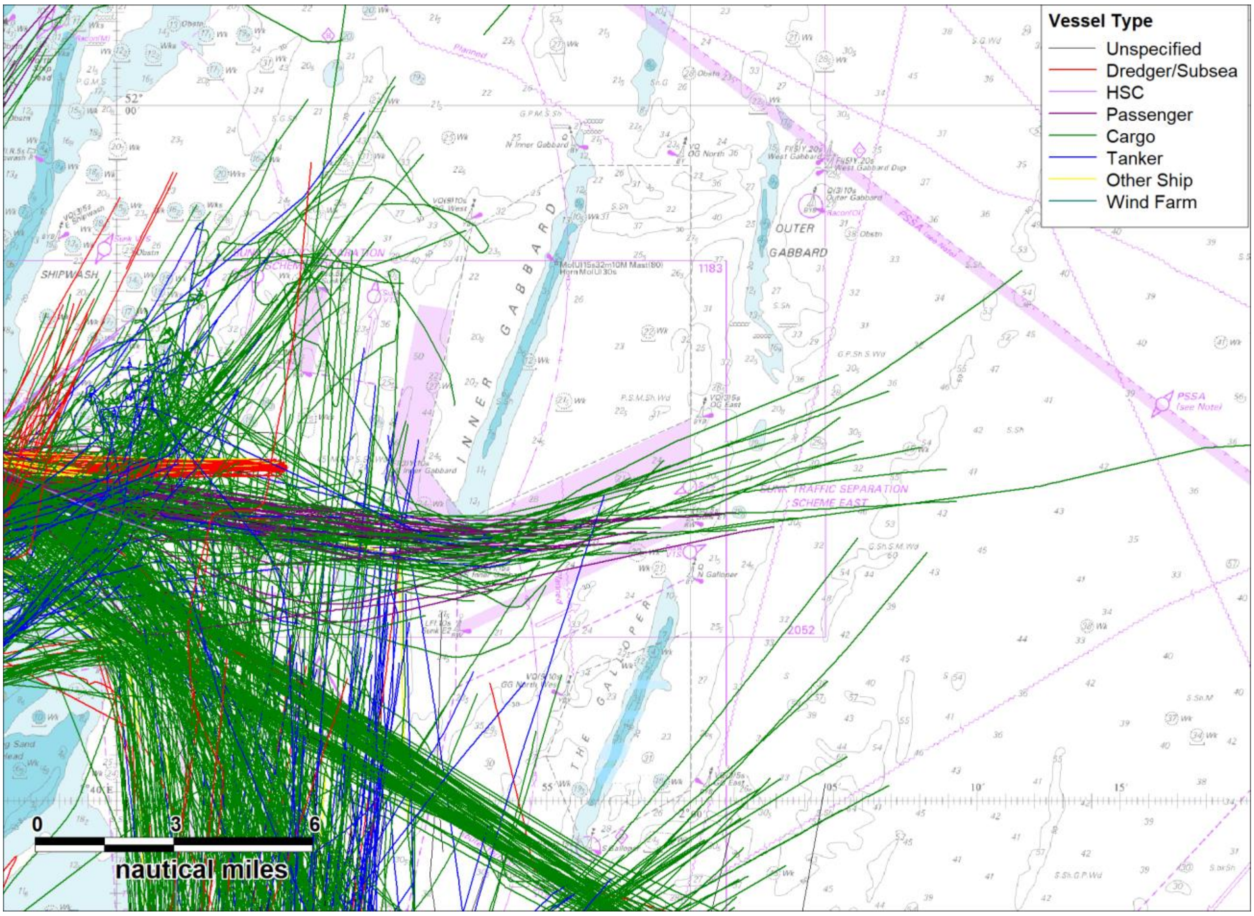

Figure 2.6 Sept/Oct 2004 – Pre Greater Gabbard and Galloper[11]

[11] Note – archive chart used; noting SUNK routeing measure was also not in existence in 2004.

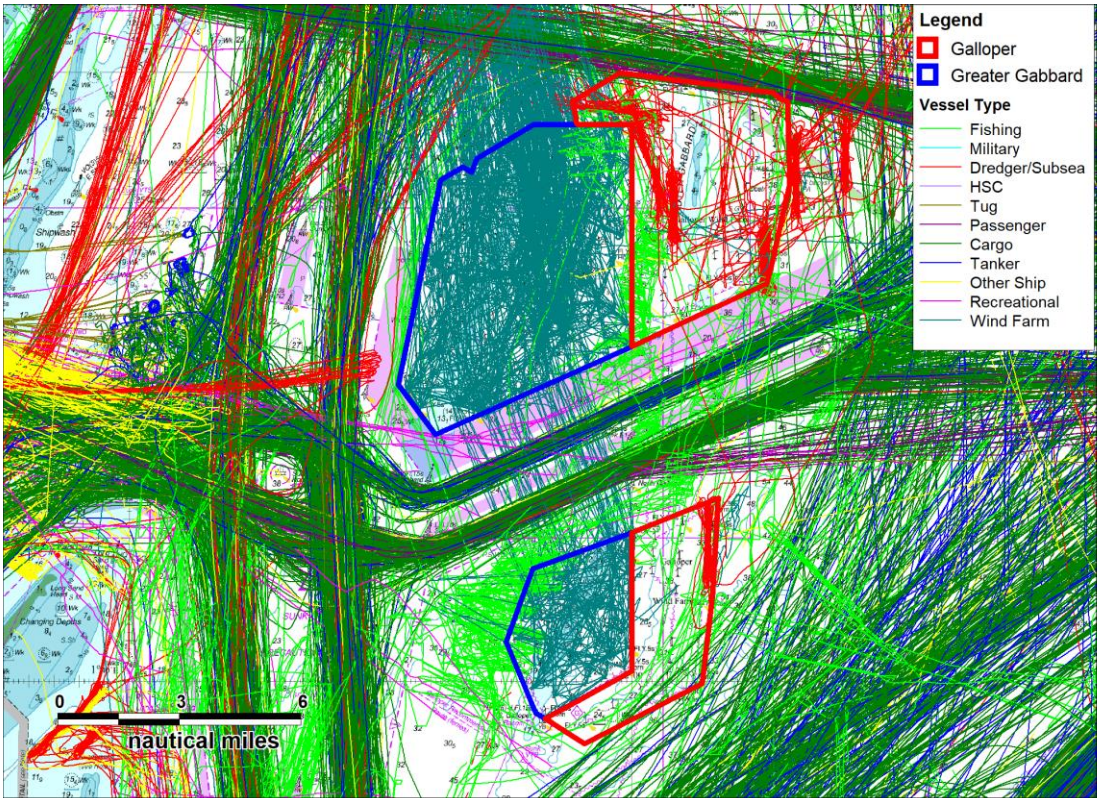

Figure 2.7 Oct 2015 – Post Greater Gabbard

Table 2-5 2017/2018 Traffic Comparison between Routing Measures

	Hudson to Ambrose and Ambrose to Nantucket TSS Lanes	SUNK Routeing Measure Between Greater Gabbard and Galloper
Wind Farm Status	Wind farms in Planning	Greater Gabbard fully commissioned in 2012 and Galloper fully commissioned in 2018
Width of TSS Lane (at the narrowest)	1.4 nm (2.6 km)	1.0 nm (1.9 km)
Average number of vessels per day	3 vessels	4-6 vessels
Types of Vessels within TSS Lanes	Dry and containerized cargo, wet bulk and passenger	Dry and containerized cargo, wet bulk and passenger
Largest Vessel to Use the TSS Lanes	1,204 ft (367 m) Container Vessel[12]	1,312 ft (400 m) Container Vessel

[12] Based on 12 months of AIS data from 2017 through 2018

2.7.2 Recently Consented Projects

Within the southern North Sea off the coast of England, the Norfolk Vanguard project has recently been consented (July 2020). Its consented boundary sits 1 nm (1.9 km) from the edge of a Deep Water Route (both to the east and the west) as shown in Figure 2.8 meaning that turbines or substations can be constructed up to that boundary line on either side of the Deep Water Route. This Deep Water Route has on average 10-12 vessels transiting it a day (multidirectional). East Anglia Three (to the south) is also consented and Norfolk Boreas (to the north) is in examination, but has had the 1 nm (1.9 km) buffer agreed with all shipping stakeholders.

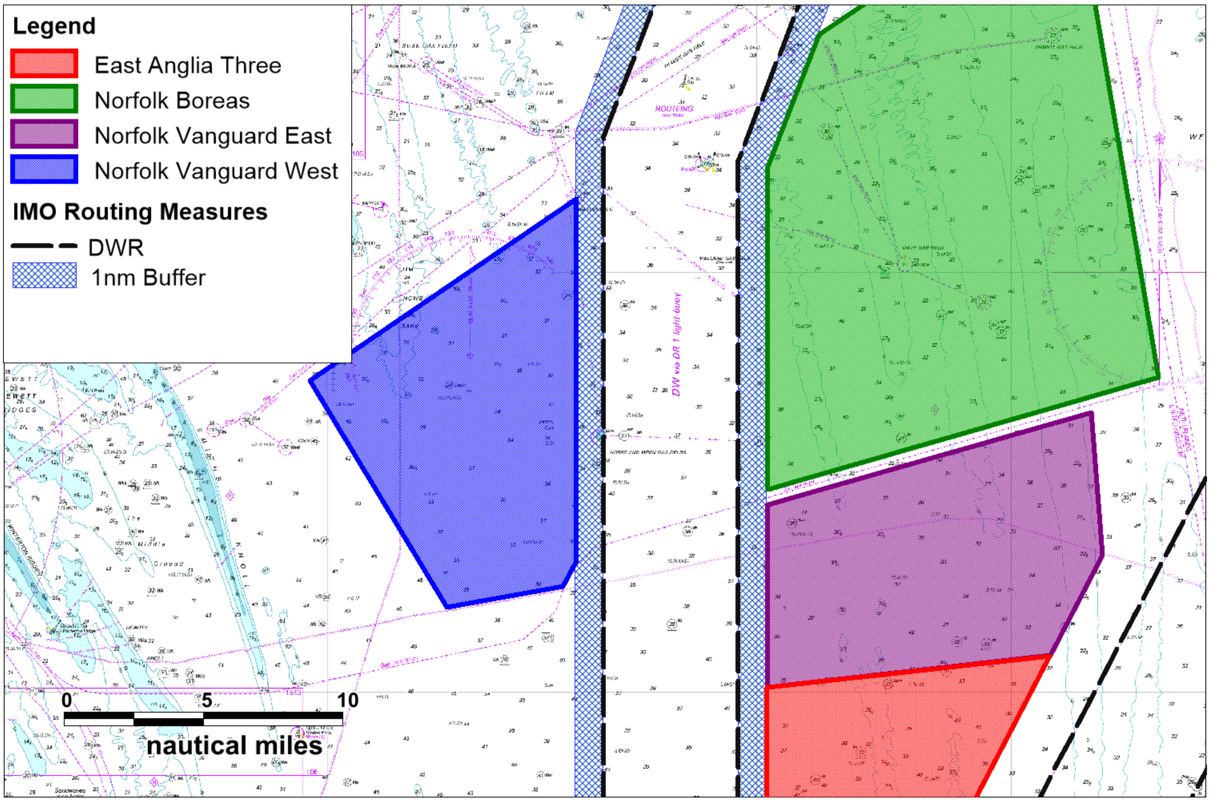

Figure 2.8 Norfolk Vanguard (East and West) Offshore Wind Farm

2.7.3 Mainland European Offshore Windfarm Developments

Following consultation responses with regards to both the '*White Paper on Offshore Wind Energy Partial Review of the National Water Plan in light of the designation of the Holland Coast area and the area north of the Wadden Islands for offshore wind energy*' (Ministry of Infrastructure and Environment, 2014) and the IMO's General Provisions On Ships Routeing (resolution A.572(14)) with regards to spacing of wind farms in relation to IMO approved routing measures, the following examples of existing wind farm developments associated with mainland European countries are shown here in this section.

2.7.3.1 Belwind (Belgium)

The charted boundary of the Belwind offshore wind farm is presented in Figure 2.9. This project comprises a total of 105 turbines and was constructed within Belgian waters in two phases. Both phases have been fully operational since May 2017. As indicated in the figure, the site is within close proximity to the TSS off North Hinder, with the closest charted turbine being positioned 1 nm (1.9 km) from the entrance of northbound lane of the TSS.

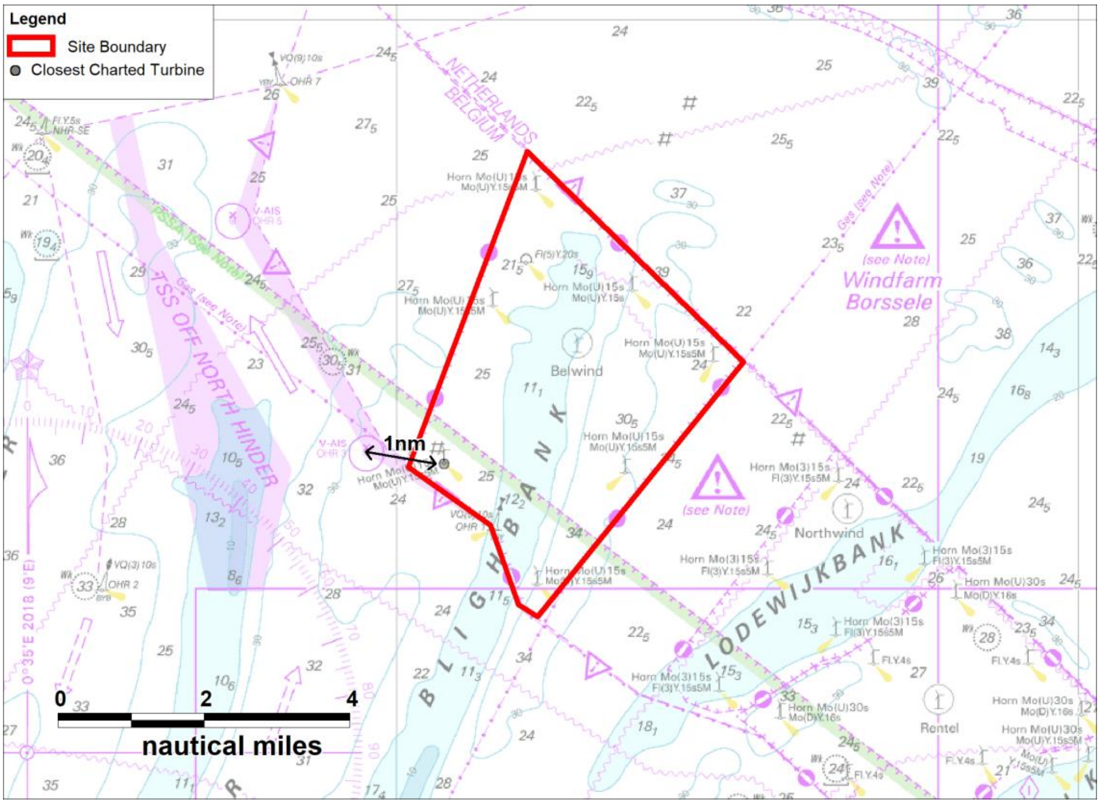

Figure 2.9 Belwind Offshore Wind Farm

2.7.3.2 Gemini (Netherlands)

The Gemini offshore wind farm is a Dutch project that has been operational since May 2017. It consists of 150 turbines in total, with those on the northern periphery located within 1.6 nm (3.0 km) of the eastbound lane of the TSS German Bight Western Approach, as shown in Figure 2.10. It is noted that the Dutch guidance, similar to the USCG Commandant Instruction 16003.2A (USCG, 2016a), defines a starting position of 2 nm (3.7 km). However, it also states that that developers should look to bespoke solutions, instead of the rigid application of a separation distance of 2 nm (3.7 km) between shipping lanes and wind farms, as demonstrated at the Gemini project.

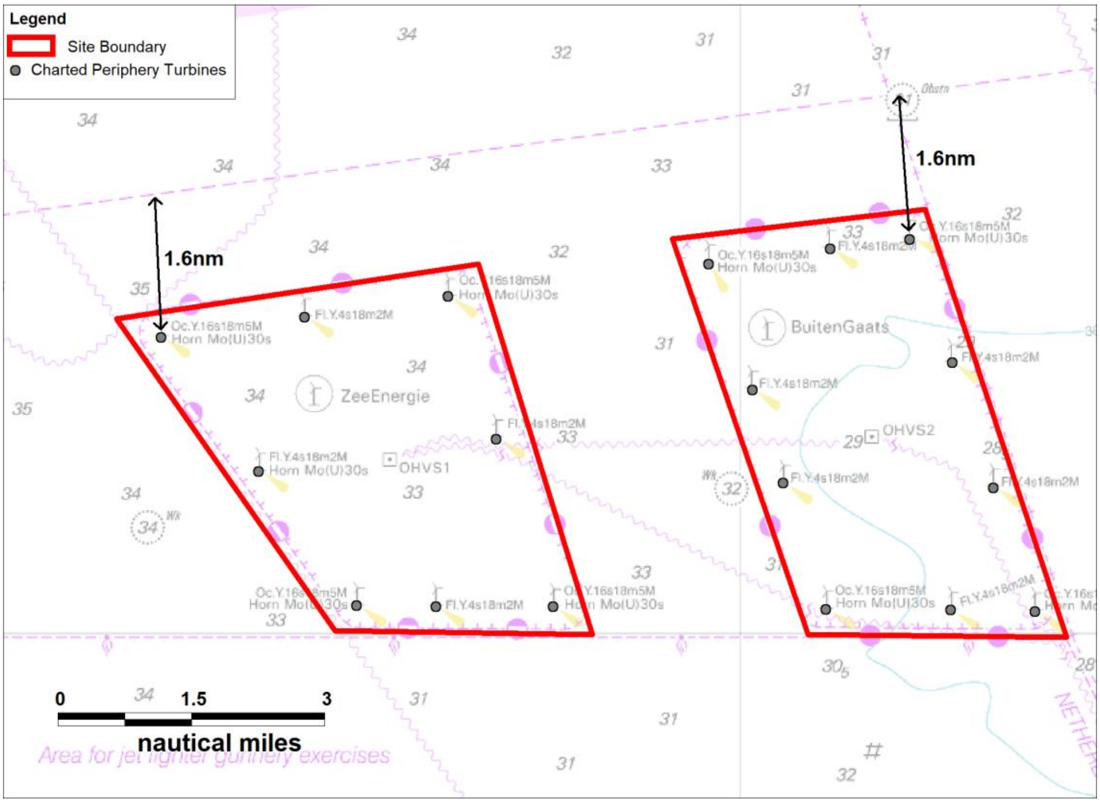

Figure 2.10 Gemini Offshore Wind Farm

3 Consultation

3.1 Summary of Shipping and Navigation Stakeholder Consultation Meetings

Empire has been engaged in stakeholder meetings since as early as 2017. Including those with a direct interest in navigational safety. A summary of the key outputs of the marine stakeholder consultation meetings undertaken to date is provided in Table 3.1. A list of those parties consulted is provided in Section 1.2.4.

It is noted that the World Shipping Council, the American Waterways Operators (AWO), Passenger Vessel Association and the Cruise Line Industry Association were all consulted with prior to drafting of the NSRA. They were also subsequently consulted in November 2019, and were provided a brief Project overview along with the Project's Layout Rules to request feedback on the layout approach. Additional consultation meetings were then held with the World Shipping Council (WSC), AWO, and the Chamber of Shipping of America (CSA) in June 2020.

Dates and attendees of specific meetings held are provided in Attachment E, and a summary of engagement with agencies is available in Appendix B of the COP.

Table 3-1 Consultation Summary – Stakeholder Meetings

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
USCG August 7 2018	Intentions over separation between the wind farm and the TSS lanes should be clarified, and it was queried as to if there were any associated conditions in the Lease.	As per Layout Rule 6 (see Section 5) a 1 nm (1.9 km) separation distance from the TSS will be maintained. There are no conditions defining a required separation distance in the Lease.
	It was recommended that developers work together to establish a standard for spacing and layout (e.g. linearity) in the absence of an established standard.	Empire has proposed a set of Layout Rules (see Section 5) with which the final layout will comply.
	Preference for straight line edges on wind farm periphery was stated.	As per Layout Rule 2 (see Section 5), periphery structures will form a straight or curved line as far as is practicable.

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
	The importance of discussing and evaluating impacts on Search and Rescue (SAR) within the NSRA was stated.	Impacts on emergency response capabilities are discussed in Section 5, Layout Rules.
USCG September 17 2018	A new fairway system across the NY Bight to support traffic and regulatory action is expected. The associated IMO process is anticipated to take 18 months.	This has been included for discussion in the cumulative assessment of routing in Section 10.4.
	Preference for the NSRA to include an assessment of vessel numbers utilizing the TSS lanes was stated.	This assessment has been undertaken and the results are shown in Section 7.2.7.
	The consensus was that the majority of tug (push/pull) traffic would transit east of the wind farm. However, wire tow/tug vessels may pass inshore.	Displacement impacts are assessed in Section 12. A simulation exercise of vessels being displaced both to the east and west of the Lease Area is available in Section 10.2.1.
	USCG were made aware of the intent to demonstrate a safety case for a 1 nm (1.9 km) buffer zone between the periphery structures and the TSS lanes within the NSRA.	The Layout Rules (which include the 1 nm (1.9 km) provision) and their background are shown in Section 5. Justification of the 1 nm (1.9 km) separation is provided in Sections 5.3 and 7.5.4.
	USCG were made aware of the proposal to use a layout rule approach, on the assumption that a maximum design scenario was assessed within the NSRA (which was anticipated would be the maximum number of structures).	The Layout Rules assumed within this NSRA are presented in Section 5.
New York VTS September 18 2018	From a harbor operations point of view, the key issues were considered to be fairway channels and any associated separation buffer from the periphery structures – in particular, any 'funnel' effect on traffic entering or exiting the TSS lanes.	Allision and collision modelling has been undertaken, as detailed in Section 10. Associated impacts are assessed in Section 12. As per the Layout Rules (specifically Section 5.2.5), Empire is proposing a 1 nm (1.9 km) separation from the TSS lanes.

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
	From a VTS perspective no particular concerns over the Lease Area were raised. However, preference that lighting and marking of the site is minimized was stated (while still ensuring the site was effectively marked).	The site will be marked and lit in agreement with USCG as per Section 14.
	Various historical incidents were discussed during consultation, including a 2007 allision between a vessel and Ambrose Tower, a recent tanker and fishing vessel collision.	An assessment of historical maritime incidents is given in Section 11.
	Concern was raised over assembly and construction activities.	Associated impacts in relation to shipping and navigation are assessed in Section 12. Specific impacts relating to construction activities (internal) will be assessed by individual risk assessments, noting that Attachment H provides preliminary consideration of anticipated transport configuration, anticipated transport schedule, representative increase to existing traffic levels, and relevant stakeholder engagement for ports under consideration.
	Further concerns were raised over the uncharted (recommended) anchoring area north of the Lease Area, particularly in relation to export cables.	Impacts associated with the export cables are assessed in Section 12.
McAllister Towing of New York September 18 2018	Recommended that historical incidents involving the *Catalonia Spirit* and the *Gray Shark* be studied.	An assessment of historical maritime incidents is given in Section 11.
	It was suggested that tug (push/pull) traffic crossing the Lease Area was likely oil traffic associated with New England.	Noted.
	Key concerns with regards to renewable developments surrounded future lease areas rather than the Project (i.e., cumulative issues).	Cumulative assessment of vessel routing has been undertaken in Section 10.4, with associated impacts assessed in Section 13.

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
	A 2 nm (3.7 km) spacing between turbines was requested for tug (push/pull) vessels transiting through the array	As per Rule 6 of the Layout Rules (see Section 5.2.6) minimum spacing will be at least 0.65 nm (1.2 km). This is maximum design scenario, and the final spacing will be dependent on the layout chosen, which will be defined in consultation with the key maritime stakeholders.
Harbor Operations September 20 2018	Presentation given to Harbor Operations Committee.	n/a
PANYNJ September 21 2018	Concerns over the export cables and associated activity impacting commercial traffic's ability to berth within harbor limits was raised.	Impacts associated with the export cables are assessed in Section 12, noting that this includes effects on port access from cable installation works.
	Concerns raised from a mariner's point of view over wake effects of the wind farm and potential allision risks to vessels NUC.	Impacts associated with the wind turbines and NUC vessels are assessed in Section 12.
USCG and Harbor Operations Sub-Committee June 19 2019	Preliminary findings of the buffer sensitivity analysis were presented and discussed.	See Section 5.3.2.
	Key areas of stakeholder concern raised as drifting allision, SAR, anchored vessels and cables, cumulative impacts, transiting fishing vessels, assessment of TSS traffic, safety case for 1 nm separation, and assessment based on worst case parameters.	▪ Drifting allision: Section 10.3.3.3; ▪ SAR: Section 12.6; ▪ Anchored vessels and cables: Section 12.7; ▪ Cumulative impacts: Section 13; ▪ Transiting fishing vessels: Section 12.4; ▪ assessment of TSS traffic: Section 7.3; ▪ Safety case for 1nm separation: Section 5.3.2; and ▪ Worst case parameters: Section 4.6.
	Concerns with radar interference and collisions with vessels within the wind farm.	Effects associated with radar interference are considered in Section 9.9.

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
Hudson River Safety, Navigation, and Operations Committee May 14 2020	Discussion of construction logistics for Gravity Based Structure foundation transport along the Hudson River. The importance of consultation with and eventual use of local operators for waterway expertise was emphasized.	Gravity Based Structure transport and local operator engagement has been addressed in Section 12.8 and in Attachment H, Port Addendum. Subsequent to this discussion, the gravity based structure foundation was removed from the PDE (see Section 4.2.2).
AWO June 22 2020	Queries raised over cable burial depths / protection.	A cable burial risk assessment will be undertaken as per Section 14.
CSA June 23 2020	In general operators will expect organizations (e.g., USCG, CSA) to respond to key areas of concern on their behalf, rather than respond themselves, and effective outreach is therefore important.	Consultation has been undertaken at both an organizational and operator level, as per this section of the NSRA (Section 3).
	Queries were raised over the quality of the marine traffic data utilized within the NSRA.	As per Attachment B, the marine traffic data utilized meets (and exceeds) the requirements of NVIC 01-19. Further, as per Section 7.1, Anatec has made reasonable effort (as far as is practicable) to ensure the data is checked, and carefully considered any limitations associated with the data.
WSC June 29 2020	It was queried whether potential for future increases in vessel size has been considered within the NSRA.	The approach to future case modelling of commercial vessels is considered conservative as discussed in Section 7.5.1.
	Concerns were raised over ability to maneuver within the TSS lanes bordering the Lease Area once structures were installed (e.g., turning circles).	This is discussed in Section 5.3.3.
	Concerns were raised over there being sufficient room for vessels to anchor between the TSS lane and wind farm in an NUC scenario.	This is discussed in Section 10.3.3.3.

Organization / Date	Comment(s)	Response to Comment and/or where Addressed in NSRA
	It was queried whether the Project assumed a 1 nm (1.9 km) setback as a starting point or whether other options were considered.	As per Section 5.3.2, a buffer sensitivity analysis was undertaken to assess setbacks of 1, 1.5 and 2 nm (1.9, 2.8 and 3.7 km). Each of these setbacks was observed to be tolerable based upon the assessment.
Harbor Operations October 7 2020	Discussion of updated setback assessment and justification.	Setback justification is addressed in Section 5.3

3.2 Regular Operator Consultation

3.2.1 Process of Identifying Regular Operators

The year of maritime traffic data assessed (as per Section 7) was used to identify regular operators within the vicinity of the Lease Area. This is a statistical analysis that uses MMSI information to identify vessels from the same operator that transit within the study area. For the purpose of this process, a regular operator was defined as an operator overseeing multiple vessels observed as regularly utilizing the area on defined routes including those vessels utilizing the TSS lanes. Additional analysis (at a high level) was also undertaken to ensure operators with vessels transiting in the vicinity of both the Lease Area and operational UK wind farms were included.

3.2.2 Identified Regular Operators

The operators that were identified and selected on this basis were subsequently contacted and provided with information of the Project and a request for a consultation response. The operators contacted, and a summary of the output of the process is presented in Table 3.2. As indicated by the table, no concerns with regards to the Project have been raised to date by the operators contacted. It is noted that while this does not necessarily mean there are no concerns, historical experience demonstrates that operators would typically respond where significant concerns exist.

It is noted that as per Section 3.1, consultation has also been undertaken with the AWO, WSC and CSA.

Table 3-2 Regular Operator Consultation Summary

Operator	Response Summary
BBC Charting GmbH	No response to date.

Operator	Response Summary
BW Tankers	Responded with no comment.
Hafnia Seaways	No response to date.
Dampskibsselskabet Torm	No response to date.
Seatrade	No response to date.
Wilhelmsen Ship Service	Acknowledged receipt.

For reference, Attachment F includes a template version of the letter (redacted as appropriate) which was sent to the identified operators.

4 Project Description

The Project description within this NSRA presents those aspects of the Project Design Envelope deemed relevant to shipping and navigation, and the associated impact assessment. The following subsections outline the maximum extent of the Project parameters for which any impacts identified are assessed.

4.1 Development Boundaries

4.1.1 Lease Area

An overview plot of the location of the Lease Area is shown in Figure 4.1. Following this, a detailed view is shown in Figure 4.2. Bounding coordinates (given in World Geodetic System 1984 (WGS84) Universal Transverse Mercator (UTM) Zone 18 North (N)) of the Lease Area are then shown in Table 4.1. The positions of which are included in Figure 4.2 for illustration. Note that these coordinates provide an area bounding the Lease Area, rather than the Lease Area itself.

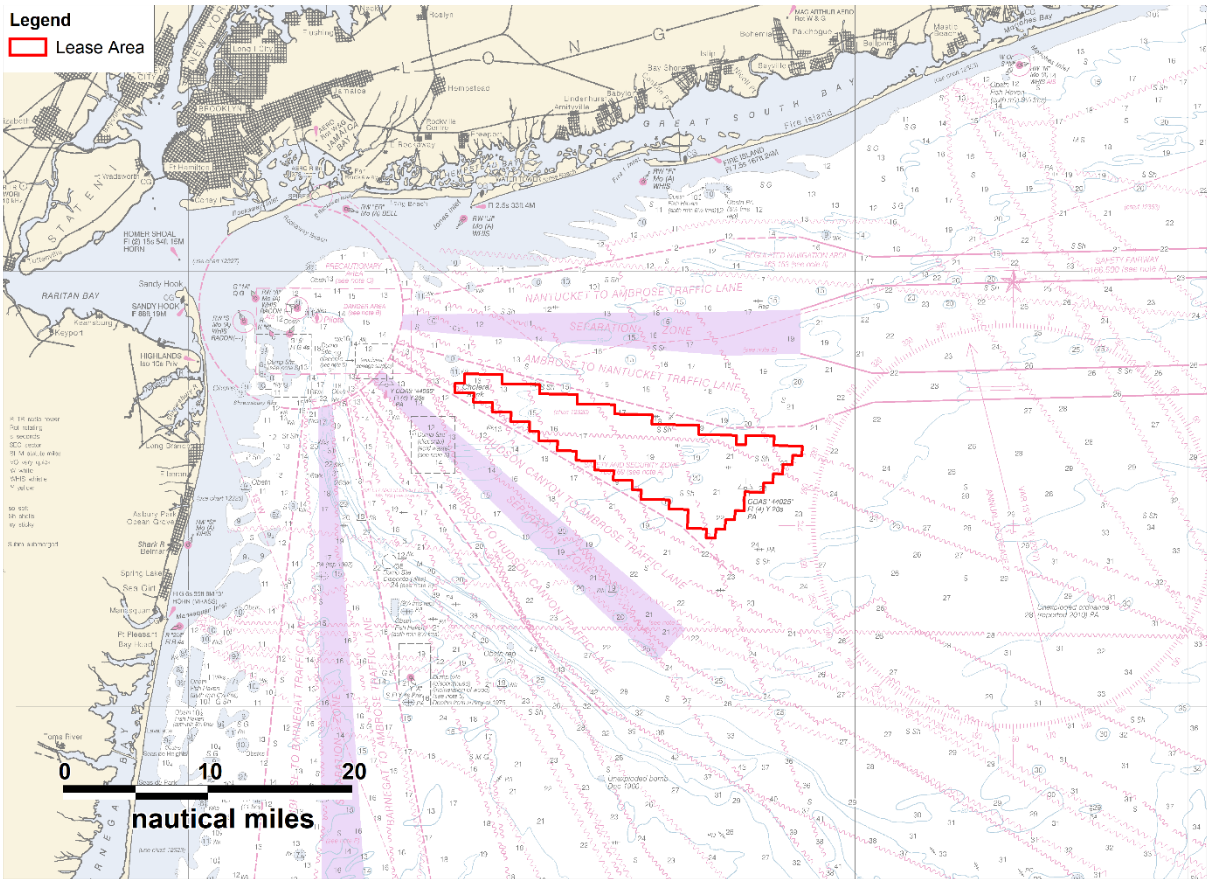

Figure 4.1 Lease Area Overview

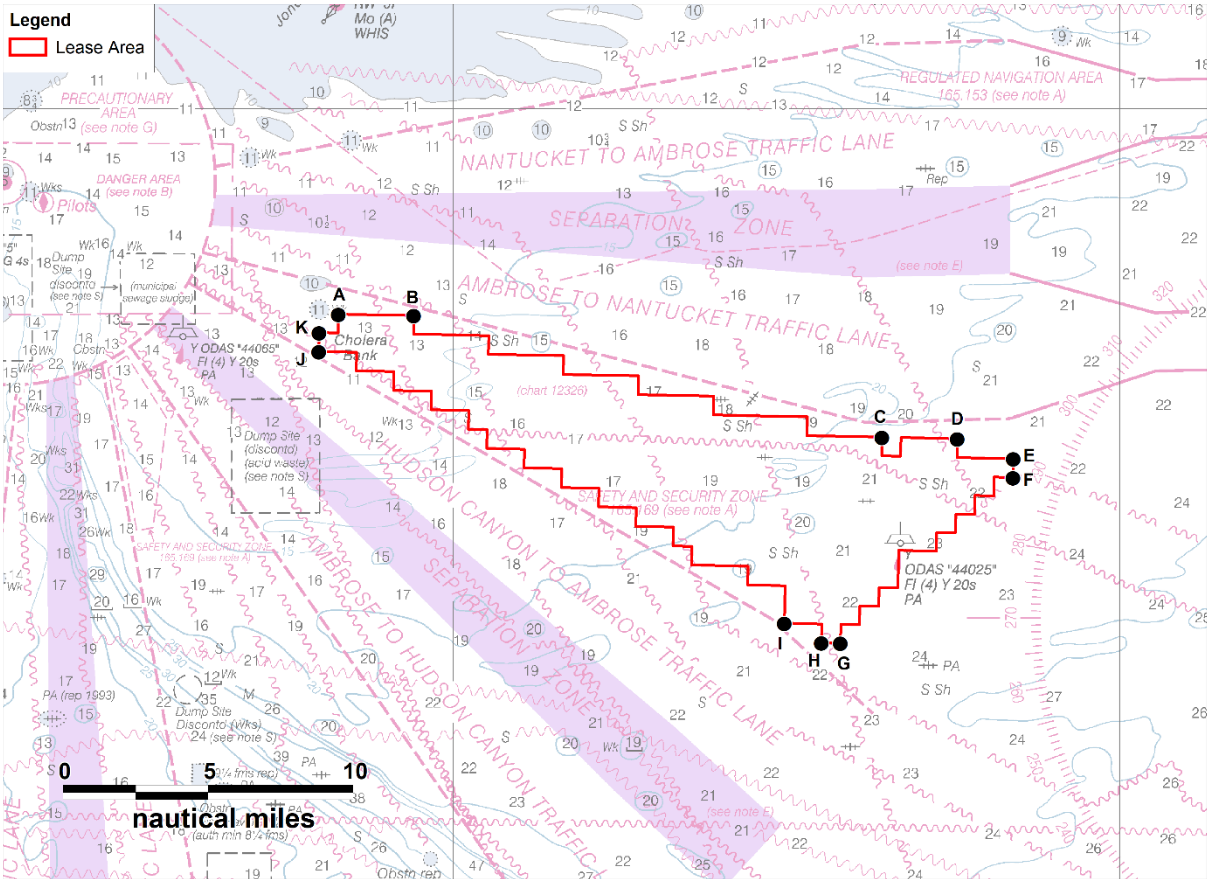

Figure 4.2 Detailed Site Overview

Table 4-1 Bounding Coordinates of the Lease Area (WGS84 UTM Zone 18N)

Point	Longitude	Latitude
A	073° 35’ 10.62” W	40° 22’ 57.92” N
B	073° 31’ 47.10” W	40° 22’ 55.38” N
C	073° 10’ 41.61” W	40° 18’ 43.86” N
D	073° 07’ 18.35” W	40° 18’ 40.61” N
E	073° 04’ 47.01” W	40° 17’ 59.21” N
F	073° 04’ 48.12” W	40° 17’ 20.31” N
G	073° 12’ 34.53” W	40° 11’ 37.53” N
H	073° 13’ 25.26” W	40° 11’ 38.32” N
I	073° 15’ 05.72” W	40° 12’ 18.76” N
J	073° 36’ 03.11” W	40° 21’ 40.72” N
K	073° 36’ 02.30” W	40° 22’ 19.63” N

4.1.2 Wind Farm Developable Area

Based on the outputs of preliminary assessments and considering precedence from European wind farms, Empire has committed to maintaining a minimum 1 nm (1.9 km) separation between the southern and northern periphery structures and the bordering TSS lanes. This is built into the Layout Rules (see Section 5.2.5), and has been discussed with the key stakeholders during the consultation period.

On this basis, the area within which structures can be built within the existing Lease Area, hereafter referred to as the Wind Farm Development Area (WFDA), is shown in Figure 4.3. This does not include sub-seabed structures such as interarray cables, which may still be installed within the Lease Area.

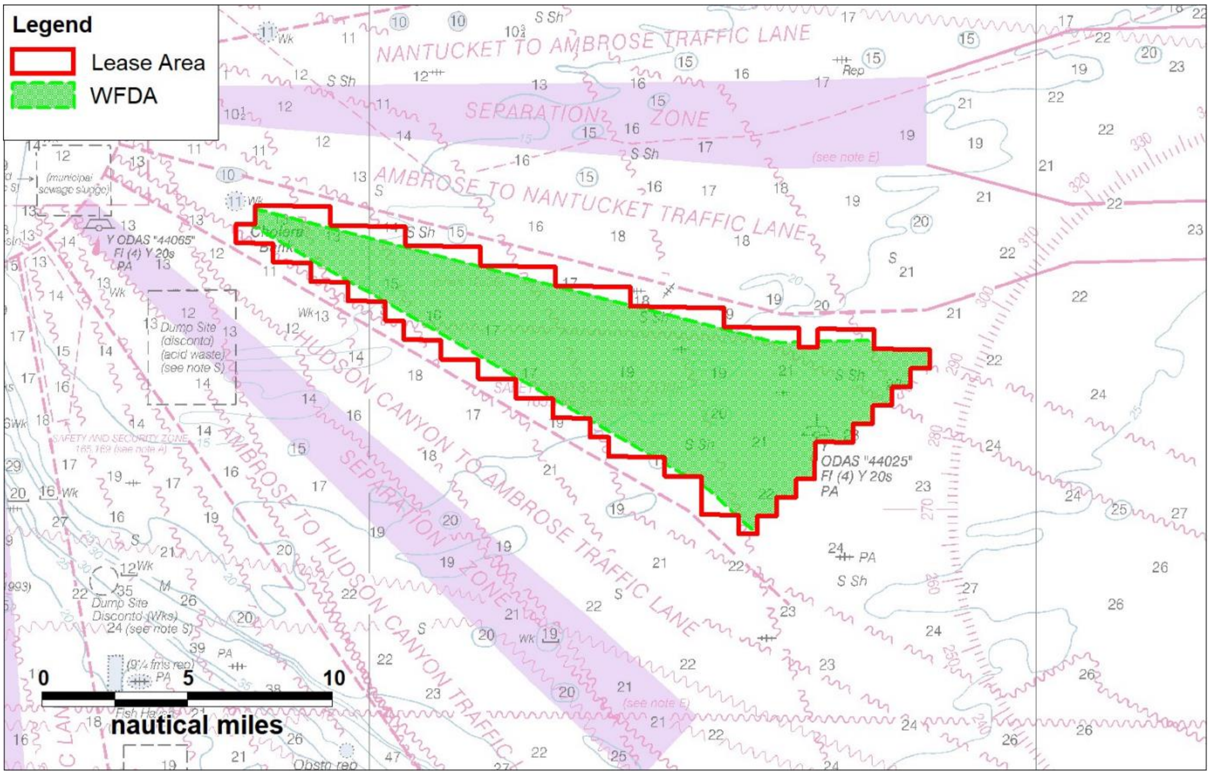

Figure 4.3 WFDA relative to the Lease Area

4.2 Array Infrastructure

4.2.1 Layout

Empire is considering various structure layouts at the time of writing, which is influenced by various constraints. For example, geology, offtake, wind resource and other environmental and social impacts. For the purposes of this NSRA, maximum design parameters (from a shipping and navigation perspective) have been assessed. This will ensure that the risks associated with what is constructed will be ALARP, regardless of the final parameters. This is discussed further in Section 4.6, where the layout chosen for modelling is also presented.

The Project's contractual commitments to New York for EW 1 (816 MW) and for EW 2 (1,260 MW), totaling 2,076 MW, will require a need for a total of up to 149 foundations to be installed. This number of foundations will allow for:

- Two offshore substation foundations;
- 138 turbine foundations for the "exact" total capacity under contract; and
- Additional nine turbine foundations to allow for overplanting[13].

Based on consultation to date and preliminary allision assessment, Empire has committed to ensuring the final layout will have at least a 1 nm (1.9 km) buffer zone between its periphery structures and the bordering TSS lanes. Furthermore, for the purpose of ensuring risks associated with the Project to shipping and navigation receptors are ALARP, Empire has defined a set of Layout Rules (which include provision for the 1 nm (1.9 km) separation distance), which the final layout will adhere to. These rules are presented in Section 5.

4.2.2 Foundation Types

Monopile foundation is the primary foundation type under consideration for the wind turbines. The offshore substations will be installed on piled jackets.

4.3 Cables

4.3.1 Export Cables

There are several potential landfall options under consideration for the export cables; four at Long Beach, NY, and one at Gowanus Bay, NY. The routes corresponding to these landfalls are shown in Figure 4.4. It is noted that the EW 1 route has variant options, also shown in Figure 4.4. Approximate lengths of each cable route (including variants) are given in Table 4.2.

The cables will be buried, with external protection utilized where target burial depths are not feasible and residual risk remains. Target burial depth is anticipated to be at least 6 ft (1.8 m) in areas not under federal management (i.e., outside of navigational channels and anchorages) and 15 ft (4.6 m) in federally managed areas[14]. Target burial depths will be defined based on cable burial risk assessment, stakeholder feedback (most notably from the U.S. Army Corps of Engineers), and geotechnical conditions.

Rule 10(E)(l) of the International Regulations for the Prevention of Collisions at Sea (COLREGs) states that *'a vessel restricted in her ability to maneuver when engaged in an operation for laying a submarine cable, within a traffic separation scheme, is exempted from complying with this rule to the extent necessary to carry out the operation'.*

[13] Overplanting is currently under review for both EW 1 and EW 2. Overplanting allows improvement in turbine availability (i.e., availability during maintenance outages) and potentially increased production at lower wind speeds.

[14] Per U.S. Army Corps of Engineers guidance, in areas where existing conditions are shallower than authorized depths, cable burial shall target 15 ft (4.6 m) below the authorized depth, which would result in burial deeper than 15 ft (4.6 m) from surface sediment.

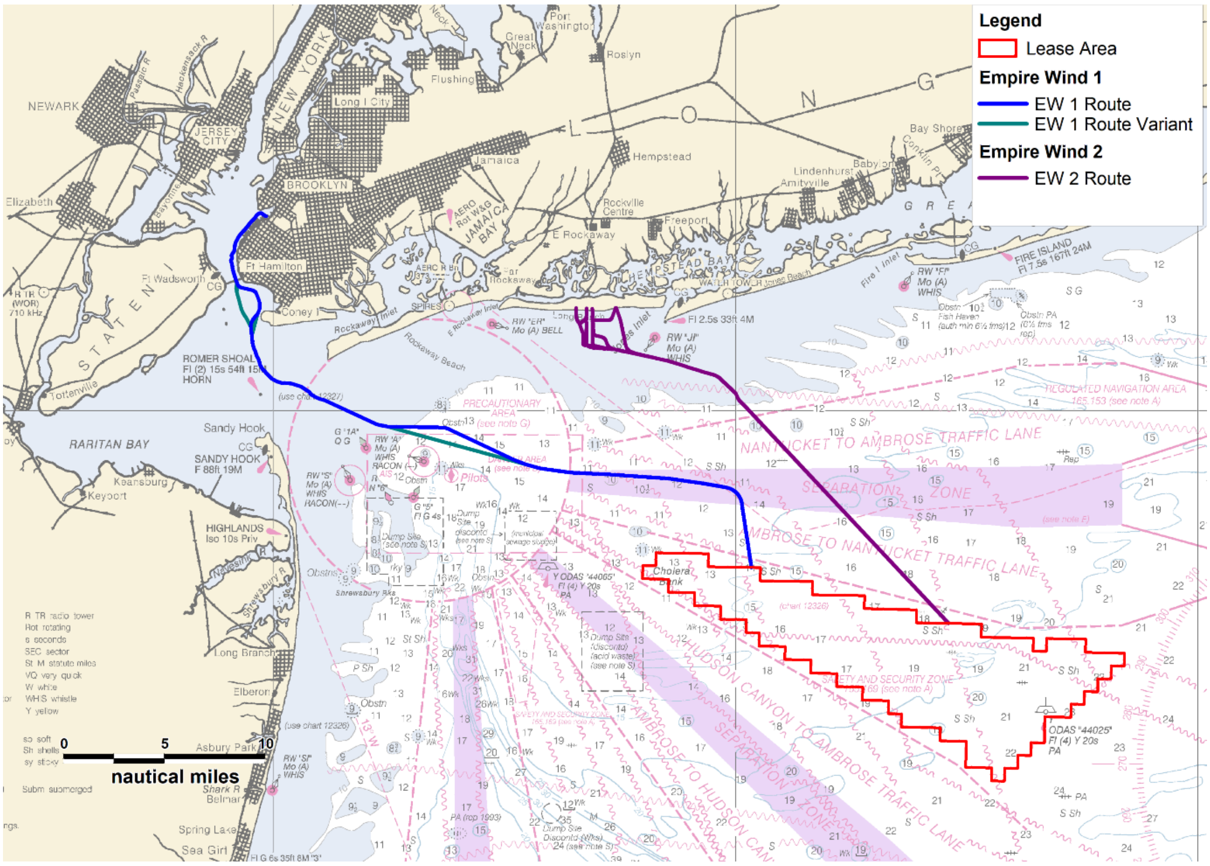

Figure 4.4 Export Cable Routes

Table 4-2 Approximate Cable Route Lengths

Cable Route (Landfall)	Approximate Length (nm)	Approximate Length (km)
EW 1 Route	40	74
EW 2 Route	26	48

4.3.2 Inter Array Cables

The number and arrangement of array cables will be dependent on the final turbine layout, with maximum length utilized estimated at 299 mi (481 km). Target burial depth will be at least 6 ft (1.8 m), with consideration for external protection where target burial depths are not feasible, as needed. As for the export cables, target burial depths will be defined based on cable burial risk assessments, stakeholder feedback, and geotechnical conditions.

4.4 Marine Coordination

The Project will establish a marine coordination center prior to the commencement of construction to ensure that Project vessel movements are managed. The marine coordination center 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 turbines; and
- Conducting personnel offshore certification checks.

In the event of an incident, the Marine Coordinator would take on the role of Operations Section Chief. In coordination and cooperation with the relevant authorities, they would be responsible for the management of all operations directly applicable to the site of the incident, to maintain contact with and support the allocation of resources where required.

4.5 Timescales

An indicative Project timeframe is presented in Table 4.3. The dates presented are dependent on a variety of factors, and are therefore subject to change. It is anticipated that the Lease Area will be constructed over two phases, as illustrated in Section 4.6.1.

Table 4-3 Project Timescale

Project Stage	Anticipated Date
Assessment Activity	2017 to 2020
Federal & State Permits and Submission	2020 to 2022
Permit Review	2020 to 2023
Initiate Offshore Construction (1st phase)	2024

4.6 Maximum Design Scenario

This Section sets out the "maximum design scenario" (i.e., the Project Design Envelope as per Section 2.4). This refers to the set of parameters in terms of structures and associated infrastructure (that could realistically be used for the Project) that would have the maximum impact on shipping and navigation users.

4.6.1 Layout

For the purposes of this NSRA, a layout comprising 174 turbine positions and two offshore substation locations has been used as input to the allision and collision modelling. To ensure the final layout is within already assessed parameters, the maximum design scenario from a shipping and navigation perspective (in terms of layout) has been applied. On this basis the layout is shown in Figure 4.5.

It should be noted that by applying the Layout Rules, the maximum design scenario which presents a 'worst case' (shipping and navigation) layout already has substantial embedded mitigation[15] applied.

It is considered that any subsequent layout that could feasibly be chosen to be constructed will result in the same or lesser impact than the layout assessed within this NSRA, assuming the following:

- It complies with the Layout Rules (see Section 5); and
- It does not exceed 174 turbines and two offshore substations.

In this regard it is noted that as per Section 4.2.1, the current envelope assumes a maximum of up to 149 foundations. Given this is fewer than has been modelled, the current envelope is considered as being within the worst case parameters assessed for the purposes of the modelling.

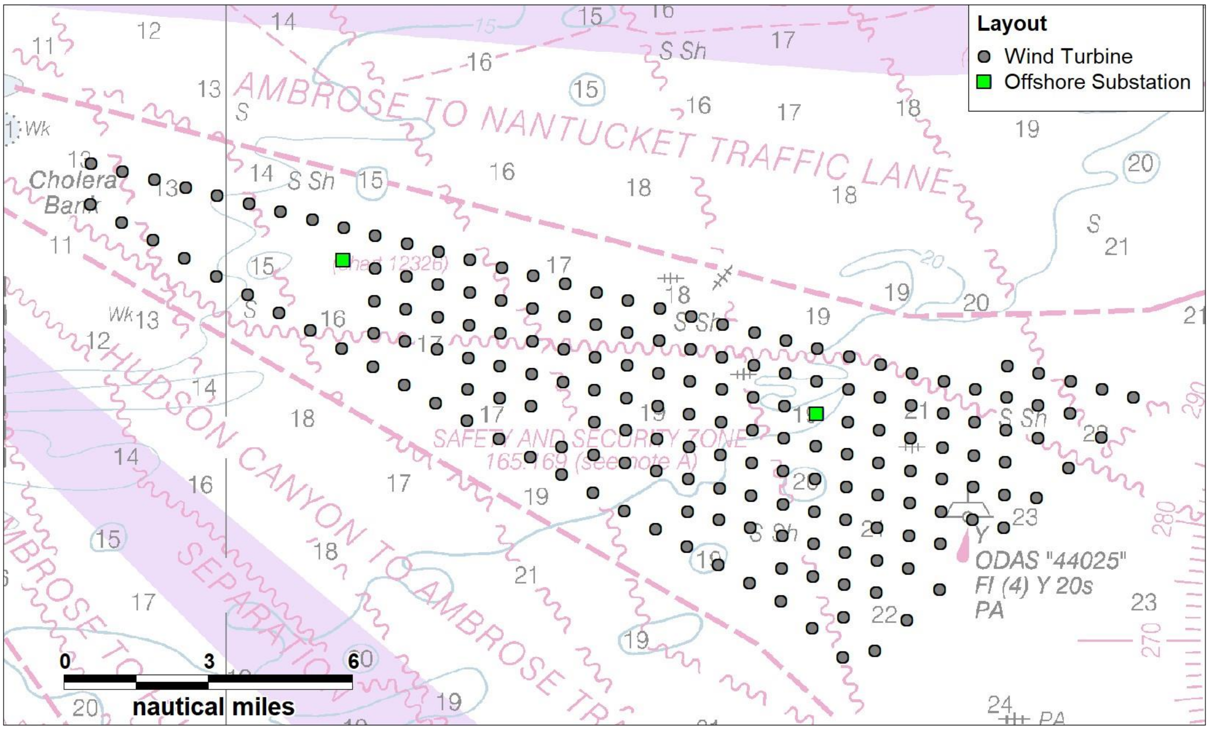

Figure 4.5 NSRA Layout – Maximum Design Scenario (structures not to scale)

It is noted that minimum distance between closest adjacent turbines will be at least 0.65 nm (1.2 km).

It should be considered that structure positions are not finalized, however the layout shown in Figure 4.5 has been chosen as being representative of what will be constructed while also being reflective of the maximum design scenario. The final layout will comply with the Layout

[15] Embedded mitigation refers to measures put in place and committed to as this stage of development; therefore they can be considered as part of the risk assessment process.

Rules, and all wind turbines and offshore substations will facilitate at least one line of orientation.

4.6.2 Structure Parameters

From an allision perspective, the foundation type chosen for the maximum design scenario (for shipping and navigation) is that with the greatest surface level dimensions. Based on the options available (see Section 4.2.2), the worst case dimensions modelled are 39 x 39 ft (12 x 12 meters (m)) at surface level. Substations have been modelled at dimensions of 203 x 194ft[16] (62 x 59m).

No specific orientations have been modelled (i.e., a 0^{o} degree orientation of the structure lengths has been assumed), noting that the wind turbines have been modelled as circles and the offshore substations have been modelled as rectangles.

It is assumed that the layout could include a combination of foundation types which would not change the risk of allision and shall comply with Rule 3 – Layout Clarity of the Layout Rules (see Section 5.2.3).

4.6.3 Cables

It will be assumed that two export cables are installed, with landfalls at Long Beach (NY) and Gowanus Bay (NY) as per Section 4.3.1.

[16] It is noted that the PDE was updated in late 2021 into early 2022. As a result, maximum values for the offshore substation topside dimensions were changed from 203 x 194 ft (62 x 59 m) to 230 x 230 ft (70 x 70 m). This is not deemed to have changed the outputs of the risk assessment.

5 Layout Rules

5.1 Background

During the development of the Project, Empire has worked to create Layout Rules which were developed through engagement with regulatory agencies and maritime stakeholders. These rules will be used to shape the final proposed array layout(s), and which restrict the array patterns employed in order to address particular navigational topics, stakeholder concerns, or environmental sensitivities. Empire has opted to impose these rules on the Project in an effort to develop an outcome that promotes both safety and the shared use of the surrounding waterways, while also maintaining adequate design flexibility. This flexibility allows Empire to apply the best available technology at the time of investment decisions and also provides the ability to adapt to stakeholder requirements during the regulatory process. The final wind farm layout will comply with these rules to the greatest extent practicable. As per Section 3, these rules were presented to the USCG and other stakeholders during consultation. The proposed rules are set out in the following subsections.

5.2 Rule Descriptions

5.2.1 Rule 1: Layout Pattern and Regularity

The position of all wind turbines and offshore substation platforms (except those covered by Rule 2 below) shall, so far as is practicable, be arranged in straight and easily understandable patterns within individual wind farm site layouts, avoiding structures which break this pattern and without any dangerously projecting peripheral structures.

Reason: To facilitate safe navigation, aid in the location of casualties or incidents during emergency response, and to avoid creating an isolated hazard in or around the wind farm, while also allowing the flexibility to optimize wind turbine arrays with consideration for issues such as local geology, seabed obstacles, and energy capture.

5.2.2 Rule 2: Perimeter-Type Layouts

The position of all wind turbines and offshore substation platforms forming a line of perimeter structures around a wind farm development area shall, so far as is practicable, be arranged in straight or curved lines[17] in an understandable pattern, avoiding structures which break this pattern and without any dangerously projecting or peripheral structures.

Reason: To facilitate safe navigation, aid in the location of casualties or incidents during emergency response, and to avoid creating an isolated hazard in or around the wind farm, while also allowing the flexibility to optimize wind turbine arrays with consideration for issues such as local geology, seabed obstacles, and energy capture.

[17] Curved refers to a gentle curve due to minor deviations from the centre line of a wind turbine row. It would still allow SAR access to occur.

5.2.3 Rule 3: Layout Clarity

Any changes in wind turbine size and separation distance within the Lease Area will be introduced so as to minimize potential visual confusion for any vessel navigating through the wind farm. For example, should the Lease Area be built out as individual wind farms in phases, a future wind farm with larger wind turbines should be designed to be distinguishable from, but not significantly different in orientations to existing wind farms previously built within the Lease Area with smaller turbines.

Reason: To facilitate safe navigation for vessels which are working within the Empire Lease Area, (noting an assumption of no significant levels of passing traffic within the zone other than fishing, small commercial, tugs and barges, and recreational craft).

5.2.4 Rule 4: Boundary Clarity

Opposing wind farm site boundaries within the Lease Area, which approach closer than 2 nm (3.7 km) to each other (for example Phase 1 and Phase 2 Projects) shall be aligned broadly parallel with one another and marked to distinguish between separate wind farms. For example, an early phase wind farm would be followed by a later phase wind farm.

Reason: To facilitate safe navigation for vessels which are working within the Wind Farm (noting an assumption of no significant levels of passing traffic within the zone other than fishing, small commercial, tugs and barges and recreational craft).

5.2.5 Rule 5: Proximity to Project Boundaries

All wind farm surface and sub-surface structures, including rotor swept areas, will be located wholly within the relevant wind farm or cable corridor Lease Area boundaries. No permanent above seabed infrastructure will be located in the export cable corridors, save for cable protection, where appropriate.

Reason: To ensure all aspects of the development are within the assessed and permitted areas.

5.2.6 Rule 6: Turbine Spacing

Where feasible, wind turbine spacing should be consistent and as far apart as possible. Maximum spacing in the dominant trawl tow direction where feasible at a minimum spacing no less than 0.65 nm (1.2 km).

Following consultation with the USCG, the requirement for 1 x 1 nm grid (1.9 x 1.9 km) spacing has been discussed. It was noted that this was an output of the MARIPARS process and was specifically designed for SAR helicopter access, allowing them to make a turn within the multiple cumulative developments located within the MA/RI lease areas spanning up to 65 nm (120 km). The OCS-A 0512 Lease Area is significantly smaller in comparison and therefore it is industry standard for helicopters to turn outside of the wind farm array. The 0.65 nm (1.2 km) spacing is understood to be satisfactory for transect flying. For comparison purposes, the OCS-A 0512 Lease Area is 2 nm (3.7 km) wide at the tip, 4 nm (7.4 km) in the center and 8 nm (14.8 km) at the widest part. The presence of TSSs on either side of the Lease prohibits future lease areas adjacent north-south to the OCS-A 0512 Lease Area. Therefore, a similar situation as the MA/RI lease areas would not occur. This NSRA and the Layout Rules have been designed specifically for this Lease Area and the waterways that surround it.

In addition to the above mentioned differences in SAR access due to size/location, this Lease Area also experiences different fisheries. While MA/RI experiences a mix of mobile and fixed gear, there is only mobile gear used within the OCS-A 0512 Lease Area. Lastly, there is no indication of the potential future increase or trend of mixed gear use within the Lease Area as lobster fisheries continue to move north.

On this basis, this area is unique from the MA/RI leases and has been treated as such in terms of spacing.

Reason: To ensure adequate space in rows for Search and Rescue (SAR) activity and to facilitate continued fishing opportunities within the operational area of the Projects.

5.2.7 Rule 7: Rows

There should be at least one line of orientation of rows of turbines with a clear line of sight and heading from one entrance at the perimeter to an exit at the opposite perimeter. Where there is a dense perimeter, but fewer turbines in the wind farm, there should be an ability to conduct SAR flights and trawl tows entering and exiting at the perimeters and maintaining a fixed heading.

Reason: To allow for safe navigation of fishing vessels or small craft within the offshore wind energy development area. Also, to ensure that potential requirements for search and rescue activities are met (for example, the search patterns of SAR helicopters).

5.2.8 Rule 8: Orientation of Rows

Where feasible, align turbines with rows that are sympathetic to the dominant trawl directions of the most active and potentially impacted fisheries. For example, for the Lease Area, a southwest to northeast orientation in line with bathymetry.

Reason: To facilitate continued opportunities for fishing vessels to tow trawls within operational Projects, minimizing modifications to existing practices. For the Lease Area, this is a southwest to northeast orientation in line with bathymetry.

5.2.9 Rule 9: Burial of Cables

Interarray and export cables are to be buried to a target burial depth of at least 6 ft (1.8 m), where feasible. Deeper burial depths are to be targeted as appropriate to CBRAs and regulatory requirements. For example, in federally managed channels, anchorage areas and areas fished by bottom impacting gear.

Reason: To minimize the risk of mariners interacting with offshore wind energy development cables.

5.2.10 Rule 10: Lower Tip Heights

Blade lower tip heights should equal or exceed 85 ft (26 m) above the Highest Astronomical Tide (HAT).

Reason: To ensure safe clearance of recreational and small commercial vessels.

5.3 Setback Justification

Rule 6 (Section 5.2.5) states that a 1 nm (1.9 km) separation distance will be maintained between the wind farm periphery and the neighboring TSS lanes. During the consultation period, Empire undertook preliminary internal studies associated with allision (Anatec, 2018) for the Project. It tested various separation distances between the Project and the TSS lanes to determine the effect on potential allision risk at a preliminary level. This work represented a precursor to the full assessment of allision given in Section 10 of this NSRA. Empire has also studied existing cases of operational wind farms in the UK and Europe to examine typical lane proximities relative to traffic levels.

Based on the work undertaken to date, a 1 nm (1.9 km) separation was deemed appropriate given the following:

5.3.1 Lessons Learned from Existing Projects

Similar scenarios to Empire OCS-A 0512 within the UK utilize a 1 nm (1.9 km) separation distance. Of note are the cases of Greater Gabbard and Galloper, as discussed in detail in Section 2.6.1. As per Section 11.3, there has only been one allision to date within a UK wind farm that involved a third party vessel, and this was a case of internal transit (i.e., separation distance would have made no difference). Therefore, despite multiple UK projects being constructed within proximity to TSS lanes, there have been no associated allision incidents to date.

It is also noted that based on assessment of maritime traffic data, vessels utilizing TSS lanes in proximity to North Sea developments (including the Greater Gabbard and Galloper wind farms mentioned above) also utilize the TSS lanes in the approach to the precautionary area. Any such vessel will already be familiar with navigating in proximity to existing wind farms.

5.3.2 Preliminary Allision Assessment

In support of the *Environmental Assessment for Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf offshore New York* (BOEM, 2016), BOEM conducted a trackline analysis and found that, "…90 percent[18] of the vessels traversing the Traffic Lanes adjacent to the WEA position themselves toward the inner edges of the Traffic Lanes, near the Separation Zone, and away from the WEA…[creating] a de facto buffer that reduces the risk of allision". Further, it was stated that "data collection and analysis could demonstrate that a restriction on the construction of permanent structures (e.g., meteorological towers, or future wind turbines) within 2 nm (3.7 km) of the TSS lanes is unnecessary, and/or that mitigation measures can partially or wholly resolve conflicts".

[18] 90 percent of the 2014 AIS tracklines used in the analysis for those vessels that enter and exit the Traffic Lane from the ends and traveling parallel.

In advance of the NSRA, and for the purpose of informing discussions around an appropriate setback distance, Anatec undertook a preliminary allision assessment (Anatec, 2018). Key findings of the assessment are summarized in Sections 5.3.2.1 to 5.3.2.3.

5.3.2.1 Guidance

The preliminary allision assessment looked at the relevant US guidance available in terms of assessing separation distances between wind farms and TSS lanes. The relevant U.S. guidance was considered to be COMDTINST 16003.2A, which makes reference to MGN 371, the predecessor of MGN 543 (MCA, 2016) (see Section 2.6.1.1).

The assessment compared the contents of COMDTINST 16003.2A with updated MGN 543, with key findings as follows:

- Both COMDINST 16003.2A and MGN 543 make it clear that the recommendations contained therein are guidelines only. Requirements for any given development should be approached on a case by case basis with the relevant regulator;
- MGN 543 no longer includes specific recommendation for siting in proximity to a TSS boundary or 5 nm (9.3 km) buffer zone around TSS terminus points; and
- A distance of less than 0.5 nm (0.9 km) between a shipping route and an offshore wind farm is considered intolerable under MGN 543 recommendations. COMDINST 16003.2A suggests similar, stating that vessels may pass 0.5-1 nm (0.9-1.8 km) from a wind farm if conditions allow. However, greater distances may be required in less favorable conditions.

5.3.2.2 Marine Traffic Assessment

The preliminary allision assessment used 28 days of AIS data as input to assess the baseline vessel activity. Of note, vessels were found to maintain distances of 1.6 nm (3 km) and 1.2 nm (2.2 km) from the Lease Area within the Ambrose to Nantucket (Outbound) and Hudson Canyon to Ambrose (Inbound) TSS lanes, respectively. This assessment has been updated for the NSRA with a data set covering a longer period and assessing passing distances to the WFDA (see Section 4.1.2) as opposed to the Lease Area. This updated assessment is available in Section 7.3, noting that the updated findings aligned with that of the preliminary assessment.

5.3.2.3 Modelling

Allision risk results as estimated within the preliminary allision assessment were considered to be within tolerable limits. It is noted that these were undertaken on a preliminary basis only, and in particular considered the Lease Area as a whole as opposed to modelling individual structures. The initial results are therefore not directly comparable to the full allision assessment undertaken within this NSRA (see Section 10). However, the findings were similar to that of the NSRA, with both powered and drifting allision impacts considered to be within tolerable parameters, assuming a 1 nm (1.9 km) setback.

5.3.3 Baseline Traffic

Based on both the preliminary assessments (Anatec, 2018) and the maritime traffic assessment within this NSRA (see Section 7.3), the majority of traffic utilizing the TSS do not transit close to the lane boundaries that border the Lease Area. As such, traffic would pass in excess of 1 nm (1.9 km) from the WFDA.

MGN 543 states that standard turning circles for vessels are worked on six times the vessel's length, noting that MGN 543 also states that "this is a good assumption when vessels on ocean or deep sea passage will not have the same maneuverability as when engines and systems are prepared for port approach".

In the case of the Project, traffic within the TSS will be accessing or leaving port via the precautionary area. As such, they are likely to be on alert, in contact with New York VTS / pilots, and transiting at lower speeds than for typical transits.

Vessels will also be able to distance themselves as per their passage plan appropriately within the TSS lane based on prevailing conditions, their own maneuverability and other traffic; noting that traffic within the TSS lane is unidirectional and operating under COLREGs Rule 10. It should also be considered that structures are only in place on one side of the TSS lane.

Vessels are known to change fuel approximately 200 nm (370 km) offshore, and any resultant associated drifting incidents would therefore not put a vessel at risk of allision with the wind turbines. As per Section 11.1.2.1, reported baseline NUC incident rates were low, with a total of 23 recorded within 5 nm (9.3 km) over the ten year period studied.

Drifting vessels would likely have a variety of mitigations available in the event of a potential allision (e.g., deployment of anchor) – see Section 12.2.4 for further details within this NSRA.

5.3.4 Mitigation

Various mitigation measures will be in place to minimize allision risks (to both cases of vessels under power and drifting). Full details are included within the mitigations listed in Section 14, with relevant measures including:

- Layout rules (e.g., straight line edges with consistent separation from TSS lanes ensure clear and safe navigation to passing vessels);
- Marking of structures on nautical charts;
- Lighting and marking as per national and international requirements;
- Marine coordination (Project vessels); and
- Traffic monitoring (all vessels).

It is also noted that third party vessels would have a variety of mitigation measures available in the event of a potential allision scenario (e.g., dropping anchor if NUC). Further details are provided in the impact assessment in Section 12.

6 Waterway Characteristics

6.1 Navigational Features

6.1.1 International Maritime Organization Routing Measures

The IMO adopted routing measures within the vicinity of the Lease Area are shown in Figure 6.1. There are three Traffic Separation Schemes (TSS) in the approach to the Port of NY/NJ, all of which converge upon a central precautionary area:

- Nantucket / Ambrose TSS;
- Hudson Canyon / Ambrose TSS; and
- Barnegat / Ambrose TSS.

Approximate dimensions of the two lanes bordering the Lease Area (i.e., the outbound Ambrose to Nantucket lane and the inbound Hudson Canyon to Ambrose lane) are shown in Figure 6.2. It should be noted when viewing this figure that, given the provision of Layout Rule 6 (Section 5.2.5), the distance between the wind farm periphery structures and the TSS lanes will be at least 1 nm (1.9 km).

The “Approaches to New York, Atlantic Ocean” safety/security zone as defined in 33 CFR 165.169 has been included in both Figure 6.1 and Figure 6.2 for reference (noting that it is not a routing measure).

An assessment of the traffic utilizing the bordering TSS lanes is given in Section 7.2.7. This includes assessment of how close vessels typically transit to the peripheries of the lanes (and therefore to the Lease Area/WFDA).

The fairways proposed under the NNYBARS (USCG, 2021) are presented in Section 10.5.

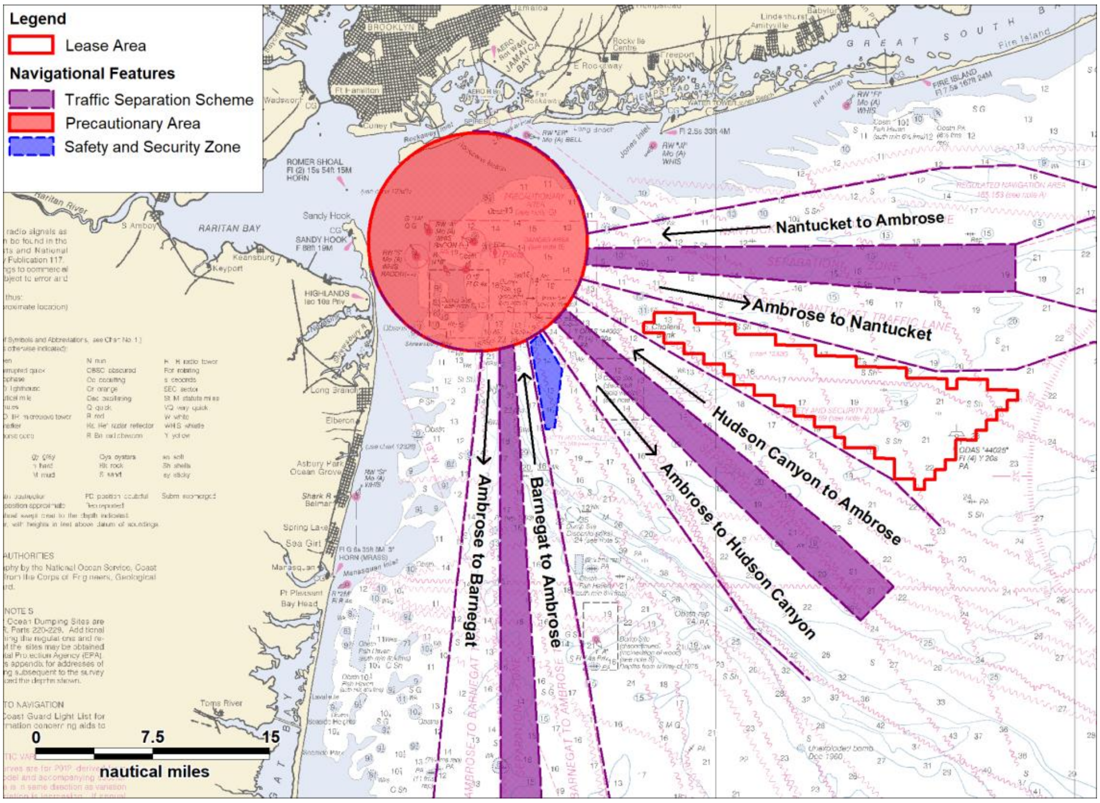

Figure 6.1 IMO Routing Measures

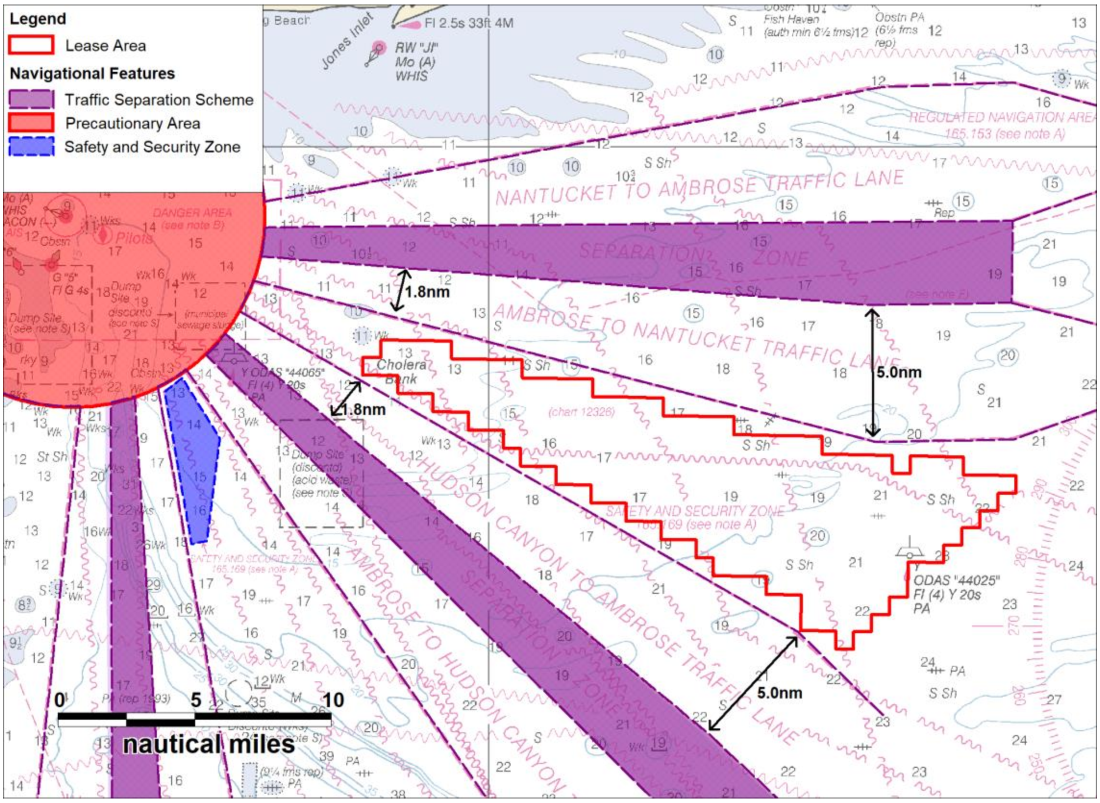

Figure 6.2 Bordering IMO Routing Measure Dimensions

6.1.2 Vessel Traffic Services and Pilotage

A VTS (which includes full radar surveillance) operates for the purpose of managing vessels requiring access to either New York or New Jersey. The VTS area covers the area shown in Figure 6.3, and as defined in 33 CFR 161.25. Included in the figure is the Pilot boarding area, located within the precautionary area. Pilotage is compulsory for registered US vessels and all foreign vessels.

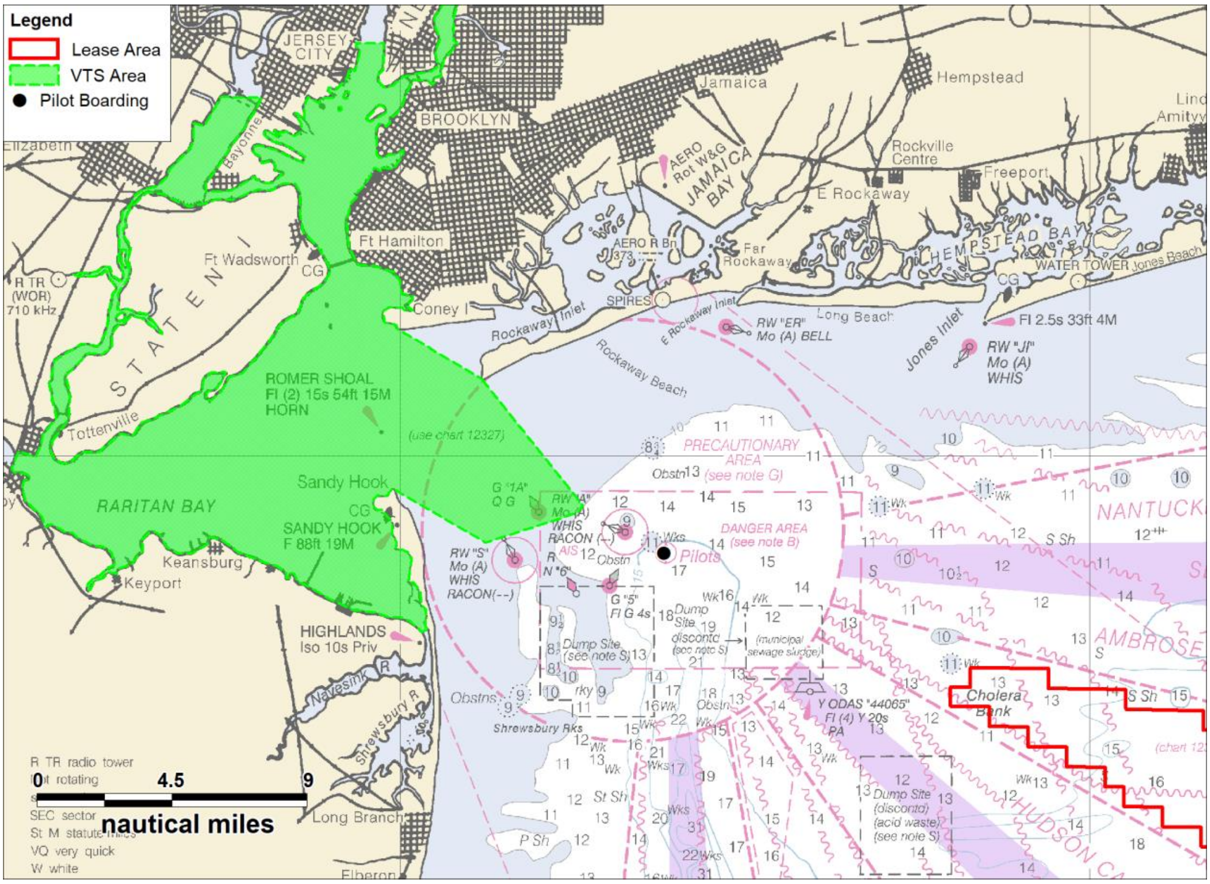

Figure 6.3 VTS and Pilotage

6.1.3 Regulated Navigation Area

A Regulated Navigation Area is established in an area defined by a boundary positioned from the territorial sea limit to the south of Long Island, as shown in Figure 6.4. Vessels transiting this area must comply with regulations set out in the U.S. Coast Pilot 2 (NOAA, 2018), Chapter 2, Section 165.153, including (but not limited to):

- Inspections to the satisfaction of the USCG prior to entry into waters within 3 nm (5.6 km) of the territorial sea baseline for vessels[19] bound for a port or place located in the US;

[19] Noting certain exemptions as detailed in U.S. Coast Pilot 2 (NOAA, 2018), Chapter 2, Section 165.153, (3).

- Vessels[20] bound for a port or place located in the US must obtain permission of the Captain of the Port (COTP) prior to entry into waters within 3 nm (5.6 km) of the territorial sea baseline, or prior to transiting or engaging in intentional movements (e.g., shifting berth, departing anchorage) whilst within the 3 nm (5.6 km) limit;
- No vessel may enter within a 1,200 yard (yd) radius of any ferry vessel transiting the Long Island Sound Marine Inspection COTP Zone without obtaining permission from the ferry vessel operator/master, and the COTP, or designated COTP patrol; and
- No vessel may enter within a 100 yd radius of any vessel engaged in commercial service while that vessel is transiting, moored, or berthed in the Long Island Sound Marine Inspection and COTP Zone without the express prior authorization from the vessel's operator/master, and the COTP, or designated COTP on-scene representative.

Vessels are still primarily bound by the requirements of COLREGs whilst within the Regulated Navigation Area.

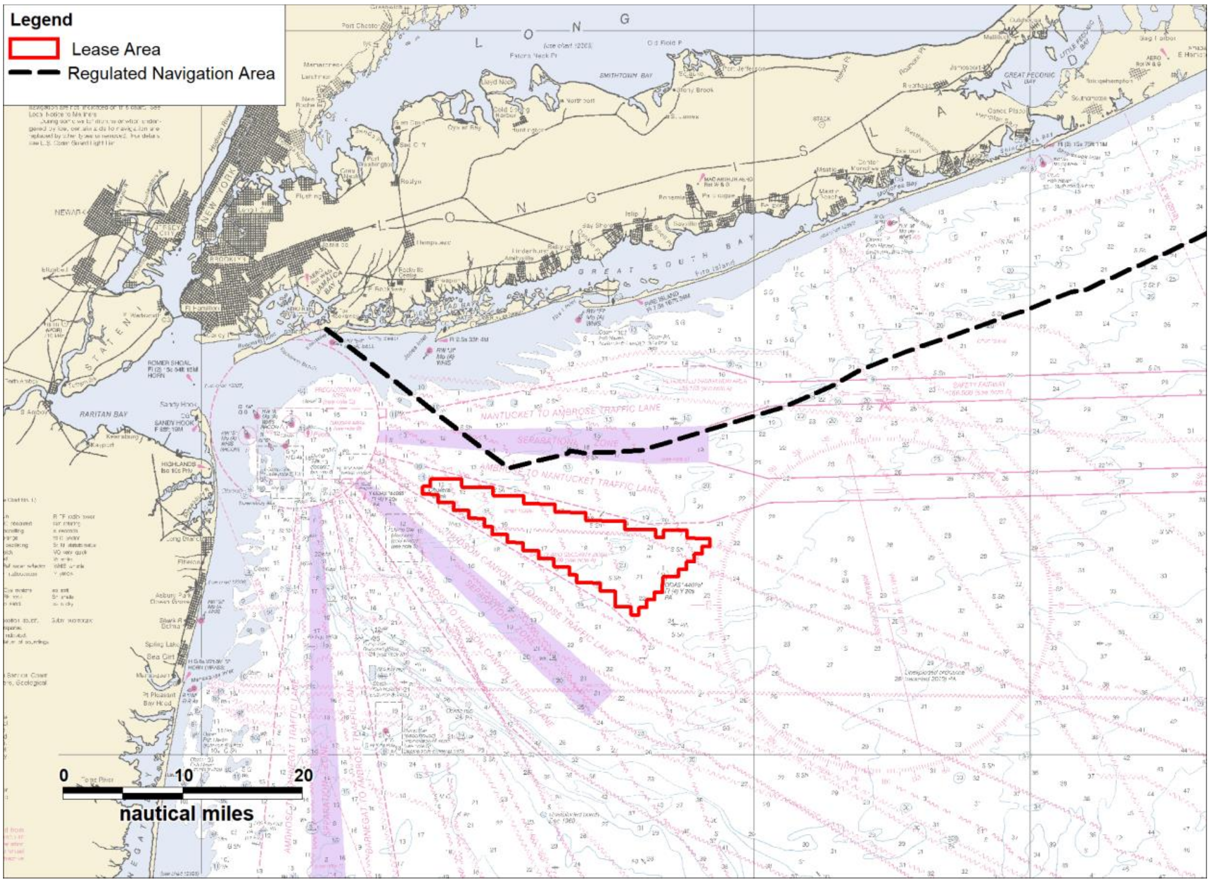

Figure 6.4 Regulated Navigation Area

[20] Noting certain exemptions as detailed in U.S. Coast Pilot 2 (NOAA, 2018), Chapter 2, Section 165.153, (4).

6.1.4 Dredged Channels

Access to port and harbor facilities within the Port of NY/NJ limits are largely via the Ambrose Channel. The Ambrose Channel is a dredged[21] channel approximately 0.3 nm (0.56 km) wide, accessible from the TSS lanes described in Section 6.1.1. Adjoining channels provide access to Sandy Hook and Raritan Bay, as shown in Figure 6.5. While additional channels exist within the various inlets out of the bay, these are omitted from the figure for clarity.

The U.S. Coast Pilot 2 (NOAA, 2018) states the Harbor Operations Committee of the Port of New York and New Jersey recommends that all vessels maintain a minimum under-keel clearance of 2 ft (0.6 m) between their deepest draft and the seabed. A 3 ft (0.9 m) minimum under-keel clearance is recommended in Ambrose Channel due to wave action.

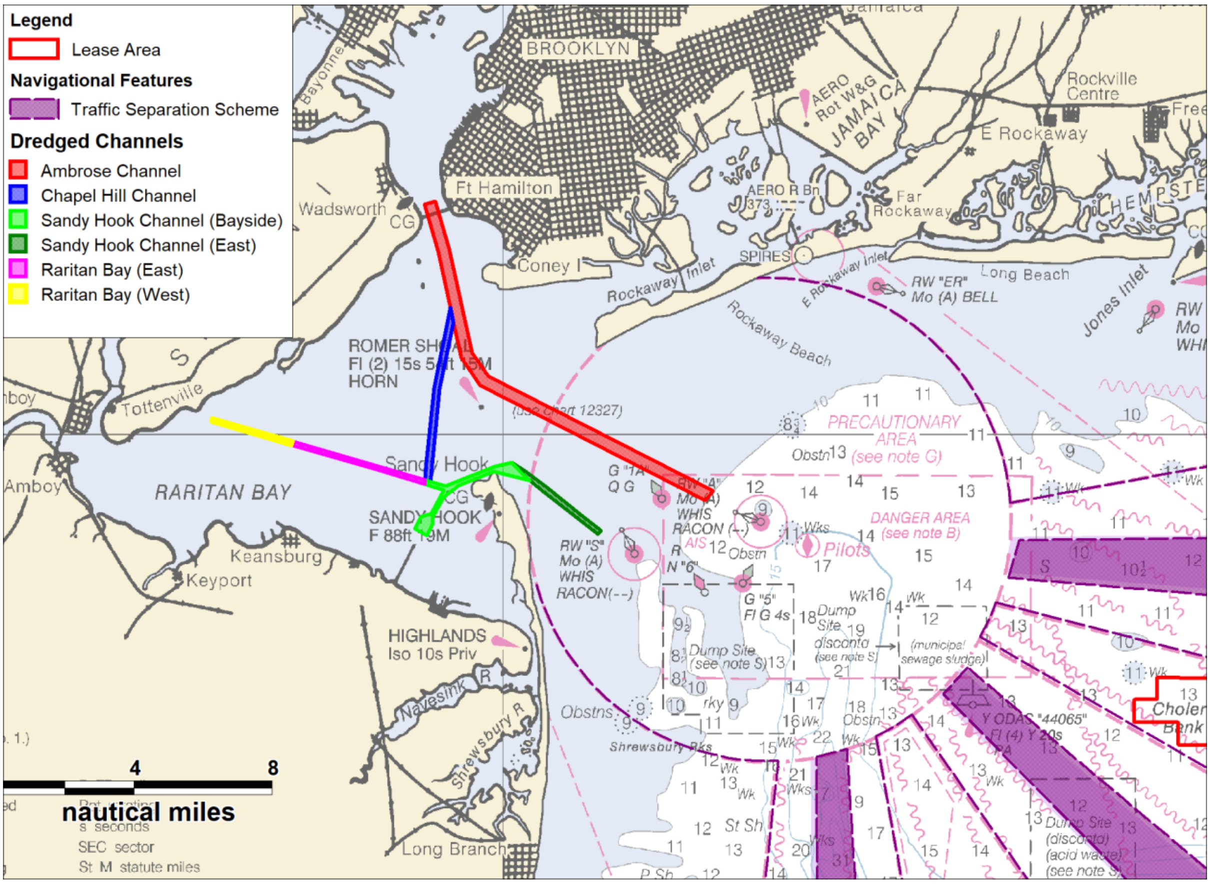

Figure 6.5 Dredged Channels

6.1.5 Aids to Navigation

Aids to Navigation (AtoNs) identified within the vicinity of the Lease Area are shown in Figure 6.6. While strictly not AtoNs, local ODAS buoys have been included. Of note is ODAS Buoy 44025, which is stationed within the very eastern extent of the Lease Area.

[21] Maintained minimum depth; which varies along the channels.

The majority of buoys within the area are those marking the dredged channels within the precautionary area, and include lights, sound signals, and other forms of electronic marking (e.g., AIS, Racon).

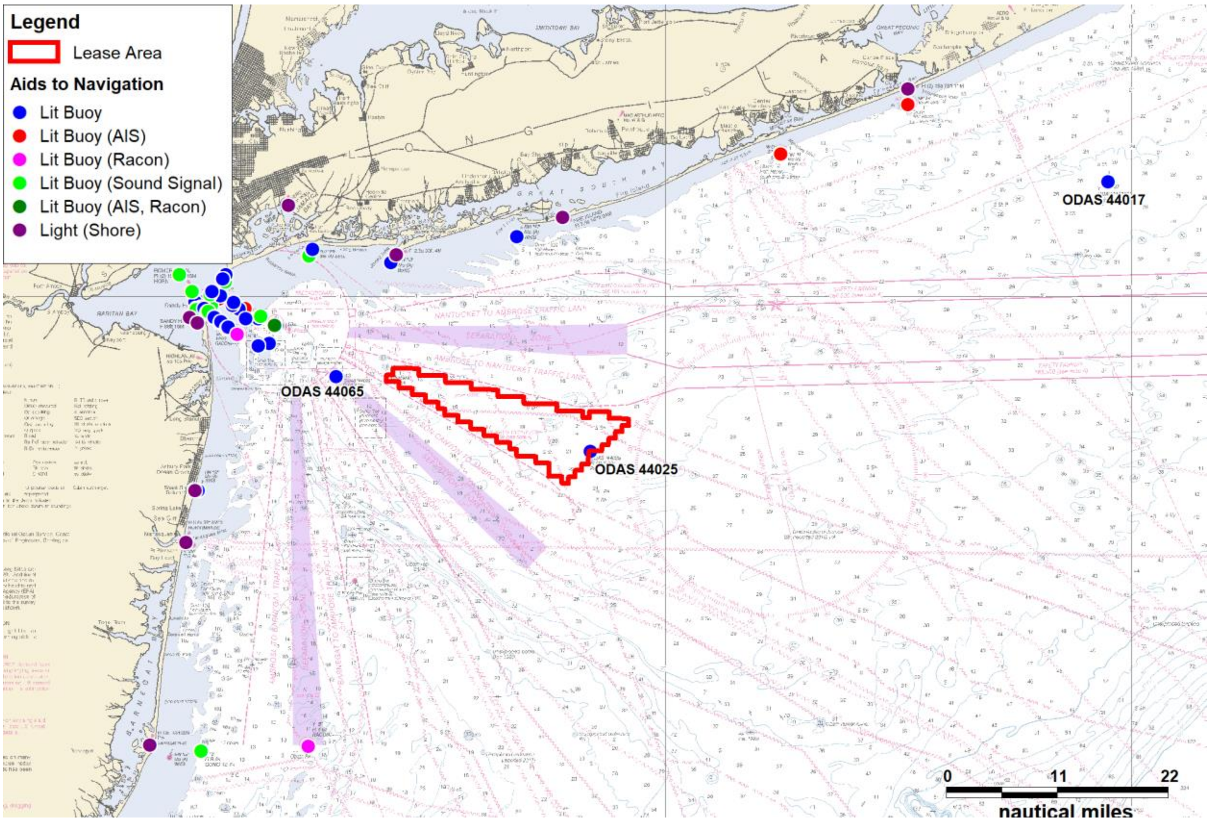

Figure 6.6 AtoNs and Weather Buoys

6.1.6 Dumping Areas and Danger Area

There are a number of dumping sites (both active and discontinued) within the vicinity of the Lease Area, as shown in Figure 6.7, which also shows the type of material associated with each site.

A charted Danger Area exists within the precautionary area (see Figure 6.1), as shown in Figure 6.7. A note on the NOAA charts states that the Danger Area is open to unrestricted surface navigation, but all vessels are cautioned not to anchor, dredge, trawl, or lay cables because of residual danger from mines on the bottom.

As per 33 CFR 165.172, a safety zone is established around unexploded ordnances located southeast of the Verrazano Bridge Brooklyn tower, as shown in Figure 6.7.

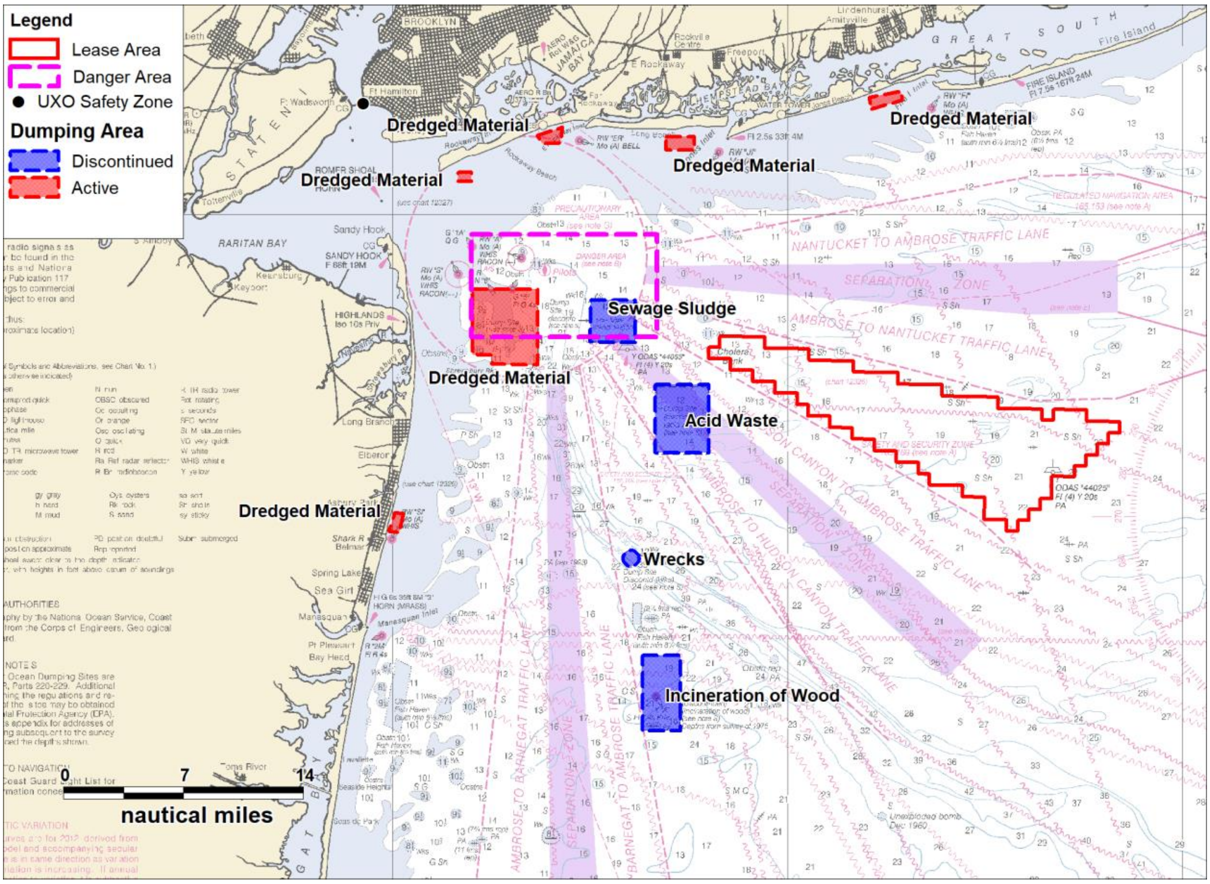

Figure 6.7 Dumping Areas and Danger Area

6.1.7 Anchorage

The U.S. Coast Pilot 2 (NOAA, 2018) states the Port of NY/NJ recommendation that vessels awaiting a berth should anchor offshore (specifically off Ambrose), given the limited availability of inshore anchorage. Based on a review of the anchoring activity identified within the marine traffic analysis (see Section 7.2.5) and additional information provided in the UK Pilot Book for the area (UKHO, 2016), a preferred / recommended anchorage is located north-east of the pilot boarding point clear of charted dangers and hazards. This is currently not a chartered anchorage, however the USCG is considering formally establishing an anchorage ground at this location, possibly with regulations governing its use. On this basis, the proposed USCG Ambrose Anchorage Area (86 Fed. Reg. 17090) is shown in Figure 6.8.

Additional marine traffic analysis in relation to anchoring (including that within the Potential Federal Anchorage Area) is undertaken in Section 7.2.5.

There are also a number of anchorages charted on UKHO charts within the precautionary area and the VTS area. The charted positions are shown in Figure 6.8 relative to the export cables.

The position of Naval Anchorage No. 49-G is included, based on the boundary detailed in 33 CFR 110.155.

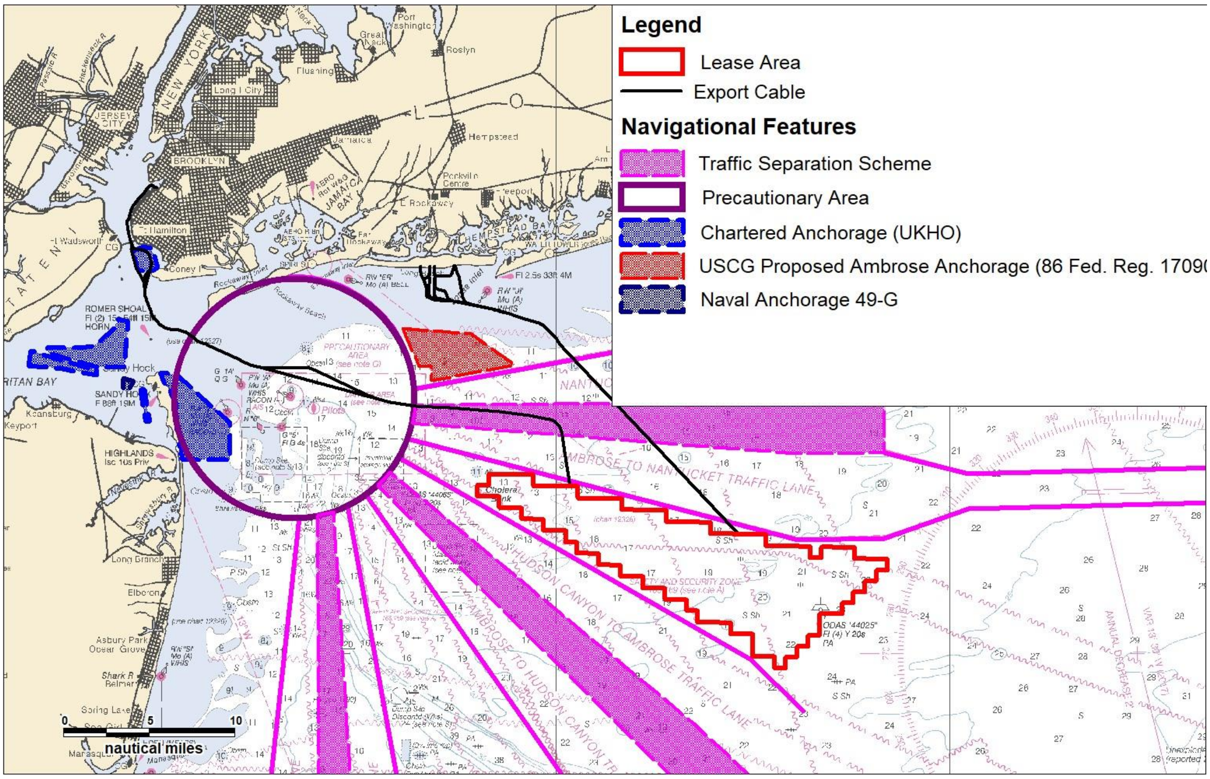

Figure 6.8 Anchorage Areas

6.1.8 Military Areas and Transit Routes

The Lease Area intersects the Narragansett Bay Operating Area (OPAREA), as shown in Figure 6.9. National defense training exercises and system qualification tests are undertaken within this area on a regular basis by the US Navy. The OPAREA also houses military transit lanes, used by US Navy submarines for underwater navigation.

The Atlantic City OPAREA is located approximately 20 nm to the southwest of the Lease Area, and is utilized for United States Atlantic Fleet training and testing exercises.

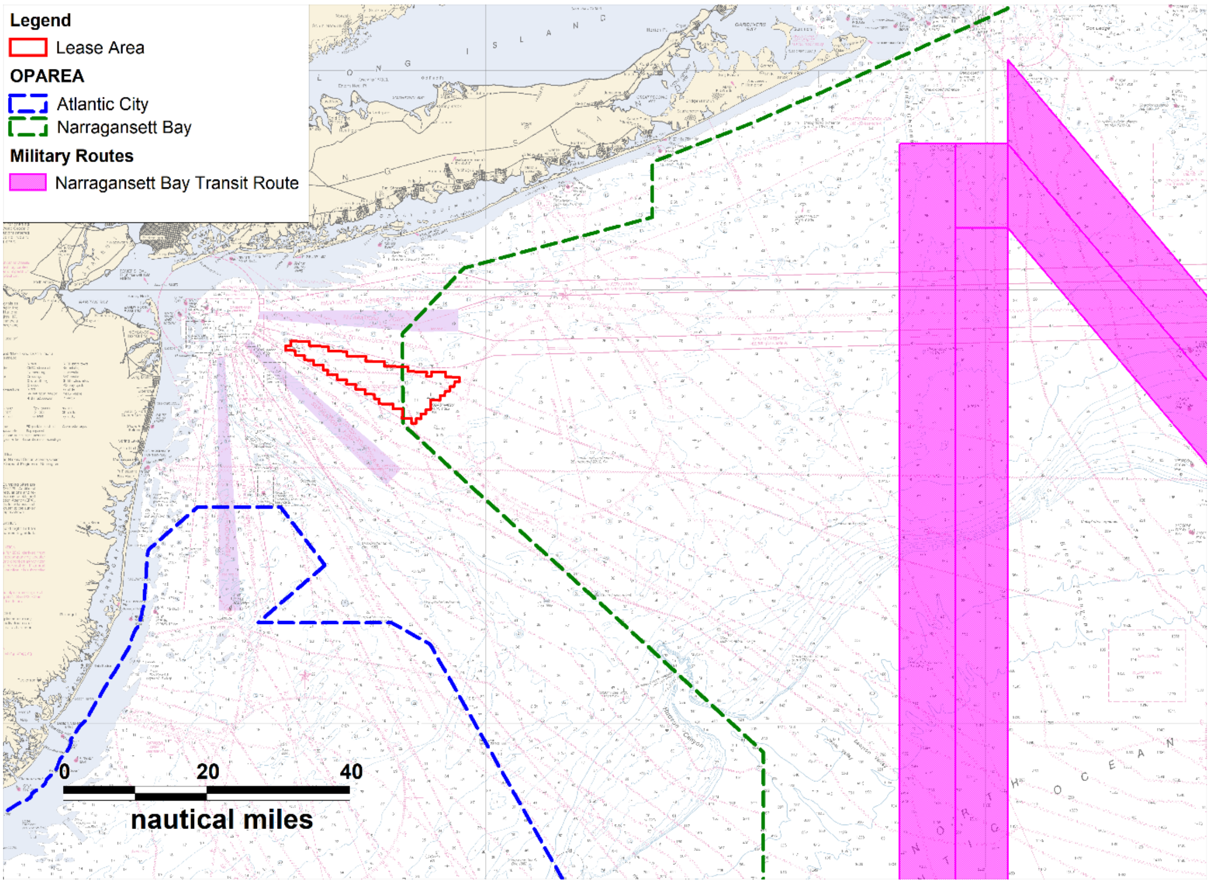

Figure 6.9 OPAREAs and Military Transit Routes

6.1.9 Wrecks and Obstructions

Subsurface wrecks and obstruction data was available from the Office of Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) (NOAA, 2013). NOAA provides both positions of wrecks and obstructions from within the AWOIS records, and also charted wreck positions. All data available within the Study Area is shown in Figure 6.10.

An assessment of wrecks and subsea obstructions relative to the cables will form part of the cable burial risk assessment (see Section 14).

The following limitations are highlighted by NOAA:

- AWOIS records are not comprehensive. There are wrecks in AWOIS that do not appear on the nautical chart and vice-versa;
- In 2016, the Office of Coast Survey stopped updating the AWOIS database; and
- Reported wrecks that have been salvaged or disproved by further investigation are not included in AWOIS.

Based on available information, a total of six (6) wrecks are recorded within the Lease Area.

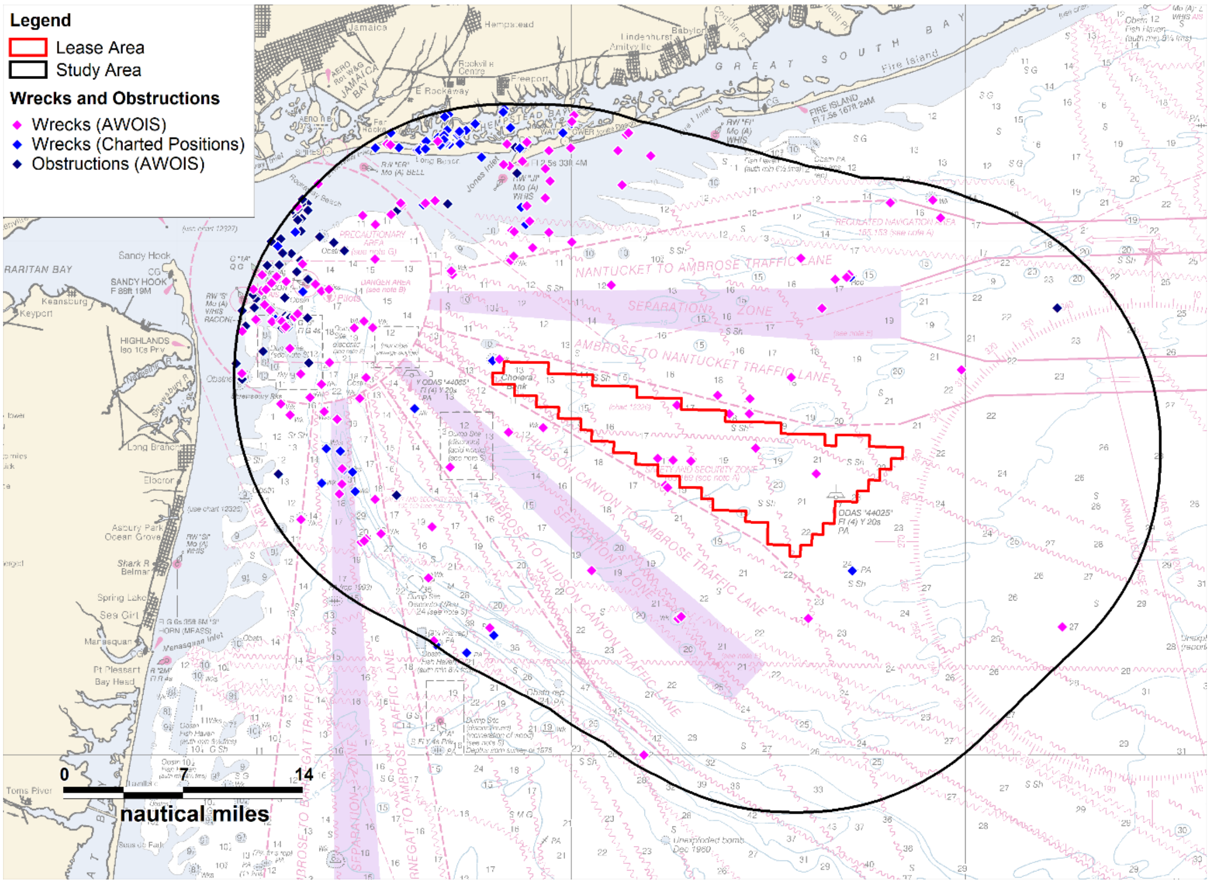

Figure 6.10 Wrecks and Obstructions

6.1.10 Submarine Cables

The submarine cables intersecting the Study Area are shown in Figure 6.11, which also includes the proposed export cable routes for context. Third party cable positions are provided as part of NOAA's data catalogue (NOAA, 2018), and have been checked against the charted positions which are also being confirmed through surveys.

A total of seven submarine cables intersect the Lease Area. The data is not supplied with status details of the cables. However, charted information has been used to identify whether they are active or disused, where such information was available.

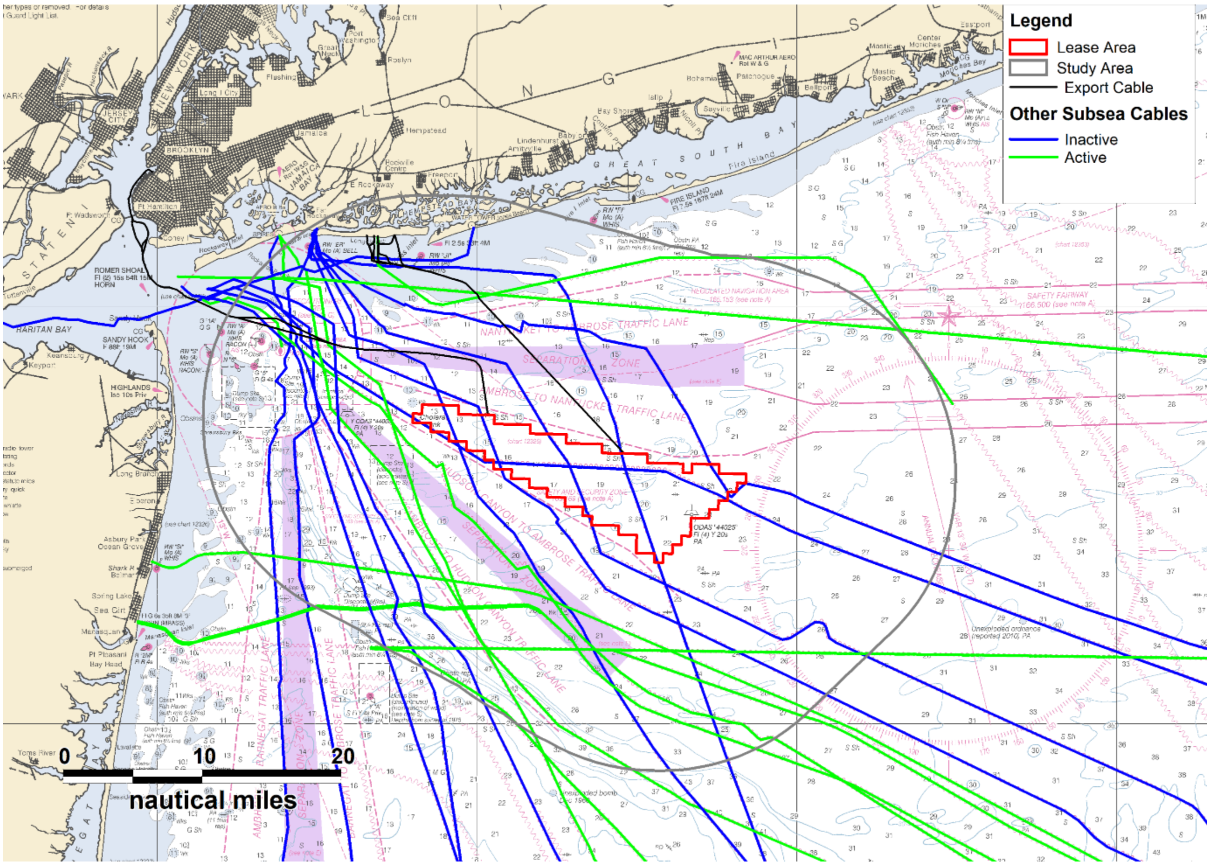

Figure 6.11 Submarine Cables

6.2 Bathymetric Data

The charted water depths within the Lease Area are presented in Figure 6.12, based on NOAA chart 12300 (49th Ed, last corrected 01/19/2019). NOAA presents water depths in fathoms over Mean Lower Low Water (MLLW), and these have therefore been overlaid with the depth in ft over MLLW in the figure for clarity.

Water depths are shallowest towards the western end of the Lease Area (approximately 78 ft or 24 m), and increase to the east to a maximum of 138 ft (42 m).

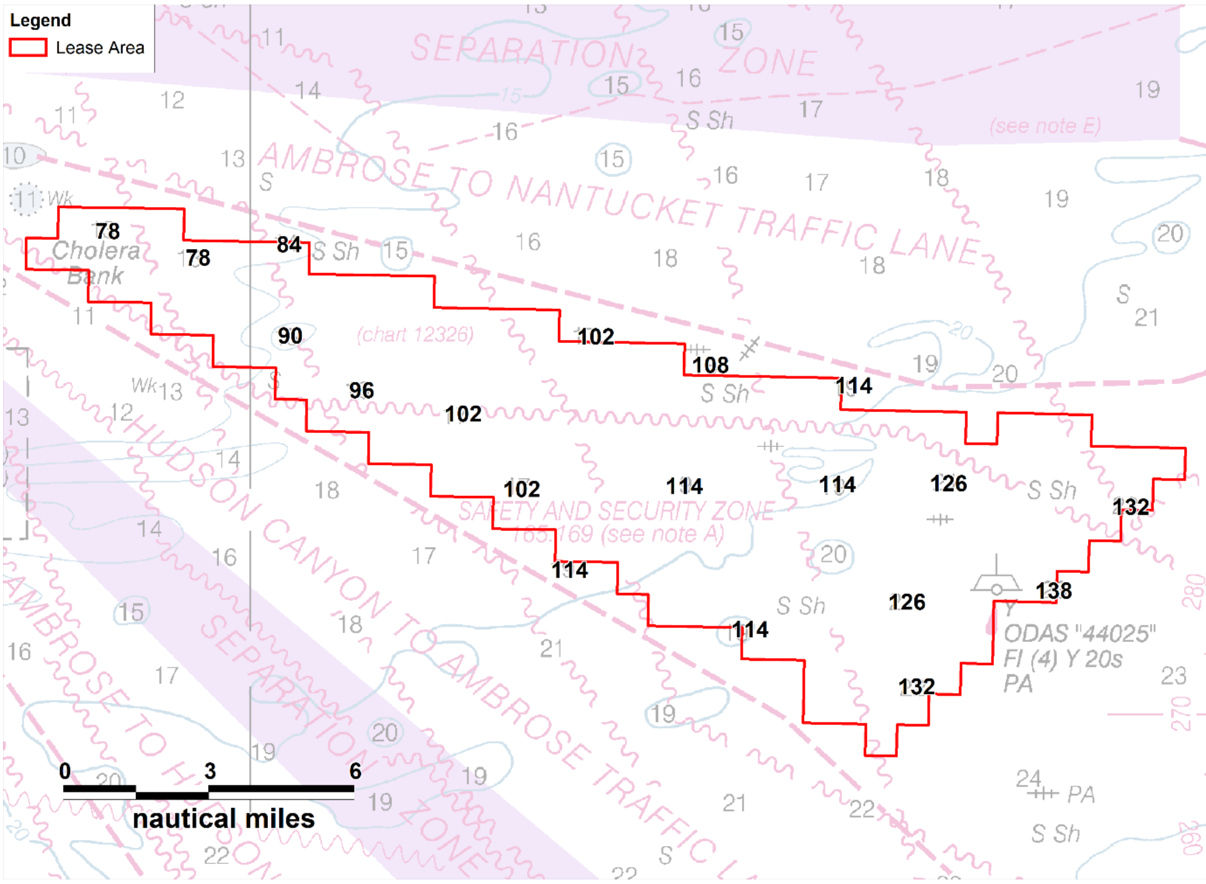

Figure 6.12 Charted Water Depths (ft over MLLW)

6.3 Meteorological Ocean Data

6.3.1 Wind

Long-term historic wind data was compiled as part of Empire's Metocean Design Basis (OCS-A 0512) (Equinor Wind, 2018). The resultant all year wind rose for the period between 2002 and 2011, and is presented in Figure 6.13, which shows the percentage of observations per 30° sector. The predominant wind direction was observed to be south westerly (i.e., from the southwest).

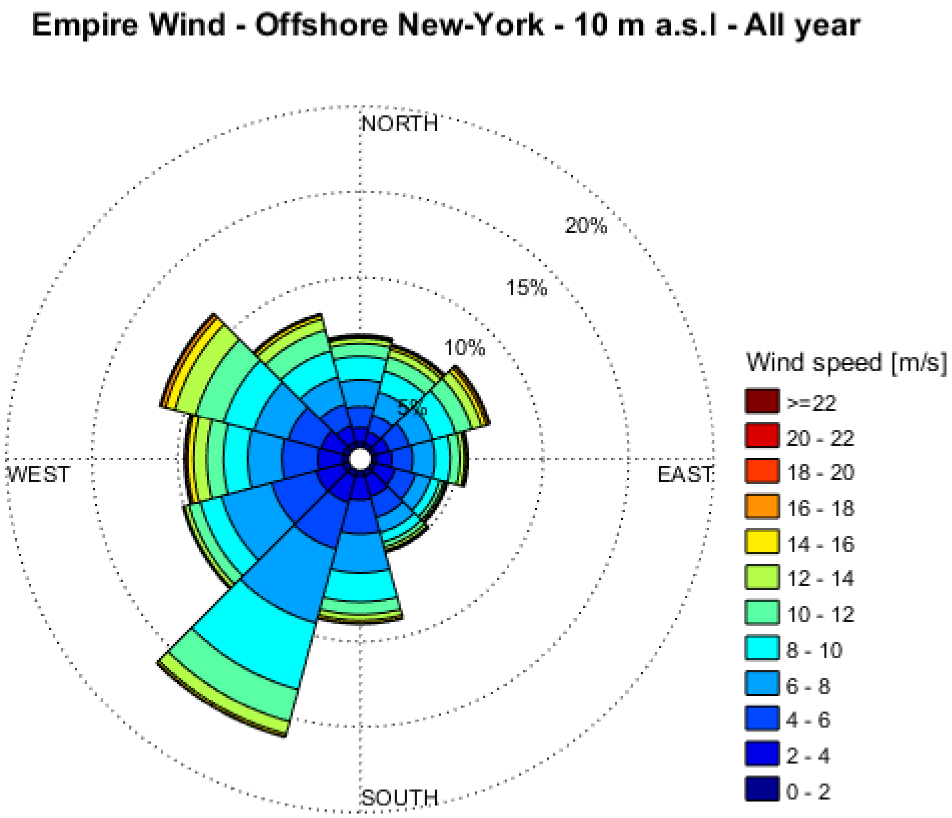

Figure 6.13 All-year wind rose for the period 2002 – 2011 (Equinor Wind, 2018)

For the purposes of validating these findings, wind direction probabilities were also calculated based on 2017 wind recordings of ODAS buoy 44025, stationed within the Lease Area, as per Section 6.1.5. The results of the validation exercise are shown in Figure 6.14 (note that erroneous observations have been excluded).

Overall, correlation was considered excellent between the two datasets. The results of the Metocean Design Basis (Equinor Wind, 2018) are therefore considered suitable for use as input into the allision and collision modelling process, available in Section 10.

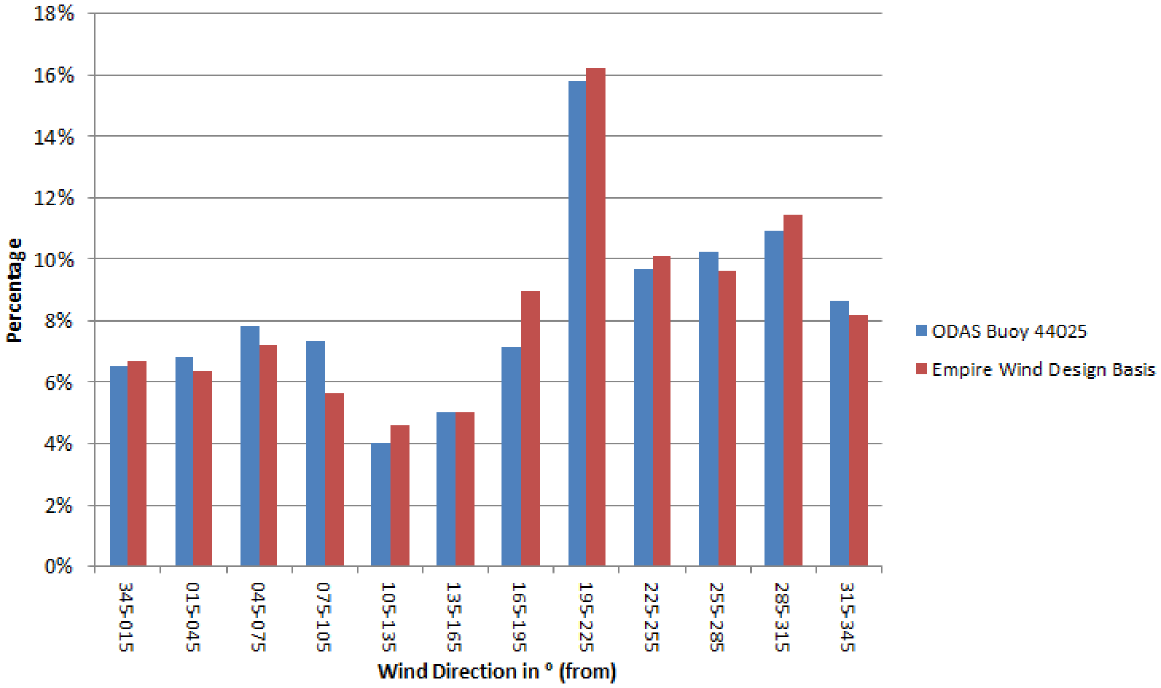

Figure 6.14 Wind Direction Validation

6.3.2 Wave

Significant Wave Height (SWH) data was provided as part of the Metocean Design Basis, as shown in Figure 6.15. SWH data was also available from ODAS buoy 44025 and has also been included. The ODAS buoy data has been compiled for the five-year period between 2013 and 2017, and any recordings identified as being erroneous have been excluded.

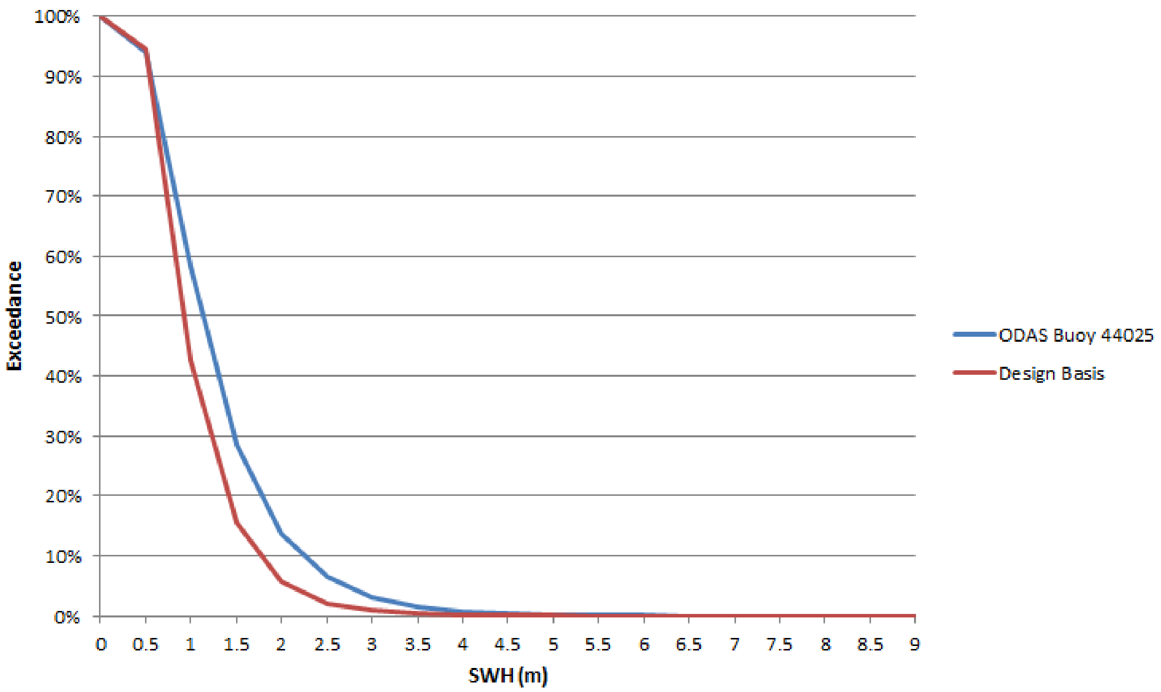

Figure 6.15 SWH Validation

SWH was observed to be generally higher based on the ODAS buoy data than that presented within the Metocean Design Basis. Therefore, to ensure a conservative assessment, the ODAS buoy data has been used as input to the relevant allision and collision modelling, which is available in Section 10.

6.3.3 Visibility

Based upon information available in Admiralty Sailing Directions NP68 (UKHO, 2016), the probability of poor visibility within the area (defined as visibility being less than 1,000 m) ranges between 1 and 10%. To ensure the maximum impact is modelled, a probability of 10% has been assumed within this NSRA.

It is noted that the United States Coast Pilot 2 (NOAA, 2018) also provides visibility details for the area, and indicates that the percentage of visibility being less than 2 nm (3.7 km) ranges from between 4.2% and 19.6%. However, as the collision and allision models are calibrated against a definition of poor visibility as being less than 1,000 m, the UKHO value (of 10%) has been used.

6.3.4 Tidal Streams

Tidal speed and direction data have been taken from UKHO Admiralty Chart 3204 (noting that tidal stream data is not provided on the NOAA charts available for the area), as shown in Table 6.1.

Given the stakeholder concerns raised to date surrounding drift speeds (see Section 3), a sensitivity assessment of other drift speeds and direction has been undertaken in addition to the standard drifting assessment (which considers the values in Table 6.1).

Table 6-1 Tidal Stream Data

Chart Number	Tidal Diamond	Flood		Ebb	
		Direction (°)	Speed (kn)	Direction (°)	Speed (kn)
3204	B	145	0.7	301	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.

6.3.5 Tropical Cyclones

NOAA defines a hurricane as a tropical cyclone with sustained surface wind of >=64 knots (kn). The NOAA density grid illustrating tropical cyclone exposure (NOAA, 2018) is shown relative to the Lease Area in Figure 6.16, with levels of exposure quantitatively defined using intersecting storm tracks, overlapping wind intensity areas, and mathematical return intervals. To provide an indication of the density at a more localized level, a local view is then shown in Figure 6.17, with suitably refined density range brackets.

As indicated by Figure 6.16 and Figure 6.17, the Lease Area is within a low density area of storm exposure on both a regional and local level. This is likely due to the sheltered location of the site when compared to areas further offshore, or further east along the coast.

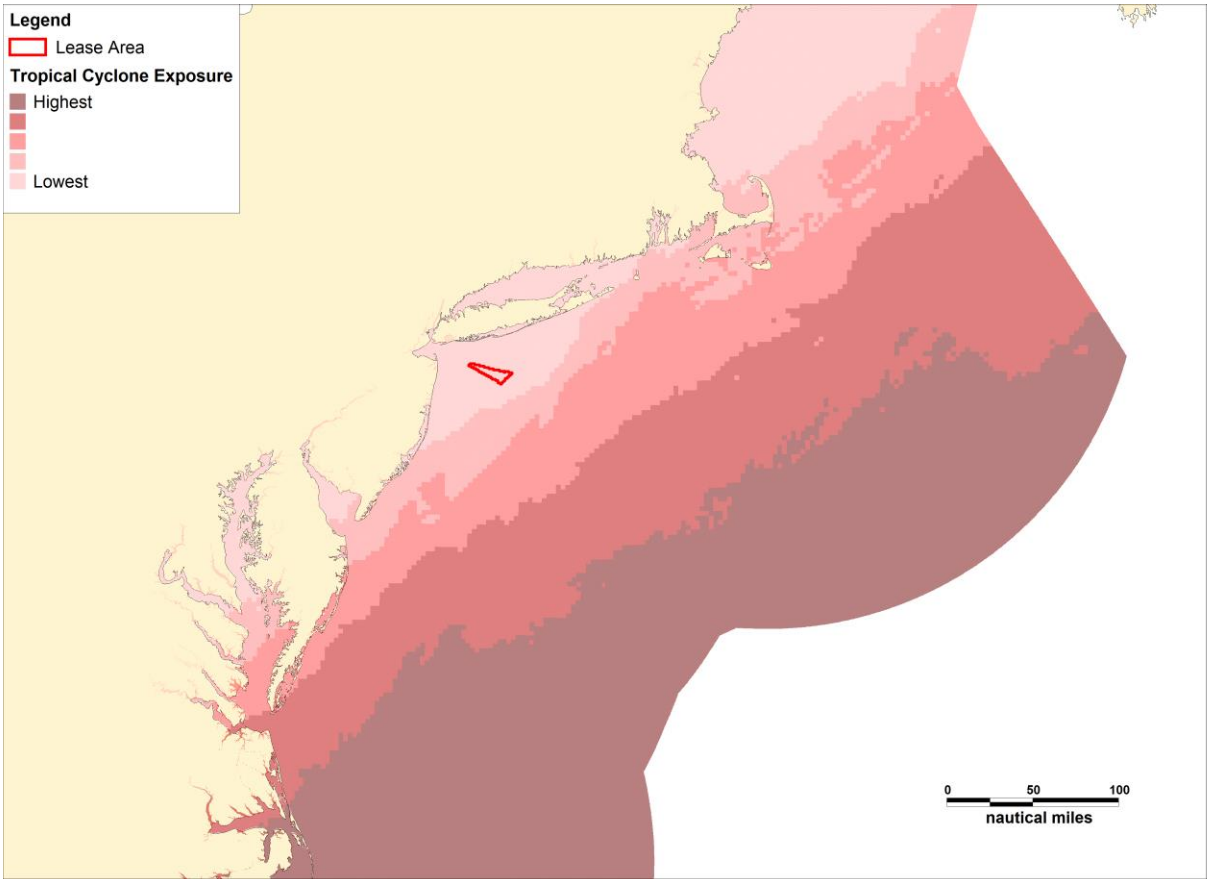

Figure 6.16 Tropical Cyclone Exposure Regional Overview

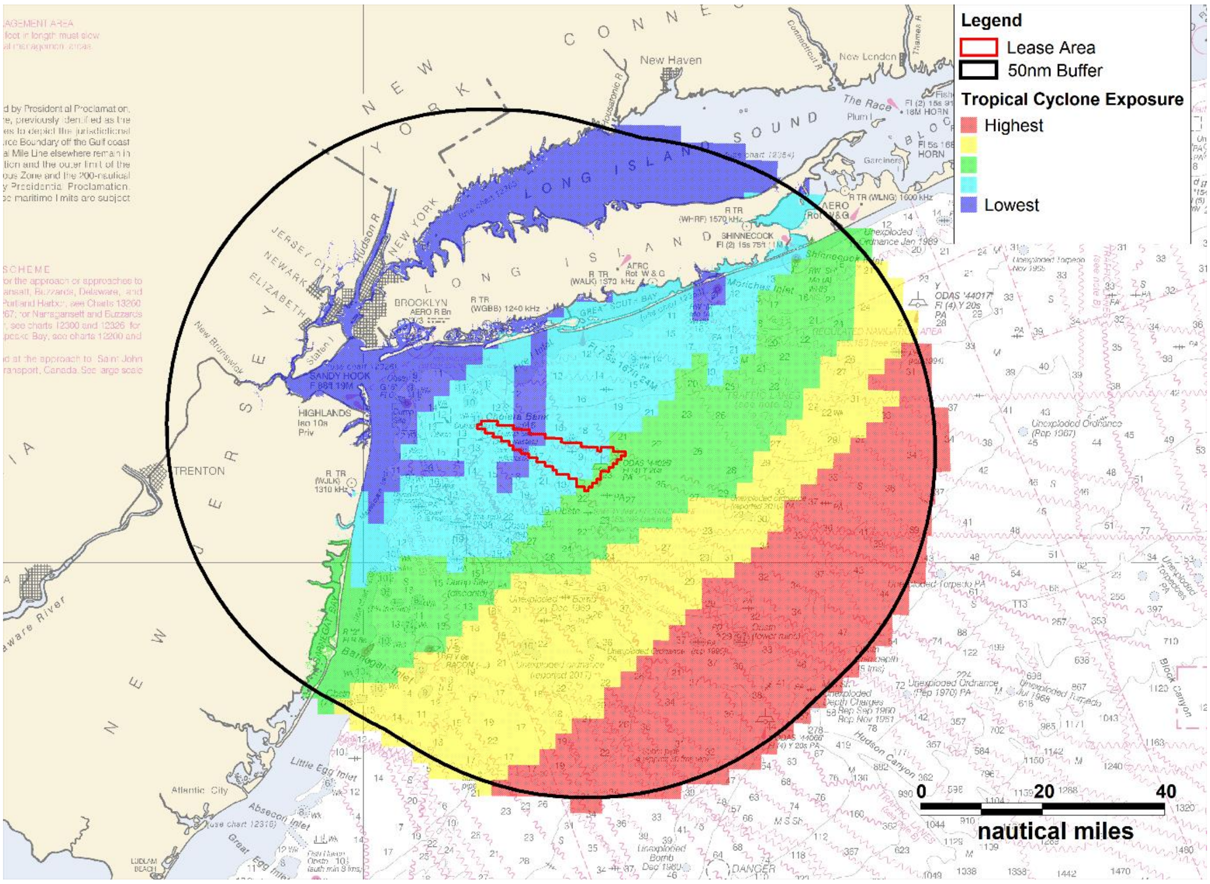

Figure 6.17 Tropical Cyclone Exposure Local Overview

Data provided by NOAA's Historical Hurricane Tracks database (NOAA, 2018), plotted using data provided by the MMC, is presented in Figure 6.18 within a 50 nm (92.6 km) area around the Lease Area. These include one Category 2 storm (*Storm Gloria*, 1985) and two Category 1 storms (*Storm Belle*, 1976, and an unnamed storm in 1934) that intersected the Lease Area itself.

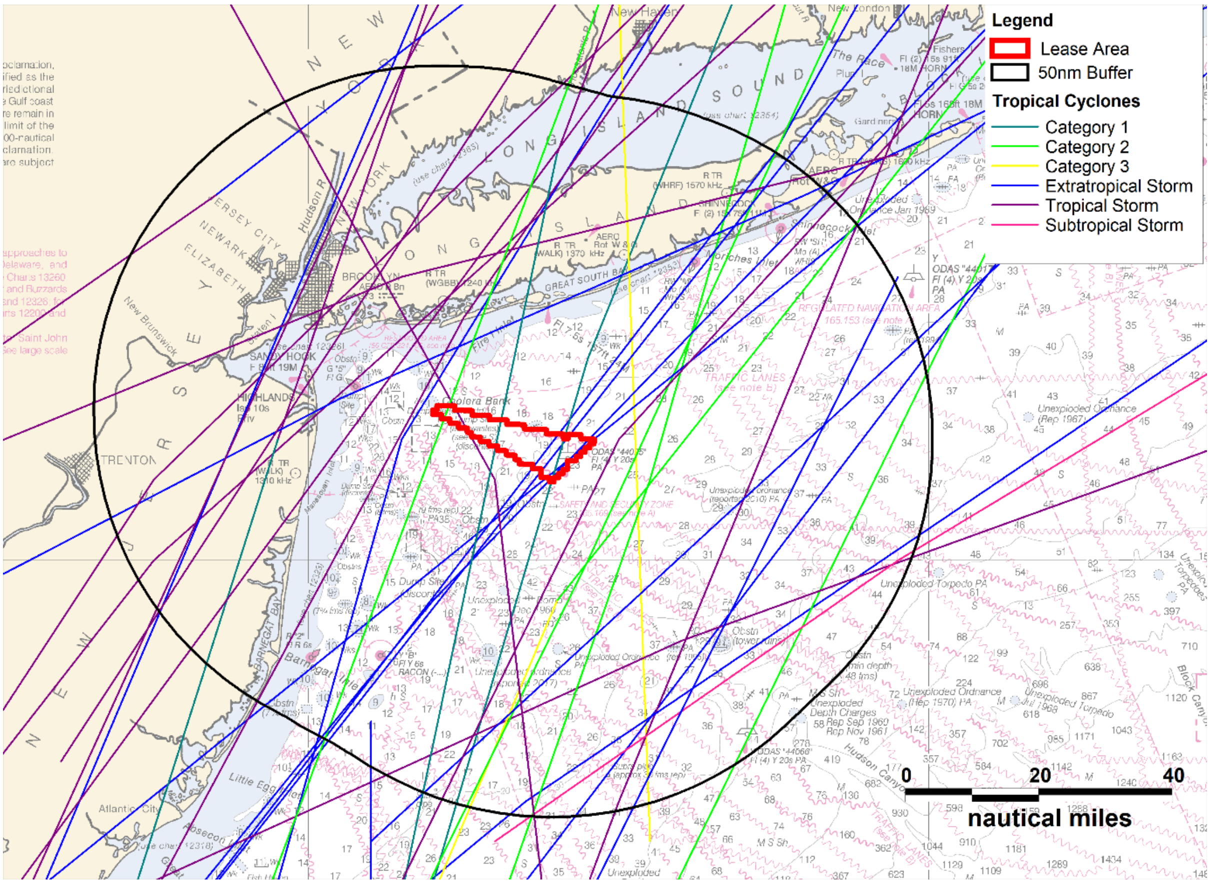

Figure 6.18 NOAA Historical Hurricane Tracks (Geographical Locations from MMC)

6.3.6 Ice

Sea ice in the area is not expected to affect the site given its offshore location. This is indicated within the UKHO Pilot Book which states the following in terms of ice:

- "*In the average winter ice forms in many rivers, estuaries, harbors' bays, and other shallow inshore localities but most of the harbors remain open*";
- "*Except for very isolated causes, icebergs are not encountered W of 67^{o}W*";
- "*Navigation is rarely hindered by ice along the New Jersey coast, but the inner waters are completely closed in severe winters";* and
- "*Navigation in New York Harbor is not restricted by ice".*

In addition to the sea ice, there is a possibility of icing of the wind turbine blades. This may lead to falling ice fragments during 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) includes a case study that found in South-Greenland, low wind speeds, high relative humidity and sub-zero temperatures gave rise to the threat of turbine icing. Figure 6.19 and Figure 6.20 present the distribution of air temperature and wind speed measurements from the ODAS 44025 data buoy, based upon data recorded over a 24-year period between 1985 and 2008. Humidity data was not available.

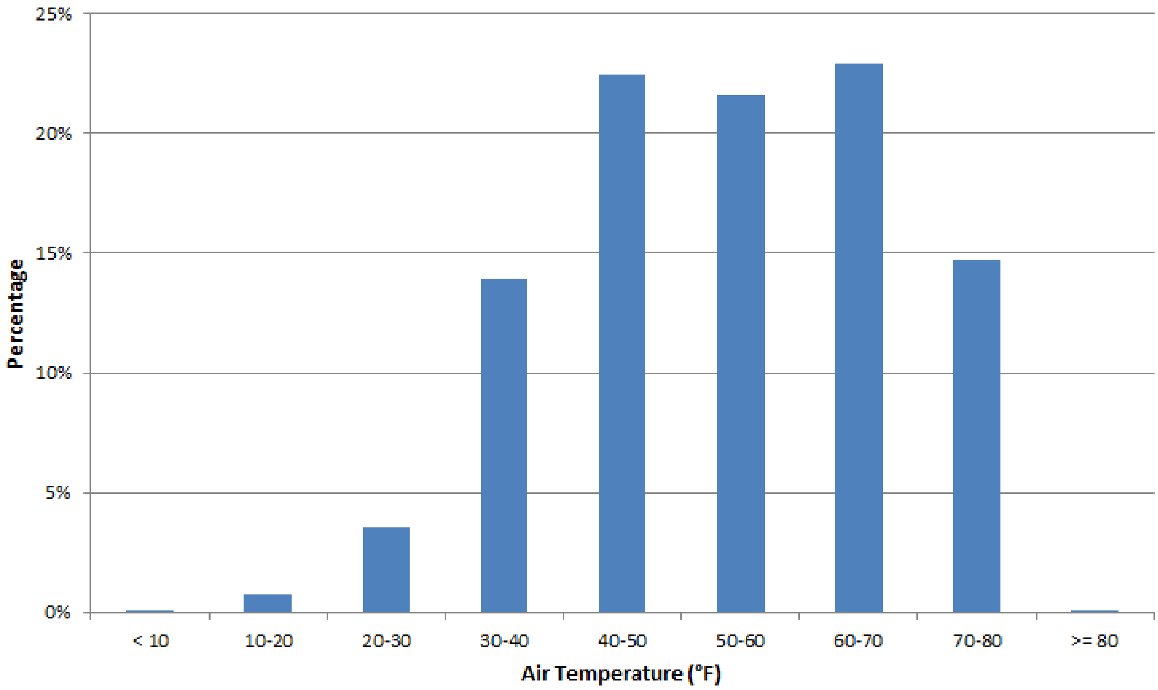

Figure 6.19 Air Temperature Distribution (ODAS 44025 Buoy, 1985 to 2008)

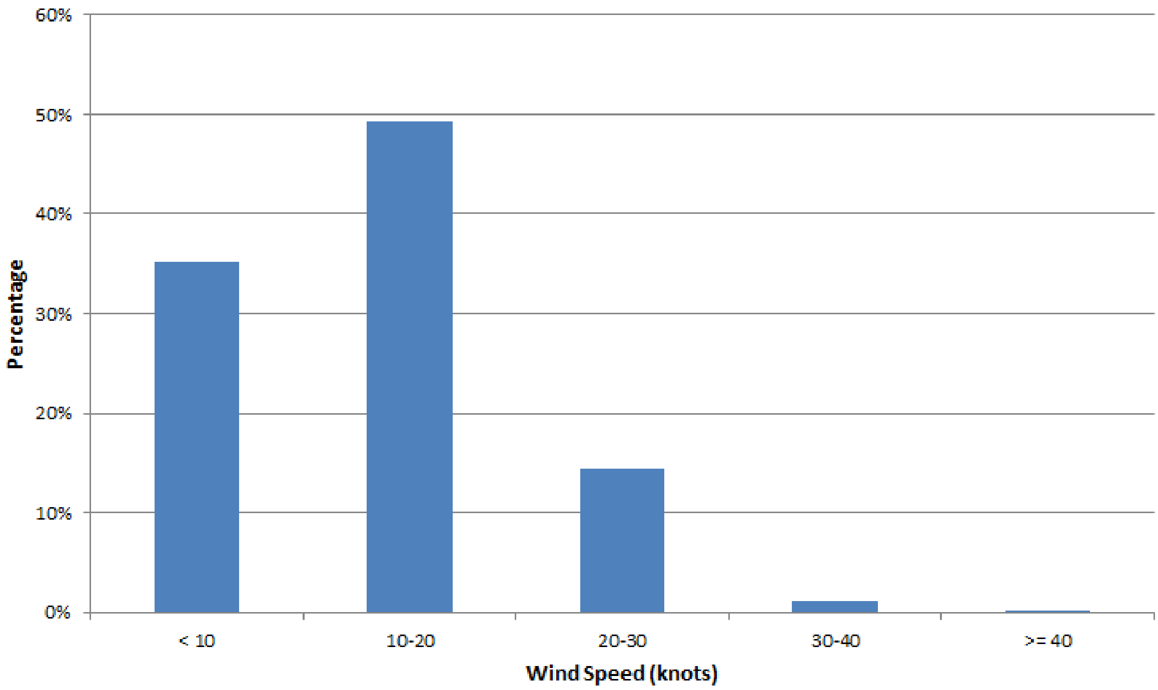

Figure 6.20 Wind Speed Distribution (ODAS 44025 Buoy, 1985 to 2008)

It can be seen that sub-zero temperatures (< 32°F) contributed only a small proportion of recordings throughout the data period (approximately 7%). Although approximately 35% of wind speed recordings were below 10 kn, only approximately 5% were 3 kn or less. Even in the absence of humidity data, it may be inferred that the number of occurrences where all three climactic conditions specified in *Icing Problems of Wind Turbines in Cold Climates* (2014) correlated was low. Given the low frequency of occurrence there is not anticipated to be any significant impacts on shipping and navigation relating to ice.

7 Maritime Traffic and Vessel Characteristics

7.1 AIS Overview

Three maritime traffic data sets have been considered within this NSRA, as per Section 1.2. These are as follows:

- 12 months of satellite AIS data (August 2017 to July 2018), supplemented with AIS collected from coastal receivers. Used as primary maritime traffic assessment tool.
- 28 days of AIS data collected from coastal receivers during June 2018. Used to assess vessel encounters (see Section 10.1.1).
- Visual observation and AIS data collected from the survey vessel *Ocean Researcher* during 2018. Used to validate main data set and to assess non-AIS traffic (see Section 7.2.7).

Any recorded data from vessels engaged in works considered as temporary (e.g., survey work) has been excluded from the maritime traffic assessment.

7.1.1 AIS 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 US 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 (see 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 kn.
- Vessels identified in Regulation IV. above engaged in dredging operations.

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

7.1.2 Data Coverage

In order to show that traffic coverage of the Study Area was as comprehensive as it was feasible with the available data, the long term AIS data collected by both satellite and coastal receivers was compiled for the assessment shown in Sections 7.2, 7.2.7, and 7.4. It should be considered that the collection frequency of the satellite receivers was less than that of the coastal receivers, and coverage further offshore was therefore observed to drop when compared to areas nearer shore.

An encounters assessment has also been undertaken as per Section 10.1.1. Given that the accuracy of the model used to identify encounters is reliant on AIS collection frequency, a separate short-term coastal receiver-only data set was used. Over the 28-day period studied in June 2018, this short-term data set was observed to provide the best transmission frequency. Further details of this are provided in Section 10.1.1.

It should be considered that the following factors can also 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 on-shore antenna.

In terms of study period, 12 months of data has been assessed in this Section to ensure any seasonal variations in traffic levels or behaviors are accounted for.

7.1.3 Vessel Dimension Units

The USCG AIS Encoding Guide (USCG, n.d.) requires vessel dimensions transmitted via AIS to be in meters (rather than ft). However, vessels transmitting their dimensions in ft were observed within the AIS data assessed in this NSRA. Although Anatec has made reasonably practical 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), confirming the correct dimensions for every vessel recorded was not practical for the length and draft analysis undertaken, given the volume of data assessed.

7.2 Lease Area Maritime Traffic

Figure 7.1 presents a plot of the vessel tracks recorded within the Study Area during the survey period, color-coded by vessel type. Following this, Figure 7.2 presents the corresponding density grid, which has been produced from the same AIS dataset.

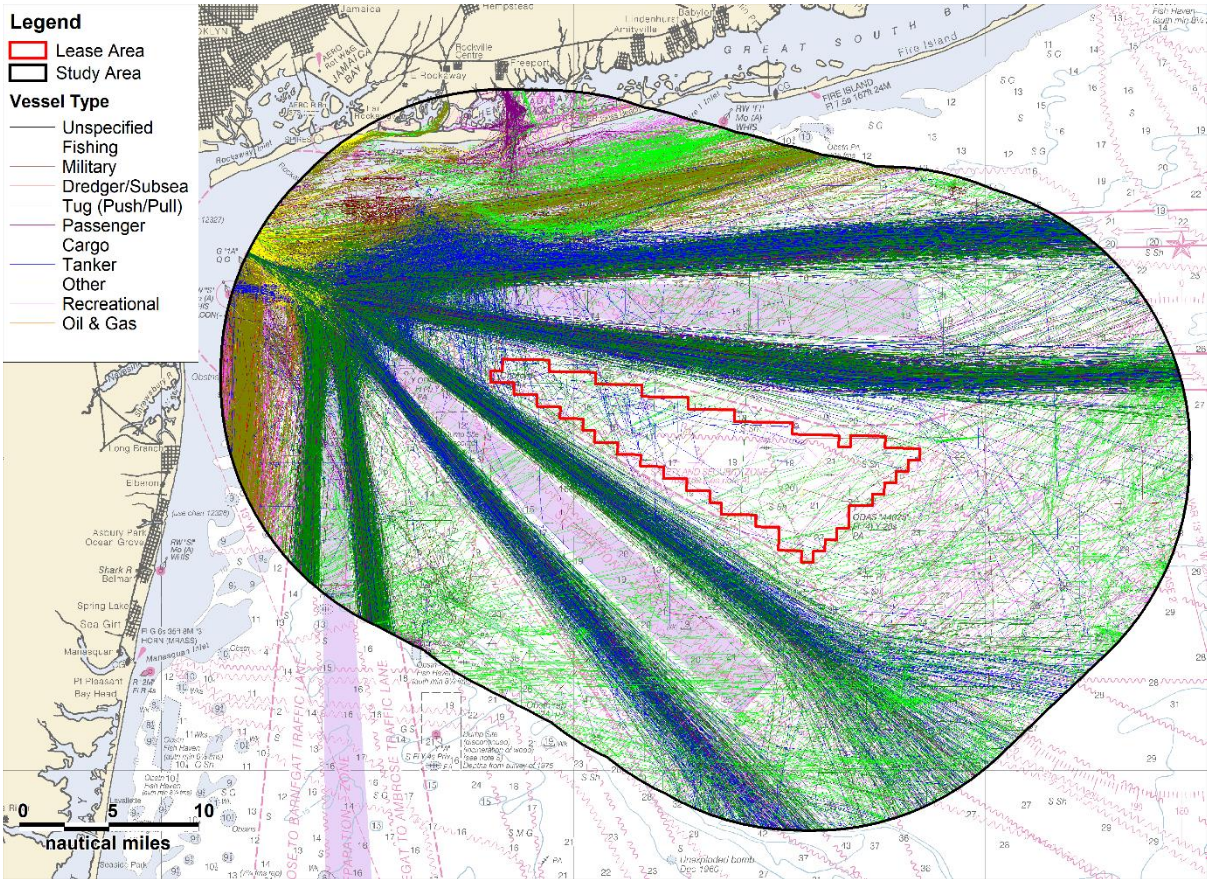

Figure 7.1 AIS tracks within Study Area color-coded by vessel type (12 months August 2017 to July 2018)

As observed in the overview plot (Figure 7.1), the majority of commercial (cargo or tanker) vessels associated with the Port of NY/NJ utilized the TSS lanes when exiting or entering the precautionary area. Commercial tug (push/pull) traffic was observed to remain largely coastal. Activity within the Lease Area was limited in comparison.

Further detailed assessment of the key vessel types recorded is available in Section 7.2.4.

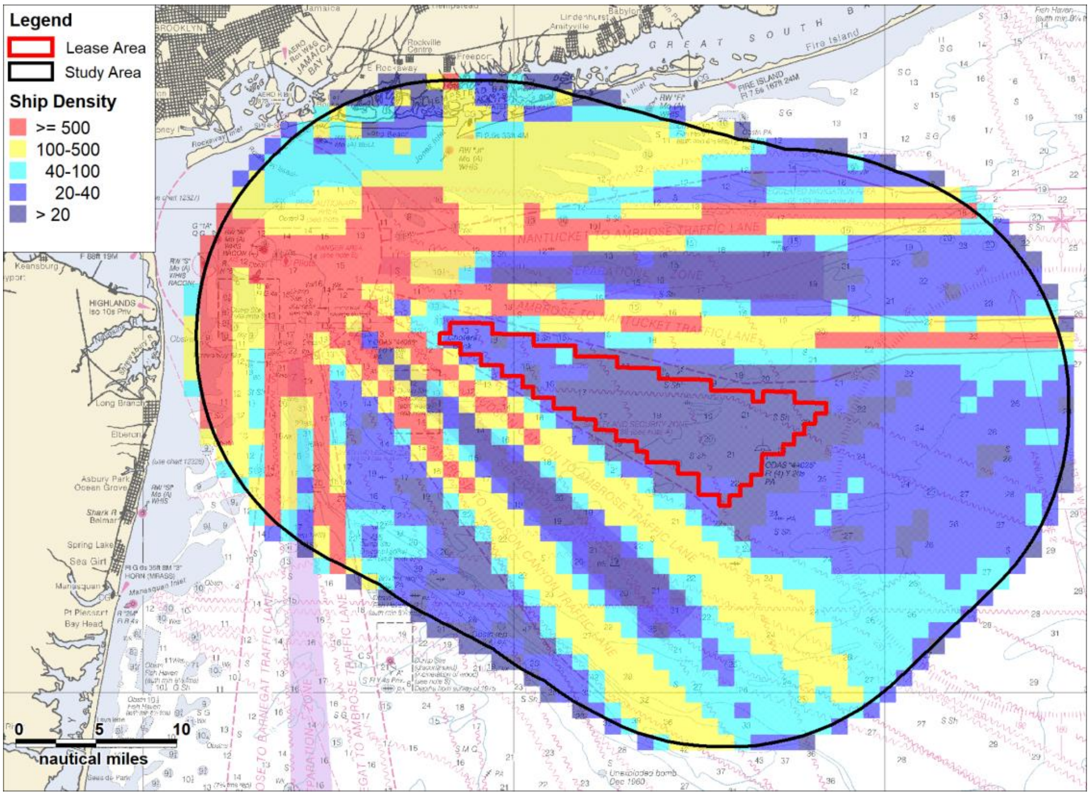

Figure 7.2 AIS density heat map within Study Area (12 months August 2017 to July 2018) – 1 x 1 nm (1.9 x 1.9 km) Cell Resolution

It can be seen that the areas of highest vessel density occurred where the TSS lanes converged at the precautionary area, and within the precautionary area itself. High density was also observed off the coast of New Jersey. The majority from tug (push/pull) vessels. The Lease Area was of low density, relative to the surrounding areas.

7.2.1 Vessel Count

Figure 7.3 presents the average number of unique vessels recorded per day within the Study Area for each of the 12 months of AIS assessed data.

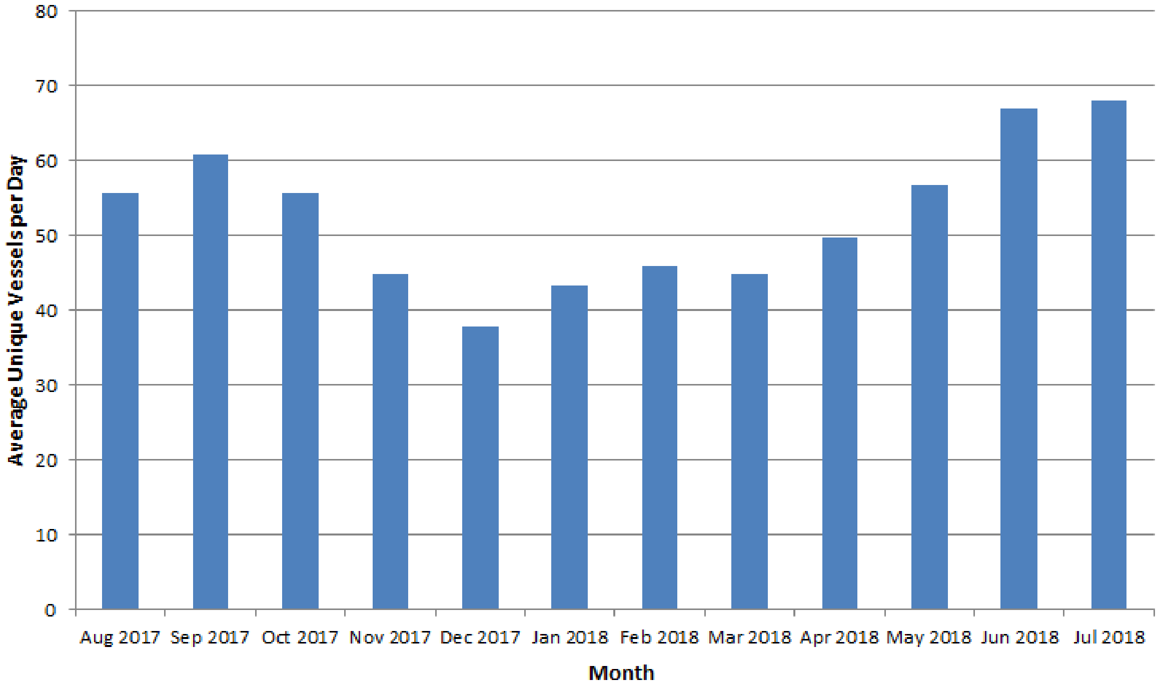

Figure 7.3 Average Unique Vessels per Day

During the survey period, an average of 53 unique vessels were recorded per day within the Study Area, with a total of 102 vessels recorded on the busiest day. The busiest month was July 2018, when an average of 68 unique vessels were recorded per day.

An average of one to two unique vessels per day were recorded within the Lease Area itself, with the maximum recorded in a single day being eight (8). Overall, approximately 1% of vessel tracks recorded via AIS within the Study Area also intersected the Lease Area. An assessment of non-AIS traffic recorded within and near the Lease Area via visual observation is available in Section 7.2.8.

7.2.2 Vessel Size

7.2.2.1 Vessel Length

Figure 7.4 presents a plot of the vessel tracks recorded within the Study Area during the survey period, color-coded by vessel length. Following this, Figure 7.5 presents the corresponding distribution of vessel lengths. It is noted that approximately 1% of vessel tracks could not be associated with a valid length and have therefore been excluded from the analysis shown in Figure 7.5.

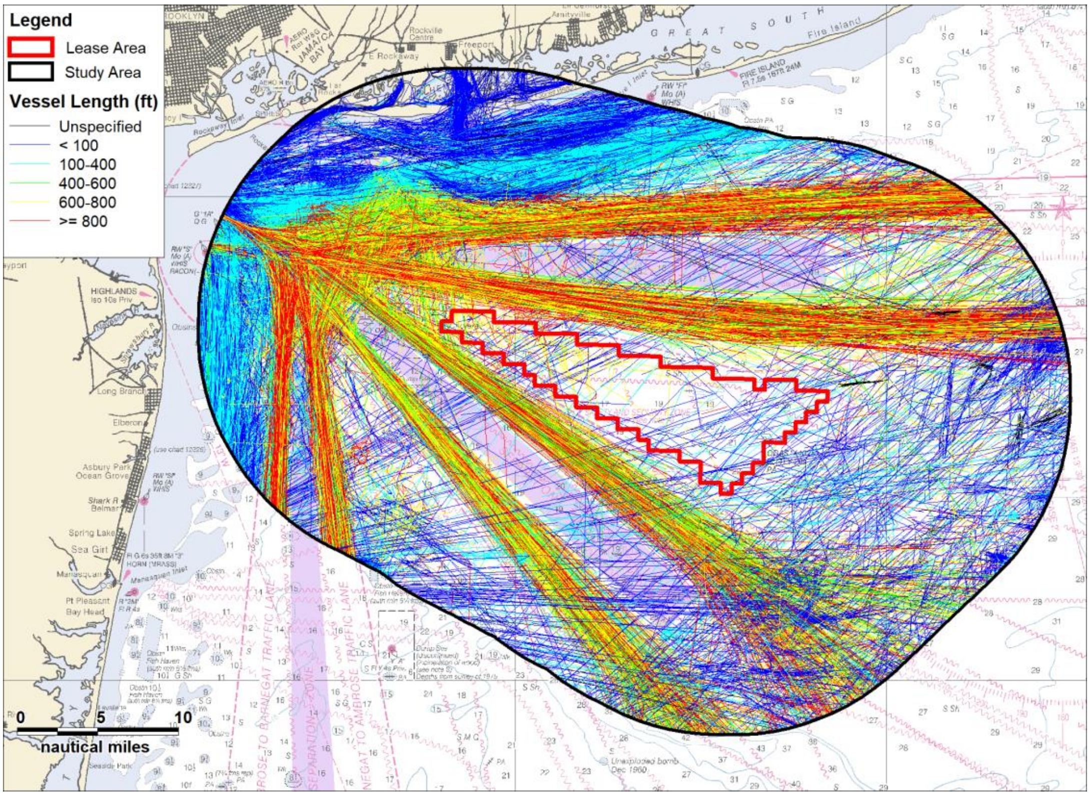

Figure 7.4 AIS tracks within Study Area color-coded by length (12 months August 2017 to July 2018)

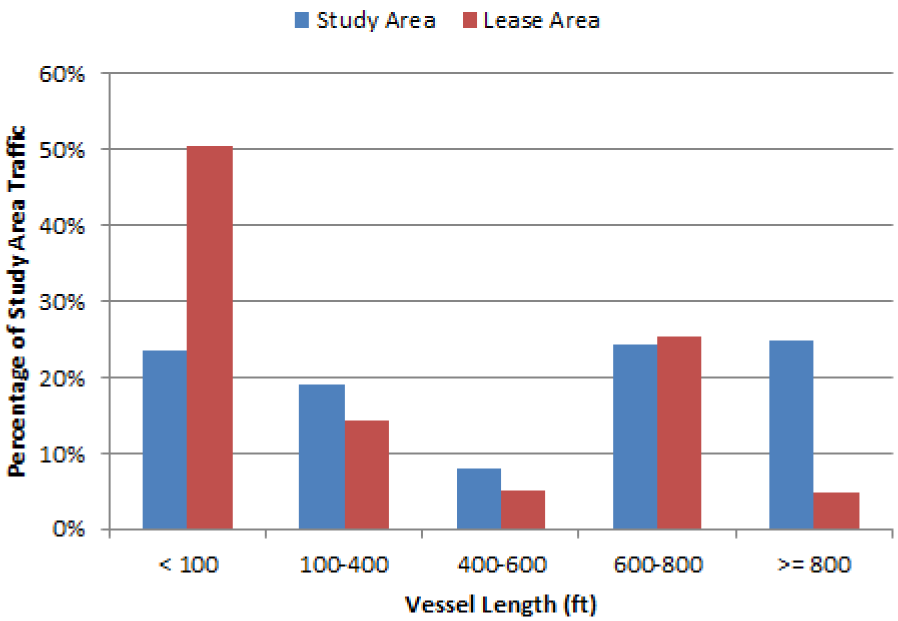

Figure 7.5 Vessel length distribution

Excluding those vessels without a valid length, the average length of vessels recorded within the Study Area throughout the survey period was 494 ft (151 m), the maximum length being

1,204 ft (367 m). The smaller vessels mostly consisted of fishing vessels, tug (push/pull) vessels, recreational vessels and 'other' vessels. The larger vessels were mostly cargo vessels and tankers utilizing the TSS lanes.

When considering only those vessel tracks intersecting the Lease Area, the average length of vessels was 300 ft (91 m). Noting that approximately half of all vessels were less than 100 ft (30 m) in length. The decrease in the average length may be attributed to the prevalence of fishing vessel traffic transiting through the Lease Area, noting that the significant majority of larger vessels (such as cargo vessels and tankers) were observed to utilize the TSS lanes, hence avoiding the Lease Area. The larger vessels that did intersect the Lease Area were, in the majority, seeking access to the nearby uncharted (recommended) anchorage area (see Section 6.1.7 and 7.2.5).

It is noted that the largest vessel recorded within the Study Area (1,204 ft [367 m]) was also recorded as intersecting the Lease Area. This vessel (the *Gerda Maersk*) crossed the Lease Area to access the precautionary area via the inbound Hudson Canyon to Ambrose TSS lane.

7.2.2.2 Vessel Draft

Figure 7.6 presents a plot of the vessel tracks recorded within the Study Area during the survey period, color-coded by vessel draft. It is noted that approximately 19% of vessels recorded did not broadcast a valid draft[22]. Therefore, for clarity, Figure 7.7 presents the same plot but with those tracks which could not be associated with a valid draft excluded. Figure 7.8 then presents the corresponding distribution of vessel drafts (again, excluding the unspecified).

[22] This is a result of the prevalence of Class B vessels which do not broadcast draft information as standard, noting that 90% of Class A vessels reported a draft.

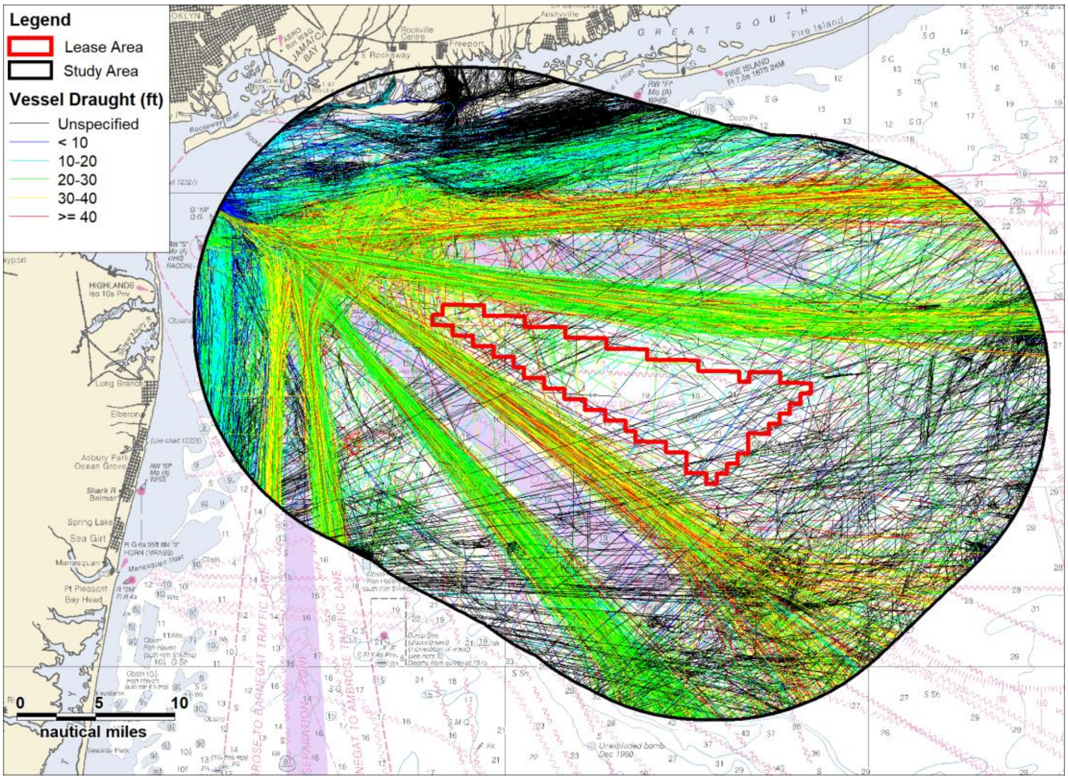

Figure 7.6 AIS tracks within Study Area color-coded by draft (12 months August 2017 to July 2018)

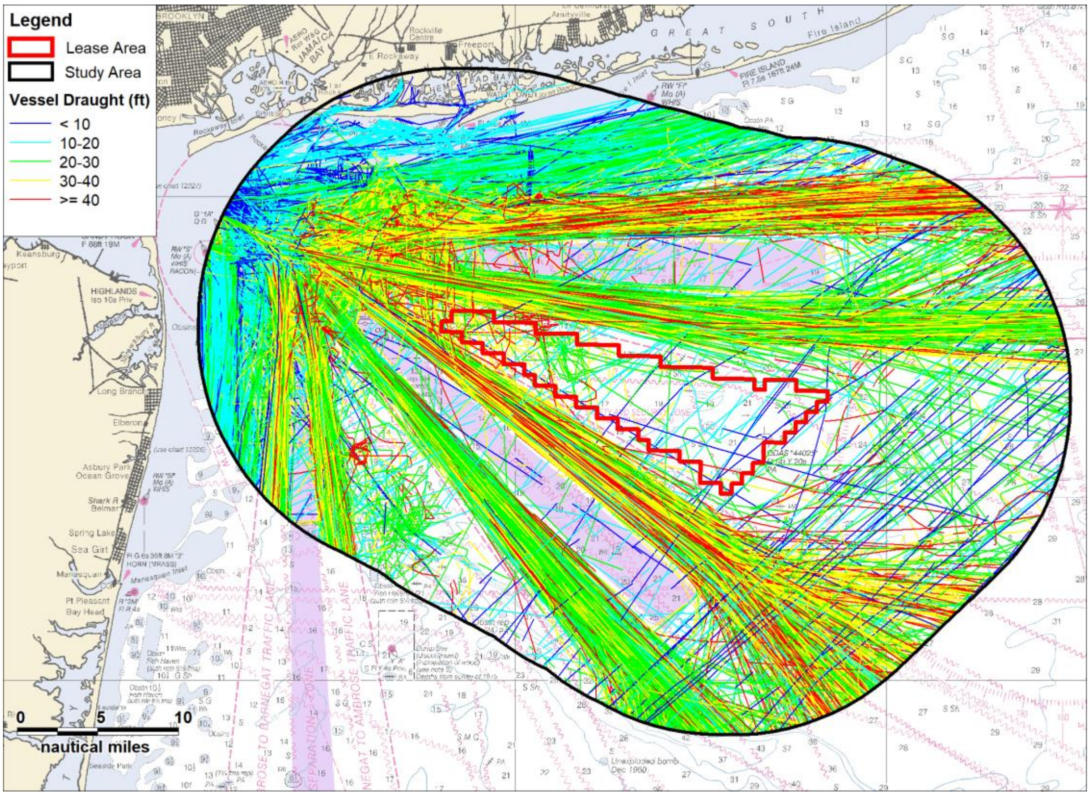

Figure 7.7 AIS tracks within Study Area color-coded by draft excluding unspecified drafts (12 months August 2017 to July 2018)

As indicated in Figure 7.6 and Figure 7.7, the significant majority of deep drafted vessels within the area utilized the TSS lanes, with shallower drafted vessels preferring coastal transit (noting that it is likely that the majority of vessels that did not transmit a draft (via AIS) are smaller vessels).

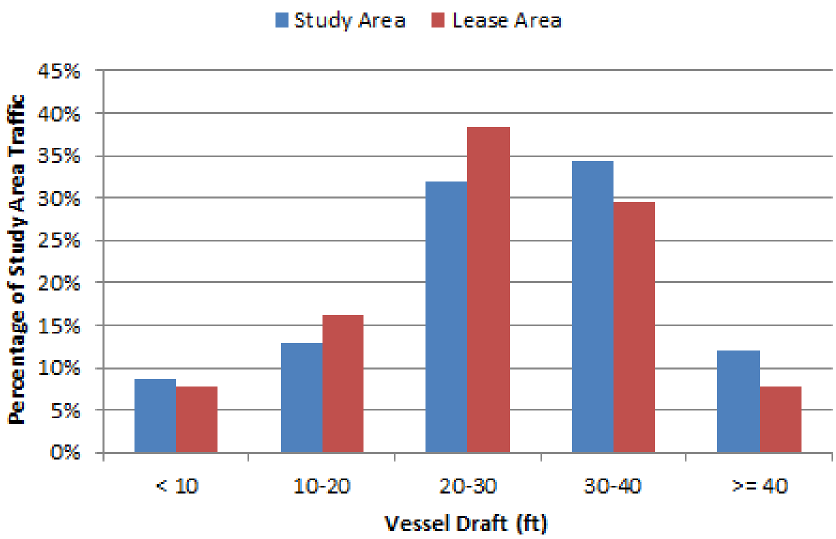

Figure 7.8 Vessel draft distribution

Excluding those vessels not broadcasting a valid draft (generally smaller vessels), the average draft recorded within the Study Area was 28 ft (9 m). The largest draft recorded was 51 ft (15.5 m).

When considering only those vessel tracks intersecting the Lease Area, the average draft of vessels was 27 ft (8 m). However, it should be considered that this value does not account for vessels with unspecified drafts, which were observed to be in the majority fishing and recreational vessels (and hence would be expected to be of a shallower draft than the average). The largest draft recorded within the Lease Area was 47 ft (14.4 m).

7.2.3 Vessel Speed

Figure 7.9 presents a plot of the vessel tracks recorded within the Study Area throughout the survey period, color-coded by vessel speed. It is noted that an accurate speed was not possible to be determined for approximately 9% of vessel tracks. Therefore, for clarity, Figure 7.10 presents the same plot but with those tracks for which a speed could not be determined excluded. Figure 7.11 then presents the corresponding distribution of vessel speeds, excluding those tracks with unspecified speeds.

It should be considered that a Seasonal Management Area (SMA) is utilized within the area for the purpose of reducing vessel strikes on North Atlantic right whales. Between the months of November and April, all vessels are limited to speeds of less than 10 knots when within the SMA. For reference, the SMA boundary is included in Figure 7.9 and Figure 7.10.

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

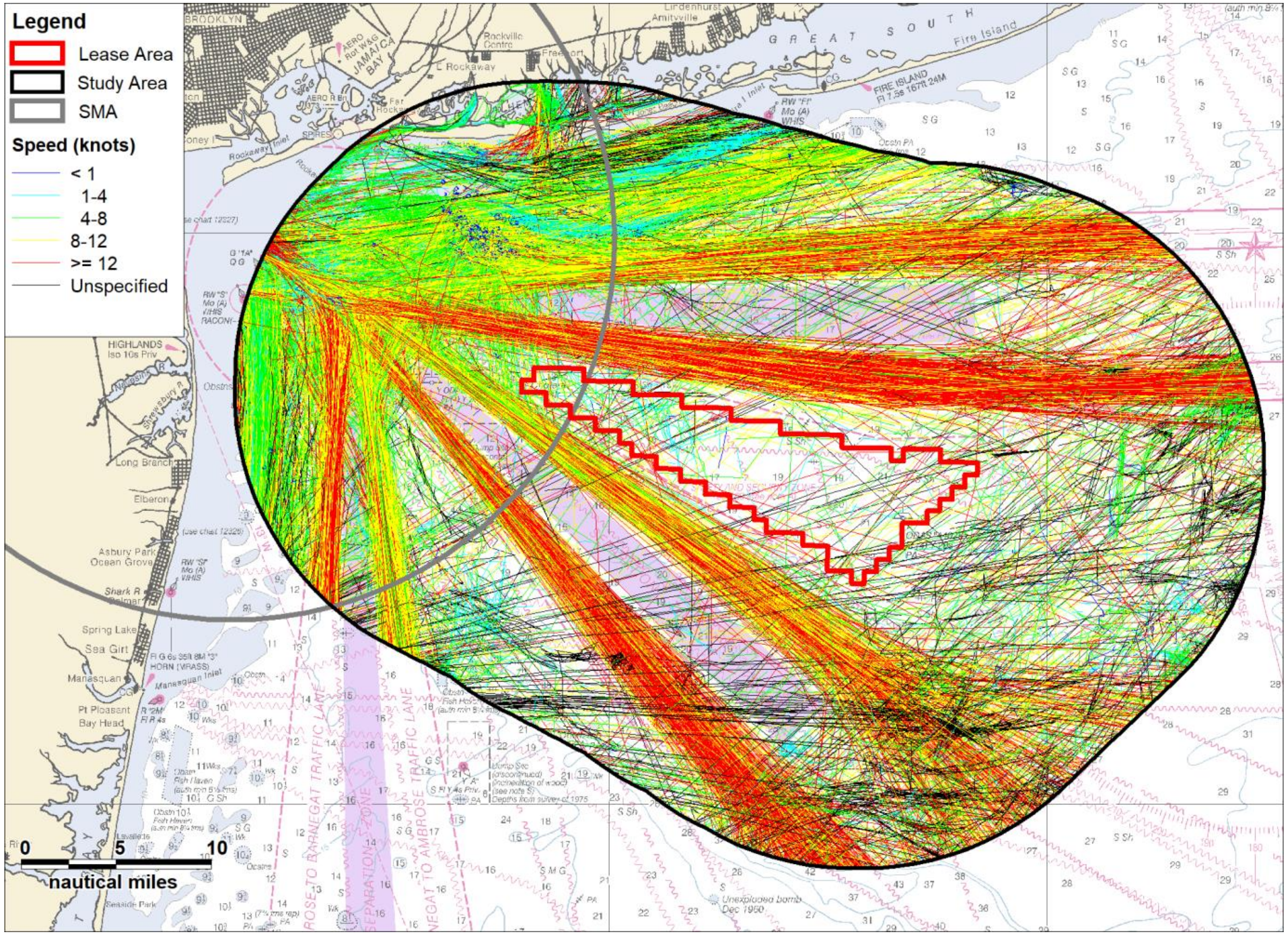

Figure 7.9 AIS tracks within Study Area color-coded by speed (12 months August 2017 to July 2018)

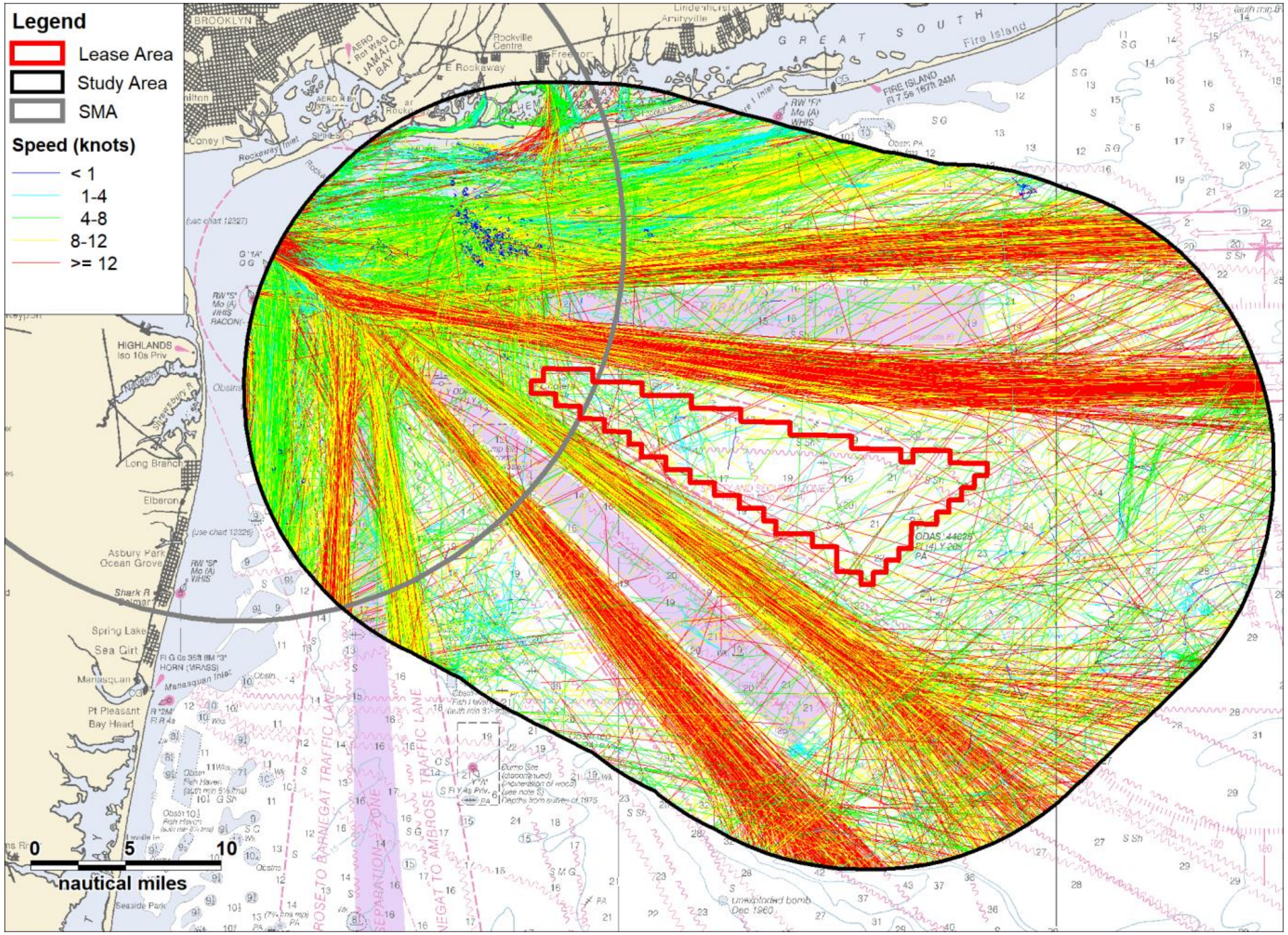

Figure 7.10 AIS tracks within Study Area color-coded by speed excluding unspecified speeds (12 months August 2017 to July 2018)

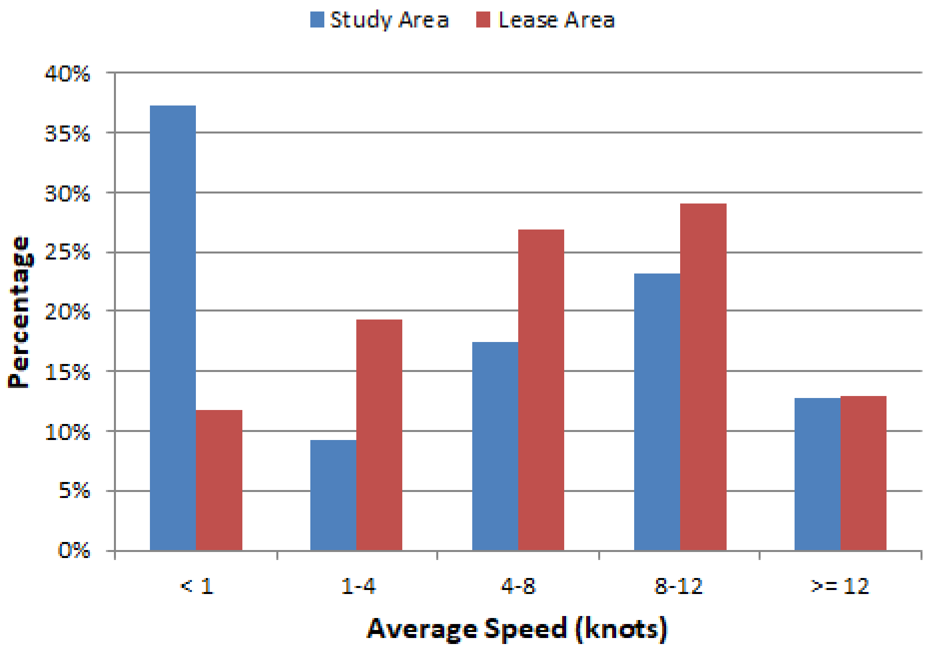

Figure 7.11 Vessel Speed Distribution

As shown in Figure 7.10, vessels tracked at the highest speeds were largely within the TSS lanes, with vessels on coastal transits typically at lower speeds.

Excluding those vessels not broadcasting a valid speed (generally fishing vessels and recreational vessels), the average speed recorded within the Study Area was 5.6 kn. It is noted that this includes anchored vessels, which will typically have very low speeds (less than 1 kn). With anchored vessels excluded, the average speed recorded within the Study Area rose to 8.6 kn.

When considering only those vessel tracks intersecting the Lease Area, the average speed of vessels was 7.2 kn.

7.2.4 Vessel Type

7.2.4.1 Overview

A plot of the vessel tracks recorded within the Study Area during the survey period, color-coded by vessel type, is presented in Figure 7.1. Figure 7.12 presents the distribution of the main vessel types within both the Study Area and the Lease Area itself. The 'other' vessels category in this figure includes those vessel types recorded in insufficient numbers to warrant their own category. For example, offshore supply vessels, military vessels, and dredgers.

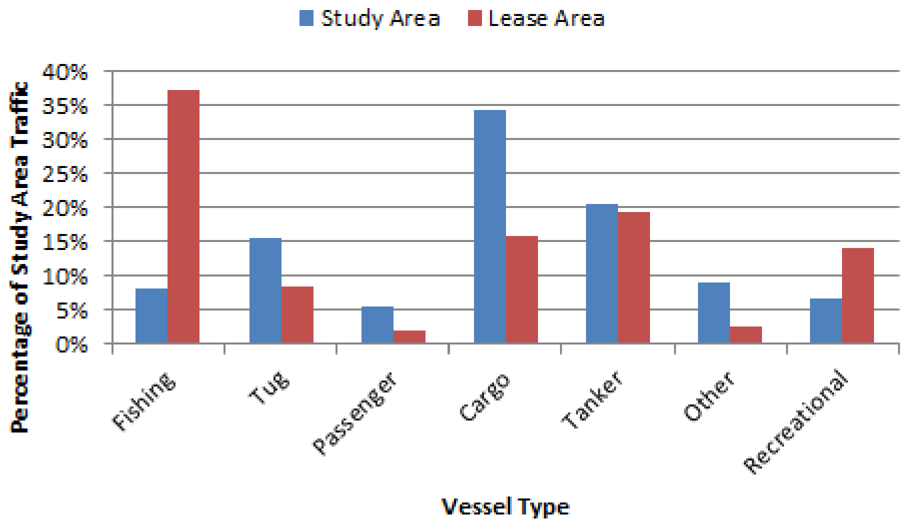

Figure 7.12 Main vessel types distribution

During the survey period, the most frequently recorded vessel types within the Study Area were cargo vessels (representing 34% of all recorded traffic), followed by tankers (20%). This corresponds to approximately 18 unique cargo vessels per day, and 11 tankers.

This is reflective of the traffic in the TSS lanes, which was observed to be comprised, in the majority, of commercial vessels.

When considering only those vessel tracks intersecting the Lease Area, fishing vessels were the most frequently recorded vessel type (37% of all vessel traffic within the Study Area) followed by tankers (19%) and cargo vessels (16%). The cargo vessels and tankers intersecting the Lease Area were largely observed to be seeking access to the uncharted (recommended) anchorage area to the north (see Section 6.1.7).

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

7.2.4.2 Commercial Vessels

Figure 7.13 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 approximately 34% of traffic within the Study Area and 16% of traffic within the Lease Area itself.

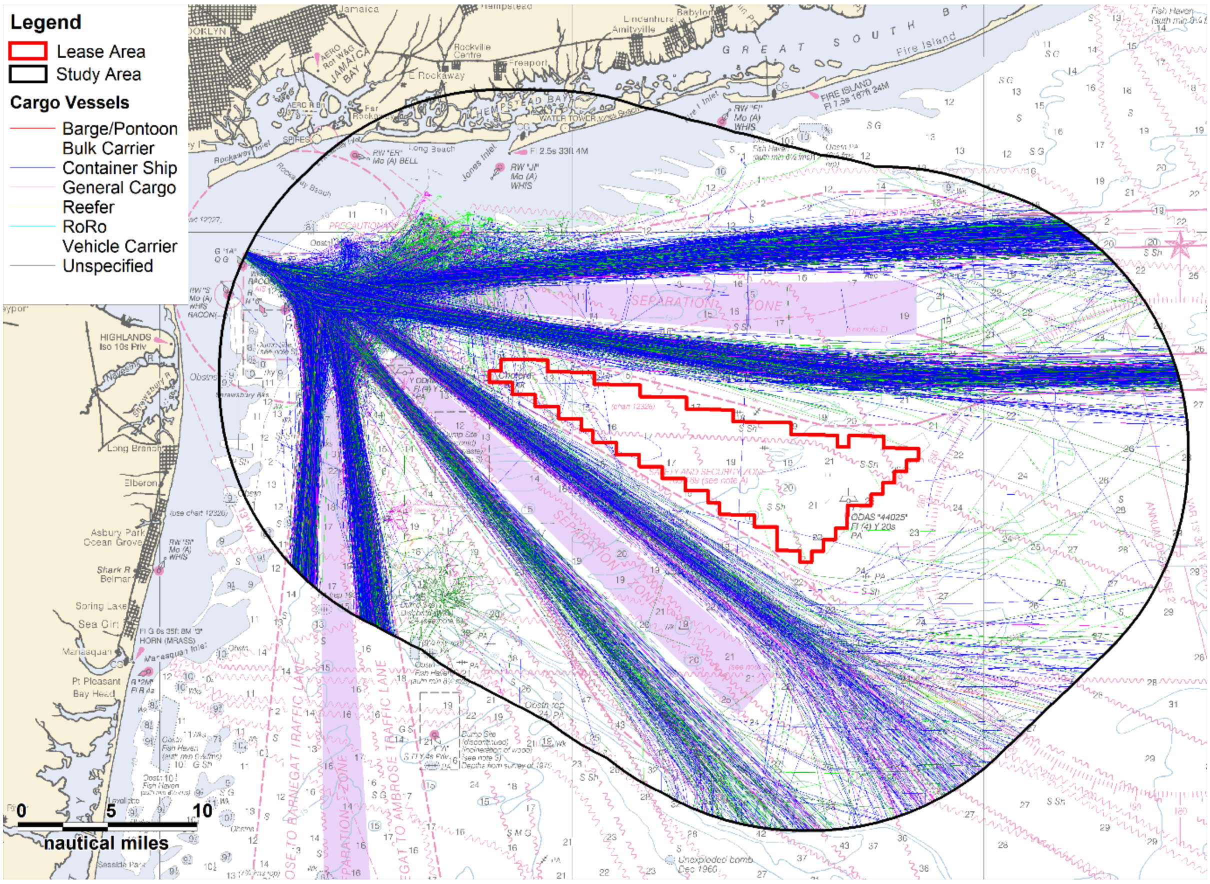

Figure 7.13 Cargo vessel tracks within Study Area (12 months August 2017 to July 2018)

Throughout the survey period, an average of 18 unique cargo vessels per day was recorded within the Study Area, and one every 11 days within the Lease Area itself. It can be seen that the cargo vessels were recorded using routes through the TSS lanes in the approaches to the precautionary area, and hence the majority of cargo vessel traffic avoided the Lease Area. The majority of those cargo vessels that did intersect the Lease Area were seeking access to the uncharted (recommended) anchorage area to the north (see Section 6.1.7).

Figure 7.14 presents a plot of the tanker tracks recorded within the Study Area throughout the survey period. Tankers accounted for approximately 20% of traffic within the Study Area and 19% of traffic within the Lease Area itself.

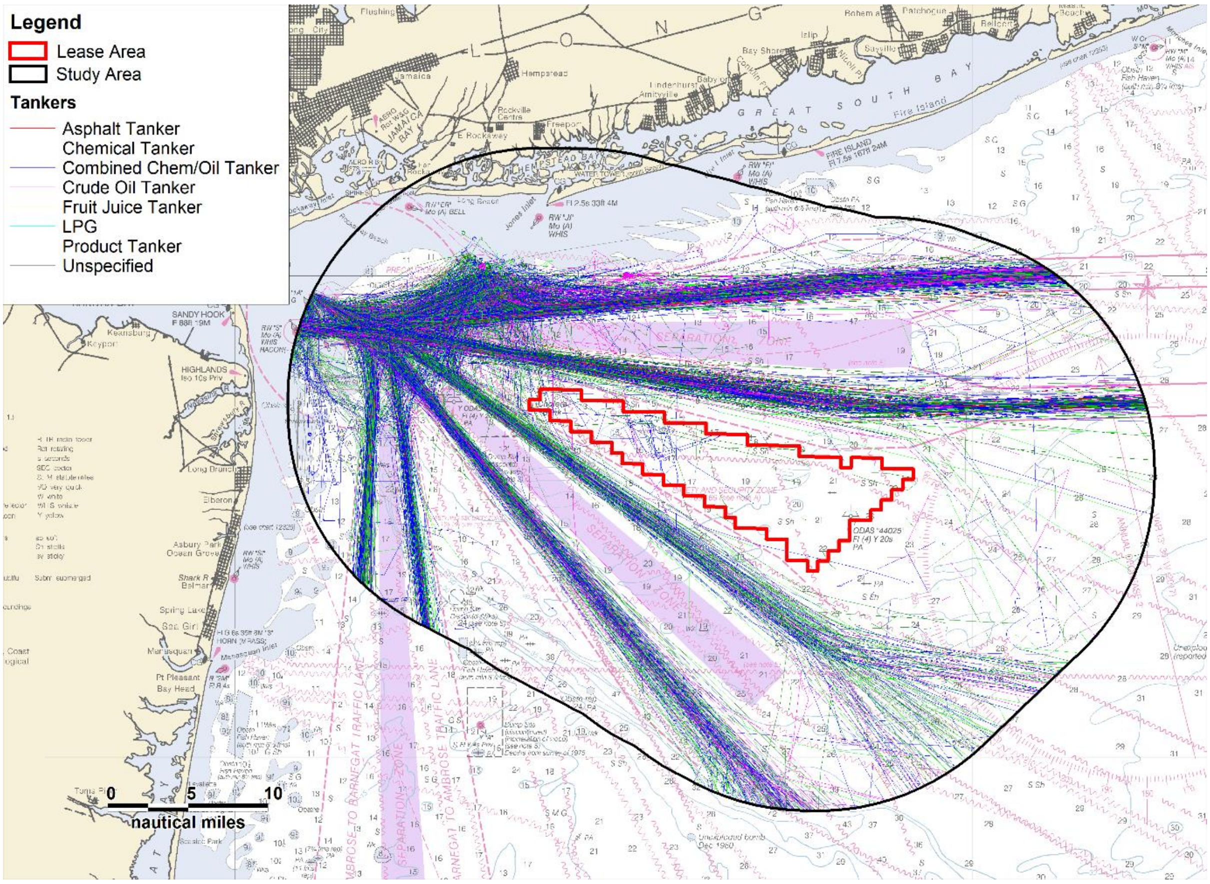

Figure 7.14 Tanker tracks within Study Area (12 months August 2017 to July 2018)

During the survey period, an average of 11 unique tankers per day were recorded within the Study Area, and one every nine days within the Lease Area itself. As with cargo vessels, the majority of tankers recorded were transiting routes through the TSS lanes in the approaches to the precautionary area, and therefore tanker traffic intersecting the Lease Area was limited.

Figure 7.15 presents a plot of the passenger vessel tracks recorded within the Study Area throughout the survey period. Passenger vessels accounted for approximately 6% of overall traffic.

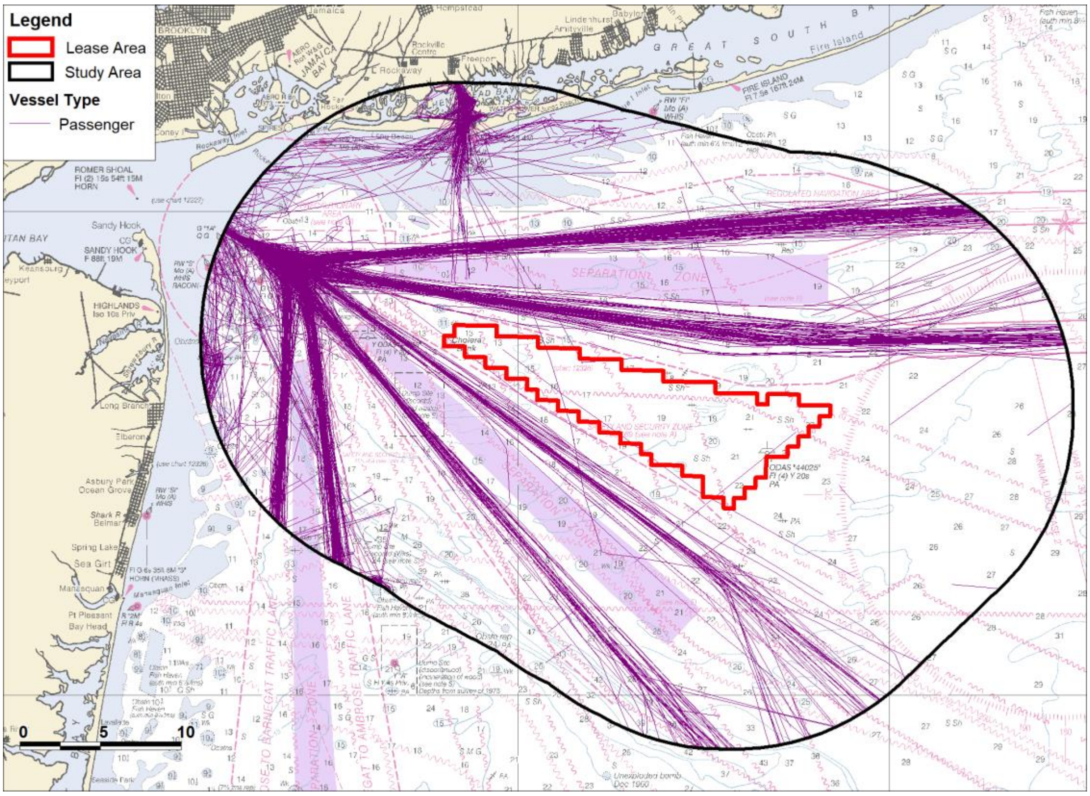

Figure 7.15 Passenger vessel tracks within Study Area (12 months August 2017 to July 2018)

Throughout the survey period, an average of three to four unique passenger vessels per day was recorded within the Study Area, and a total of five passenger vessels within the Lease Area itself. The majority of passenger vessels recorded utilizing the TSS lanes were observed to be large cruise ships, with vessels on coastal transits being smaller, day-trip vessels.

7.2.4.3 Push/Tow

Figure 7.16 presents a plot of the tug (push/pull) tracks recorded within the Study Area throughout the survey period. Such vessels accounted for approximately 15% of overall traffic levels.

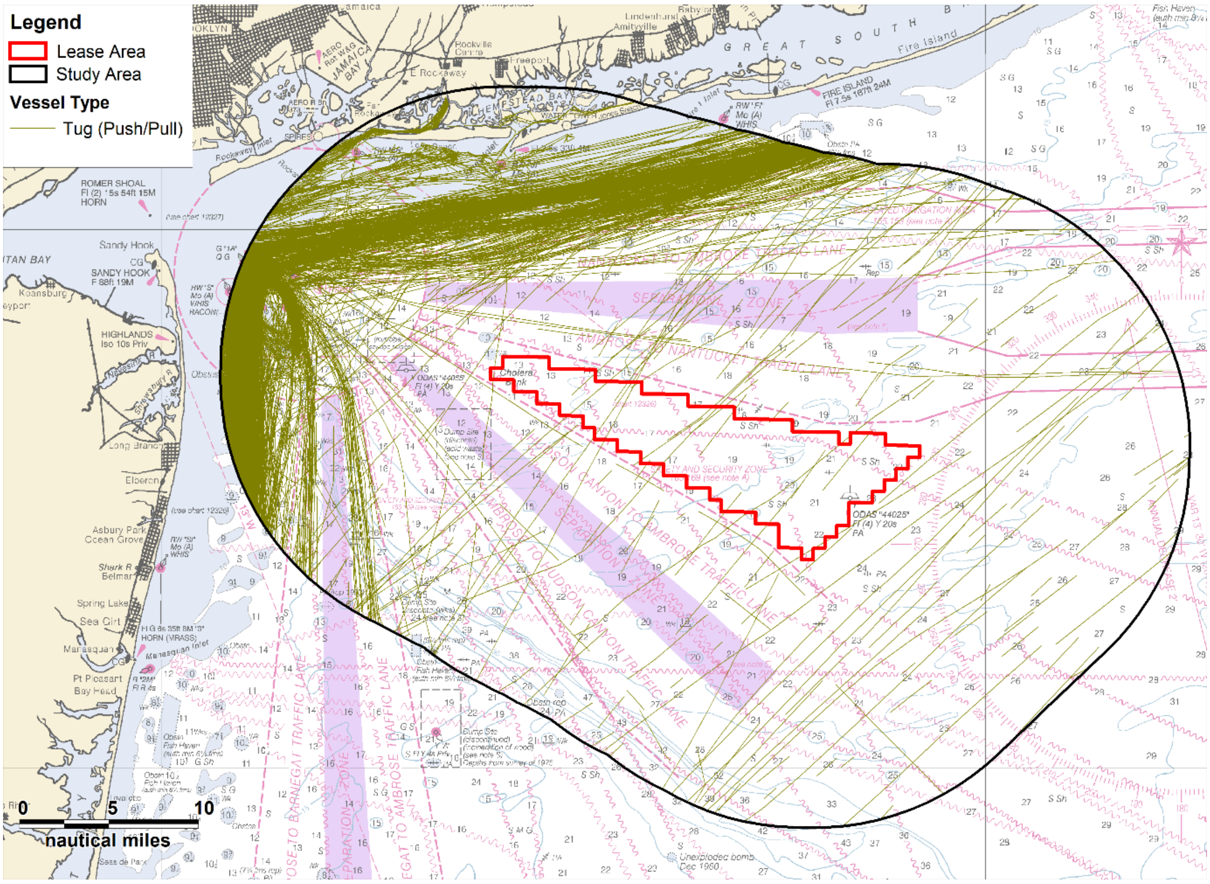

Figure 7.16 Push/Tow vessel tracks within Study Area (12 months August 2017 to July 2018)

Throughout the survey period, an average of eight unique tug (push/pull) vessels were recorded within the Study Area per day, falling to less than two per month within the Lease Area itself. The majority of tugs (push/pull) vessels were observed to be associated with the Port of NY/NJ and hence were mostly recorded on transits close to the coastline. However, limited levels of transits further offshore were also recorded.

7.2.4.4 Pilot Vessels

As per Section 6.1.2, the Port of NY/NJ provide a pilotage service, with the designated boarding area located within the precautionary area. Figure 7.17 presents a plot of the pilot vessel tracks recorded within the Study Area during the survey period. For context, the charted position of the pilot boarding area (see Section 6.1.2) is included in the figure.

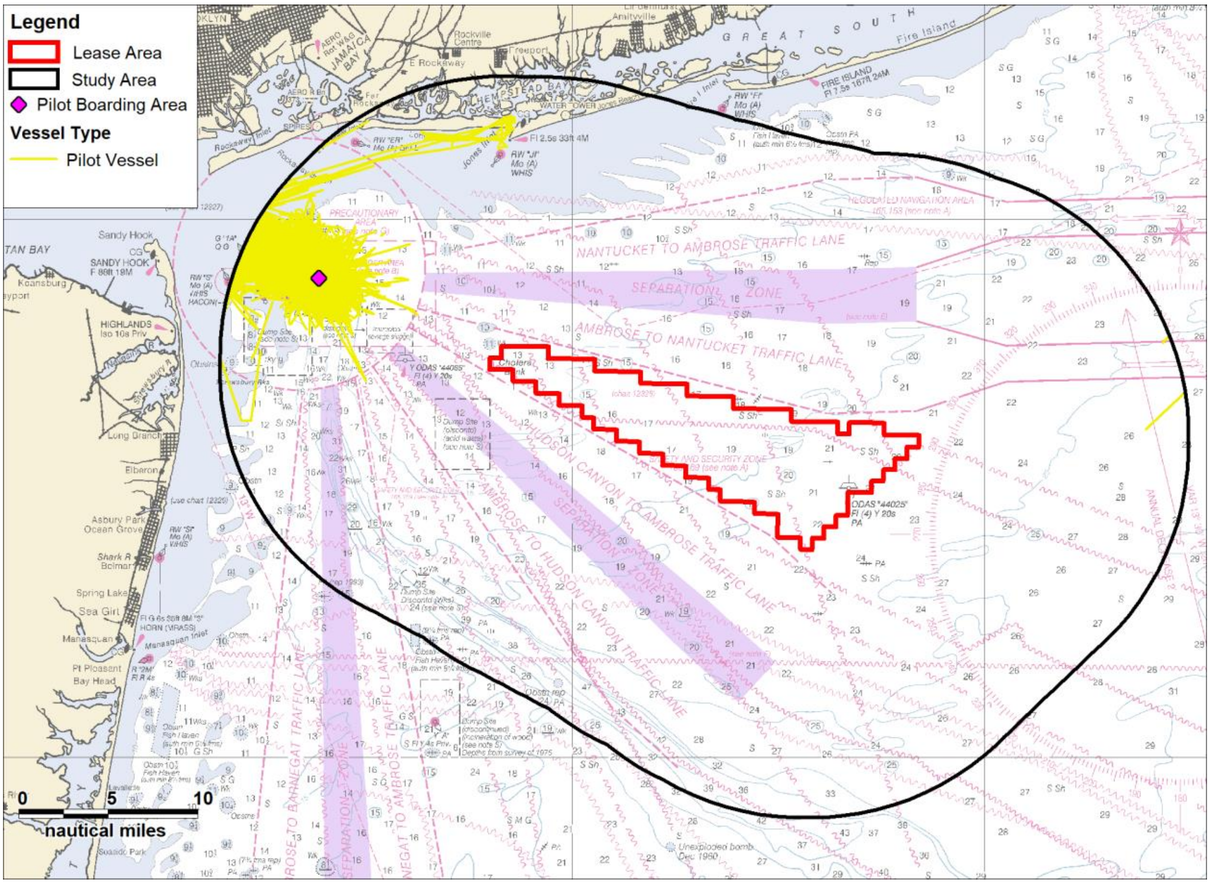

Figure 7.17 Pilot vessel tracks within Study Area (12 months August 2017 to July 2018)

During the survey period, an average of three unique pilot vessels per day were recorded within the Study Area. There were no pilot vessels recorded intersecting the Lease Area itself, noting that, as would be expected, the significant majority of activity recorded occurred within the precautionary area. Pilot vessels were instead recorded operating mainly within the western extent of the Study Area between various New York and New Jersey ports, with limited levels of transits associated with the Jones Inlet also recorded.

7.2.4.5 Fishing Vessels

Figure 7.18 presents a plot of the fishing vessel tracks recorded within the Study Area throughout the survey period. Following this, to provide an indication of areas of active fishing, Figure 7.19 presents a plot of the same tracks, color-coded by average vessel speed, noting that a lower speed may indicate active fishing (rather than transit).

Fishing vessels accounted for approximately 8% of AIS traffic throughout the survey period. Noting that assessment in this section is AIS only, VMS data is considered in Section 7.2.7, and additional assessment of non-AIS traffic (including fishing vessels) recorded within and near the Lease Area via visual observation is available in Section 7.2.8.

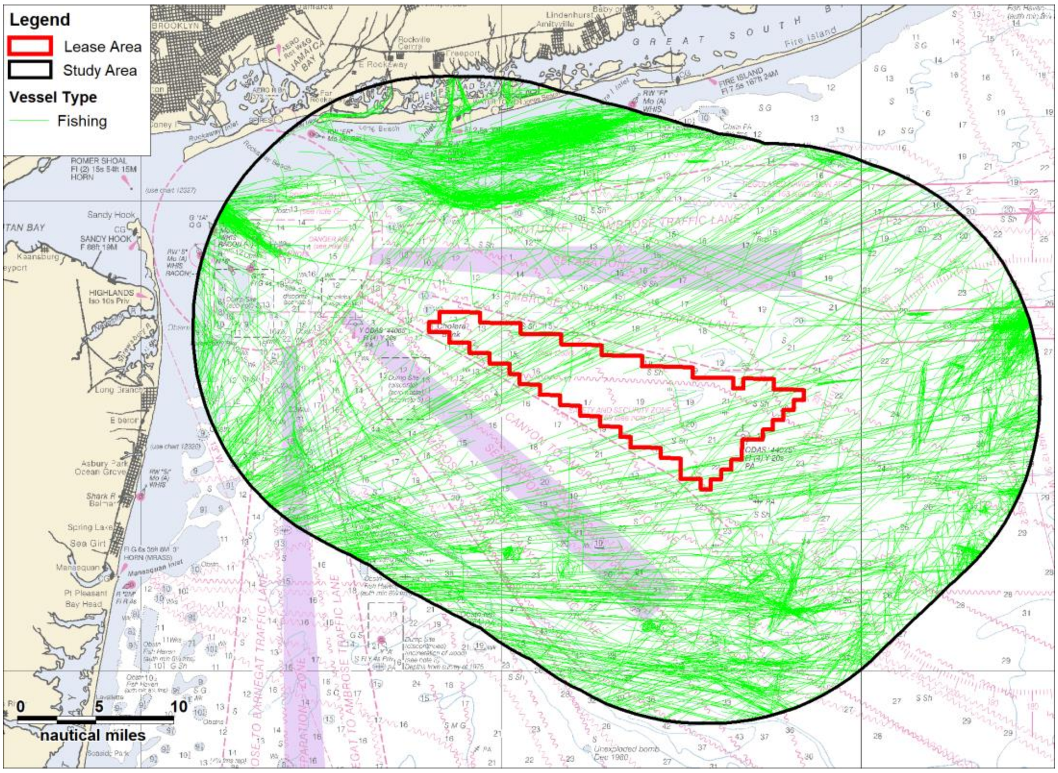

Figure 7.18 Fishing vessel tracks within Study Area (12 months August 2017 to July 2018)

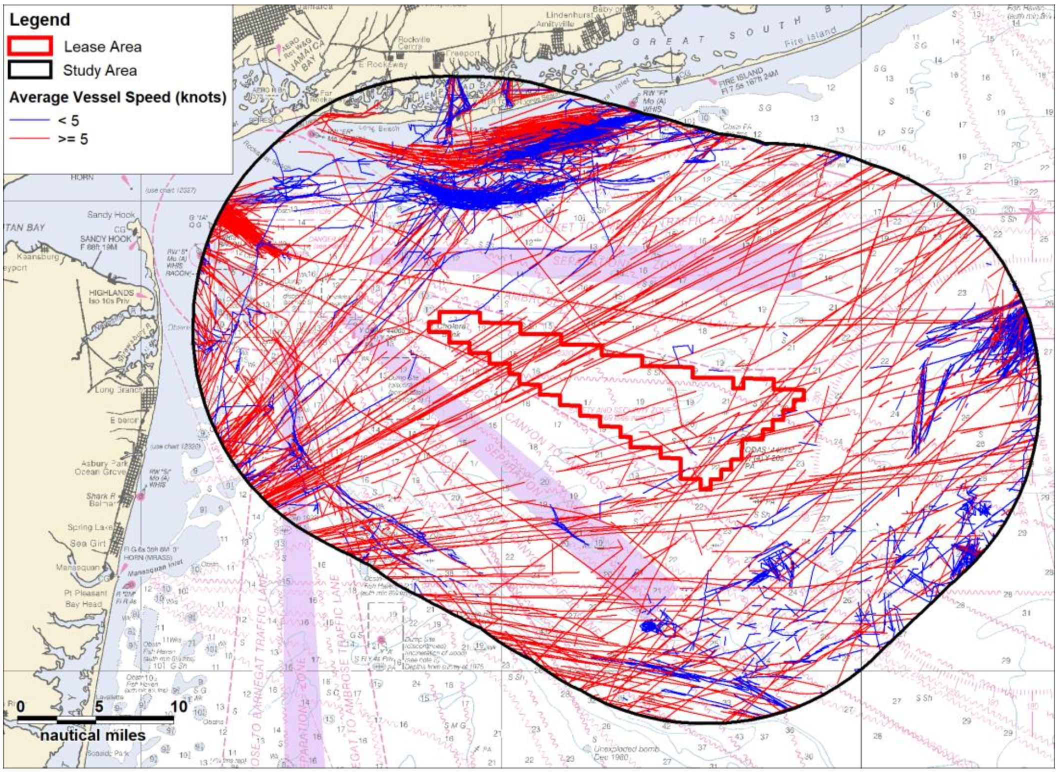

Figure 7.19 Fishing vessel tracks color-coded by average speed

During the survey period an average of five unique fishing vessels per day were recorded within the Study Area and one in every six days within the Lease Area itself (meaning approximately 3% of fishing vessel tracks recorded intersected the Lease Area). The maximum number of fishing vessels within the Lease Area on a single day was five.

Based upon the nature of the vessel tracks and the average speeds, fishing vessels were observed to be mostly transiting through the Lease Area with active fishing activity restricted to the northern, eastern and southern extents of the Study Area.

7.2.4.6 Recreational Vessels

Figure 7.20 presents a plot of the recreational vessel tracks recorded within the Study Area throughout the survey period. Recreational vessels accounted for approximately 7% of the AIS data recorded.

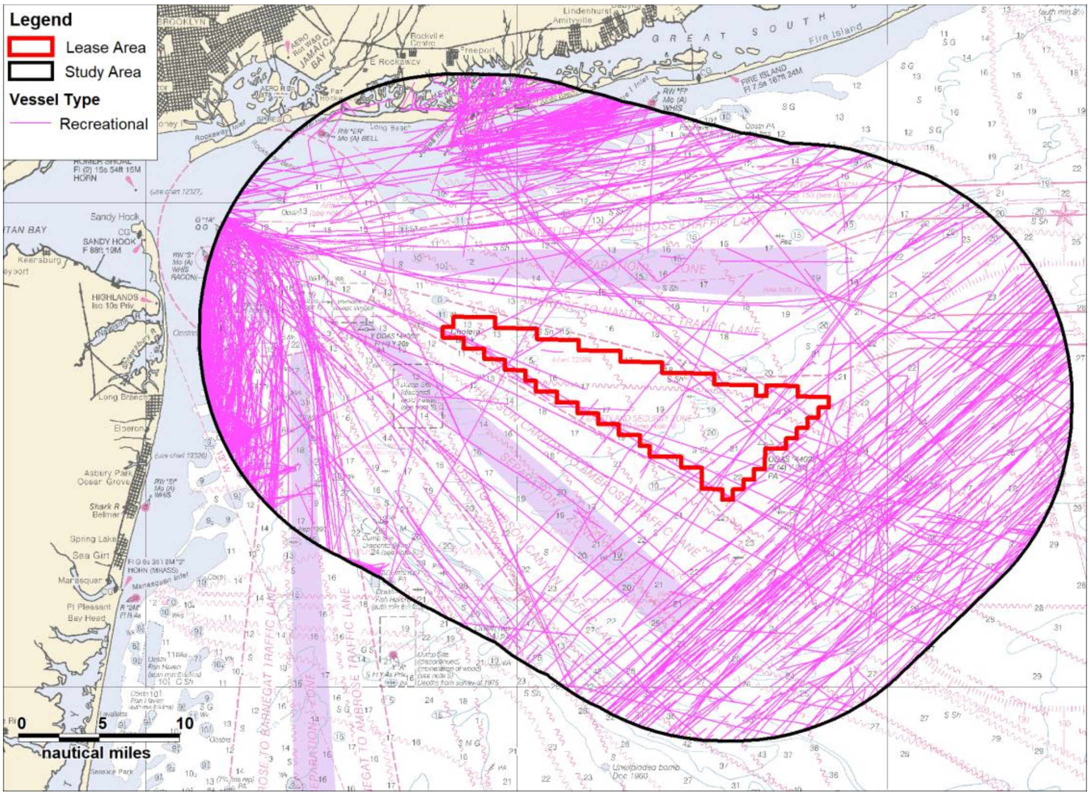

Figure 7.20 Recreational vessel tracks within Study Area (12 months August 2017 to July 2018)

An average of three to four unique recreational vessels per day was recorded within the Study Area during the period studied, with the majority of this traffic being coastal. It is noted that higher levels of recreational traffic passed further offshore to the east of the Lease Area, and within the Barnegat / Ambrose TSS. Recreational vessel levels in the other TSS lanes were limited in comparison.

A total of 35 recreational vessels were recorded via AIS within the Lease Area during the year of data studied. The majority of these were small (average length of 76 ft (23.2 m)) privately owned sailing vessels or yachts.

It is likely that only a minority of recreational vessels operating in the region broadcast on AIS, therefore, the tracks are considered to provide only an indication of the recreational activity in the area. An assessment of non-AIS traffic (including recreational vessels) recorded within and near the Lease Area via visual observation is available in Section 7.2.8.

7.2.5 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, incorrectly transmitted navigational statuses are common. Therefore, the vessels transmitting a status other than "At Anchor" were filtered using a set of behavioral criteria[23] 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.

The vessels identified as being at anchor on this basis are shown in Figure 7.21 color coded by type. It should be noted that pilot vessels often exhibit anchoring like activity within the precautionary area. However, these have been excluded from the anchoring analysis.

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

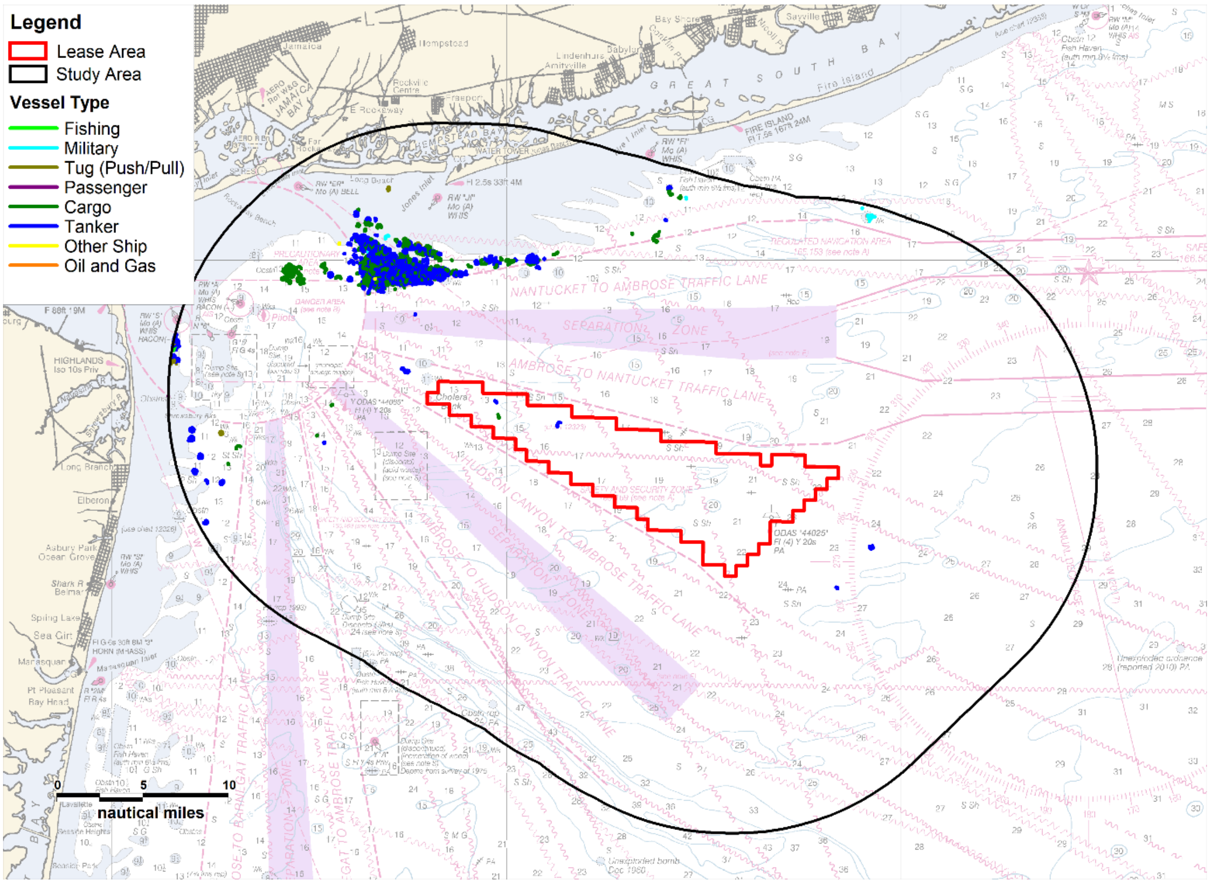

Figure 7.21 Anchored vessel tracks within Study Area (12 months August 2017 to July 2018)

An average of eight unique vessels per day was deemed to be at anchor within the Study Area. Over the year, just three instances of a vessel recorded at anchor within the Lease Area itself were observed:

- The 1,100 ft (335 m) cargo vessel *Ever Lucky*, anchored for seven hours on October 30, 2017;
- The 883 ft (269 m) tanker *European Spirit*, anchored for approximately 34 hours between July 2 and 3, 2017; and
- The 640 ft (195 m) tanker *Ainazi*, anchored for approximately 38 hours between September 18 and 19, 2017.

It can be seen that the majority of anchored vessels were recorded at anchor to the north of the Nantucket to Ambrose TSS, noting that this area corresponds to the USCG Proposed Ambrose Anchorage (86 Fed. Reg. 17090) discussed in Section 6.1.7. Vessels were also recoded at anchor within, and south of, the Precautionary Area.

7.2.6 Vessel Routing

The maritime traffic data collected was used to identify the main vessel routes intersecting the Study Area. The routes were identified statistically with cases of vessels transiting at similar headings and locations classed as a main route. AIS data may also be analyzed to show vessels (by name and/or operator) that frequently transit those routes, thus identifying 'regular runner/operator routes. A total of ten routes were identified on this basis, as shown in Figure 7.23.

The shipping route width is then calculated using the 90th percentile rule (as shown in MGN 543, 2016) from the median line (i.e., mean route position) of the potential shipping route as shown in Figure 7.22 – noting that this figure is a generic figure used to demonstrate how a 90th percentile is calculated. The 90th percentile method assumes that the route width covers the 90% of vessels that are nearest the median line (total vessel count x 0.9). The 90th percentiles are shown relative to the identified main routes in Figure 7.23.

It is noted that the mean route positions shown are based on the median positions across the route width and as such may not be "central" within the corresponding track data or 90th percentiles.

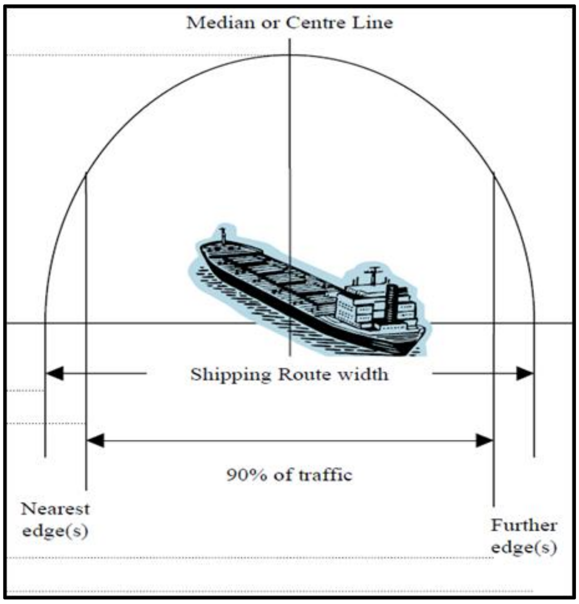

Figure 7.22 Illustration of Main Route calculation (taken from MGN 543)

Description summaries of each route are given in Table 7.1. It is noted that the identification of main routing helps analyze key vessel routing and movements in the Study Area. However, all individual tracks have also been considered within the risk assessment as shown in Section 10.3 and within the impact assessment in Section 12.

It is noted that given the complexity of routing within the precautionary area associated with pilotage, the dredged channels, and access to the anchorage area, routes have not been defined within the precautionary area boundaries.

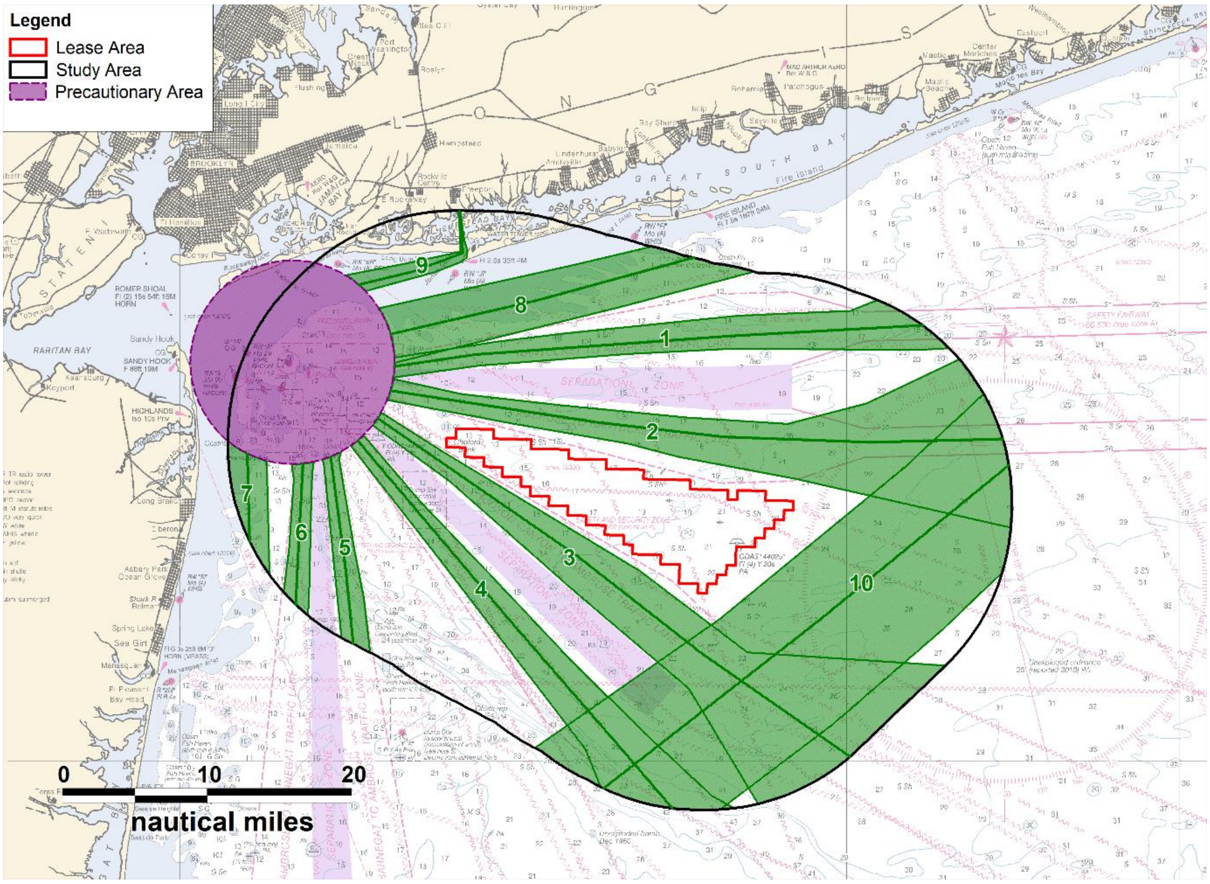

Figure 7.23 Main Routes and 90th Percentiles

Table 7-1 Summary of Main Routes

Route	Terminus Ports	Vessels per Day	Description
1	Nantucket to Ambrose	6	Traffic utilizing the Nantucket to Ambrose (inbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels.
2	Ambrose to Nantucket	4	Traffic utilizing the Ambrose to Nantucket (outbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels. Includes traffic to Europe (notably Rotterdam).
3	Hudson Canyon to Ambrose	4	Traffic utilizing the Hudson Canyon to Ambrose (inbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels.

Route	Terminus Ports	Vessels per Day	Description
4	Ambrose to Hudson Canyon	4	Traffic utilizing the Ambrose to Hudson Canyon (outbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels. Includes notable levels of traffic to Bermuda.
5	Barnegat to Ambrose	4	Traffic utilizing the Barnegat to Ambrose (inbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels.
6	Ambrose to Barnegat	6	Traffic utilizing the Ambrose to Barnegat (outbound) TSS lane. Majority of traffic using the lane are large commercial (cargo or tanker) vessels. Includes notable levels of traffic associated with Norfolk, Virginia (VA) and Baltimore, Maryland (MD).
7	Port of NY/NJ / Philadelphia	3	Coastal tug (push/pull) traffic associated with New York, NY, in the majority from Philadelphia, Pennsylvania (PA).
8	Ambrose / Boston	1	Coastal traffic associated with New York, NY, in the majority from Boston, Massachusetts (MA). Traffic is likely using the Cape Cod Canal, with the majority being tug (push/pull) traffic.
9	Port of NY/NJ / Hempstead Bay	< 1	Coastal passenger (day trip) vessel route.
10	Philadelphia / Boston	< 1	Largely tug (push/pull) traffic between Philadelphia, PA and Boston, MA. Includes larger commercial (cargo or tanker) traffic.

Individual tracks (future case) outside those identified as main routes are shown within Section 7.2 Lease Area Maritime Traffic and Section 10.2.1 Deviations and Encounters (future case).

7.2.7 VMS Data

To enhance the fishing vessel baseline established by the AIS data (see Section 7.2.4.5), additional VMS collected by the NEODP during 2015-16 (NEODP, 2018) has been assessed. This was the most recently available VMS data provided by the portal. Data for multispecies of groundfish, monkfish, scallop, surfclam / ocean quahog, and pelagic species (squid, mackerel, herring) were available, and data for each relative to the Lease Area is shown in Figure 7.24 to Figure 7.28.

Notable levels of pelagic, scallop and surfclam / ocean quahog fishing activity were recorded via VMS within the Lease Area. The available format of the VMS data (density grids) does not allow for quantitative assessment, or direct comparison against the AIS data findings, however the potential for additional non AIS fishing vessels has been considered within the quantitative assessment of fishing vessel allision (see Section 10.3.4.2).

It should be considered that the format of the VMS data does not provide any quantification of the density ranges (i.e., “Low” to “Very High”). On this basis the VMS figures shown are not directly comparable to the AIS density figures included elsewhere within this NSRA.

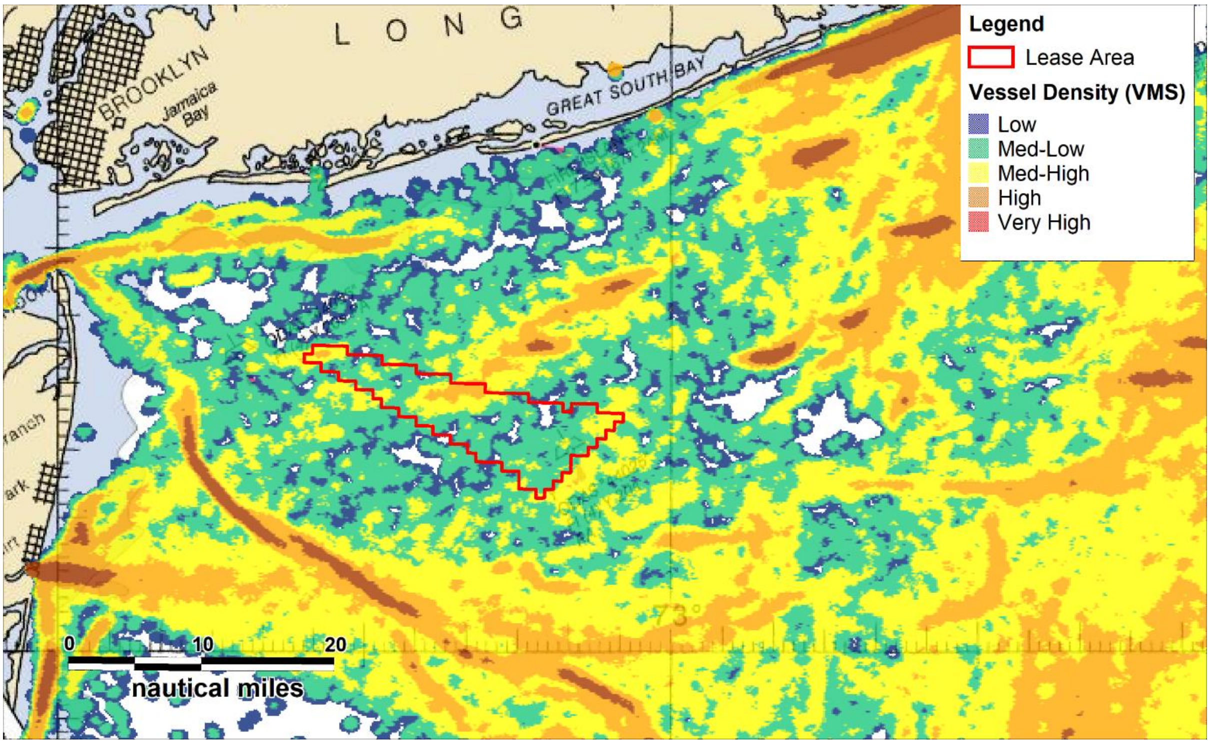

Figure 7.24 VMS Density (2015/16) – Pelagics (Squid, Mackerel, Herring)

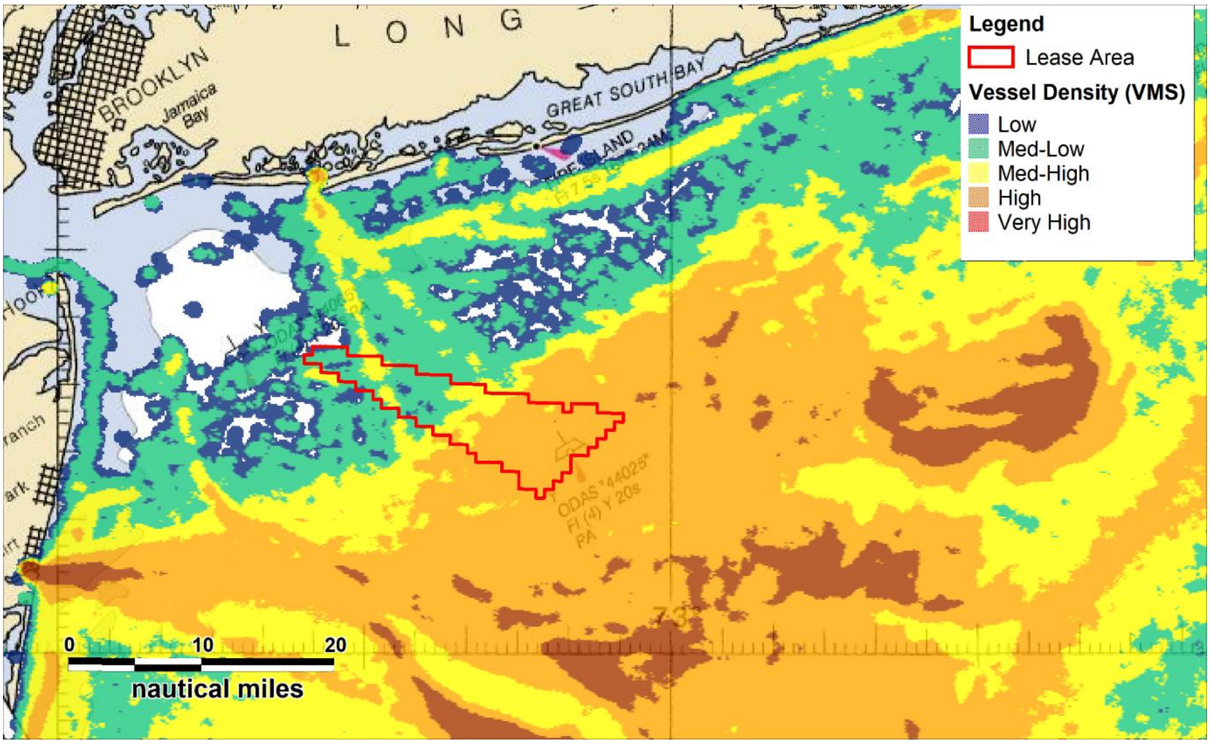

Figure 7.25 VMS Density (2015/16) – Scallops

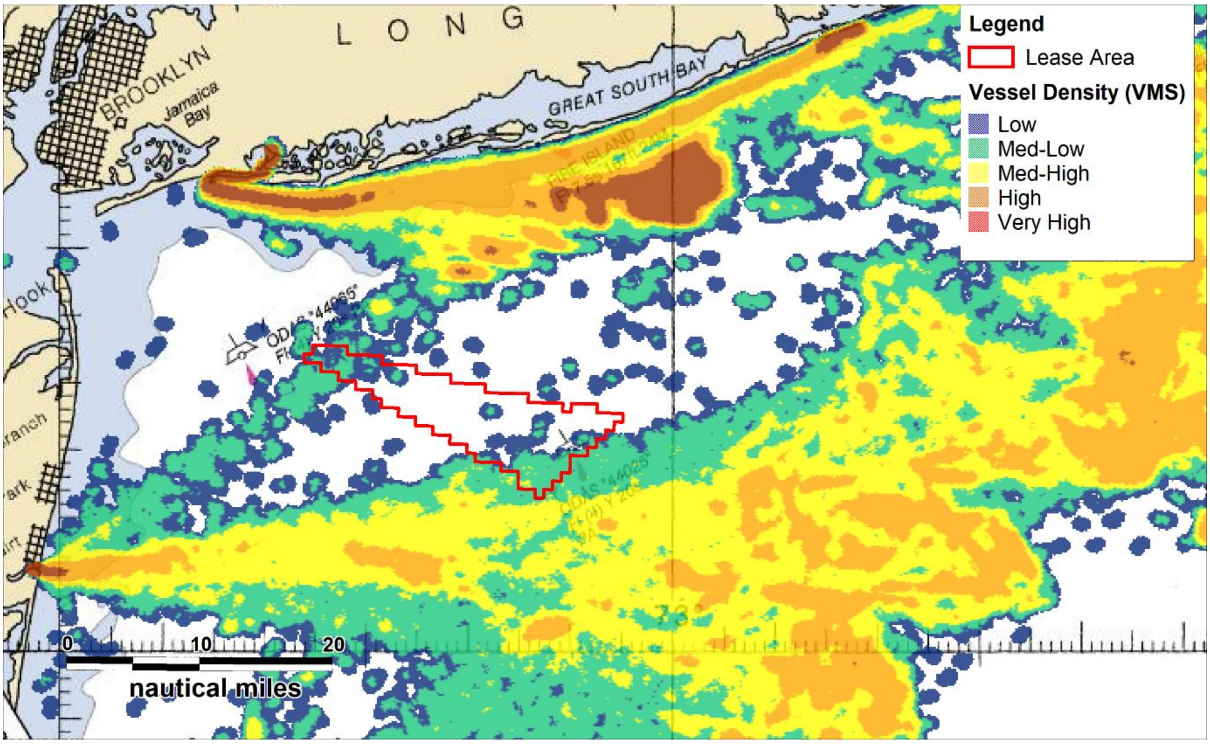

Figure 7.26 VMS Density (2015/16) – Surfclam / Ocean Quahog

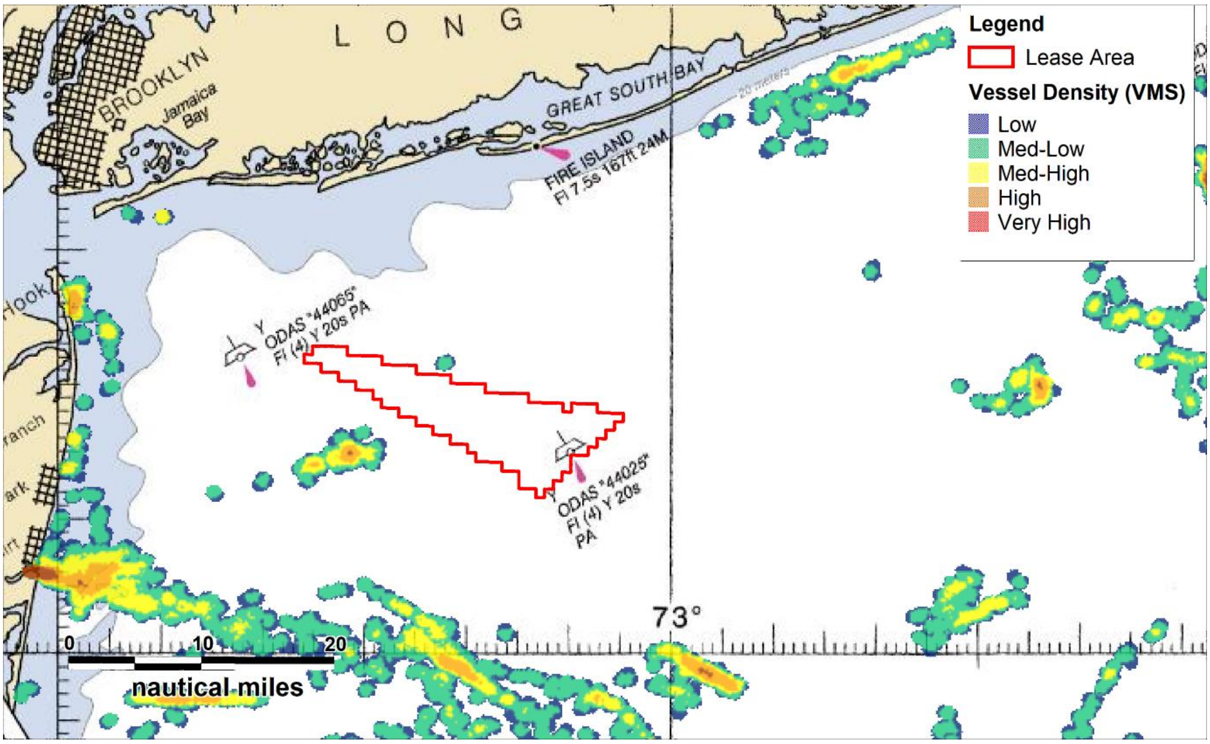

Figure 7.27 VMS Density (2015/16) – Monkfish

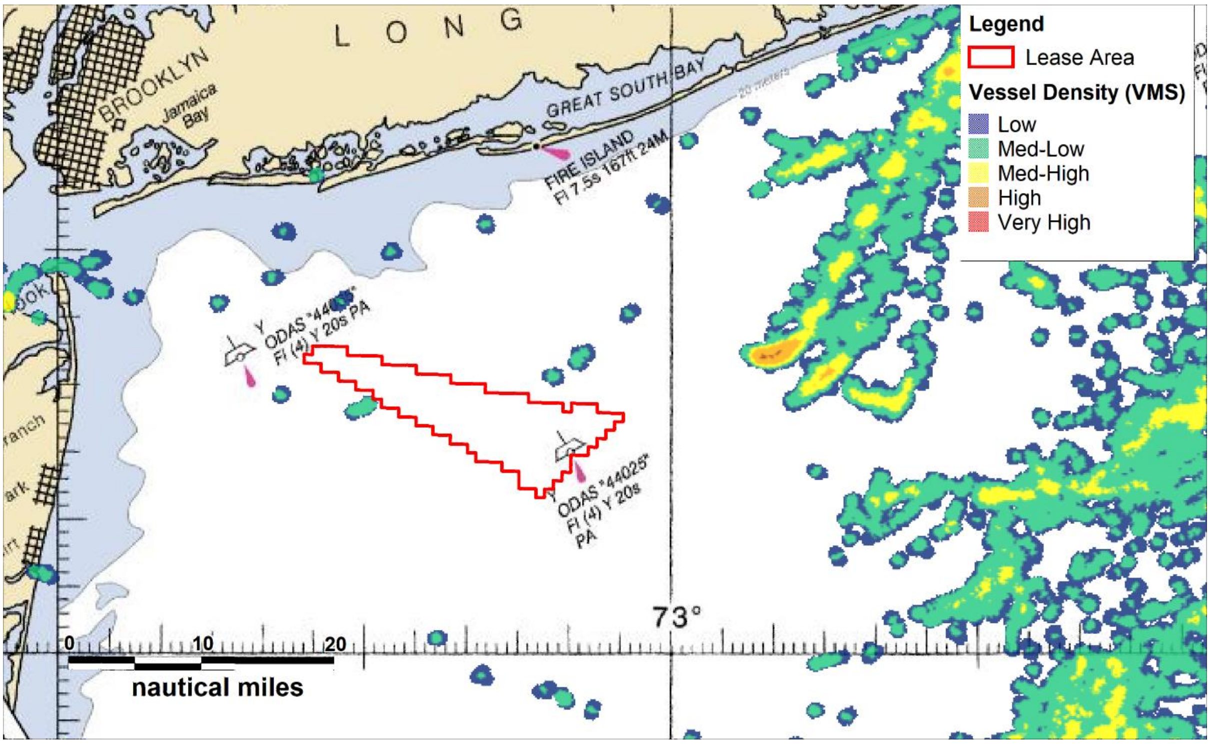

Figure 7.28 VMS Density (2015/16) – Multispecies Groundfish

7.2.8 Visual Observation Data

The survey vessel *Ocean Researcher* recorded visual observation data of non-AIS targets within the vicinity of the Lease Area between June 8th and June 27th. This visual data has been used to supplement the other data sources considered (e.g., AIS, VMS – see Section 1.3) and consultation to ensure the baseline is as comprehensive as practicable based on the available data.

This data is shown relative to the Lease Area in Figure 7.29. An average of between four and five vessel sightings were recorded on the 14 days on which data was available, with the majority of these observed to be either fishing or recreational vessels.

In line with the AIS data studied, both fishing vessels and recreational vessels were recorded within the Lease Area and surrounding TSS lanes. Such vessels formed the significant majority of the non-AIS traffic in the area (70% recreational, 27% fishing). The observed recreational vessels included small yachts, sports fishing, and motor boats.

It should be considered that recreational and smaller fishing vessel levels would be expected to be higher in the summer months and therefore the winter levels are likely to be less than that observed by the *Ocean Researcher* during June 2018.

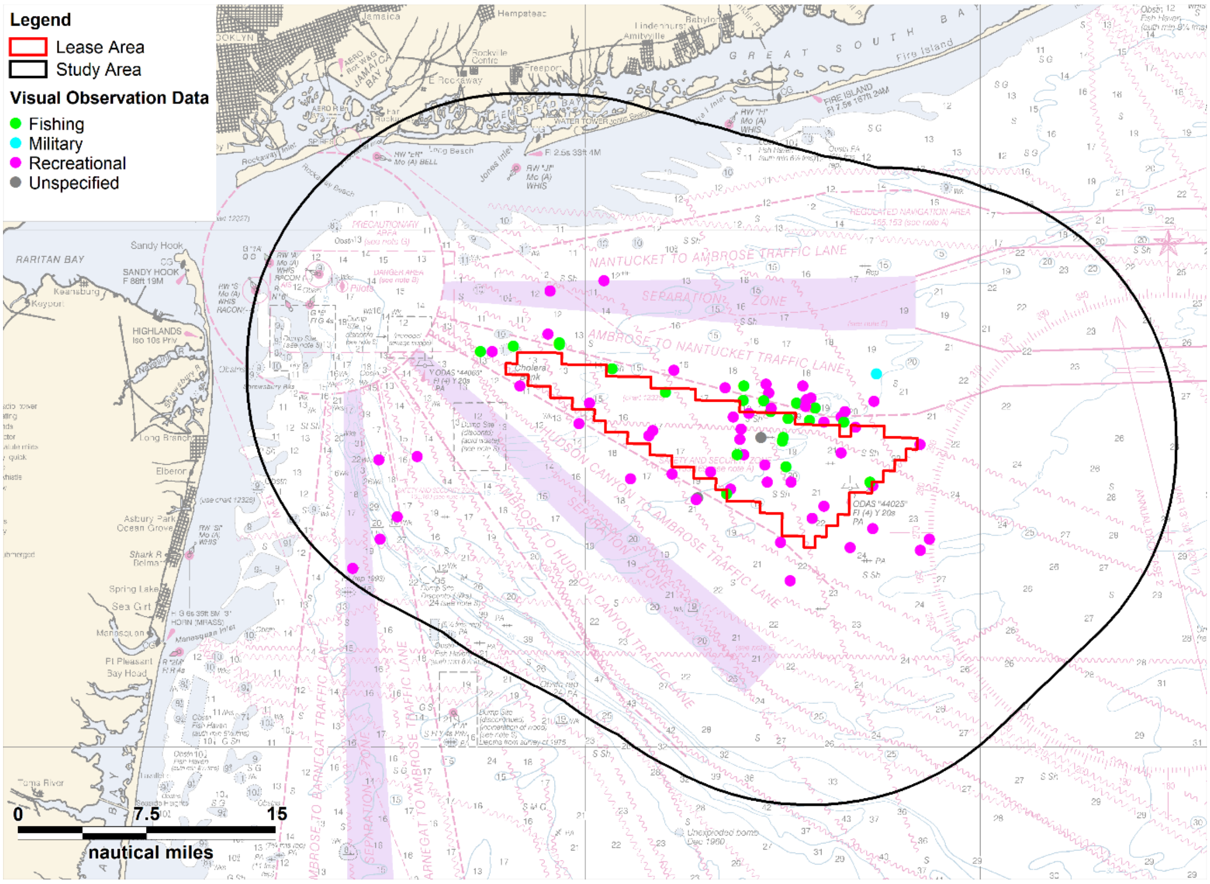

Figure 7.29 Visual Observation Data of Non-AIS Targets

7.3 TSS Maritime Traffic

This Section presents an assessment of traffic specifically within the TSS lanes, with a focus on the lanes bordering the Lease Area, namely the Ambrose to Nantucket lane to the north, and the Hudson Canyon to Ambrose lane to the south. Characteristics of the lanes themselves are presented in Section 6.1.1.

The 12 months of satellite AIS was used to estimate the number of unique vessels per day using each of the six TSS lanes in the area. The results of this assessment are shown in Figure 7.30. The maximum number of unique vessels recorded on a single day is also included for reference. However, it should be considered that the maximum values represent peak days within the year of data studied, and as such are not reflective of typical traffic levels.

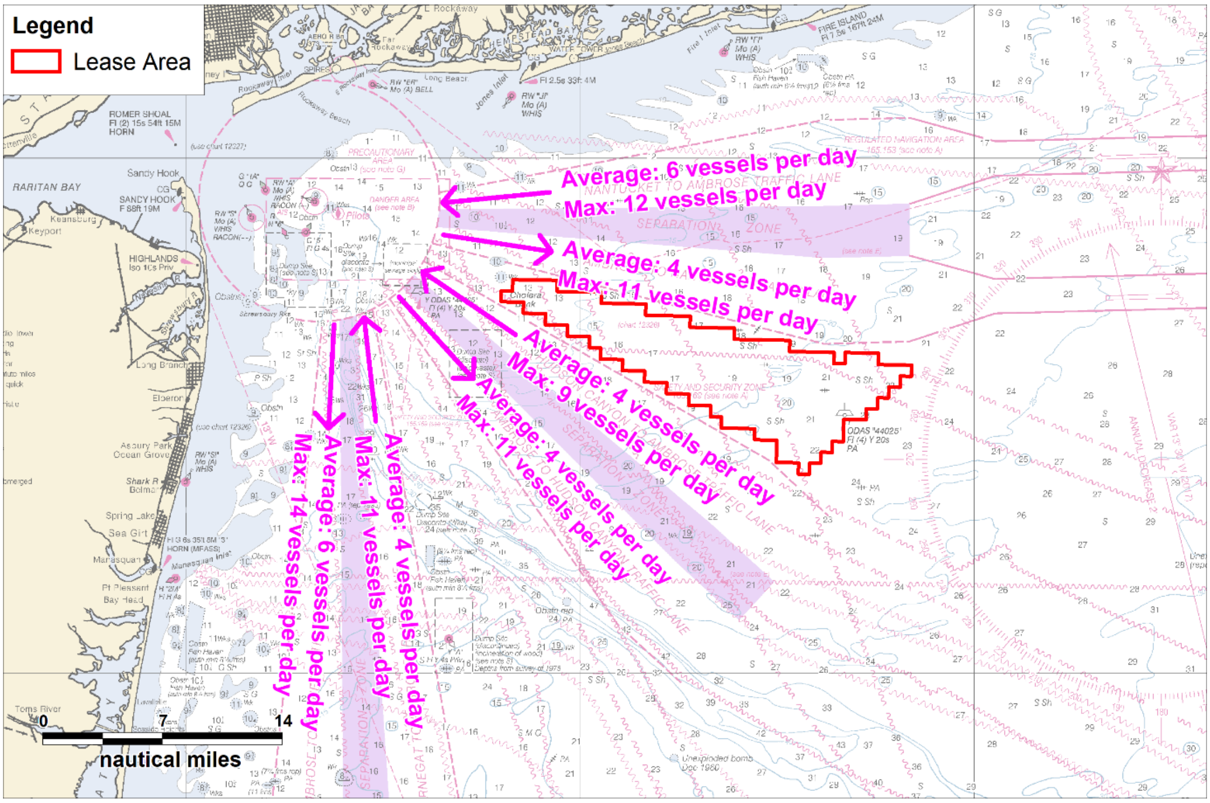

Figure 7.30 TSS Unique Vessel Numbers per Day

The busiest lanes were observed to be Nantucket to Ambrose (inbound) and Ambrose to Barnegat (outbound), with both estimated as being utilized by six unique vessels per day. The lanes bordering the Lease Area were both transited by an estimated four unique vessels per day. In order to assess the typical passage vessels utilizing these two bordering lanes take, a density analysis of the associated tracks was undertaken. The results of this density analysis are shown in Figure 7.31, which shows the number of tracks recorded on an annual basis within each cell of 820 x 820 ft (250 x 250 m) resolution grid spanning the two bordering lanes. Only tracks identified as utilizing one of the two bordering lanes has been considered within this density assessment.

As indicated in Figure 7.31, the majority of traffic utilizes the center of the lanes, with most vessels within the widest section of the lanes tending to avoid utilizing the southern extent of the Ambrose to Nantucket lane and the northern extent of the Hudson Canyon to Ambrose lane (i.e., the edges closest to the Lease Area). However, as the lanes reduce in width as they converge on the precautionary area, the full width of the lanes is more typically used. To illustrate this further, the distance of each track recorded from the edge of the WFDA (i.e., assuming a 1 nm (1.9 km) separation from the TSS lanes) was calculated at the four points indicated in Figure 7.31. The output of this proximity assessment is shown in Figure 7.32.

This assessment allowed the number of vessels per year transiting at any given distance from the WFDA to be estimated. For example, as shown in Figure 7.32, approximately 160 vessels per year passed the WFDA at a distance of 2 nm (3.7 km) at Point C.

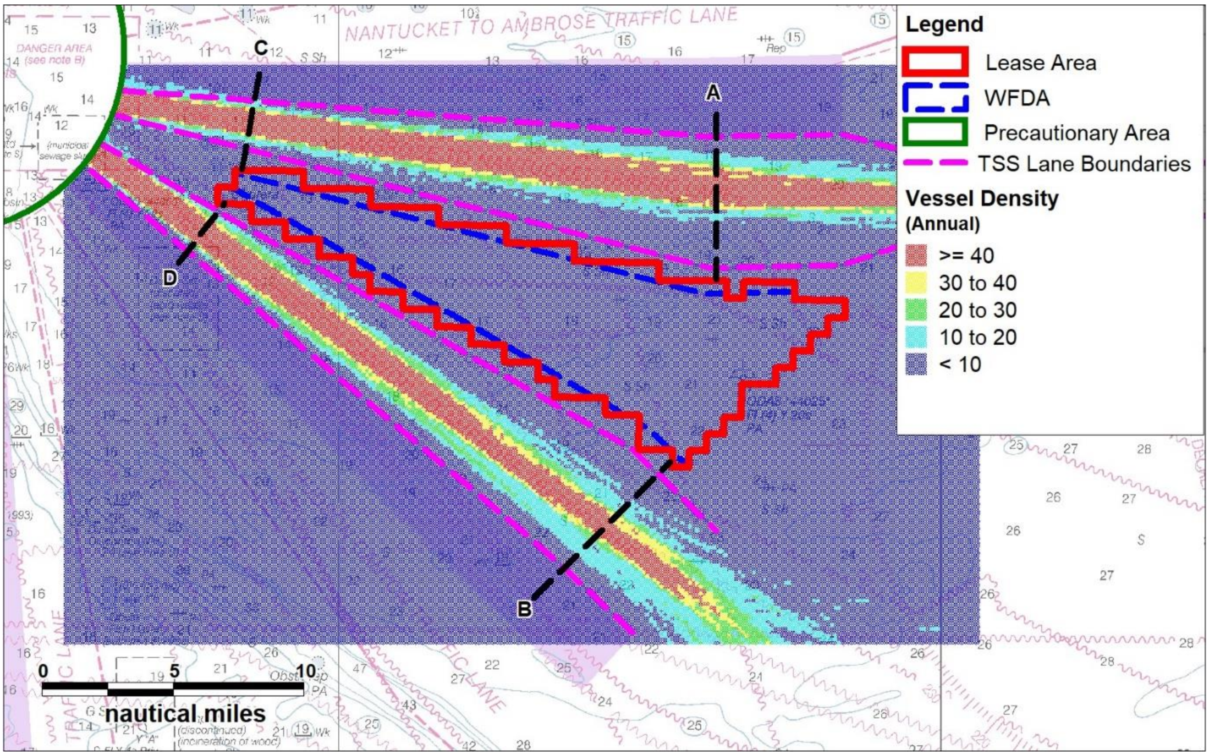

Figure 7.31 Bordering TSS Lane Density

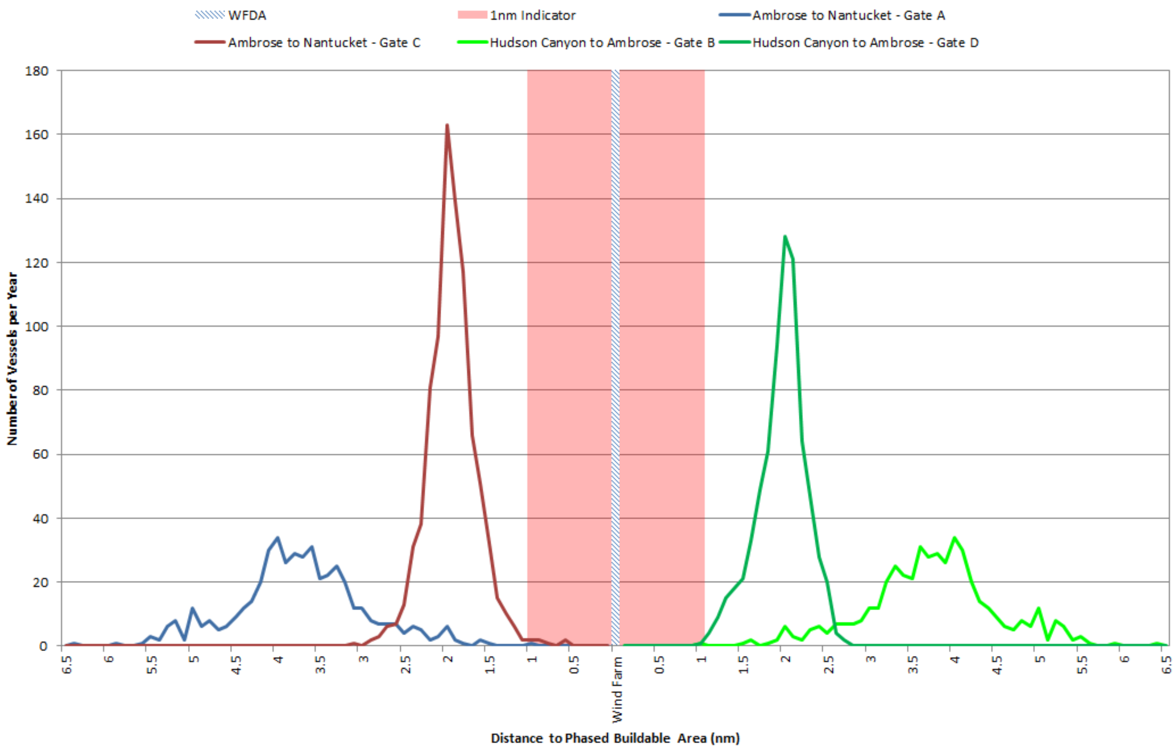

Figure 7.32 TSS Lane – Vessel Distribution

The average distance at which vessels passed from the WFDA at the easternmost points studied (A and B, i.e., where the lanes were widest) was estimated to be 4.0 nm (7.4 km) and 3.8 nm (7.0 km) for the Ambrose to Nantucket and Hudson Canyon to Ambrose lanes respectively.

At the narrowest points studied (C and D), the average distances fell to 2.0 nm (3.7 km) for both lanes. As shown in Figure 7.28, the majority of these vessels remained at least 1 nm (1.9 km) from the WFDA. This is in line with findings of preliminary assessments which were used to define Layout Rule 6 (see Section 5.2.5) which sets out the 1 nm (1.9 km) separation distance between the TSS lanes and the wind farm boundaries.

In general, vessels on transit through the northern section of the Hudson Canyon lane were observed to pass closer to the Lease Area than those utilizing the southern section of the Ambrose to Nantucket lane (i.e., the vessels nearest the southern wind farm periphery passed closer than those nearest the northern periphery).

7.4 Export Cables Maritime Traffic

In addition to the assessment of traffic within the vicinity of the Lease Area, further high-level assessment has been undertaken of traffic deemed relevant to the export cables. Given key impacts to the export cables are associated with anchor interaction and under keel clearance, the assessment has focused on vessel drafts and levels and locations of anchoring activity.

7.4.1 Overview

An overview of the maritime traffic data recorded within the export cable Study Area is presented in Figure 7.33, color coded by type.

In terms of vessel numbers, an average of 227 unique vessels per day were recorded within the export cable Study Area. However, it should be considered that the significant majority of this traffic was associated with vessels within the inshore areas of the Ambrose and associated channels.

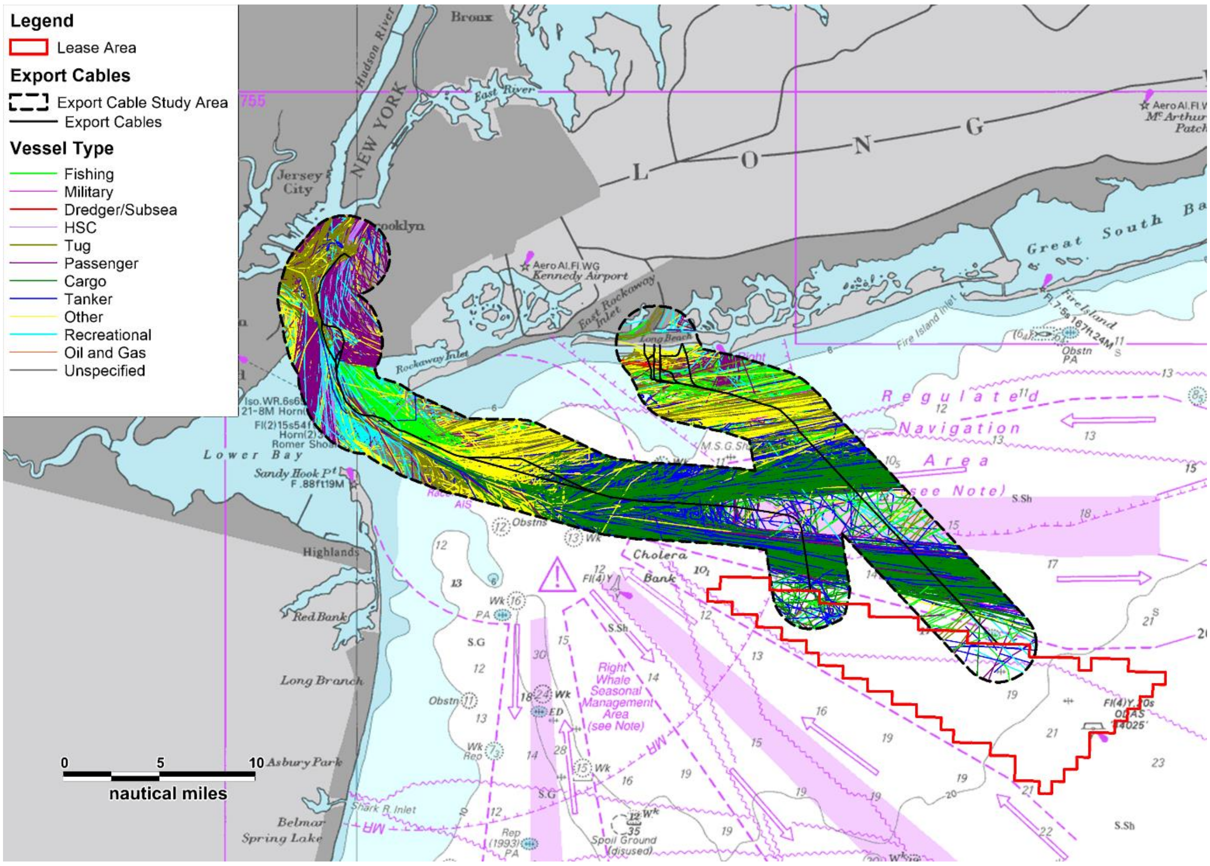

Figure 7.33 Export Cable Maritime Data Overview (Aug 2017 to July 2018)

7.4.2 Vessel Draft

Over the year of data studied, approximately 21% of vessels recorded within the export cable Study Area did not transmit a draft via AIS. This included all Class B vessels (as draft is not an available field for Class B) and a minority of Class A vessels. The transmitted draft information (i.e., vessels with unspecified drafts excluded) is presented in Figure 7.34.

As indicated in the figure, the significant majority of vessels with deeper drafts utilized the TSS lanes for entry or exit to the precautionary area, with shallower drafted vessels generally preferring coastal transits. Within the precautionary area, and the NY VTS area, larger drafted vessels exclusively utilized the dredged channels, with the un-dredged areas utilized by shallower drafted vessels only.

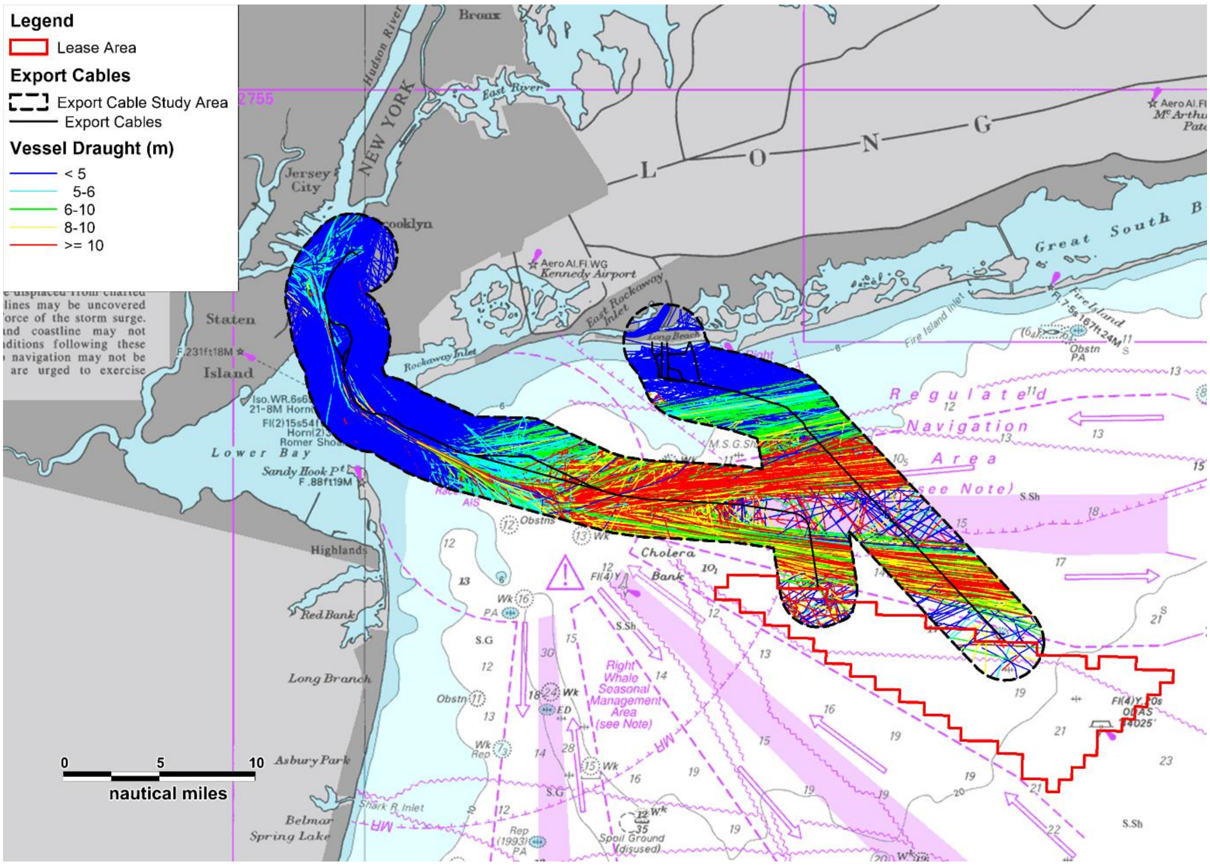

Figure 7.34 Export Cable Maritime Data by Draft excluding Unspecified (Aug 2017 to July 2018)

7.4.3 Anchored Vessels

Vessels at anchor within the export cable Study Area have been identified using the methodology described in Section 7.2.5. However, quantitative assessment has only been undertaken up to the Verrazzano-Narrows Bridge, noting substantial levels of vessels at low speeds beyond this point.

The identified anchored vessels are shown in Figure 7.35 relative to the export cables. For reference, the location of the Verrazzano-Narrows Bridge is included in the figure.

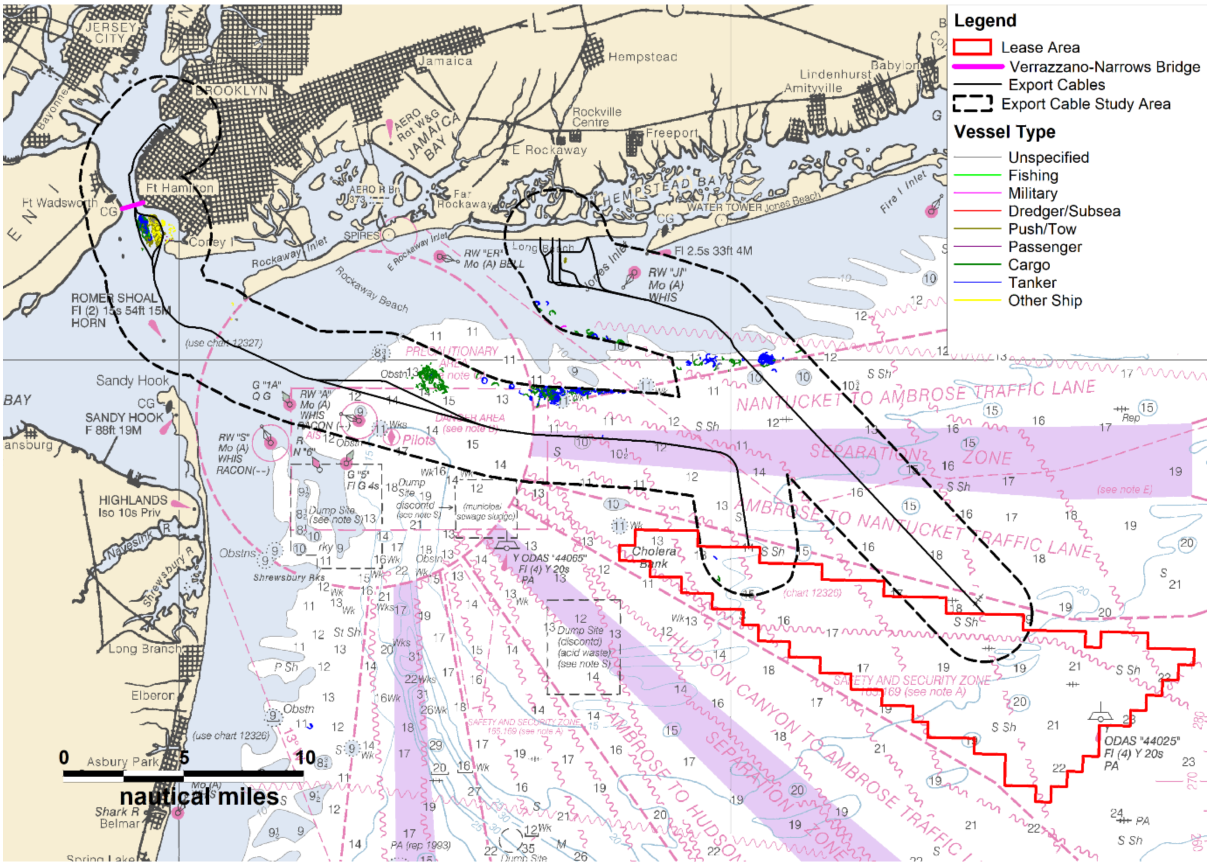

Figure 7.35 Anchored Vessels within 2 nm (3.7 km) of Export Cables (excluding waters north of Verrazzano-Narrows Bridge)

The southern extremity of the recommended anchorage area to the north of the Lease Area (see Section 6.1.7) intersects the export cable Study Area, with vessels recorded at anchor within this area either awaiting entry into New York or next orders. It was estimated that an average of seven unique vessels per day utilize this area for anchoring purposes. However, the majority of this activity was outside of the export cable Study Area.

Limited levels of anchoring (less than one vessel per day) were also identified within the precautionary area, activity which the EW 1 cable option was observed to pass in proximity to.

The EW 1 options also intersects the charted Gravesend Bay anchorage, where notable levels of anchoring were recorded from commercial vessels and tug (push/pull) vessels. It was estimated that an average of three unique vessels per day anchor within this area.

Finally, limited levels of commercial vessel anchoring (approximately one vessel per day) were recorded in the immediate vicinity of the EW2 cable options north of the Nantucket to Ambrose TSS lane.

7.5 Future Case Maritime Traffic

The current level and nature of vessel traffic as outlined in previous sections is considered to be the base case scenario within the collision and allision risk modelling (see Section 10). This subsection outlines the level and nature of vessel traffic anticipated for the future case scenario. This involves estimating the potential growth in shipping movements and traffic types as well as any foreseeable changes in the marine environment.

7.5.1 Increases in Commercial Vessel Activity

Given the uncertainty associated with long-term forecasting of vessel traffic growth including the potential for any major new developments in US ports, a conservative potential growth in commercial shipping movements of 10% has been applied directly to the base case as a set increase of traffic volume (this is the standard approach taken with the majority of UK developments). This increase is in line with the assessment of other renewable developments.

It is noted that this is a conservative assumption given the general historical trend towards fewer movements being made by vessels with larger capacity (as per a study undertaken by the International Transport Forum (ITF) at the Organization for Economic Cooperation and Development (OECD) on the impact of 'Mega Ships' (OECD/ITF, 2015)).

7.5.1.1 Anchorage and Channel Proposals

It is noted in that the U.S. Army Corps of Engineers have undertaken studies and environmental assessment into the need for changes to the existing channels and anchorage associated with PANYNJ to accommodate larger sizes of vessels than the current channels and anchorages were designed to facilitate.

The Deepening Channel Improvements Navigation Study (U.S. Army Corps of Engineers, 2020a) has proposed deepening the relevant channels by a depth of 5 ft (1.5 m) up to a maintained depth of -55 feet (ft) (-16.8 m) MLLW to accommodate larger vessels. The study assumed a design vessel size of 1,308 ft (~ 399 m), which represents an increase of approximately 100 ft (30.5 m) over the maximum size of vessel identified within the data studied for this NSRA (see Section 7.2.2.1). The period of analysis of the study ends in 2088, and as such is interpreted as suggesting that 1,308 ft (399 m) is a suitable "maximum" vessel size to consider over the lifetime of the Project.

While this value is 100 ft (30.5 m) larger than the maximum size of vessel observed within the marine traffic data, the extent of the change is not considered as having any effect on the impact assessment undertaken within Section 12.2.

The New York and New Jersey Harbor Anchorages Final General Reevaluation Report and Environmental Assessment (U.S. Army Corps of Engineers, 2020a) proposed the following in relation to the Gravesend Bay Anchorage:

- Deepening the Gravesend Anchorage to a required depth of -50 ft (-15.2 m) (MLLW);
- Widening the Gravesend Anchorage to 3,000 ft (914 m) and associated modifications of the Approach Area; and

- Maximum designed swing area up to 3,600 ft (1,097 m).

The study assumed a design vessel size of 1,200 ft (~ 366 m), which is comparable to the size of the maximum vessel recorded within the data studied for this NSRA (1,204 ft / 367 m as per Section 7.2.2.1). The period of analysis of the study ends in 2075, and as such is anticipated to be valid over the lifetime of the Project.

7.5.2 Increases in Commercial Fishing Vessel 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 long-term forecasting of vessel traffic growth. Therefore, based upon the discussion presented, no growth in fishing vessel movements (transit, not those engaged in fishing) has been considered, noting that fishing vessels have not been quantitatively modelled in Section 10 but future case scenarios have been considered in Section 10.2.1.

7.5.3 Increases in Recreational Vessel Activity

There are no major developments currently known of which may impact the activity of recreational vessels in the region. Therefore, based upon the discussion presented, no growth in recreational vessel movements has been considered, noting that recreational vessels have not been quantitatively modelled in Section 10 but future case scenarios have been considered in in Section 10.3. 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 12.3.

7.5.4 Commercial Traffic Routing

Following construction of the Project, commercial vessels will likely have to deviate around the development. It is not possible to consider all options and so the shortest and therefore most likely alternatives have been considered within this NSRA. It should be considered that, as per Section 2.2.2, proposed ACPARS fairways have not been considered on a quantitative basis given uncertainty over how and when these would be implemented. However, they have been considered at a qualitative level given that would represent the likely passage that certain commercial vessels would utilize.

Internal and external studies undertaken by Anatec at a number of offshore wind farms in UK 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 vessels do pass consistently and safely within 1 nm (1.9 km) of established offshore wind farms with the passing distance dependent upon the sea room available and the prevailing conditions. The evidence suggests that the mariner defines their own safe passing distance (outside of defined routing measures) based upon 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, hence the 1 nm (1.9 km) minimum distance assumed above (note: this an assumed 1 nm (1.9 km) passing distance based on experience at existing windfarms).

When considering lessons learned from vessel routing at existing UK wind farms it can be seen how MGN 543 has been used to assess the passing distance between wind farm boundaries and shipping routes but that it has not been considered as a *'a prescriptive tool'* but needed *'intelligent application*' on a case by case basis.

None of the main routes identified (see Section 7.2.6) are deemed as requiring a deviation as a result of the Project, noting navigation within the TSS lanes will not be impeded. It also noted that it is not anticipated that any changes to vessel emission requirements will result in variations to routing patterns in proximity to the Lease Area. However, a sensitivity assessment of displacement of the vessels crossing the Lease Area (1-2 vessels per day) is presented in Section 10.2.1.

8 Facility Characteristics

Wind farm structures associated with the Project will be lit and marked in accordance with FAA Advisory Circular 70/7460-1L (FAA, 2018), BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (2021), and International Association of Marine Aids (IALA) to Navigation and Lighthouse Authorities Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA 2013). Relevant USCG guidance will also be considered (USCG, 2015) and (USCG, 2020)).

This process will be undertaken in consultation with BOEM, USCG, and FAA, but on a preliminary basis will likely include the following:

- All foundation structures will be painted yellow from the level of Highest Astronomical Tide (HAT) up to 50 ft (15.3 m) and utilize retro reflective material.
- Wind turbine towers will have alphanumeric marking in black, approximately 3 m high and will be visible in all directions in both daytime and nighttime. Unique alphanumeric marking scheme will be subsequently determined, in coordination with the USCG. Letters shall be easily visible by using either illumination or retro-reflecting material.
- Each turbine should be lit as an offshore structure in accordance with 33 CFR § 67 and USCG First District LNM Entry 33-20.
- Lighting will be located on all turbine structures and visible throughout a 360-degree arc from the water's surface.
- Corner Towers/Significant Peripheral Structures (SPSs) will have quick flashing yellow (QY) energized at a 5 nm (9.3 km) range.
- Outer Boundary Towers will have yellow 2.5 sec (FL Y 2.5s) energized at 3 nm range.
- Interior Towers will have yellow 6 sec or yellow 10 sec (FL Y 6/FL Y 10) energized at a 2 nm (3.7 km) range and all lights should be synchronized by their structure location within the field of structures.
- Also noting that all temporary base, tower and construction components preceding the final structure completion must be marked with Quick Yellow obstruction lights visible throughout 360 degrees at a distance of 5 nm (9.3 km). These will not require permits, only USCG notification for appropriate marine notices and broadcasts until the final structure marking is established.
- The AtoN on each turbine will be mounted below the lowest point of the arc of the rotor blades and will exhibit at a height above HAT of no less than 20 ft (6 m) and no more than 50 ft (15 m).
- Sound signals will be located on all structures located at corners/SPSs and will sound every 30 seconds (4s Blast, 26s off), will be set to project at a range of 2 nm (3.7 km); should not exceed 3 nm (5.6 km) spacing between perimeter structures, and will be Mariner Radio Activated Sound Signal activated by keying VHF Radio frequency 83A five times within ten seconds.
- Sound signals will be timed to energize for 45 minutes from last VHF activation.
- Aeronautical obstruction lights which when fitted to the tops of turbines are not visible below their horizontal plane.

- Aeronautical obstruction lights will be night vision imaging system compliant.

In addition to these characteristics, the wind farm structures will comply with applicable BOEM standards, based on consultation with Federal Aviation Administration (FAA) requirements, namely the appropriate marking of structures exceeding 200 ft (61.0 m) height or other as deemed required during the consultation process.

8.1 Shut Down Procedures

Where technically possible, the wind turbine design will satisfy the requirements of the NVIC 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, 2016) (which is referenced by Annex 5 of MGN 543 (MCA, 2018)) 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.

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 G.

9 Navigation, Communication, and Position Fixing Equipment

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

9.1 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 in the UK. As part of these trials, tests were undertaken to evaluate the operational use of typical small vessel Very High Frequency (VHF) transceivers (including Digital Selective Calling (DSC)) when operated close to wind farm structures.

The 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 turbines, then it is reasonable to assume that larger vessels with higher powered and more efficient systems would also be unaffected.

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

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

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

Following consideration of these reports, the Project is anticipated to have no significant impact upon VHF communications as demonstrated at other operational sites.

Since the trials detailed above, no significant issues with regards to VHF have been observed or reported in relation to UK wind farm projects.

9.2 Very High Frequency Direction Finding

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

Throughout the 2005 SAR trials carried out at North Hoyle, the Sea King radio homer system was tested. The Sea King[24] 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. With the aircraft and the target vessel within the wind farm, 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 UK wind farm projects.

9.3 Rescue 21

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

- Direction-finding capability that provides search and rescue responders with lines of bearing to vessels in distress;
- DSC support, which allows mariners with DSC-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 DSC equipped vessels; and
- Automated transmission of urgent marine information broadcasts.

Figure 9.1 presents the line of sight coverage for the Rescue 21 system.

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

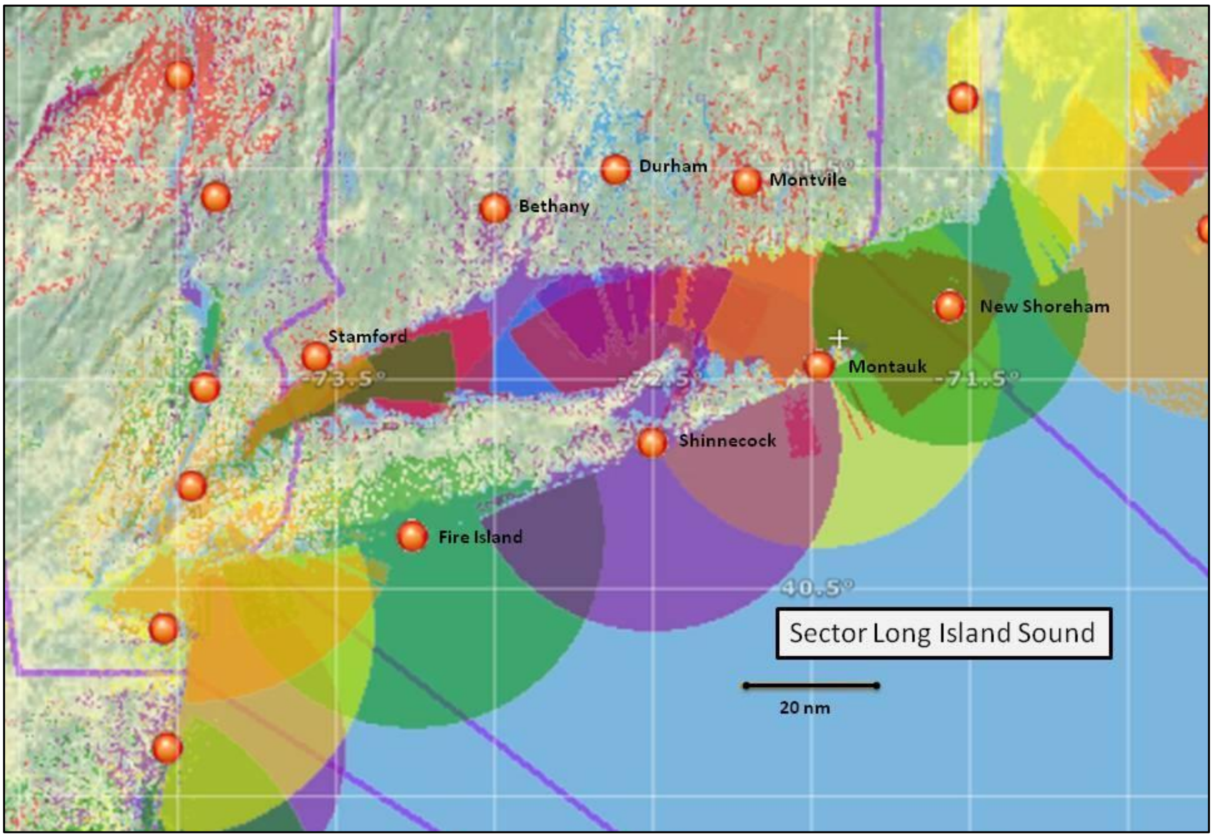

Figure 9.1 Rescue 21 Regional Coverage Analysis of VHF Receive Antenna Based on Geographical Line of Sight (USCG)

The Project is primarily covered by the shore-based antenna at Fire Island. Given that the system is based on VHF and that no adverse effects have been found with VHF use (including DSC), there is not expected to be any anticipated impacted on Rescue 21 systems during or following the construction of the Project.

9.4 Automatic Identification System

No significant issues with interference to AIS transmission from wind farms has been observed or reported at operational wind farm projects to date. Such interference was also not evident in the trials carried out at the North Hoyle Offshore Wind Farm (MCA and QinetiQ, 2004).

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

9.5 Navigational Telex Systems

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

There are two NAVTEX frequencies. All transmissions on NAVTEX 518 Kilohertz (kHz), the international channel, are in English. NAVTEX 518kHz provides the mariner (both recreational and commercial) with weather forecasts, severe weather warnings and navigation warnings such as obstructions or buoys off station. Depending on the user's location, other information options may be available such as ice warnings for high latitude sailing. In the US, NAVTEX is broadcast from various Coast Guard facilities including Cape Cod, MA.

Although no specific trials have been undertaken, no significant effect on NAVTEX has been noted at operational sites and therefore no effects are expected to arise from the Project.

9.6 Global Positioning System

GPS is a satellite based navigational system. GPS trials were also undertaken throughout the 2004 trials at North Hoyle Offshore Wind Farm and it was stated that "*no problems with basic GPS reception or positional accuracy were reported during the trials.*"

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

Therefore, there are not expected to be any significant impacts associated with the use of GPS systems within or in proximity to the array; noting that GPS works the same way across the globe

9.7 Long Range Navigation Systems

Long Range Navigation (Loran)-C is a radio navigation 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 Long Range Navigation (eLoran) is currently in use outside of the US.

Based on technology used for Loran it is assumed that since similar systems are not expected to be impacted by the array that Loran will not be significantly affected, noting that dedicated surveys have not been undertaken.

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

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

The Empire export and array cables will be alternating current (AC), with studies indicating that AC does not emit an electromagnetic field (EMF) significant enough to impact marine magnetic compasses (OSPAR, 2008).

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

9.9 Marine Radar

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

9.9.1 UK Trials

During the early years in offshore renewables within the UK, maritime regulators completed a number of trials into the impacts of turbines on the use and effectiveness of marine radar – both shore-based and vessel-based.

In 2004 trials undertaken at the North Hoyle Offshore Wind Farm (MCA, 2004) identified areas of concern regarding the potential impact on marine and shore-based radar systems due to the large vertical extents of the wind turbines (based on the technology at that time). This 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 range (below 1.5 nm (2.8 km)) and with large objects. Side lobe echoes form either arc on the radar screen similar to range rings, or a series of echoes forming a broken arc.

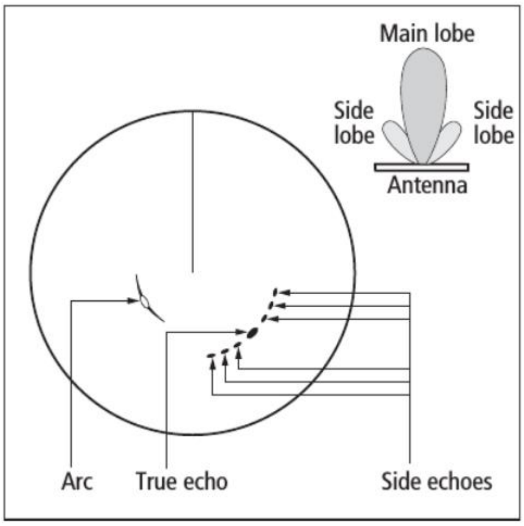

Figure 9.2 Side Lobes

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.

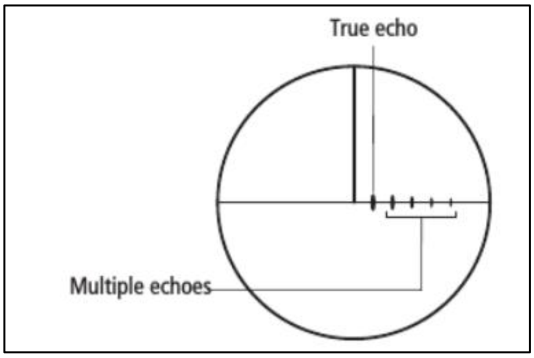

Figure 9.3 Multiple Reflected Echoes

Based upon the results of the North Hoyle trials, the MCA produced a *'Shipping Route Template'* designed to give guidance to mariners on the distances which should be considered when assessing safe spacing 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 use of marine radar in proximity to wind farm arrays grew, the MCA have refined their guidance, offering more flexibility, within the most recent *'Shipping Route Template'* contained within MGN 543 (MCA, 2016). MGN 543 has been used within this NSRA to assist consideration of radar impacts given that the US guidance does not yet have specific detail.

A second set of trials conducted at Kentish Flats Offshore Wind Farm in 2006 on behalf of the British Wind Energy Association (BWEA) now called Renewables UK (BWEA, 2007) also found that radar antennas which are sited unfavorably with respect to items of the vessels 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 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 in the UK, on marine radar systems was undertaken by the Atlantic Array project (2012) and considered a wider spacing of turbines than that considered within the early trials. The main outcomes of the modelling were the following:

- Multiple and indirect echoes were detected under all modelled parameters.
- The main effects noticed were stretching of targets in azimuth (horizontal) and appearance of ghost targets.
- There was a significant amount of clear space amongst the returns to ensure recognition of vessels moving amongst the wind farm structures and safe navigation.
- Even in the maximum design scenario with radar operator settings artificially set to be poor, there is significant clear space around each wind turbine that does not contain any multipath or side lobe ambiguities to ensure safe navigation and allow differentiation between false and real (both static and moving) targets.
- Overall, it was concluded that the amount of shadowing observed was very little. (Noting that the model considered lattice-type foundations which are sufficiently sparse to allow radar energy to pass through.)
- The lower the density of structures the easier it is to interpret the radar returns and fewer multipath ambiguities are present.
- In dense, target rich environments S-Band radar scanners suffer more severely from multipath effects in comparison to X-Band scanners.
- It is important for passing vessels to keep a reasonable separation distance (see Table 9.1) between the wind farm structures in order to minimize the effect of multipath and other ambiguities.
- The potential radar interference is 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 without AIS installed which are usually fishing and recreational craft).
- 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 UK 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 the 'careful adjustment of radar controls'.

The MCA has also produced guidance to mariners operating in the vicinity of OREIs in the UK which highlights radar issues amongst others to be taken into account when planning and undertaking voyages in the vicinity of OREIs (MCA, 2008). The interference 'areas' presented in Table 9.1 are based on MGN 371 (MCA, 2008), MGN 543 (MCA, 2018) and MGN 372 (MCA, 2008). This information had been used given that US guidance does not contain specific information of 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 wind farms has increased.

Table 9-1 Distances at which impacts on marine radar occur

Distance at which effect occurs	Identified Effect
0.5 nm (0.9 km)	▪ Intolerable impacts can be experienced. ▪ X Band radar interference is intolerable under 0.25 nm (1,519 ft (463 m)) ▪ Vessels may generate multiple echoes on shore-based radars under 0.45 nm (2,734 ft (833 m))
1.5 nm (2.8 km)	▪ Under MGN 543 impacts on radar are considered to be tolerable with mitigation between 0.5 nm and 3.5 nm. ▪ S band radar interference starts at 1.5 nm. ▪ Echoes develop at about 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 turbines. ▪ The turbines produced strong radar echoes giving early warning of their presence. ▪ Target size of the wind turbine echo increases close to the wind turbine with a consequent degradation of target definition and bearing discrimination. ▪ Effects were encountered on both X and S band radars.

As noted in Table 9.1 the onset range from the wind turbines of false returns is approximately 1.5 nm (2.8 km), with 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, 2016). For the purposes of SAR within the wind farm, it is noted that the intolerable effects do not block targets from being seen but instead could create multiple echoes. However, this would require the vessel (radar scanner) and target to be within close proximity to the wind turbines at which point visual observations are likely to also be undertaken. This situation is considered similar to SAR within an enclosed waterway whereby shore based features could interfere with radar returns.

9.9.2 U.S. Trial

The simulation study into effects of OREI on marine radar commissioned by the USCG (USCG, 2008) for the purpose of assessing navigational safety impacts associated with the Cape Wind Project concluded that while all targets within a 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 turbines using non-lattice foundations is increasing so is the spacing between turbines meaning that a transiting vessel will observe multipath or side lobe effects less frequently than in a dense array with smaller turbines.

The study found no concerns around targets outside the wind farm.

9.9.3 Experience From Operational Projects

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 9.4, which shows the wind turbines installed within the Galloper and Greater Gabbard wind farms in the UK, relative to the nearby TSS lanes and yet there have been no reported incidents or issues raised by mariners who operate within the vicinity. The interference 'areas' presented in Figure 9.4 and as per Table 9.1.

As indicated by Figure 9.4, vessels utilizing these TSS lanes will experience some radar interference based on the available guidance. Both projects are operational, and each of the lanes is used by a minimum five vessels per day on average. However, to date, there have been no incidents recorded (including any related to radar use) or concerns raised by the users.

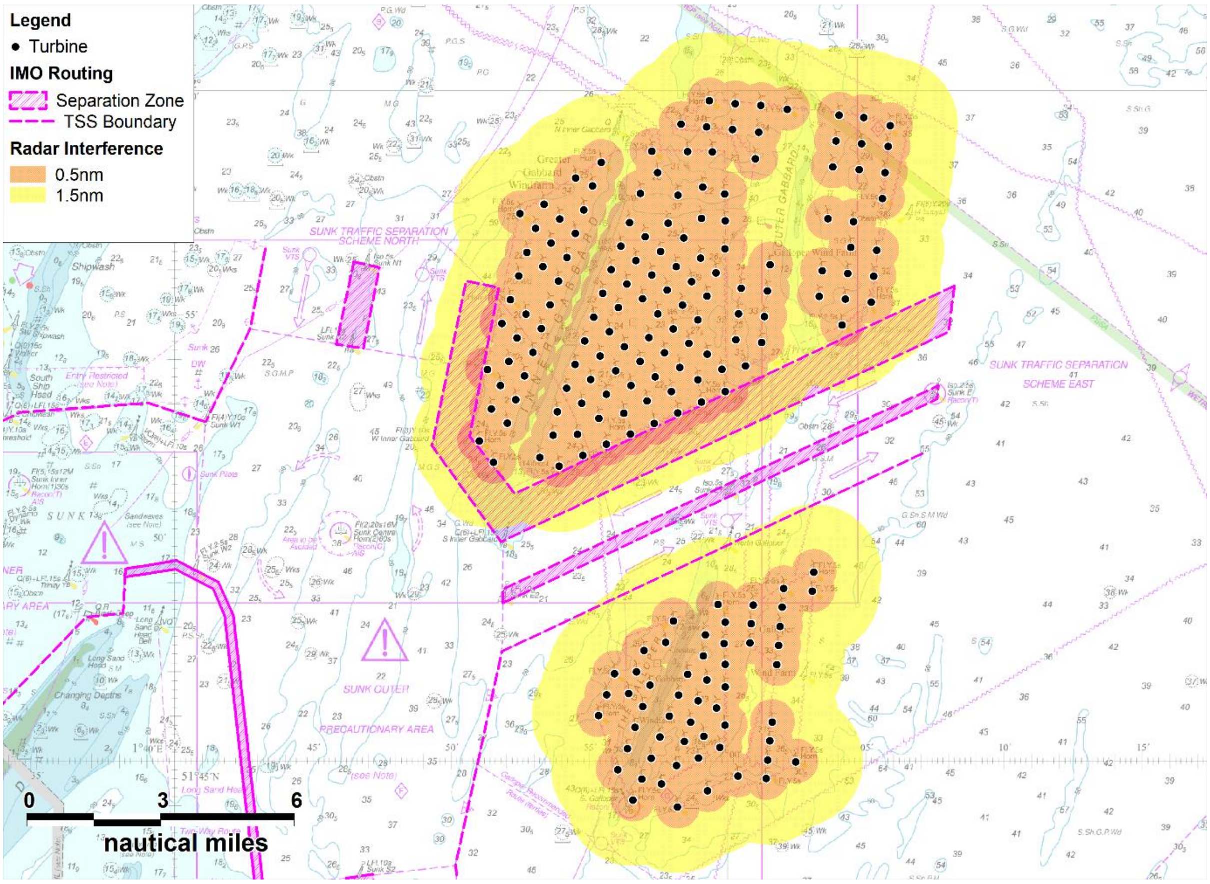

Figure 9.4 Potential Radar Interference Illustration – Greater Gabbard and Galloper

AIS information can also be used to verify the targets of larger vessels (generally vessels above 65 ft (19.8 m) in 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% of the vessel traffic recorded within the Study Area was below 65 ft (19.8 m) in length, with a similar proportion within the Lease Area itself. There are increasing number 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 a wind farm.

9.9.4 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 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 turbine height in the wind farm will not create any effects in addition to those already identified from existing operational wind farms (i.e., interfering side lobes, multiple and reflected echoes).

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.

9.9.5 Fixed Radar Antenna use in Proximity to an Operational Windfarm

It is noted that there are multiple windfarms including Galloper in the U.K that successfully operate fixed radar antennas from locations on the periphery of the constructed wind farms. These antennae are able to provide accurate and useful information to marine coordination centers.

9.9.6 Lease Area

Upon development of the Project, some commercial vessels may pass within 1.5 nm (2.8 km) of the wind farm infrastructure (noting that as per Layout Rule 6, Section 5.2.5, there will be a minimum of 1 nm (1.9 km) spacing between the TSS lanes and the periphery turbines) and therefore may be subject to a minor level of radar interference. Trials, modelling and experience from existing projects note that any impact can be mitigated by adjustment of radar controls.

It is noted that the TSS lanes limit the distance at which vessels may pass the periphery structures, particularly at the westernmost edge of the site where the lanes reduce in width as they converge on the precautionary area. However, there is considered to be sufficient sea room for vessels to increase their clearance further if they consider it necessary, beyond the potential range of radar interference (approximately 1.5 nm (2.8 km)) if they choose to do so.

This is illustrated in Figure 9.5 which shows the simulated future case AIS tracks relative to buffers indicating areas within which potential radar interference may be experienced by passing vessels (based on the layout that has been modelled, see Section 4.6.1).

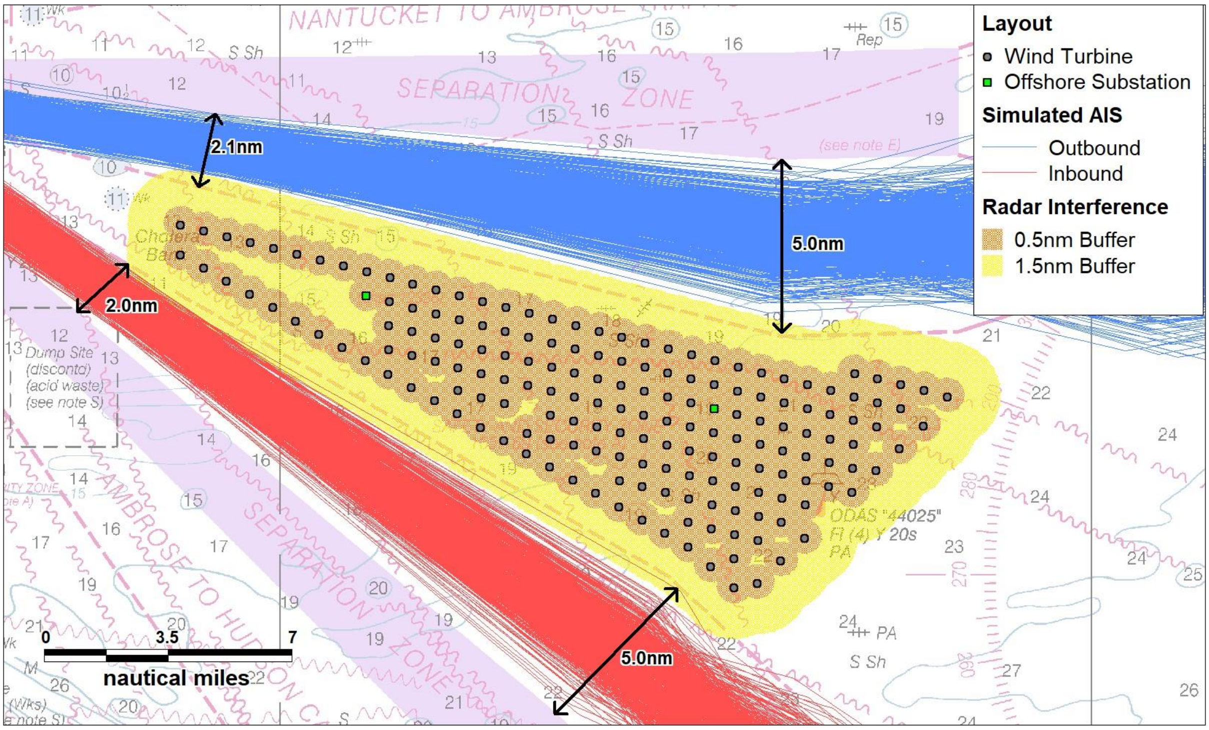

Figure 9.5 Potential Radar Interference Effects relative to Simulated AIS

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

As noted within the Cape Wind trials (USCG, 2008) vessels navigating outside of the array would be able to identify targets within the array although this would be more difficult than an open sea area. However, it is noted that with 1 nm (1.9 km) spacing from the edge of the TSS both vessels would be able to more clearly identify one another once the vessel navigating internally within the array was outside of the shadow of the wind turbines. This would still allow sufficient time for both vessels to comply with COLREGs. It is noted that the vessels associated with the construction and operation of the Project will be managed by a marine coordination center.

Overall impact on marine radar is expected to be very low and no further impact upon navigational safety is anticipated within managed parameters.

9.10 Sonar Systems

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

9.11 Noise

9.11.1 Surface Noise

The sound level from a wind farm at a distance of 1,148 ft (350 m) has been predicted to be between 51 decibels (dB) and 54 dB (A). Furthermore, modelling undertaken during the consenting process for the Atlantic Array Offshore Wind Farm showed that the highest predicted level due to operational turbine noise (for a 410 ft (125 m) tall 8 MW turbine) is around 60 dB (Atlantic Array, 2012).

A vessel's whistle for a vessel of 23 ft (7.0 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 of the Project.

There are therefore no indications that the sound level of the Project will have a significant influence on marine safety.

9.11.2 Underwater Noise

In 2005, the underwater noise produced by turbines of 361 ft (110 m) height and with 2MW capacity was measured at the Horns Rev Offshore Wind Farm in Denmark. The maximum noise levels recorded underwater at a distance of 328 ft (100 m) from the wind turbines was 122 dB or 1 micropascal (µPa) (Institut für technische und angewandte Physik [ITAP], 2006).

During the operational phase of the Project, the subsea noise levels generated by turbines will likely be greater than that produced at Horns Rev given the larger turbine size, but nevertheless is not anticipated to have any significant impact upon sonar systems as they are designed to work in pre-existing noisy environments.

Therefore, no impacts are anticipated. However, it should be noted that Empire will also undertake a robust underwater noise assessment.

9.12 Existing Aids to Navigation

The only buoys within 5 nm (9.3 km) of the Lease Area are the ODAS weather buoys as can be seen in Figure 9.6. There are no navigational buoys within 10 nm (18.5 km) and the wind farm is therefore anticipated to have no associated impact. Furthermore, it is noted that the wind farm itself will form an AtoN given its lighting and marking. Private Aids to Navigation will be submitted to the USCG at appropriate stages of Lease Area buildout.

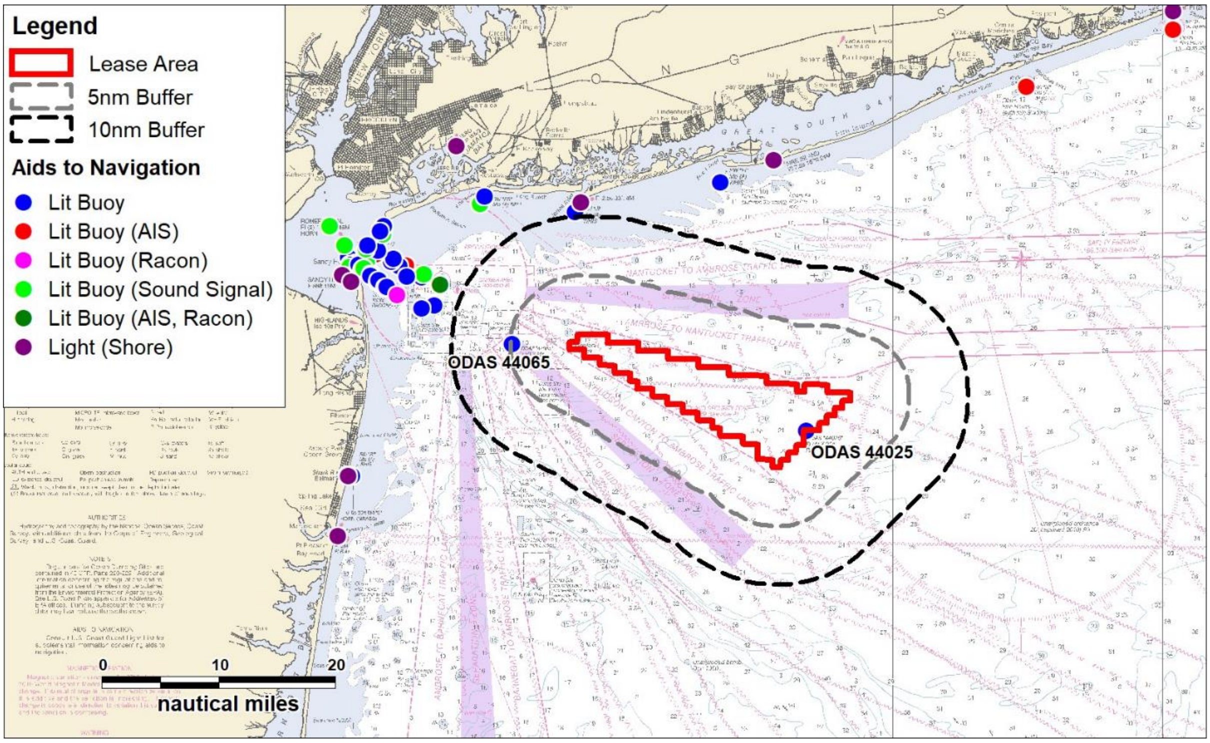

Figure 9.6 AtoN within vicinity of Project

9.13 Summary of Effects on Communication and Position Fixing Equipment

Table 9.2 summarizes the impacts of the Project on communication and position fixing equipment.

Table 9-2 Summary of effects on communication and position fixing equipment

Topic		Sensitivity	Screen In/Out (Isolation)	Screen In/Out (Cumulative)
Type	Specific			
Communication	VHF (Section 9.1)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	VHF direction finding (Section 9.2)	No notable degradation and therefore no anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	Rescue 21 (Section 9.3)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out

Topic		Sensitivity	Screen In/Out (Isolation)	Screen In/Out (Cumulative)
Type	Specific			
	AIS (Section 9.4)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	NAVTEX (Section 9.5)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	GPS (Section 9.6)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
EMF (Section 9.8)	Cables	No anticipated impacts.	Screened out	Screened out
	Turbines	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
Marine radar	Use of marine radar (Section 9.9)	Vessels have sufficient sea room to distance themselves from the array in line with the shipping template to mitigate any effects. For vessels navigating within the TSS there is a further mitigation available which involves minor adjustments to radar settings (such as gain) to mitigate the effects.	Screened out	Screened out
Noise	Turbine generated noise (Section 9.11)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out
	Sonar (Section 9.10)	No anticipated impacts. Not impacted by layout design.	Screened out	Screened out

10 Collision, Allision, and Grounding – In Isolation

This section provides a quantitative assessment of potential interactions associated with the development of the Project. A base-case and future-case assessment is included, with hazards assessed including:

- Increased vessel to vessel collision risk;
- Powered vessel to structure allision risk;
- Drifting vessel to structure allision risk; and
- Grounding vessel risk.

The quantitative assessment is only one part of the NSRA, and feeds into the qualitative assessment undertaken in Section 12. Given that historical maritime incident data is used to calibrate the models and minor collisions and allision incidents are not frequently reported, it is only possible to make a comprehensive quantitative assessment of major interactions (i.e., major collisions and allision incidents).

The base-case assessment uses vessel traffic survey data in combination with consultation responses and other baseline data sources. The future-case assessment makes potential vessel traffic growth assumptions as per Section 7.5.

Quantitative assessment results are generally given as an annual frequency (i.e. number of expected occurrences per year) but also as a return period (i.e. expected number of years between occurrences, the inverse of the annual frequency). This is a standard method for presenting collision and allision risk results relating to offshore installations.

10.1 Modelling Background

The modelling within the current version of the NSRA has been updated to reflect revisions in the Project Design Envelope. This includes the modelling of a new layout to that considered in early NSRA versions (see Section 4.6.1).

Under the updated modelling parameters, total allision and collision risk had decreased (includes collision, powered allision, drifting allision and fishing allision) when compared to the previous NSRA modelling. By extension, all individual risk calculations remain within ALARP parameters.

10.2 Pre-Wind Farm

10.2.1 Encounters

This section presents a quantitative assessment of encounter levels within the vicinity of the Lease Area, based on modelling of 28 days of AIS data (see Section 7 for further details). The data used was collected from onshore receivers during June 2018 as this was observed to provide the greatest overall transmission frequency and coverage within the area. Details of the marine traffic data sources considered within this NSRA are provided in Section 7, which includes associated limitations.

The input data was run through Anatec's *Encounter* software which identified any instance of two (or more) vessels being within 1 nm (1.9 km) of each other within a single minute. On this basis, the program will check 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 *Encounters* software will extract all associated transmissions from the associated vessels and create the corresponding tracks in order to illustrate the encounter.

An encounter is therefore defined as any instance where two or more vessels are within 1 nm (1.9 km) of each other within the same 60 second period.

It should be considered that no account has been given as to whether the encounters are head on or stern to head; just close proximity.

The output of this process was then manually filtered to identify any cases where an encounter situation was the result of a planned multiple vessel operation. 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 transit). On this basis, the following situations (where identified) have been removed:

- Dual towing operations (i.e., towing operations involving two tug (push/pull) vessels);
- Military operations;
- Encounters associated with Leg 12 of the 2017/2018 Clipper Round the World Yacht Race (June 26, 2018);
- Pair trawling; and
- Encounters within the precautionary area involving a pilot vessel.

Where there was doubt as to whether an encounter was genuine or not, it has been retained.

10.2.1.1 Encounter Overview

The output of the *Encounter* software is shown in Figure 10.1, color coded by vessel type. The number of daily encounters recorded over the 28-day period studied is then shown in Figure 10.2.

Overall, 1,518 encounters were identified within the Study Area over the 28-day period, noting that no encounters were identified within the Lease Area itself.

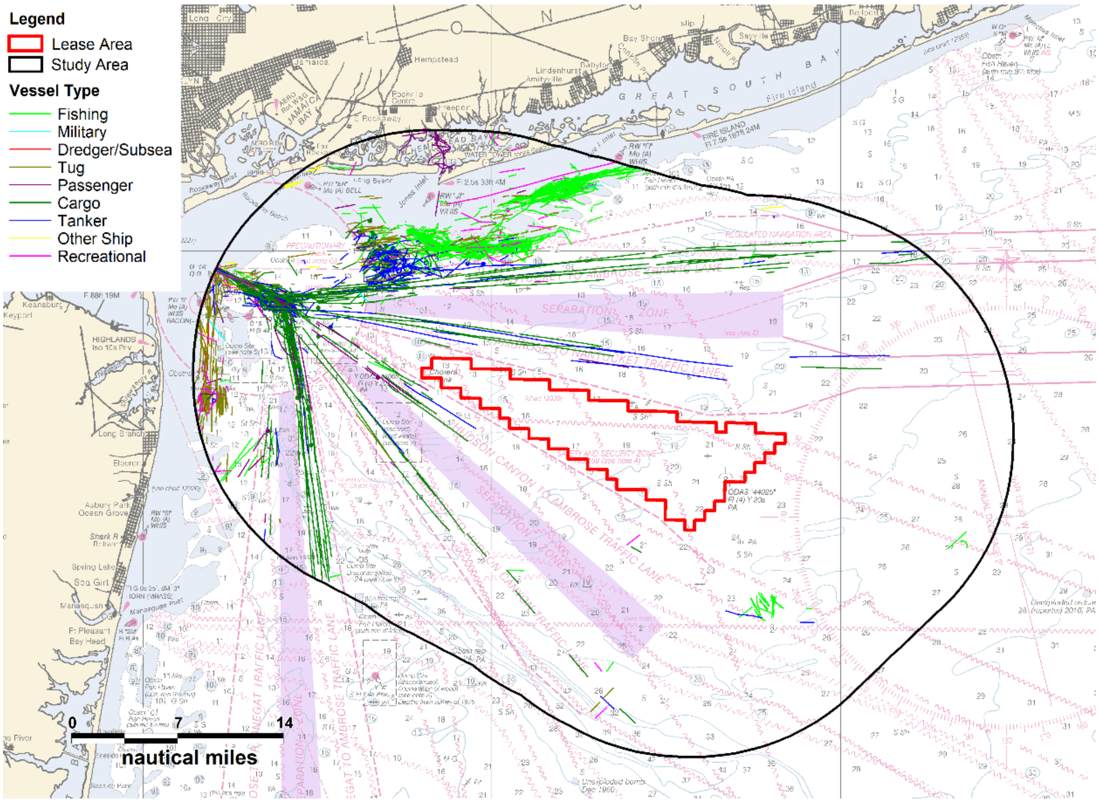

Figure 10.1 Overview of Encounters – June 2018

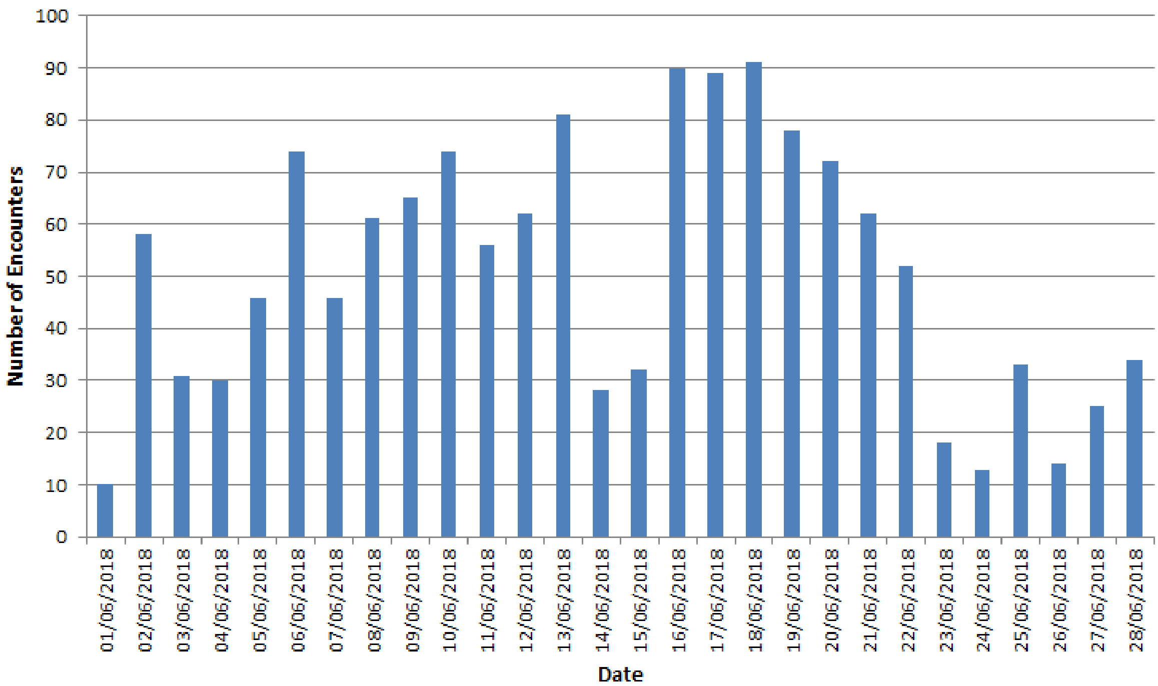

Figure 10.2 Number of Encounters per Day – June 2018

An average of 51 encounters per day were recorded within the Study Area over the 28-day period. Contextually speaking, this is a high level of encounters, and is reflective of the busy precautionary area, and the fishing and anchoring activity occurring north of the Lease Area.

The maximum number of encounters recorded on a given day was 91, on June 18, 2018. As per Section 10.1.1, encounters involving a pilot vessel within the precautionary area have been excluded. However, for reference, an average of 35 such encounters per day was identified.

10.2.1.2 Encounters – Vessel Types

The distribution of vessel types involved in the identified encounters is presented in Figure 10.3. As indicated by the figure, the majority of vessels involved (54%) were commercial (cargo or tanker), with fishing vessels accounting for a further 27%.

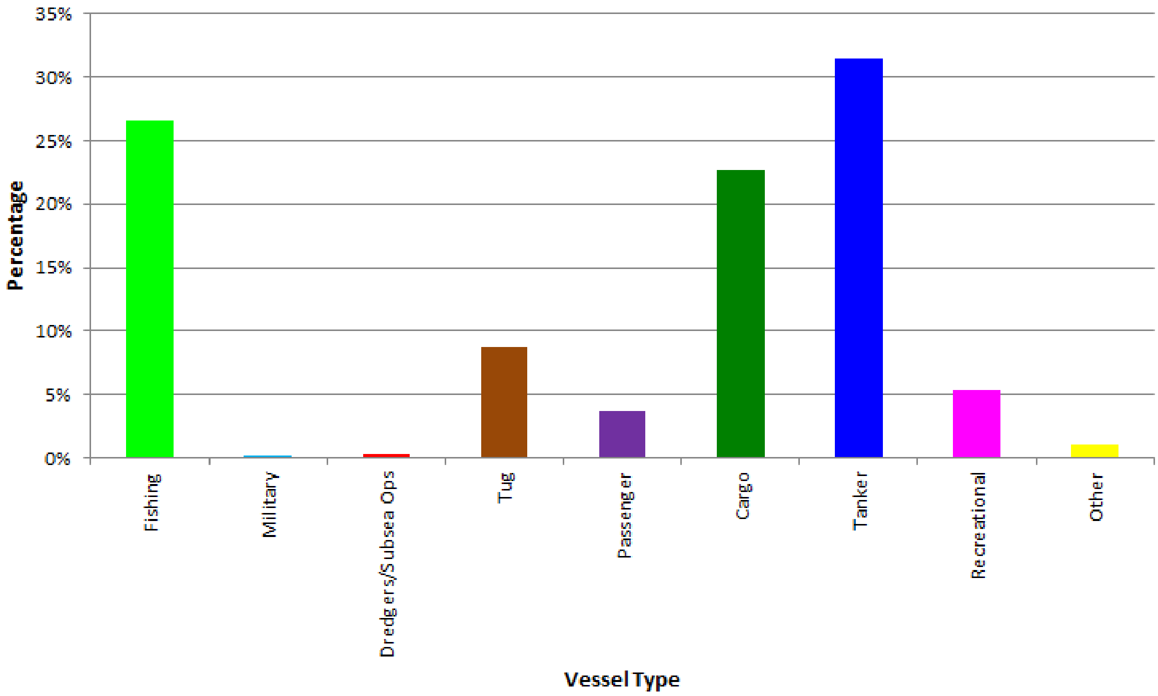

Figure 10.3 Encounters – Vessel Type Distribution

10.2.1.3 Encounter Density

The density of encounters within the area is shown in Figure 10.4, which was calculated by counting the number of tracks identified as being involved in an encounter within each cell of a 0.5 x 0.5 nm (0.9 x 0.9 km) resolution grid.

The busiest areas in terms of encounters were observed to be within the precautionary area, and the area to the north of the Nantucket to Ambrose TSS lane where commercial vessels anchor and high levels of fishing occur. In terms of the TSS lanes themselves, moderate levels of encounters were recorded, with the most recorded within the Barnegat to Ambrose Lane.

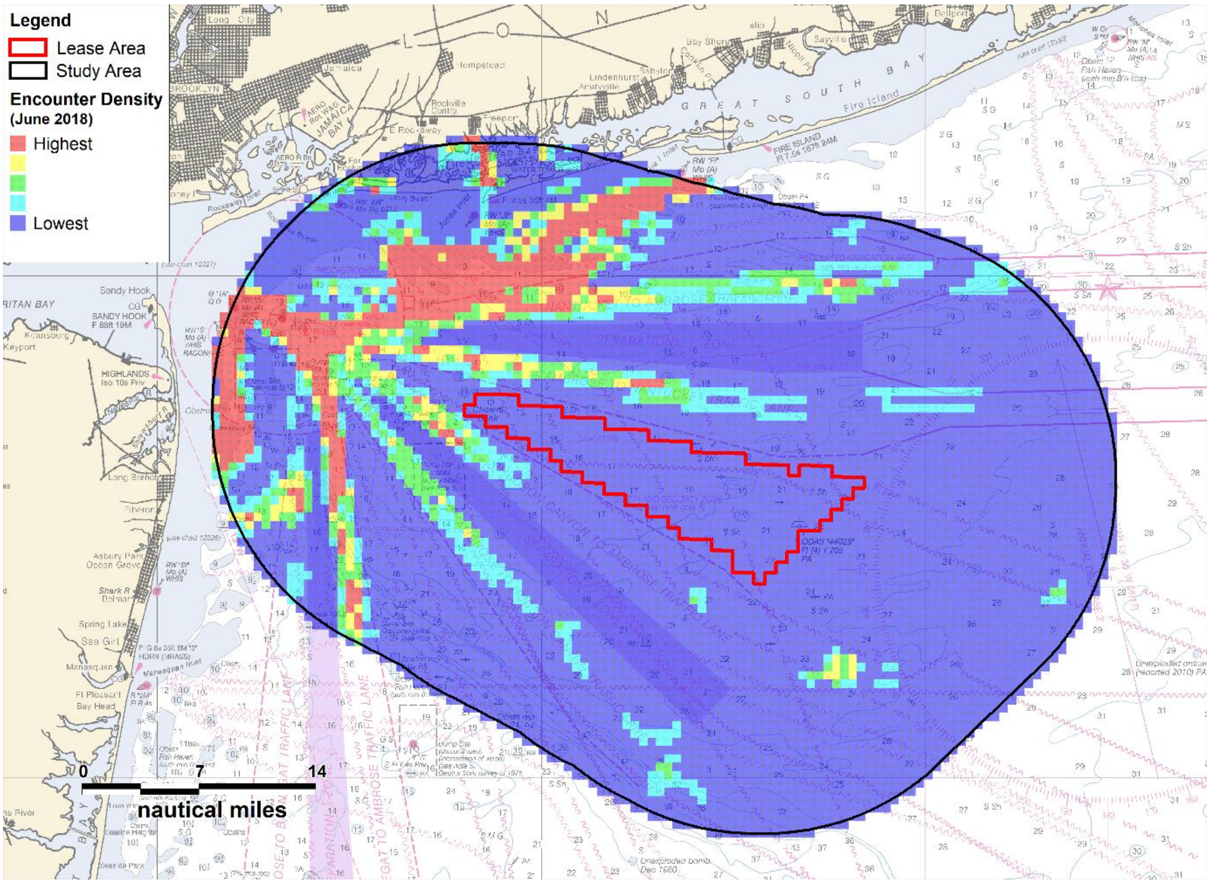

Figure 10.4 Encounter Density – June 2018

10.2.2 Vessel to Vessel Collisions

To assess vessel to vessel collision rates pre-wind farm, the vessel routes identified (see Section 7.2.6) were used as input to the collision function of Anatec's COLLRISK modelling software suite. The COLLRISK collision model uses vessel density as the primary input to assess collision risk. The likelihood of a major incident takes account of the probability of poor visibility (noting that collisions are more likely when visibility is poor), and is calibrated against historical maritime incident data.

The output of the model is shown in Figure 10.5.

It is noted that the collision risk within the precautionary area has been excluded, noting associated complexities and accepted navigation practices as detailed in Section 7.2.6.

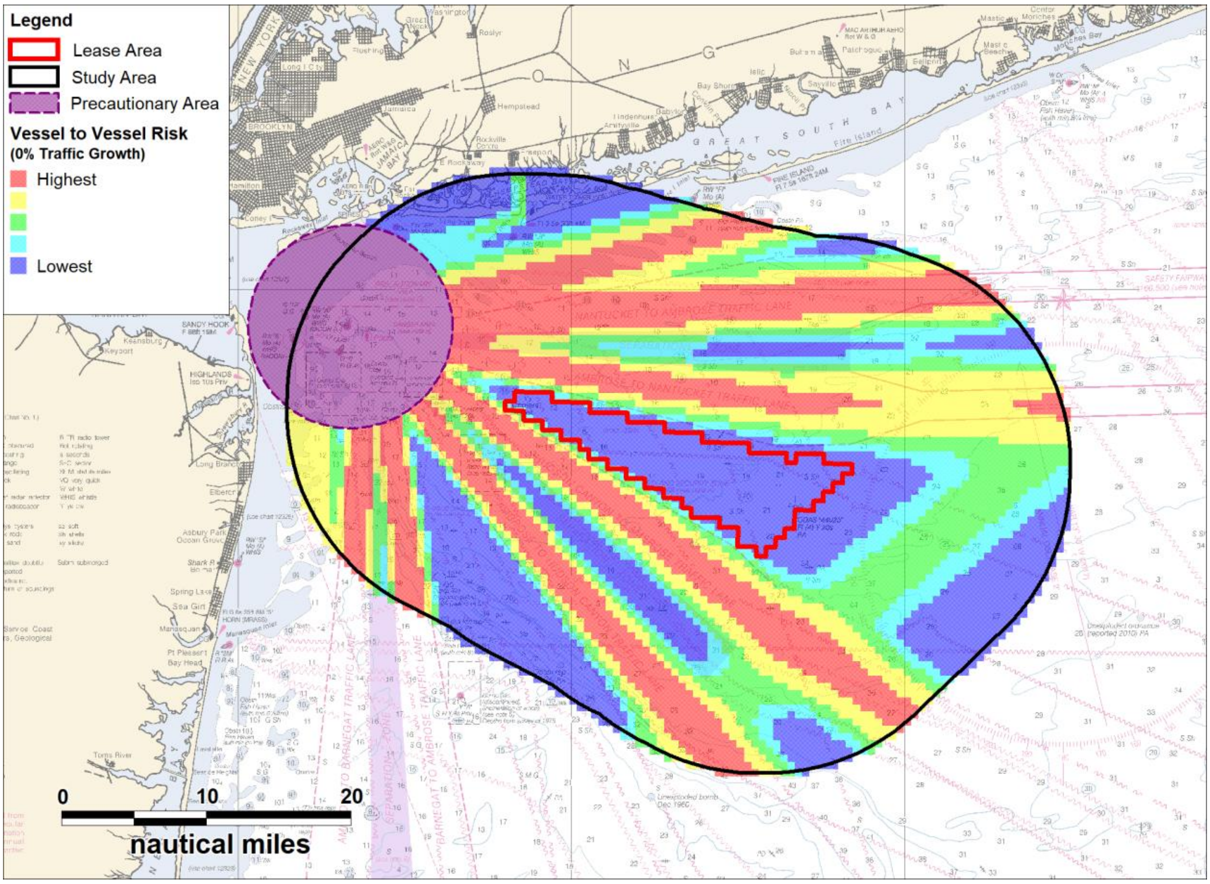

Figure 10.5 Vessel to Vessel Collision Rates – 0% Traffic Growth

It was estimated that, based on current routing patterns and traffic levels, a vessel would be involved in a collision once every 137 years within the Study Area (excluding the precautionary area). As indicated in Figure 10.5, the majority of this risk was associated with the TSS lanes, particularly where they converge towards the precautionary area (i.e., the risk increases as the lane width decreases). Traffic passing east of the Lease Area was observed to contribute limited risk.

Assuming a 10% traffic increase to represent potential future traffic trends (see Section 7.5.1), it was estimated that the vessel to vessel collision risk would rise by approximately 20%, meaning a vessel was estimated to be involved in a collision[25] once per 114 years.

10.3 Post Wind Farm

Assessment on specific vessel types is included within Section 12.

10.3.1 Deviations and Encounters

As discussed in Section 7.5.4, none of the main routes identified are considered as requiring deviation post wind farm. However, it should be noted that low levels of traffic were identified

[25] Anatec's modelling suite is calibrated against historical collision incidents which resulted in at least "material damage" to one of the involved vessels.

as intersecting the Lease Area within the AIS data studied, but not in high enough quantities to be considered a main route. Given the low levels of this traffic, the associated displacement is not considered as being significant in particular when we consider the Layout Rules.

To demonstrate this, an assessment of encounters (see Section 10.1.1 for further details of encounters) using three simulated scenarios was undertaken:

- Scenario 1: simulation of base case;
- Scenario 2: simulation of all vessels passing to the east (offshore) of the Lease Area; and
- Scenario 3: simulation of all vessels passing to the west (inshore) of the Lease Area.

The first scenario represented the pre-wind farm case, based on the AIS as it was recorded (see Section 7). Each AIS track recorded as intersecting the Lease Area was used as the basis for a simulated track (in terms of direction, vessel type, and vessel size). The use of simulated tracks allowed for a fair comparison with the second and third scenarios (where simulation was necessary), but was still considered reflective of the actual AIS recording given each simulated track was based on an actual recorded track.

The second scenario assumed all displaced vessels would pass east of the Lease Area, and the third that all vessels would pass west (i.e., between the Lease Area and the precautionary area). To ensure a maximum impact assessment, vessels deviating to the east have been assumed to join the existing traffic transiting within this area, and traffic passing to the west has been assumed to pass 1 nm (1.9 km) from the wind farm periphery.

The three simulated scenarios are presented in Figure 10.6 (green represents the base case scenario, with blue and red representing the western and eastern deviation cases respectively). As alluded to above, each of the three scenarios presented is simulated, with track start and end times of each simulated track based on that of an actual recorded track from the year of AIS assessed in Section 7.

It is important to state that this sensitivity assessment represents a simplified approach to deviation, and has only been undertaken to demonstrate the effect of displacing the existing traffic at a high level. Therefore, the following should be considered when viewing the results:

- The two potential scenarios considered are simplified – in reality vessels will pass both inshore and offshore of the Project, dependent on various factors including vessel type, vessel size, and weather conditions;
- Simulated deviations, associated route widths and standard deviations have been designed to reflect current navigation within the area;
- COLREGs requires vessels to cross TSS lanes at as near to a right angle as practicable but that this is often a subjective interpretation; and
- Only vessels observed to be in transit through the site have been considered during the simulation process.
- It is not considered likely, based on the AIS data considered, that vessels will navigate east to west (and vice versa) outside of TSS lanes or near shore areas i.e. within the Lease

Area. However, should any emergency situation arise for vessels within the TSS lanes there are options of either exiting the TSS lane to the side with no array present or proceed into the 1 nm (1.9 km) buffer between the TSS lane and the array which is considered to be sufficient sea room to maneuver if required.

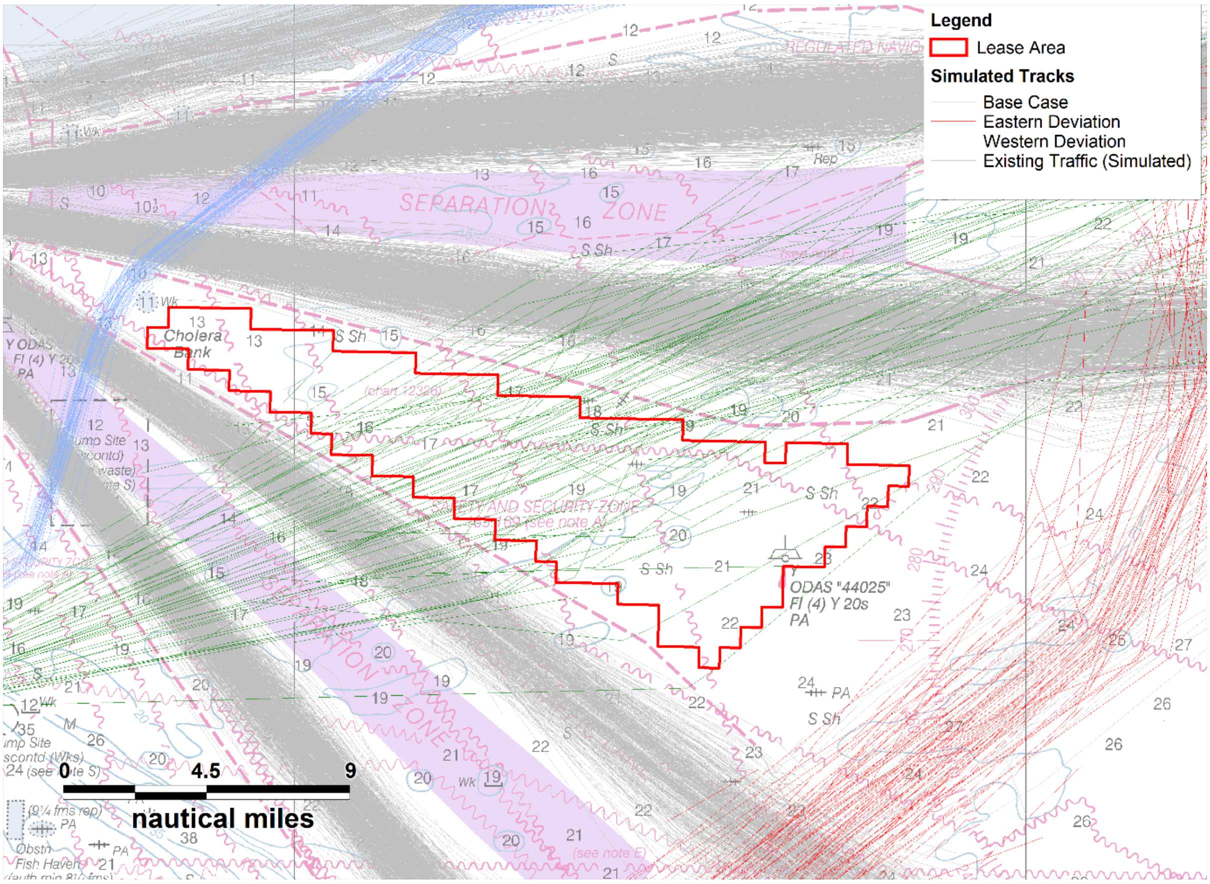

Figure 10.6 Simulated Scenarios

The three scenarios were run through Anatec's *Encounter* software separately to estimate encounter levels for each. The results are shown in Table 10.1. Only encounters within the Study Area have been considered, and encounters within the precautionary area have been excluded.

Given that this represents a simplified scenario and only considers vessels in transit on a main route, the results of this assessment are not comparable with the encounters assessment undertaken on 28 days of actual data given in Section 10.1.1 which included vessels engaged in non-transit activities, notably anchoring and fishing.

Table 10-1 Encounter Sensitivity Assessment

Scenario	Number of Encounters (Annual)	Number of Encounters per Day	% Increase
No deviations	521	1.4	n/a
All vessels deviate east	527	1.4	1%
All vessels deviate west	534	1.5	2%

Assuming a base case traffic pattern simulated scenario, 521 encounters were identified on an annual basis within 15 nm (27.8 km) of the Lease Area, corresponding to between one and two encounters per day. Simulating a scenario where all affected vessels deviated to the east resulted in a total of 527 encounters, an increase of 1%. The corresponding assessment for a deviation to the west identified 534 encounters, a rise of 2%. Neither is considered a significant rise in terms of encounter rates.

10.3.2 Vessel to Vessel Collisions

Given that no main routes were identified (via the AIS assessment as per Section 7.2.6) as requiring deviation post wind farm and therefore traffic patterns have not changed and the discussion of potential effects of the wind farm on navigation, communication, and vessel positioning (Section 9) indicates no impact, quantitative assessment of vessel to vessel collisions post wind farm was not considered necessary. It is noted that the routing analysis is AIS only, and hence vessels not broadcasting via AIS are not accounted for. Consideration of non AIS traffic is given in Sections 7.2.7 and 7.2.8.

Concerns were raised during consultation with regards to a scenario whereby a vessel exiting the array collides with a vessel within the TSS as a result of radar interference. However, as per Section 9.9, evidence shows that vessels are quick to adapt to any effects of operational wind farms on radar, noting that such effects have been observed to be limited. Further, turbine spacing and setback of the array from the TSS (based on experience from existing developments) is deemed sufficient that visual identification of vessels within or near the array would not be hindered. It should be considered that as per Section 10.2.1, a simulation exercise demonstrated that encounter rates of vessels in transit were estimated to increase by 1% and 2% post wind farm. Given the limited size of the increase, and noting that only a fraction of encounters would be expected to lead to a collision, no significant rise in collision risk is anticipated.

Vessels associated with the construction and operation of the Project will also create additional collision risk (albeit temporary), particularly noting that certain such vessels will be Restricted in their Ability to Maneuver (RAM). However, as shown in Section 14 and discussed in Section 12.2.2, mitigations will be in place to protect both third party and Project vessels from collision risk including marine coordination and the use of entry/exit points and designated routes (that will be charted in weekly notices of operations).

10.3.3 Vessel to Structure Allisions

10.3.3.1 Powered

The vessel routing patterns identified for the region (see Section 7.2.6) were used as input to the powered allision function of Anatec's COLLRISK software modelling suite. A powered allision represents the scenario of an errant vessel under power deviating from its route to the extent that it comes into proximity with a wind farm structure, leading to an allision. The COLLRISK powered allision model uses vessel numbers, types, sizes (length and beam), mean route positions and standard deviations and layout and structure size to assess allision risk. The likelihood of a major allision incident is determined using the probability of poor visibility, and is calibrated against historical maritime incident data.

To ensure a maximum design scenario, no account has been made for the potential for one structure to shield another.

It is noted that this quantitative assessment considers powered allision to risk to passing commercial vessels. The powered allision risk to smaller vessels transiting internal to the array is considered on a qualitative basis in Section 12.3.3 for recreational vessels and Section 12.4.4 for fishing vessels.

The results of the model are shown graphically in Figure 10.7.

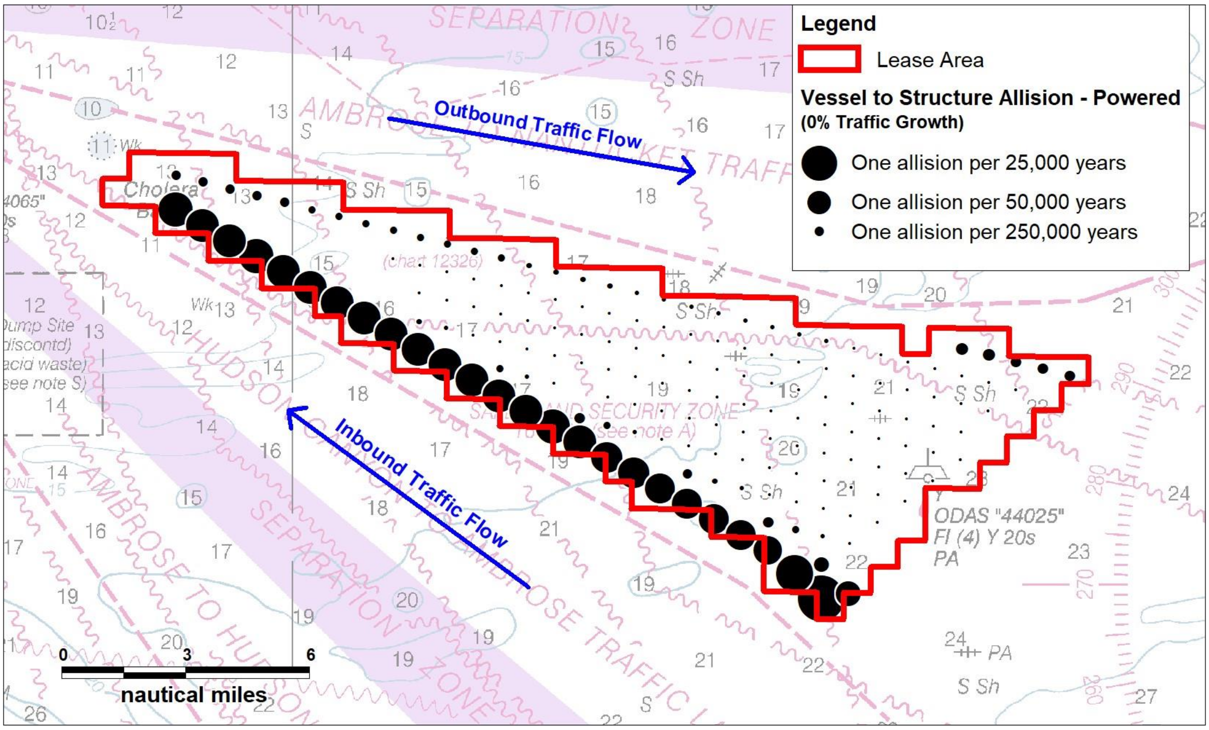

Figure 10.7 Vessel to Structure Allision – Powered Scenario

Overall, it was estimated that a powered allision between a passing vessel and a structure within the Lease Area would occur approximately once every 976 years. The majority of this risk was observed to be from vessels within the Hudson Canyon to Ambrose TSS lane to the structures on the southern periphery. However, it should be considered that the maximum risk to a single structure on this periphery is still considered low (the maximum frequency of allision to a single structure was estimated at one allision per 16,000 years). The risk to structures on the northern periphery was observed to be less, which was due to the preference of vessels utilizing the Ambrose to Nantucket lane to avoid the southern extent of the lane.

There was limited risk to the eastern periphery turbines, which is reflective of the sea space to the east of the Lease Area allowing vessels plenty sea space to pass a safe distance from the structures, and the limited traffic levels within this area when compared to the TSS lanes.

Assuming a 10% traffic increase to represent potential future traffic trends (see Section 7.5.1), it was estimated that the powered allision risk would rise from one incident per 976 years to one per 888 years.

10.3.3.2 Vessel Stopping Under Power

Every vessel has two different stopping distances depending on when/how the vessel needs to stop. The 'inertia' stop is when a vessel engine is stopped but the vessel will continue moving in the same direction i.e., no form of braking is applied. A 'crash' stop is where a vessel suddenly needs to stop in an emergency with full astern likely being applied to allow the vessel to stop in the shortest distance and time. In a scenario whereby a vessel is on a course where it may allide with a structure it is assumed that a 'crash stop' would be applied, significantly shortening the distance at which the vessel will need to stop (data which is individual to each vessel and defined as part of a vessels sea trials). As vessels get larger, technology also advances which means vessels are more able to 'crash' stop i.e., more power engines, thrusters etc. However, should the 'crash' stop not sufficiently reduce the forward motion of the vessel, other options also exist such as emergency anchoring or alterations to course (including use of emergency steering gear) to minimize the risk of allision.

10.3.3.3 Drifting

The vessel routing patterns identified for the region (see Section 7.2.6) were used as input to the drifting allision function of Anatec's COLLRISK software modelling suite. The COLLRISK drifting allision model uses vessel numbers, types, sizes (length and beam), mean route positions and standard deviations and layout and structure size to assess allision risk. The likelihood of a major incident is determined using drift speed and direction (from wind and tidal data), and has been calibrated against historical maritime incident data.

The model is based on the premise that propulsion on a vessel must fail before a vessel would drift, with the type and size of the vessel, number of engines, average time to repair, and differing sea state conditions taken into account. The exposure times for a drifting scenario are based upon the vessel hours spent in proximity to the structures (up to 15 nm (27.8 km) from the perimeter). These have been estimated based upon the traffic levels, speeds and routing patterns.

Using this information, the overall rate of a mechanical failure within the area surrounding the Lease Area was estimated. The probability of a vessel drifting towards a wind farm structure and the drift speed are dependent upon the prevailing wind, wave, and tidal conditions at the time of the accident.

The probability of vessel recovery from drift is estimated based upon the speed of drift and hence the time available before reaching the wind farm structure. Vessels which do not recover within this time are assumed to allide. Given stakeholder concern over the speed at which a vessel within one of the TSS lanes would drift towards the structures in the event of breakdown, an additional sensitivity analysis of drift speed has also been undertaken.

Three drift scenarios were considered and subsequently modelled:

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

After modelling each of these scenarios, the maximum impact was observed to arise if drift directions were based upon wind direction (see Section 6.3.1), and this result has therefore been used within this NSRA for the purposes of assessing drifting allision risk.

It is noted that this quantitative assessment considers drifting allision to risk to passing commercial vessels. The drifting allision risk to smaller vessels transiting internal to the array is considered on a qualitative basis in Section 12.3.4 for recreational vessels and Section 12.4.5 for fishing vessels.

The output of the modelling is presented graphically in Figure 10.8. It should be noted that differing range brackets have been used to present the drifting allision results in this figure than were used for the powered case (Figure 10.7), and the figures are therefore not directly comparable.

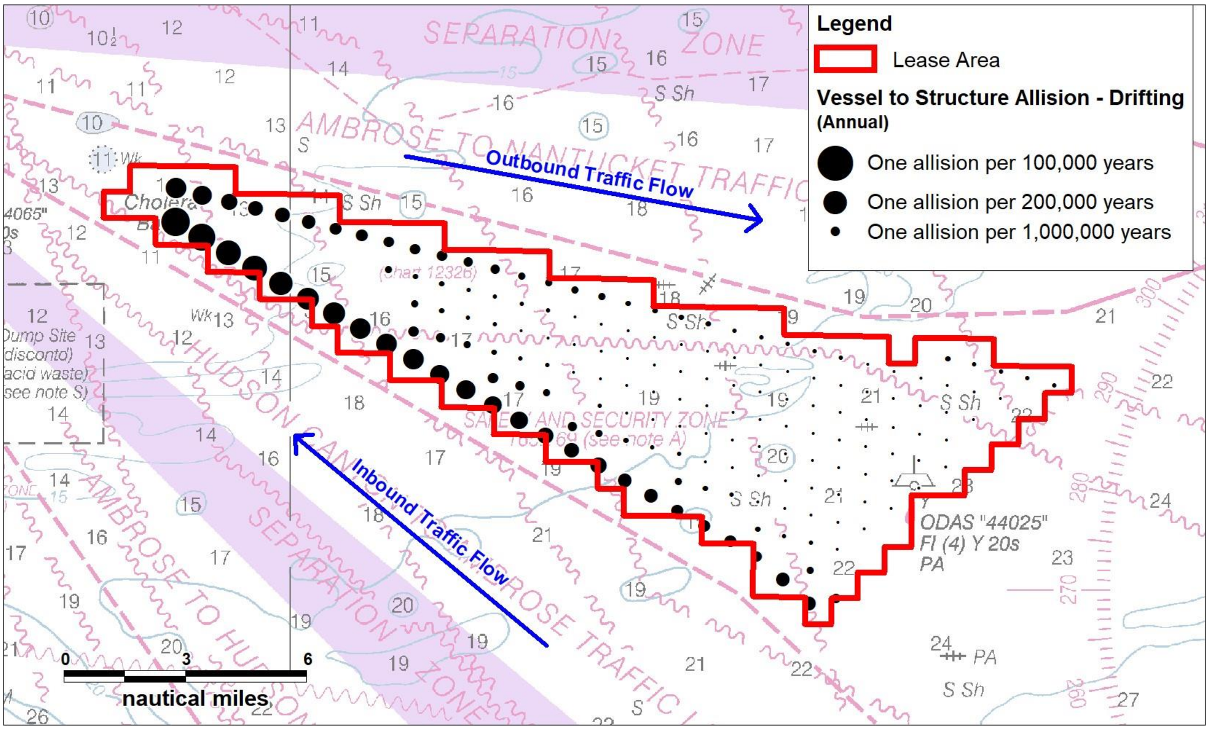

Figure 10.8 Vessel to Structure Allision – Drifting Scenario

It was estimated that a drifting vessel would allide with a wind farm structure once per 7,400 years. The greatest risk was observed to be to the structures on the southern periphery, and a general trend of the risk increasing as the width of the bordering lanes decreased was also identified.

Assuming a 10% traffic increase to represent potential future traffic trends (see Section 7.5.1) it was estimated that the drifting allision risk would rise from one incident per 7,400 years to one per 6,700 years.

10.3.3.4 Emergency Anchoring

It is noted that concern was raised during consultation over whether a drifting vessel would have sufficient space to anchor between the TSS lane and the wind farm structures assuming a 1 nm (1.9 km) setback (see Section 5.3). To illustrate the room available, the anchor spread of the largest vessel recorded at anchor within the Study Area during the year of marine traffic data studied (see Section 7.2.5) was simulated between the TSS lane and the WFDA, as shown in Figure 10.9. Actual dimensions of the vessel have been used to produce the outlines shown.

It is noted that, as per Section 7.2.5, vessels were recorded as anchoring within the Lease Area. However, these were all smaller vessels (and smaller anchor spreads) than that shown in Figure 10.9.

Figure 10.9 Simulated Anchor Spread

As can be seen the largest vessel recorded at anchor within the Study Area has sufficient room to anchor within the area between the TSS lane and the WFDA. Regardless, any NUC vessel should consider the available room when determining when / where to drop anchor. COLREGs Rule 10 does not prevent vessels from anchoring within a TSS lane (vessels should "so far as practicable avoid anchoring" in a TSS), and therefore such action could still be undertaken if necessary.

10.3.3.5 Drifting Sensitivity Analysis

The drifting scenario model assumes drift speed changes with sea state, up to a maximum of 3 kn. However, given stakeholder concern over drift speeds (particularly with regards to NUC vessels within the TSS lanes), an additional sensitivity assessment was undertaken, which involved rerunning the model multiple times with each run assuming every vessel that broke down would drift at a set speed regardless of sea state. The output of this assessment is shown graphically in Figure 10.10, and then in tabular form in Table 10.2.

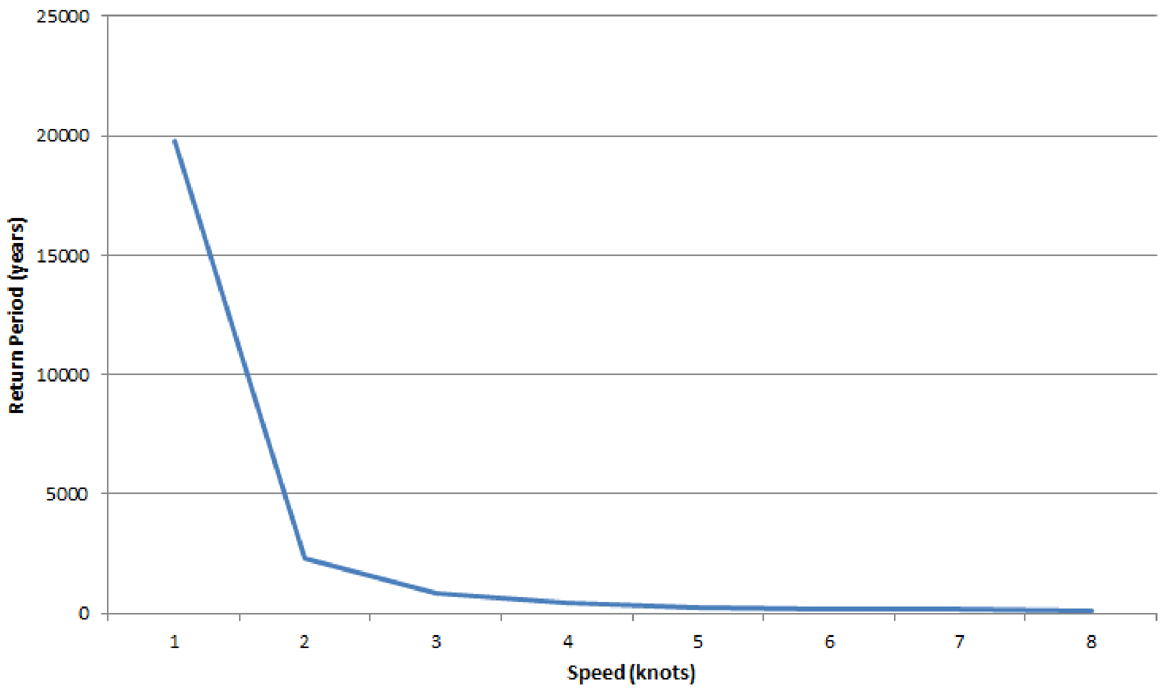

Figure 10.10 Drift Speed Sensitivity Analysis

Table 10-2 Summary of Drift Speed Sensitivity Analysis

Speed (kn)	Annual Frequency of Drifting Allision	Return Period (years)
1	5.05×10^{-5}	19,805
2	4.32×10^{-4}	2,316
3	1.23×10^{-3}	814
4	2.33×10^{-3}	429
5	3.63×10^{-3}	275
6	5.07×10^{-3}	197
7	6.57×10^{-3}	152
8	8.11×10^{-3}	123

Note: These results are not all considered to be realistic scenarios but have been included based on stakeholder feedback during consultation. The full drifting assessment given in Section 10.2.3.2 is considered as being the best reflection of drifting risk and as such has been considered within the impact assessment in Section 12.

Assuming every vessel that broke down drifted at a flat rate of 1 kn, it was estimated that a drifting allision would occur approximately once every 20,000 years. Should every vessel that broke down drift at 8 kn (the maximum speed considered), this rose to one allision per 123 years. It is emphasized that this is not considered a realistic scenario, given that in the majority of circumstances a vessel would not drift at a constant speed of 8 kn. The sensitivity analysis instead represents a simplified approach over the full drifting assessment, and it has been undertaken merely to demonstrate to stakeholders the effect of altering the drift speeds within the modelling process. The full assessment (see Section 10.2.3.2) takes the probability of differing sea states into consideration, and is regarded as the more accurate approach.

10.3.4 Fishing Allision Risk

10.3.4.1 Modelling

The 12 months of AIS data (see Section 7) was used as input to the fishing allision function of Anatec's COLLRISK modelling software suite to assess the potential fishing vessel to structure allision risk following the installation of the Project.

A fishing vessel allision is classified separately from other allisions since, unlike in the case of the commercial traffic characterized via the main route analysis (see Section 7.2.6), fishing vessels may be either in transit or actively fishing within the area. Further, fishing vessels could be observed internally within the array in addition to externally (noting that experience shows that larger commercial vessels e.g., cargo vessels and tankers, will generally avoid wind farm structures). The COLLRISK fishing allision model uses fishing vessel numbers, sizes (length and beam), array layout, and structure dimensions as input. The likelihood of a major allision incident has been calibrated against historical maritime incident data and historical AIS vessel traffic data within operational offshore arrays.

Noting uncertainty around fishing vessel behavior post wind farm, it should be considered that the model conservatively assumes no changes to baseline activity in terms of proximity to structures (i.e., vessels are not altering their navigational patterns based on the presence of structures in line with good seamanship). This is considered a very conservative approach given experience shows that while commercial fishing vessels do continue to transit operational arrays, activity immediately around the structures is very likely to reduce. The potential for any increases in recreational activity (including recreational fishing) associated with the wind farm is considered within Section 12.3.

The results of the fishing allision assessment are shown geographically in Figure 10.11. It should be considered when viewing the figure that specific risk ranges have been utilized to ensure clarity, and as such the plot is not directly comparable to the allision results shown in Sections 10.3.3.1 and 10.3.3.3.

The model takes AIS data only as input, however consideration of non AIS traffic is given in Section 10.3.4.2.

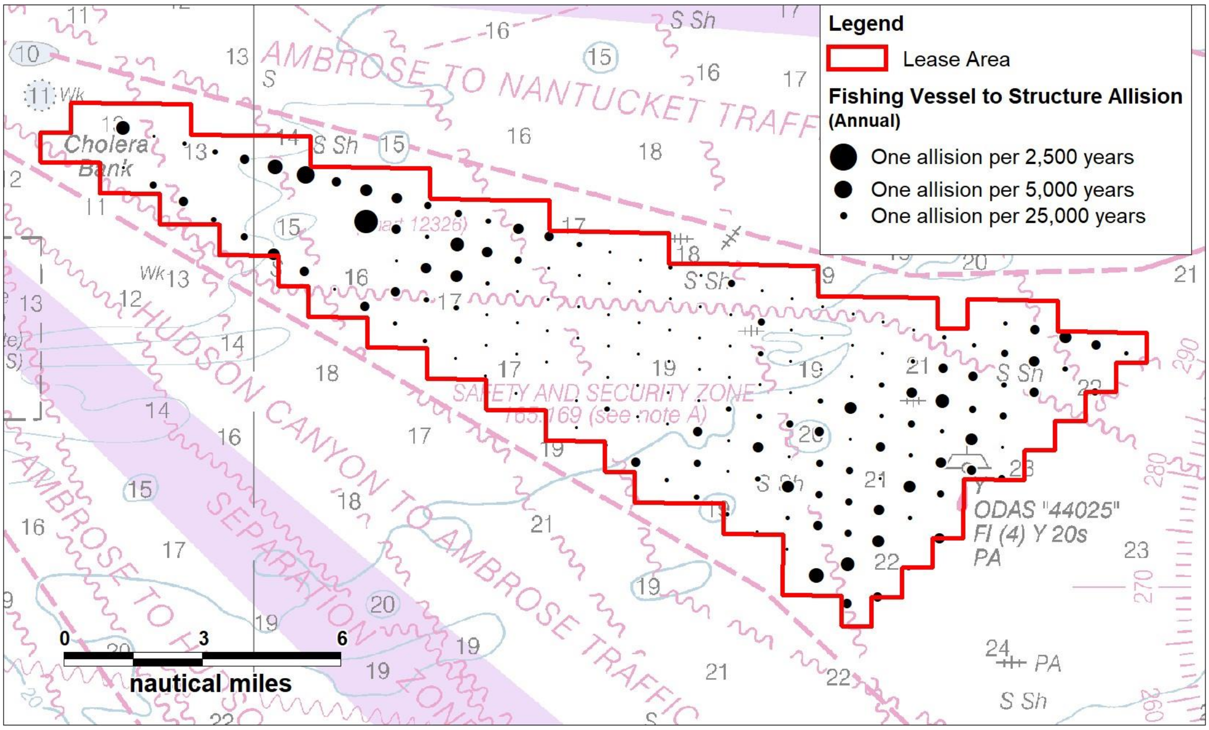

Figure 10.11 Fishing Vessel to Structure Allision

For the base case scenario, it was estimated that the annual fishing vessel allision return period across all turbines and substations was approximately one in 169 years. The greatest annual fishing vessel allision return period associated with any individual structure was one in 3,100 years, noting that this was an offshore substation location. Assuming the future case scenario (10% traffic increase), the allision return period rose to one in 153 years.

The majority of allision risk was observed to be associated with the structures in the easternmost and westernmost sections of the Lease Area, with the turbines in the central section generally at lower risk. This is reflective of the passage utilised by fishing vessels based on the marine traffic data studied (see Section 7.2.4.5), with typical transits to fishing grounds of relevance observed to avoid the central section of the Lease Area.

The model is calibrated against known allision incidents within UK wind farms (see Section 11.3). The model does not give an indication of consequence but indicates that an allision (or contact) of any severity is estimated to occur once per 169 years. Most likely consequences (based on incident statistics) will be a low impact / minor contact with no significant damage, no injuries to persons, and no pollution.

10.3.4.2 Non AIS Traffic

It is noted that while the model is based upon input AIS only, additional assessment of non AIS traffic has been undertaken in Sections 7.2.7 (fishing VMS data) and 7.2.8 (visual observation data).

It is not possible with the available data and consultation to assess how many non AIS vessels transit the Lease Area when compared to the AIS only analysis. However, given that the AIS only analysis will underrepresent the allision risk, the fishing allision model was rerun assuming a conservative non AIS factor of 50% (i.e., a 50 / 50 split between AIS and non AIS fishing vessels, therefore total traffic will double over the assessment shown in Section 10.3.4.1).

Assuming this additional non AIS factor, it was estimated an allision would occur once every 111 years. As discussed in Section 10.3.4.1, it should be considered that this conservatively assumes no changes to baseline activity in terms of proximity to structures (i.e., vessels are not altering their navigational patterns based on the presence of structures in line with good seamanship), and that this represents all "contact" incidents.

10.3.5 Vessel Grounding Risk

As per Section 4.3, there is the potential that the export and inter array cables will be protected via external protection where target burial depths cannot be met. 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 the shallow water areas of the cable corridor. However, the extent and locations of any required external protection are not known at the time of writing, and quantitative assessment of the risk has therefore not been undertaken.

Water depths within the Lease Area are shallowest towards the western extent, starting at approximately 78 ft (23.8 m), and increasing to approximately 138 ft (42.1 m) in the eastern extent (based on the charted water depths). The largest vessel draft recorded within the Lease Area during the year of AIS data studied was 47 ft (14.3 m). However, it should be noted that this draft was from a large cargo vessel, and such a vessel would be unlikely to enter into the array area once the wind farm is installed, based on consultation to date.

No grounding incidents were recorded within the USCG maritime incident data studied (see Section 11.1) within the Lease Area, with all such incidents recorded as occurring near shore.

10.3.6 Risk Results Summary

A summary of the allision and collision modelling undertaken is presented in Table 10.3. The frequency of each risk is presented for pre and post wind farm scenarios, assuming both base case (0% traffic increase) and future case (10% traffic increase) traffic levels.

The return periods are included for reference under each risk frequency.

Table 10-3 Allision and Collision Modelling Output Summary

Scenario	Base Case (0% Traffic Increase)			Future Case (10% Traffic Increase)		
	Pre Wind Farm	Post Wind Farm	Change	No Wind Farm	Post Wind Farm	Change
Collision	7.31×10^{-3} (137 years)	7.31×10^{-3} (137 years)	0	8.80×10^{-3} (114 years)	8.80×10^{-3} (114 years)	0
Powered allision	0	1.02×10^{-3} (976 years)	1.02×10^{-3}	0	1.13×10^{-3} (888 years)	1.13×10^{-3}
Drifting allision	0	1.36×10^{-4} (7,400 years)	1.36×10^{-4}	0	1.50×10^{-4} (6,700 years)	1.50×10^{-4}
Fishing Allision	0	5.93×10^{-3} (169 years)	5.93×10^{-3}	0	6.53×10^{-3} (153 years)	6.53×10^{-3}
Total	**7.31×10^{-3} (137 years)**	**1.44×10^{-2} (69 years)**	**7.09×10^{-3}**	**8.80×10^{-3} (114 years)**	**1.66×10^{-2} (60 years)**	**7.80×10^{-3}**

In line with the assumption there will not be any changes to the main routes identified (see Section 7.5.4), collision risk is not anticipated to increase post Project (see Section 10.3.2). However, the installed turbines and platforms will create allision risk (given that the only surface piercing allision risks in place at the time of writing are buoys).

Overall, assuming base case traffic levels, the frequency at which a vessel is estimated to be involved in a collision or allision is expected to rise from one incident per 137 years pre wind farm to once per 69 years post wind farm. At future case traffic levels, the corresponding rise is estimated at one incident per 114 years pre wind farm to one per 60 years post wind farm. It is noted that these results only represent the frequency of an allision / collision, and must be considered in conjunction with potential consequences (see Section 10.4).

As detailed in Section 10.3.2, collision risk associated with Project vessels is assessed within Section 12.2.2.

10.3.7 Comparison with UK Wind Farms

For the purpose of providing context to the allision and collision results given in Section 10.2.6, modelling results presented in the applications submitted for UK North Sea wind farms are given in Table 10.4. It should be considered when viewing the results that the area of which risk has been assessed will differ per project (this NSRA has assessed risk within 15 nm (27.8 km), whereas the majority of UK wind farm applications considered a 10 nm (18.5 km) Study Area).

Table 10-4 Comparison with UK Projects

Project	Vessel to vessel collision return period		Powered vessel to structure allision return period	Drifting vessel to structure allision return period
	No Wind Farm	Post Wind Farm		
Empire (OCS-A 0512) 201 structures	1 every 114 years	1 every 114 years	1 every 976 years	1 every 7,400 years
Hornsea Three *361 structures*	1 every 193 years	1 every 152 years	1 every 1,084 years	1 every 1,369 years
Hornsea Project Two *368 structures*	1 every 44 years	1 every 36 years	1 every 2,089 years	1 every 878 years
Hornsea Project One *345 structures*	1 every 74 years	1 every 60 years	1 every 878 years	1 every 986 years
East Anglia One *325 structures*	Not directly comparable	Not directly comparable	1 every 197 years	1 every 434 years
East Anglia Three *182 structures*	Not directly comparable	Not directly comparable	1 every 34 years	1 every 483 years
Rampion *175 structures*	1 every 1.2 years	1 every 1.2 years	1 every 5,100 years	1 every 1,800 years
Greater Gabbard *149 structures*	Unavailable	Unavailable	1 every 111 years*	1 every 3,400 years*
Galloper *147 structures*	1 every 22 years	1 every 22 years	1 every 334 years	1 every 760 years

*** Considered nearest high risk routes only**

10.4 Consequences Assessment

10.4.1 PLL and Pollution

The most likely consequences for the majority of hazards associated with shipping and navigation are anticipated to be minor (such as collisions/ allision resulting in no hull breaches, foundering or injury to personnel). However, the worst-case consequences may be severe, including events with PLL.

For larger commercial (merchant) vessels an allision incident would likely result in the wind turbine structure collapse before it is able to significantly damage the hull of the vessel (see Section 10.4.2). 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 Attachment A. This assessment applies the results presented in this section to historical data regarding collision and allision incidents and oil pollution. In summary, the overall annual increase in PLL estimated due to the impact of the development on passing vessels is approximately 5.17×10^{-5}, or one fatality per 19,000 years, assuming a 10% increase in traffic. In terms of individual risk to people, the incremental increase estimated due to the impact of the development for the future case is 9.35×10^{-7}. 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, and traffic were to increase by 10%, the overall increase in oil spilled from passing vessels would be 28 gallons per year. Based upon data available from the Bureau of Transportation Statistics (BTS) (BTS, 2018), the annual average volume of petroleum oil spilled from all vessels affecting navigable US waterways between 1995 and 2016 was approximately 629,000 gallons. Therefore, the overall change in pollution estimated due to the Project represents a negligible increase in the total volume of oil spill (<0.01%).

10.4.2 Structure Integrity

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 structure 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 10.3.3).

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 structure could collapse after impact. However, the study also noted that vessels in the area would be unlikely to cause 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.

It is noted that as per NVIC 01-19 (16d), should an allision occur, Empire will advise the USCG if the structure is deemed a hazard to navigation.

10.5 Cumulative Routing Assessment

As detailed in Section 2.2, a tiered approach has been taken towards the inclusion of other wind farm projects into the cumulative assessment of routing undertaken for this NSRA.

10.5.1 Tier 1a

Projects considered as Tier 1a are those in which data confidence is high, are within 100 nm (185 km) of the Lease Area, and that may impact any of the main routes identified in Section 7.2.6. On this basis Tier 1a projects have been scoped into the cumulative quantitative routing assessment, and are as follows:

- New Jersey Lease Area (Atlantic Shores); and
- New Jersey Lease Area (Ocean Wind).

The main routes identified as passing within the Study Area (see Section 7.2.6) were checked for potential interaction with the Tier 1a sites, and it was determined that the routes associated with east coast ports south of the Lease Area (most notably Philadelphia) could be impacted. Vessels from these ports would be required to pass either inshore or offshore of the Ocean Wind and Atlantic Shores projects to access New York.

The affected routes are summarized below, with full details of each available in Section 7.2.6:

- Routes 5 and 6, associated with the Barnegat / Ambrose TSS lanes;
- Route 7, coastal tug (push/pull) route from Philadelphia; and
- Route 10, commercial and tug (push/pull) traffic passing east of the Lease Area.

Given that routes 5 and 6 are associated with the TSS lanes, passage of these routes will be unaffected by the Project. Vessels utilizing the two routes are, in the majority, larger commercial vessels, and noting that sea space and water depths are limited inshore, it is anticipated that these vessels would pass offshore of the Ocean Wind and Atlantic Shores projects, leading to minor deviations to the east.

Route 7 is primarily used by tug (push/pull) vessels, and remains coastal between Philadelphia and New York, and will hence be unaffected by Empire. However, the Atlantic Shores and Ocean Wind sites may push vessels utilizing the route further inshore. Water depths here are shallow. However, given typical drafts of the tug (push/pull) vessels identified on the route, inshore passage is still considered a feasible option. The option to pass offshore of the Atlantic Shores and Ocean Wind sites would also be available to these vessels. However, this would result in a larger deviation.

Route 10 is a low use route utilized by vessels passing offshore of the Lease Area. The combination of the Project and the Atlantic Shores /Ocean Wind sites may result in the associated vessels passing further to the east than they currently transit to ensure a safe passing distance from the wind farm structures.

Figure 10.12 presents a simulated scenario of vessel routing post installation of the three wind farms considered in the Tier 1a assessment produced via Anatec's AIS Simulator software. This software randomly distributes vessel tracks across each main route identified (see Section 7.2.6), based on the vessel numbers estimated per route. For reference, the Route number (as per Section 7.2.6) has been included in the figure.

This simulation represents a simplified scenario for illustrative purposes, and is only intended to demonstrate potential routing options which may be utilized on a cumulative basis based on the Tier 1a sites.

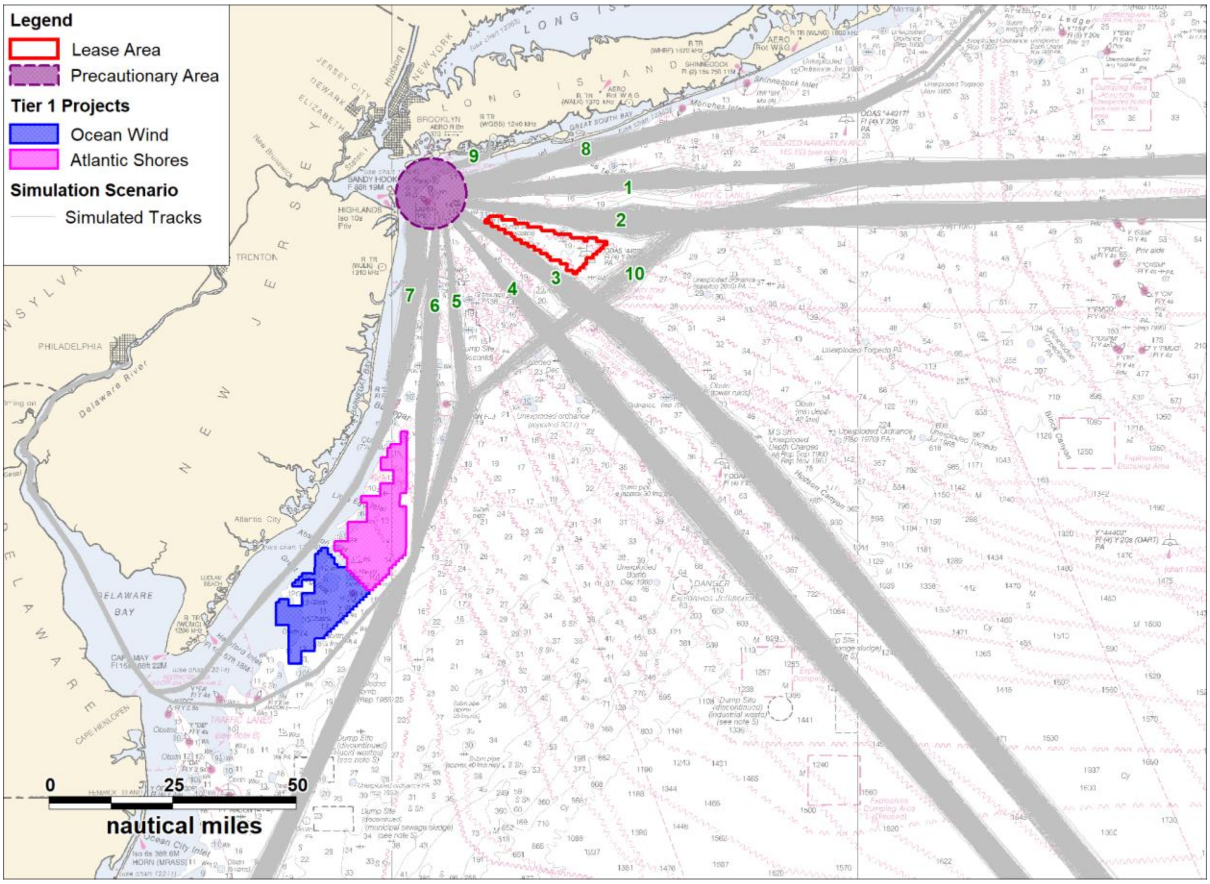

Figure 10.12 Tier 1a Cumulative Routing

10.5.2 Tier 1b

The Tier 1b category captures the New York Bight leases successfully auctioned under the Feb 23, 2022 New York Bight Wind Sale. These projects are of relevance to routing in the area given their proximity to the Lease Area, however are of lower data confidence than the Tier 1a projects (see Section 10.5.1). On this basis qualitative assessment of rerouting has been considered.

The relevant 1b lease areas are shown in Figure 10.13.

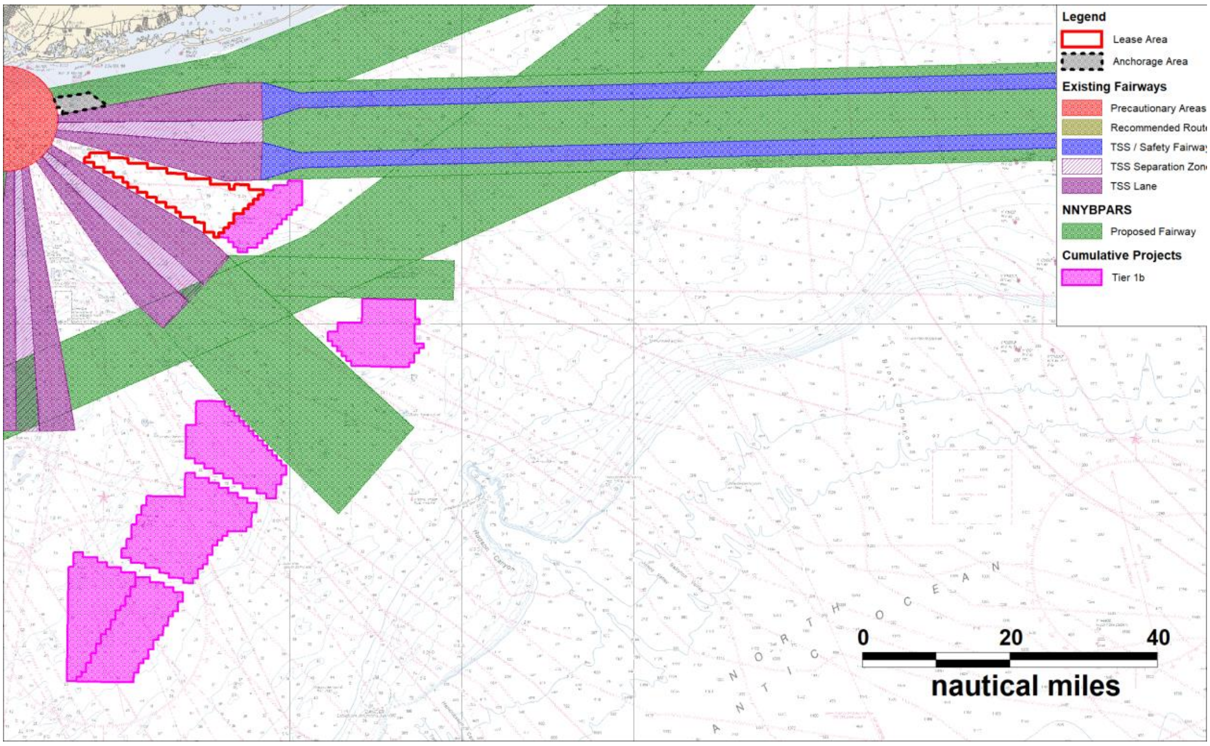

Figure 10.13 Tier 1b Cumulative Routing

It is noted that the NNYBPARS Final Report (USCG, 2021) included proposals to revise/establish fairways, including a proposal to amalgamate the separate Nantucket/Ambrose Fairways into a single fairway. The proposed and existing fairways are shown in Figure 10.13 for reference.

The Tier 1b projects are all within Lease Areas that take into account the local IMO adopted routing measures, and are therefore not anticipated to have any notable impact on vessel routing when considering traffic associated with New York, given that the TSS lanes will remain free for transit and provide access to Providence and Cape Cod Canal for vessels on coastal transits, and to the safety fairways for larger vessels. Further, the fairways proposed under the NNYBPARS account for the Tier 1b projects, and indicate that suitable routing options for vessels associated with New York would be available assuming build out of these projects.

10.5.3 Tier 2

Tier 2 projects are those that are within 150 nm (278 km) of the Lease Area and that may impact any of the main routes identified in Section 7.2.6. On this basis Tier 2 projects are listed below, and shown relative to the Lease Area in Figure 10.11:

- Orsted/Deepwater Wind (including South Fork and Revolution Wind); and
- Lease Area OCS-A 0522.

As per Section 10.5.2, the NNYBPARS Final Report (USCG, 2021) included proposals to revise/establish fairways, including a proposal to amalgamate the separate

Nantucket/Ambrose Fairways into a single fairway. The proposed fairways are shown in Figure 10.13, noting that the existing fairways are also shown for reference.

As for Tier 1b, The Tier 2 projects are within Lease Areas that take into account the local IMO adopted routing measures, and are therefore not anticipated to have any notable impact on vessel routing when considering traffic associated with New York, given that the TSS lanes will remain free for transit and provide access to Providence and Cape Cod Canal for vessels on coastal transits, and to the safety fairways for larger vessels. This is illustrated in Figure 10.13.

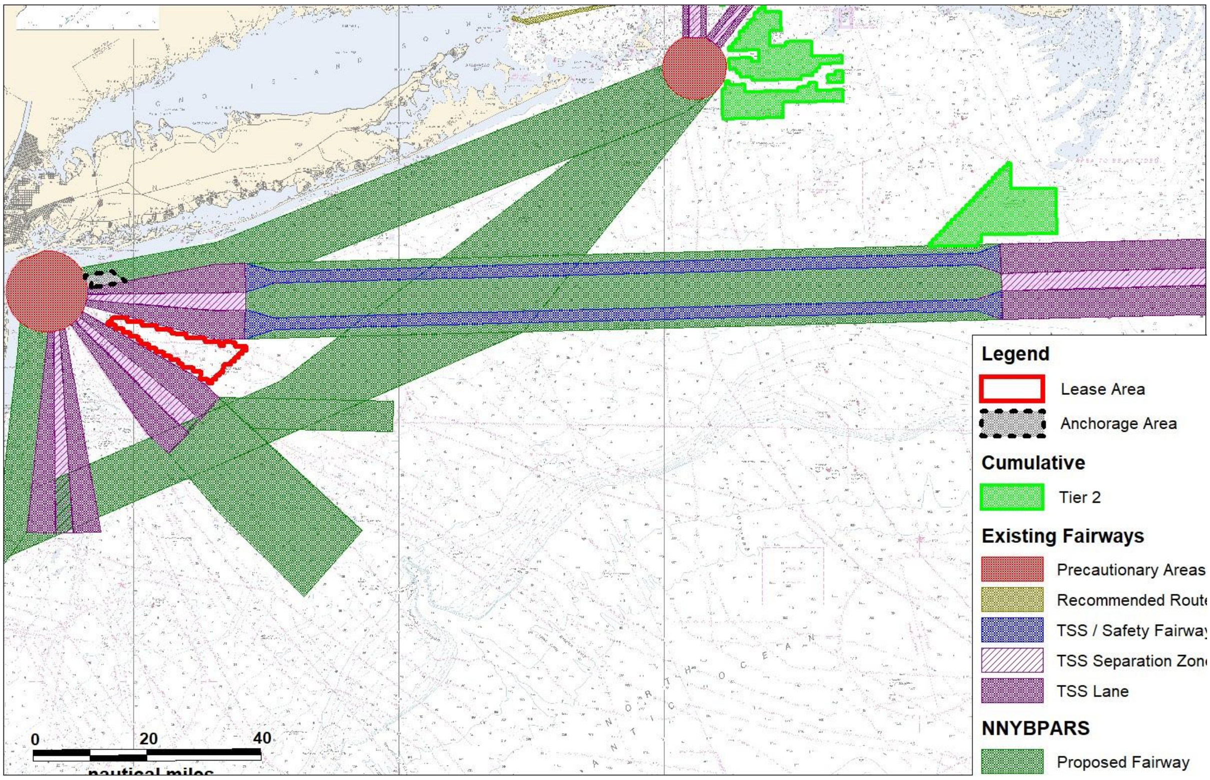

Figure 10.14 Tier 2 Projects

10.5.4 Tier 3

Tier 3 projects were defined as any call areas within 150nm that may impact upon main routes identified in Section 7.2.6. On this basis, Tier 3 projects were identified as being Central Atlantic Call Areas A and B. These Call Areas are shown relative to the Lease Area in Figure 10.14. Existing routing measures and the proposed NNYBPARS fairways are included for reference.

Any vessels on routes which may interact with the Tier 3 projects will need to either pass inshore or offshore of any sites therein. Given low data confidence at this stage previse routing options are unable to be confirmed, however as shown in Figure 10.14, the existing TSS lanes and proposed NNYBPARS fairways (USC, 2021) will remain unimpeded regardless of how much of the Call Areas are built out.

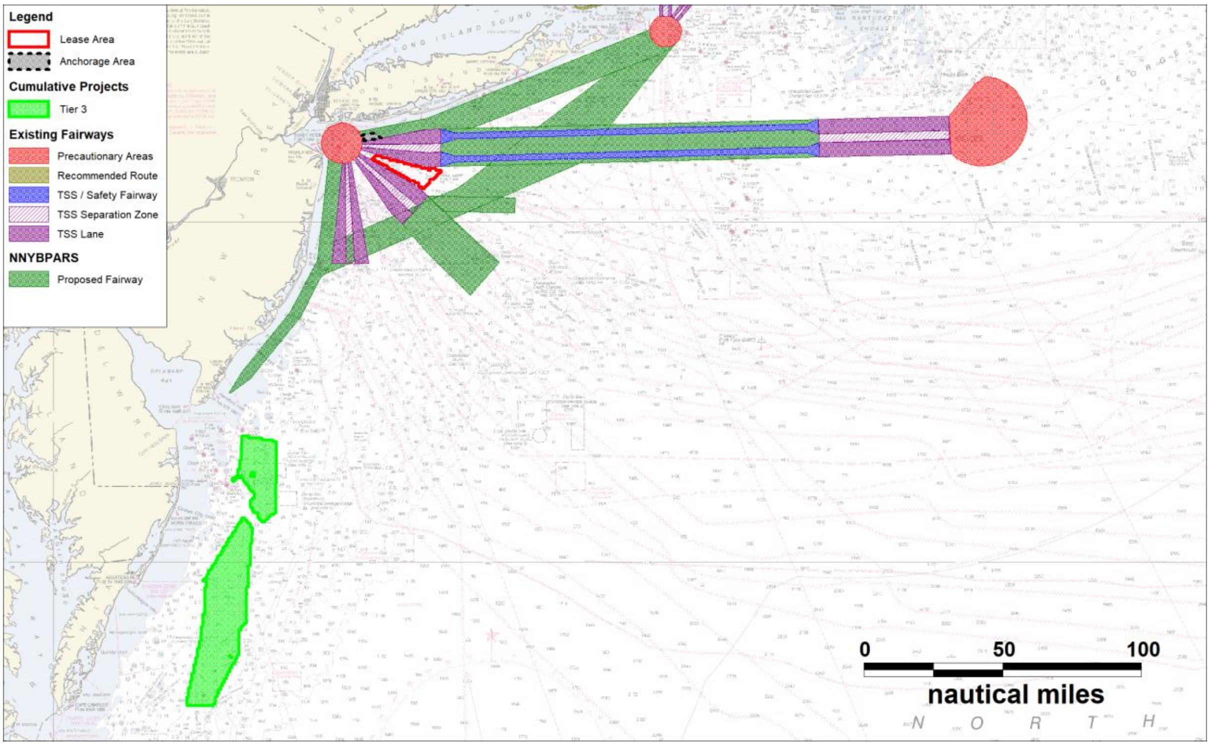

Figure 10.15 Tier 3 Projects

10.5.5 Tier 4 (Screened Out)

As per Section 2.2, Tier 4 projects have been screened out of the cumulative assessment and therefore on this basis are not considered within this section.

11 Search, Rescue, Environmental Protection and Salvage

11.1 United States Coast Guard

11.1.1 Stations

The mission of the USCG is to ensure maritime safety, security and stewardship in the US. There are two area commands (Atlantic Area and Pacific Area) which are each split into a number of district commands. The Project lies within the First District in the Atlantic Area (specifically, Sector New York) for the purposes of the USCG. However, it should be noted that District Five covers the New Jersey east coast and is therefore also relevant.

The First District office is based in Boston, Massachusetts and is responsible for Coast Guard activities in northern New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont and Maine. District Five covers the mid-Atlantic region, including southern New Jersey. The locations of the active USCG stations within Districts One and Five that are in proximity to the Lease Area (and deemed as relevant to the Project) are shown in Figure 11.1.

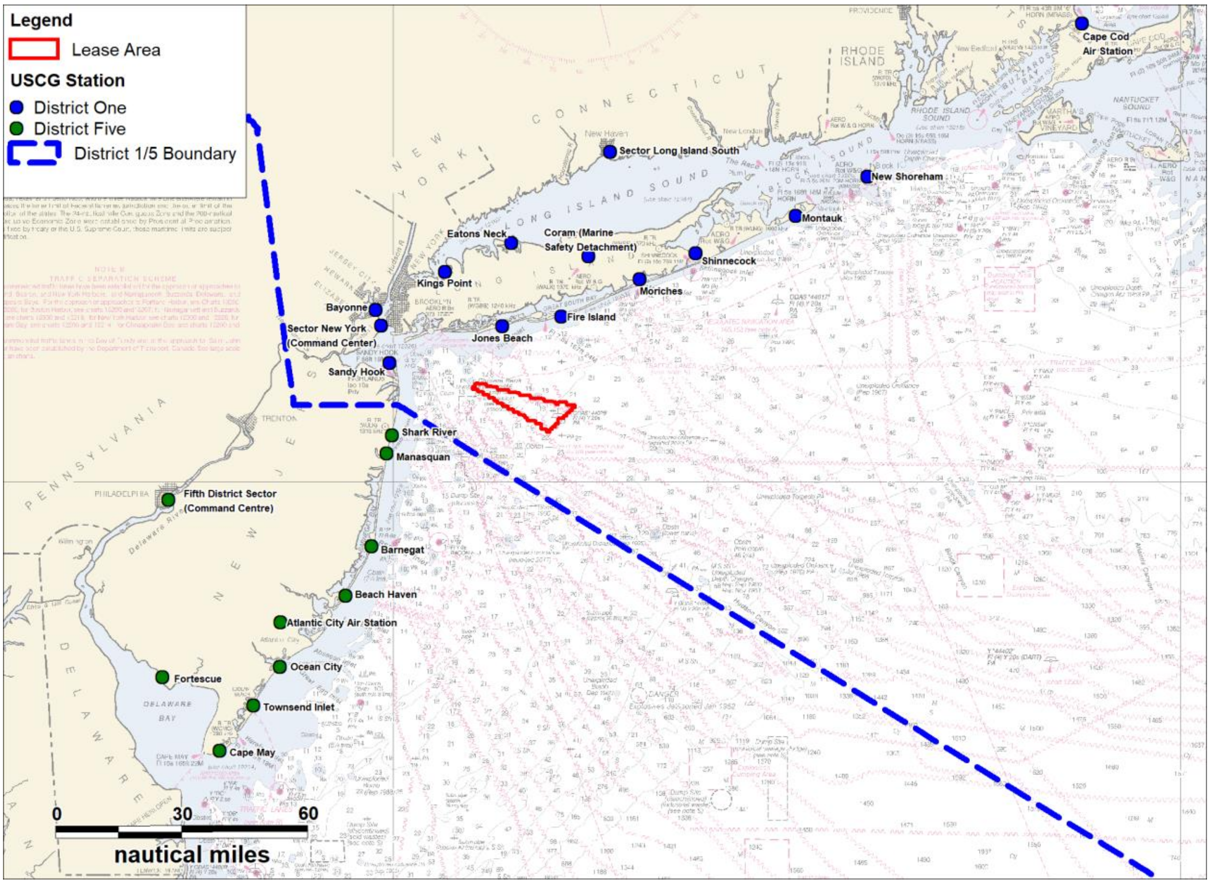

Figure 11.1 USCG Station Locations

Sector New York offshore small boat operations are conducted from the Sandy Hook station, located approximately 20 nm (37.0 km) to the west of the westernmost point of the Lease Area. The nearest USCG air station is located in Atlantic City, approximately 75 nm (139 km) to the southwest. This station covers the area between Virginia and Connecticut (and therefore also covers the Empire OCS-A 0512 site). Assets may also be mobilized from Air Station Cape Cod in the event of an incident. This station is located approximately 150 nm (278 km) to the north east of the Lease Area.

11.1.2 Incident Responses - SAR

The positions of SAR incidents to which the USCG have responded over the ten-year period between 2008 and 2017 are shown in Figure 11.2, according to the MISLE database. USCG Responses not associated with SAR (e.g., law enforcement) are not included. It should also be noted that multiple responses may be associated with the same incident.

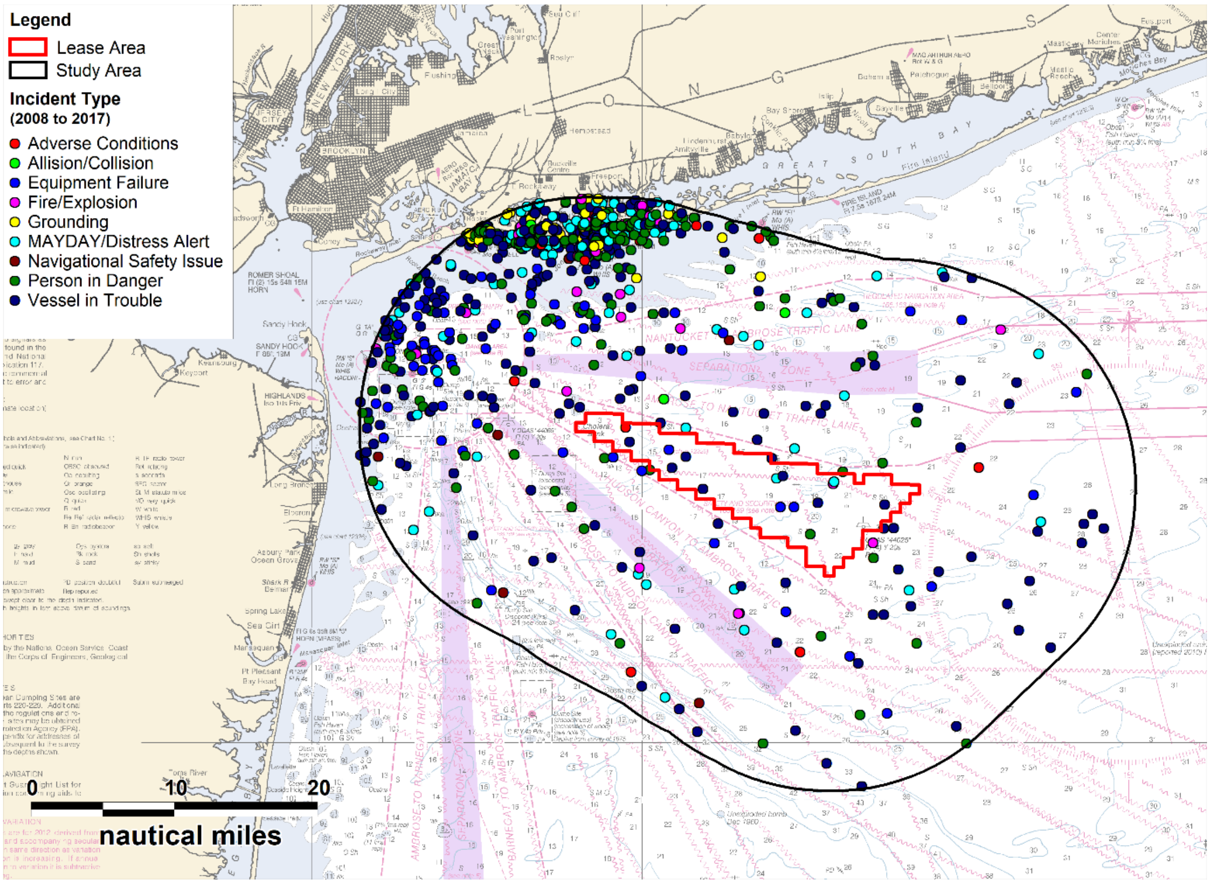

Figure 11.2 USCG Incident Responses (2008 to 2017)

A total of 922 responses to SAR related incidents were recorded between 2008 and 2017, 18 of which were in response to incidents within the Lease Area. Approximately 40% of the 922 incidents were related to vessels being in trouble and requiring assistance, with a further 25% in relation to an individual person being in danger.

Based on the information included within the MISLE database, none of the 18 incidents within the Lease Area resulted in lives lost or property damage.

11.1.2.1 NUC Incidents

Given stakeholder concern over the potential for vessels utilizing the TSS lanes to allide with a structure within the Lease Area whilst NUC, the incident subtypes of the "Vessel in Trouble" category (see Figure 11.2) interpreted as meaning the vessel was NUC are shown in Figure 11.3. It should be considered that not every instance of a vessel being NUC during the period studied will have been reported (and hence logged by the USCG).

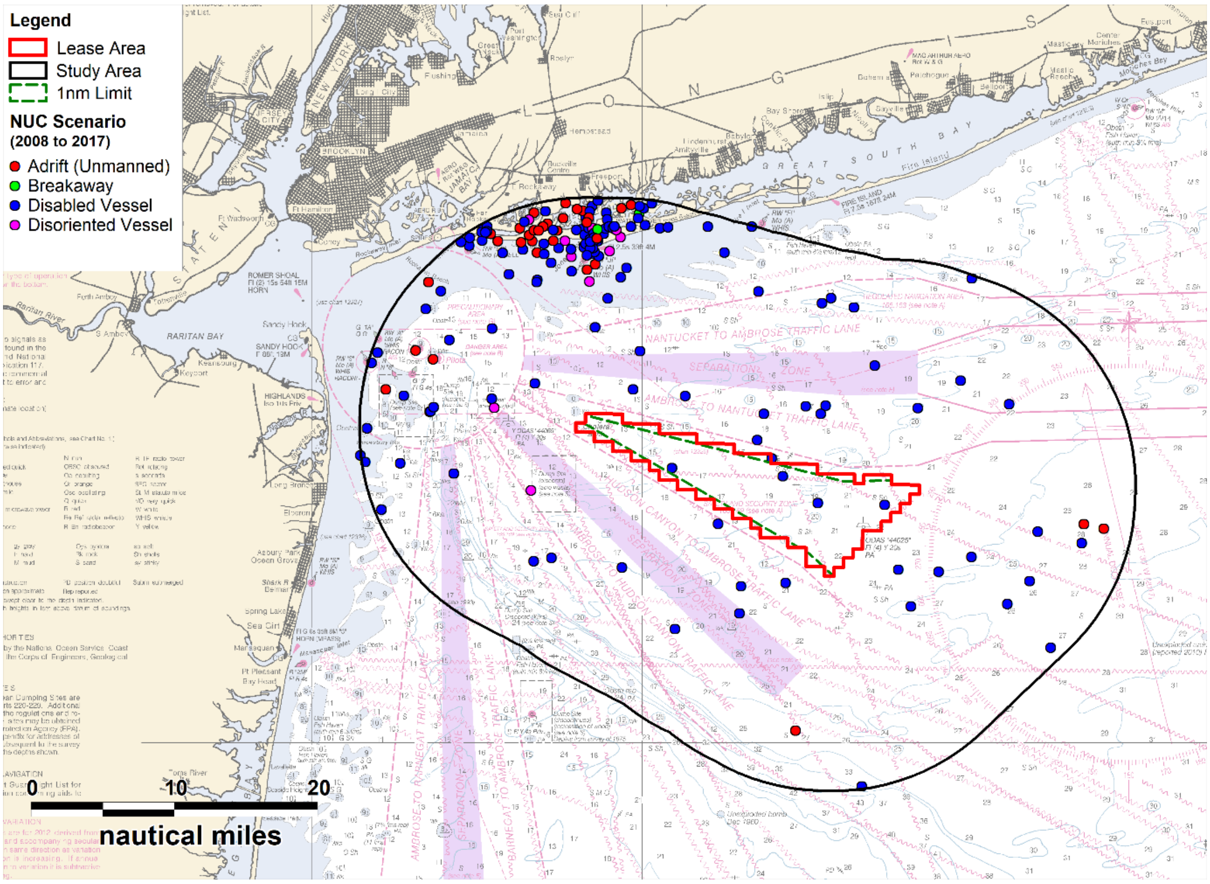

Figure 11.3 USCG Incident Responses – NUC Scenarios (2008 to 2017)

It is important to note that as there were no surface piercing structures within the Lease Area at the time of these incidents, the positions shown are not necessarily indicative of the scenario in which the Project is being constructed or operational (i.e., vessels in or near the Lease Area may have chosen a different transit had the Project been installed). However, the exercise is still considered useful in that it provides an indication of NUC incident rates within the vicinity of the Lease Area.

The distances from the reported position of each NUC incident shown in Figure 11.3 to the periphery of the wind farm (assuming a 1 nm (1.9 km) separation from the TSS lanes) is shown in Figure 11.4.

As shown in Figure 11.4 and illustrated in Figure 11.3, reported incidents of NUC vessels within the immediate proximity of the Lease Area were limited over the ten years studied, with only 23 incidents reported within 5 nm (9.3 km).

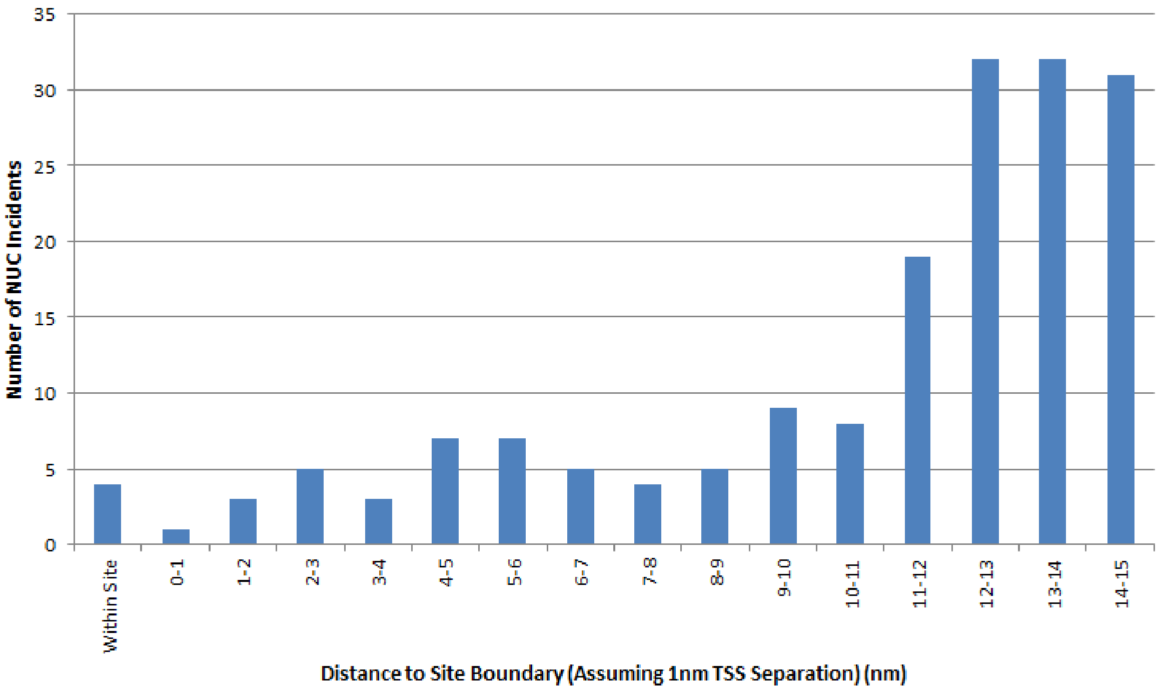

Figure 11.4 NUC Vessel proximity to Site (Assuming 1 nm (1.9 km) Separation Zone from TSS)

11.1.2.2 Allision, Collision and Grounding

The locations of allision, collision, and grounding incidents responded to by the USCG between 2007 and 2018 are shown in Figure 11.5. A total of 26 incidents were recorded (13 collision, 7 allision, and 6 grounding), with the majority of these being coastal or inshore.

One collision incident was recorded within the Ambrose to Nantucket (outbound) TSS lane, between the cargo vessel *Balder* and the fishing vessel *Atlantic Queen* on July 30, 2010. An allision incident was also recorded within the Nantucket to Ambrose (inbound) lane. However, this was listed as being between the *Frederick E Bouchard* and the Victory Highway Bridge. It is therefore assumed that the positional information attached to this incident is inaccurate, given that neither the Victory Highway Bridge nor any other potential allision targets are in the area specified.

During consultation, the recent collision between the tanker *Tofteviken* (which was at anchor at the time) and the fishing vessel *Polaris* (which was in transit) on May 12, 2018 was raised. This incident fell out of the period and geographical area studied. However, the USCG did respond to and record the incident. For reference, the USCG listed it as occurring approximately 67 nm (124 km) to the east of the Lease Area.

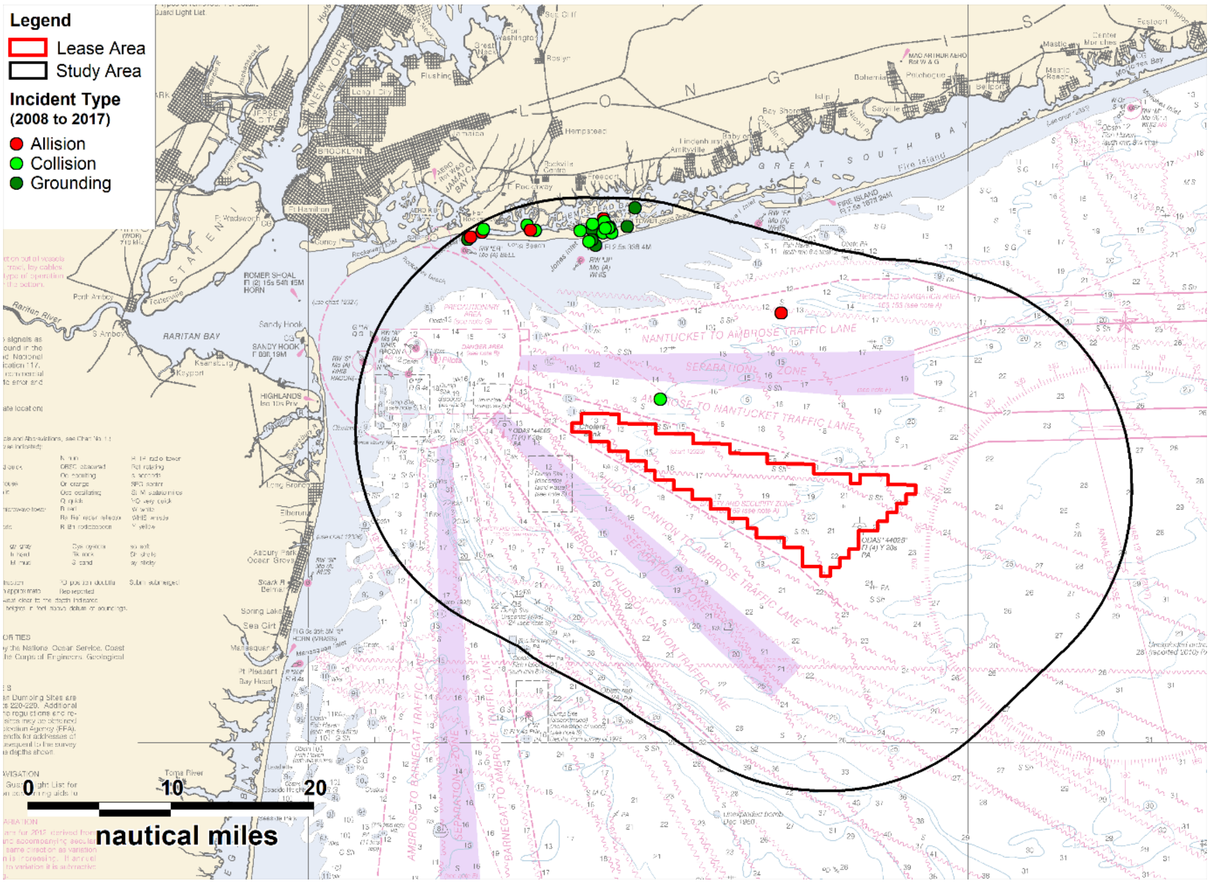

Figure 11.5 USCG Incident Responses – Allision, Collision and Grounding Incidents (2008 to 2017)

Allisions with the Ambrose Tower were also raised during consultation. No such incidents were recorded by the USCG within the data period studied (the most recent was in 2007). However, for reference, known incidents are listed in Table 11.1.

It should be considered when viewing this table that the Ambrose light has taken various forms during its history as both light ships and light towers.

It should be considered when viewing these incidents that the Ambrose light is central within the significantly busy precautionary area. The wind farm is to be built between the bordering TSS lanes, and therefore is not intersected by the majority of passing traffic in the approach to the precautionary area. The Lease Area itself sees much lower traffic density, as can be observed in Section 7.2.

Further, vessel navigation technology and procedures have advanced significantly since the majority of the recorded incidents occurred.

Table 11-1 Historic Allisions with Ambrose Light

Date of Allision	Event	Description
November 3, 2007	Allision with Ambrose Light Tower II	819-foot (250 m) Bahamas-Registered Tankship M/T *Axel Spirit* struck the tower. Ambrose Light was damaged beyond repair.
January 1, 2001	Allision with Ambrose Light Tower II	In January 2001, the 492-foot (150 m) Maltese freighter *Kouros V* struck the new tower, shortly after the repairs from the previous incident had been completed. Tower suffered extensive damage, and the light was rendered inoperable.
October 1, 1996	Allision with Ambrose Light Tower I	On a clear night the 754-foot (230 m) Greek oil tanker *Aegeo* struck the tower, causing severe damage
March 1, 1950	Lightship collision with heavy damage	Grace Line vessel rammed the Ambrose in a dense fog, rupturing her hull.
January 1, 1950	Lightship "brushed" and damaged	Lightship was "brushed" in heavy fog by an unidentified vessel, suffering damage to the radio antenna and losing her spare anchor.
September 1, 1935	Lightship collision and sustained heavy damage.	In September 1935, the Grace Liner Santa Barbara allided with the lightship, with both ships sustaining heavy damage.
March 24, 1919	Lightship collision, foundered.	In 1919, lightship was struck and sunk by a Standard Oil barge while relieving the Cornfield Point Lightship (LV-14).

11.1.3 Incident Responses - Pollution

The locations of pollution incidents responded to by the USCG between 2007 and 2018 are shown in Figure 11.5. A total of 68 incidents were recorded, with the majority of these (62) being recorded as oil spills.

No incidents were recorded within the Lease Area itself. However, one was logged in very close proximity at the western periphery of the site. The majority of incidents were observed to be inshore or coastal, and concentrated around the Jones Inlet area.

Potential consequences associated with spills are assessed within Attachment A.

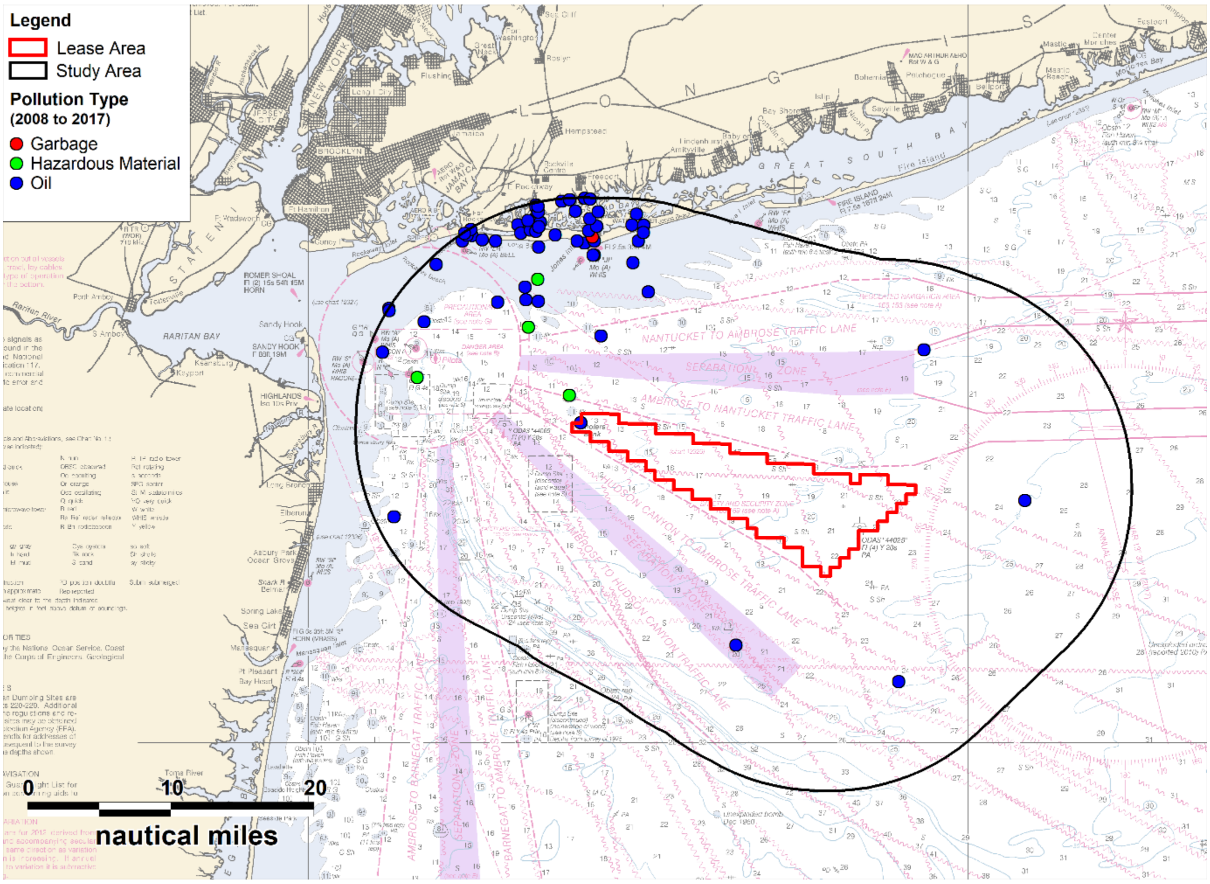

Figure 11.6 USCG Incident Responses – Pollution Incidents (2008 to 2017)

11.2 Other Incidents Raised during Consultation

During consultation (see Section 3), it was suggested a drifting incident involving the liquefied natural gas carrier *Catalunya Spirit,* and a fire incident involving the Roll On Roll Off vessel *Grey Shark* be included for discussion within the NSRA. Summaries of these incidents are detailed below:

- In 2008, the *Catalunya Spirit* suffered power failure approximately 50 nm (92.6 km) southeast of Boston, caused by dirty relays. The vessel subsequently began to drift as the crew was unable to restart the engines, which the USCG would go on to determine was due to inadequate training. The vessel was taken under tow before it grounded on Cultivator Shoals.
- On March 14, 2015, one of the *Grey Shark's* two engines failed, leading the vessel Master to return to port. On March 15, 2015, complications associated with the second engine caused a fire to break out within the vessel's cargo spaces. The fire was contained, and the vessel was subsequently towed back to port following assistance from the USCG and a McAllister operated tug.

11.3 Historical UK Offshore Wind Farm Allision Incidents

As of the time of writing[26], there are 39 fully commissioned and operational offshore wind farms in the UK, ranging from the North Hoyle Offshore Wind Farm (fully commissioned in 2003) to the Hornsea One Offshore Wind Farm (fully commissioned in May 2021). These developments consist of 15,312 fully operational turbine years.

To date there have been nine[27] known cases of an allision between a vessel and a wind turbine (under construction, operational or disused) in the UK, with all but one involving a support vessel for the development and the errant vessel in each case under power rather than drifting. Therefore, there has been an average of 1,701 years per turbine allision incident in the UK, noting that this is a conservative calculation given that only operational turbine hours have been included (whereas allision incidents counted include non-operational turbines).

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

[26] Date: 01/03/2021
[27] Note that previous revisions of this NSRA referenced 11 allision incidents. This number reflected the conservative inclusion of incidents with imprecise location details. However, they have since been confirmed as not occurring within UK wind farms and as such have been removed from this updated analysis.

12 Impacts Assessment

12.1 Introduction

This section uses the characteristics (waterway, vessel traffic and facility), quantitative assessment and consultation outlined within this document to assess the impact of the major hazards and risk assessment 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 subsections, with the following users identified:

- Commercial vessels;
- Recreational vessels;
- Commercial fishing vessels;
- Military vessels (including USCG);
- Anchored vessels; and
- Port access and services.

It has been assumed that the embedded mitigation listed in Section 14 and referenced within the impact assessment will be in place. On this basis, the significance of each impact (per user) has been determined as either broadly acceptable, tolerable, or unacceptable based on the definitions given in Table 2.1. Where necessary, additional mitigation is then introduced to bring impacts to within ALARP parameters (see Section 2.1 for further details). The mitigations are then summarized and listed within Section 14.

Each impact (per user) includes summary introductory text in **bold**, prior to the main discussion of the impact and the relevant embedded mitigation. The final significance ranking is then given (based on the definitions given in Section 2.1), again in **bold**.

12.2 Commercial Vessels

For the purposes of this assessment, commercial vessels are considered to be dry bulk, wet bulk, vehicle carriers and containerized cargo vessels, passenger vessels, marine aggregate dredgers and tug (push/pull) vessels. They do not include commercial fishing vessels which are assessed separately in Section 12.4.

12.2.1 Deviations

12.2.1.1 Impact Description

The presence of the array may lead to commercial vessels deviating around the structures therein resulting in increased journey times and distances.

Given the majority of regular routed traffic in the area utilize the pre-established IMO routing measures, none of the ten main routes identified from the marine traffic survey are likely to require notable deviation as a result of the structures within the array (see Section 7.5.4). It should be noted that commercial vessels were observed to intersect the Lease Area within the AIS data studied. However, not in sufficient numbers for the traffic to be defined as utilizing a main route (as defined in Section 7.2.6). This intersecting commercial traffic was limited, with less than one such vessel per day transiting through the site.

Given consultation to date (both Project and industry specific) has indicated commercial vessels would avoid the array unless turbine spacing was sufficiently large, it is likely that the majority of such traffic would deviate to avoid the structures entirely, rather than transit through the array, given that there are limited time or distance savings to be made by navigating through. Smaller vessels may pass to the west (inshore) of the wind farm. However, given the presence of the precautionary area, it is assumed that larger vessels would pass to the east. Regardless, commercial vessels will be able to passage plan in advance given the promulgation of information relating to the Project, and given the low number of vessels this may affect (noting that, as previously discussed, the majority of traffic will remain unaffected given they utilize the TSS lanes), there is not considered to be a significant impact.

It is noted that larger vessels may still choose to pass through the array and the precautionary area to access the anchorage area. However, there is considered enough sea room (noting the Layout Rules) for such transits to be undertaken safely.

12.2.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation); and
- Monitoring of traffic via AIS from the Project marine coordination center (see Section 14) during construction to review how the actual deviations compare to the output of this NSRA.

12.2.1.3 Impact Significance

Levels of commercial traffic through the Lease Area are low (with the significant majority of commercial traffic in the area utilizing the TSS lanes) and therefore deviations are considered to be low frequency with negligible consequences. With the mitigation in place, the impact is assessed to be **broadly acceptable** and within ALARP parameters.

12.2.2 Increased Encounters and Collision

12.2.2.1 Impact Description

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

As per Section 12.2.1, it is assumed likely that the majority of commercial vessels would choose to deviate to avoid the structures within the array, rather than transit through, noting that levels of affected commercial traffic are considered to be limited, with the majority of existing traffic utilizing the TSS lanes and hence will be unaffected (in terms of displacement) by the Project. This may lead to a small increase in vessel density at the eastern and western peripheries of the array (the two potential areas into which vessels are likely to deviate), which would result in a small increase in collision risk.

Based on the collision modelling undertaken for the Project, it was estimated that a vessel utilizing one of the main routes identified would be involved in a collision once every 137 years within the area (excluding the precautionary area), assuming current traffic patterns and levels. Should traffic rise by 10%, this was estimated to rise to once every 114 years. It is emphasized that these are current collision rates, and do not account for the array. Given the low levels of deviations that may be associated with the Project for commercial vessels (see Section 12.2.1), collision rates are not expected to change significantly following the construction of the structures in the array. This was demonstrated in a simulation exercise (see Section 10.2.1) which showed increases in encounter rates of between just 1% and 2% following displacement of the regular routed traffic intersecting the Lease Area.

Given the minimum spacing between turbines within the Lease Area (approximately 0.65 nm (1.2 km)), there are not expected to be any issues with the structures blocking or hindering the view of other vessels underway. Further, the impacts of the Project on communication and position fixing equipment are anticipated to be limited (see Section 9).

It should be considered that the vessels associated with the construction and operation/maintenance of the Project have the potential to create additional collision risk to third party vessels, particularly as such vessels will include those that are restricted in maneuverability (RAM). However, the associated risk will be managed via marine coordination (as detailed in Section 14), marking of the construction area (temporary lighting and buoyage as agreed with USCG), safety zones (see Section 14 bullet 1), and other operational procedures such as designated entry/exit points to the array and designated transit routes for Project vessels to ensure that they do not increase risk for third party vessels i.e., by avoiding exiting the construction areas in the TSS lanes.

12.2.2.2 Relevant Embedded Mitigation

Embedded mitigation (see Section 14 for full details) deemed relevant to increased encounters and collision risk resultant of deviations is as follows:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation); and
- Monitoring of traffic via AIS from the Project marine coordination center (see Section 14) during construction to review how the actual deviations compare to the output of this NSRA.

The following mitigations are of relevance to increased encounters and collision risk from Project vessels:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Compliance by vessels associated with the Project with international and flag state regulations including COLREGs and SOLAS;
- Marine coordination for vessels associated with the Project;
- Monitoring of third-party vessel traffic by AIS;
- Operational procedures for Project vessels such as entry/exit points and designated routes; and
- Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.

12.2.2.3 Impact Significance

Given the low frequency of deviations the potential for increased encounters is also considered to be low. When considering the deviations that may occur and the potential for increased future traffic levels (noting the mitigation in place including those pertinent to construction and operational Project traffic management) the most likely consequence are considered to be an encounter with no collision with the potential for worst case consequence (damage to a vessel) being of a very low frequency. Therefore, the impact is assessed to be **broadly acceptable** and within ALARP parameters.

12.2.3 Vessel to Structure Allision Risk (Powered)

12.2.3.1 Impact Description

The presence of the array may create a risk of a commercial vessel under power experiencing an allision with one of the structures therein.

Based on the powered allision modelling undertaken as part of this NSRA, it was estimated that a vessel utilizing one of the main routes in the area may allide with a structure within the array whilst under power once every 976 years, assuming base case traffic levels. The majority of this risk was observed to be from vessels utilizing the Hudson Canyon to Ambrose TSS lane, noting that vessels within this lane were observed, in general, to pass closer to the array than those utilizing the Ambrose to Nantucket Lane.

Lighting and marking would be defined in consultation and agreement with the USCG (who will determine the lighting and marking requirements for the Project) and would be designed to make the presence and location of the structures clear to passing maritime traffic. During construction, temporary lighting and buoyage may also be utilized, with the operational scheme becoming active upon commissioning of the wind farm. Safety zones may also be utilized during construction (see Section 14 bullet 1), so that passing traffic can identify that the array is under construction along with promulgation of information.

In order to ensure that the array is designed to be sympathetic to shipping, Empire has taken a proactive step and defined Layout Rules for the purpose of ensuring the risk (including allision risk) of the final layout to third party traffic is ALARP, as shown in Section 5. This includes the following commitments:

- Ensuring a consistent 1 nm (1.9 km) gap will be maintained between the periphery structures bordering the TSS lanes (see Section 5.2.5 and 5.3), and the lane boundaries themselves;
- The array will maintain at least one line of orientation; and
- The turbines and other structures will be arranged in a regular pattern (as far as is practicable) with a minimum spacing of 0.65 nm (1.2 km).

Furthermore, embedded mitigation includes lighting and marking of the structures, ensuring they are visible during both day and nighttime hours.

The consistent separation (noting there will be no isolated or protruding structures), regular layouts and safe lighting and marking (as per embedded mitigation, Section 14) will make the periphery and internal structures clear to both internal and passing traffic.

It is noted that the modelling only included vessels utilizing identified main routes (see Section 7.2.6) within the area, and therefore vessels within the array itself are not accounted for, noting that it is not considered likely that many commercial vessels would transit through the array based on existing usage demonstrated in Section 7.2.4.2, where one commercial vessel every 5 days was recorded within the Lease Area.

12.2.3.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Application and use of safety zones of up to 500 m radius during construction and decommissioning (see Section 14 bullet 1);
- Implementation of the Layout Rules; and
- Use of a safety vessel where deemed appropriate by risk assessment.

12.2.3.3 Impact Significance

Given that Empire is installing up to 149 foundations (inclusive of two offshore substations) within an area previously void of structures the impact on allision risk for powered commercial vessels is assessed to be **tolerable** with mitigation (due to the presence of those new structures). When considered against the very low frequency of commercial vessels within the Lease Area and the embedded mitigation in place, the impact is assessed to be ALARP with a potential increase in frequency of occurrence that can be effectively managed by mitigation including lighting and marking of those structures so mariners can passage plan safely. 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.

12.2.4 Vessel to Structure Allision Risk (Drifting)

12.2.4.1 Impact Description

The presence of the array may create a risk of a commercial vessel not under command (NUC) alliding with a structure in an emergency situation.

Based on the drifting allision assessment undertaken within this NSRA, it was estimated that a commercial vessel utilizing one of the main routes in the area may allide with a structure in the array whilst NUC approximately once every 7,400 years based on base case traffic levels. The majority of this risk was observed to be related to the periphery structures towards the western end of the Lease Area (i.e., where the TSS lanes narrowed) – see Figure 10.8.

The potential for a vessel utilizing a TSS lane to become NUC and drift towards the array was raised as a key concern during consultation undertaken for this NSRA. The consultation output fed into the definition of the Layout Rules (see Section 5), notably the commitment to maintaining a 1 nm (1.9 km) separation between the TSS lane boundaries and the periphery wind farm structures.

An assessment of historical NUC incidents (recorded by the USCG, see Section 11.1) showed that over the ten year period studied, the USCG responded to a total of 23 incidents of a vessel being NUC within 5 nm (9.3 km) of the array (i.e., less than three per year). It is acknowledged that a NUC vessel may not necessarily inform the UCSG of the incident, and the actual number of incidents could therefore be greater than this. However, it would be expected that a vessel breaking down within a TSS lane in proximity to a key port would report, particularly if there were the potential to ground or drift into danger.

In the event that an NUC vessel did drift towards the array (noting that the tidal or wind conditions may push it away from the array), it is likely that it would first initiate its own emergency plans that are likely to include the use of thrusters and anchors, which would likely prevent an allision. It is also noted that any vessels associated with the Project which were currently on site may be able to assist an NUC vessel in liaison with the USCG, assuming it was safe to do so as per SOLAS (IMO, 1974).

12.2.4.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Use of a safety vessel where deemed appropriate by risk assessment;
- Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation; and
- Provision of self-help capability.

12.2.4.3 Impact Significance

On this basis, and although Empire is installing up to 149 foundations into a previously void area, the impact is assessed to be **broadly acceptable** and within ALARP parameters given the low frequency of occurrence (frequency of occurrence considered likelihood of NUC event occurring, tide/weather pushing the vessel to the wind farm and the vessel being unable to take its own avoiding action) and the mitigation in place. It was considered that high consequence events (damage to vessel or structure) could occur but when considered against the low frequency (low chance of engine failure combined with the high likelihood that emergency can be mitigated before a vessel allided with structure) the risk is within ALARP parameters.

12.3 Recreational Vessels

For the purposes of this assessment, recreational vessels are comprised of pleasure craft both private and chartered.

12.3.1 Deviations

12.3.1.1 Impact Description

The presence of the array may lead to recreational vessels deviating around the structures therein whilst in transit resulting in increased journey times and distances.

Based on the available data, no regular recreational “routes” were identified as passing through the Lease Area. The maritime traffic assessment showed recreational AIS traffic through the Lease Area to be very low, with the majority of recreational traffic observed to remain on coastal or near shore routes.

It should be considered that recreational vessel levels are likely to be underrepresented within this assessment (given AIS carriage requirements). The visual observation assessment (see Section 7.2.8) showed that during summer periods, recreational vessels do transit within the Lease Area, including small yachts, sports fishing vessels, and motorboats.

It is noted that there could be an increase in future case recreational fishing given the benefit of fish aggregation around the foundations (and noting that as per the visual assessment, sports fishing already occurs in the area). However, this is not expected to be at a level that requires additional assessment given that overall, it’s likely to be a negligible increase against total vessel numbers.

During construction, given the presence of the associated vessels and activity, the low level of recreational users who do use the area may choose to avoid the structures altogether (or at least the areas where construction is ongoing), instead transiting either to the east or west, noting that activity within the TSS lanes from smaller recreational vessels was limited. However, it should be considered that “curious” recreational users may seek to pass in closer proximity to the ongoing works than larger commercial vessels. It should also be considered that recreational users may be less experienced than the crews of larger commercial vessels, and would be less likely to have formal procedures in place with regards to transit in the vicinity of renewable developments. However, 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.

During operation, given the wind turbine spacing, it is likely that recreational users would be comfortable navigating through the array. Based on both the AIS and visual observation data assessment, recreational vessels are anticipated likely to be small, and minimum spacing of 0.65 nm (1.2 km) is considered as being sufficient to facilitate navigation of such vessels, noting that blade clearance will be at least 85 ft (26 m) above MHHW. This is ensured via the definition of the Layout Rules (see Section 5).

12.3.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Implementation of the Layout Rules; and
- Minimum blade clearance of 85 ft (26 m) above MHHW.

12.3.1.3 Impact Significance

Therefore, the overall displacement impact to recreational users is expected to be less than for commercial vessels (given the low frequency of recreational users in the area and their smaller vessel size allowing greater flexibility for internal navigation). It is also noted that the consequences are expected to be negligible given recreational vessels are not on commercial schedules and the impact is therefore considered to be **negligible (no impact)** and hence within ALARP parameters.

12.3.2 Increased Encounters and Collision Risk

12.3.2.1 Impact Description

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

Given the very low potential for recreational displacement to the east or west of the Lease Area, particularly during construction (see Section 12.3.1), there may be increased levels of encounters with commercial vessels (within the TSS lanes) within these areas at the array peripheries. It is noted that there will be no restrictions on entry during construction, (other than through active safety zones (see Section 14 item 1). However, given the presence of RAM vessels and the associated activity, recreational users are likely to passage plan to avoid the ongoing works.

Should recreational vessels deviate to the west, where sea room is limited between the western array periphery and the precautionary area, encounters may increase with commercial vessels seeking access to the anchorage area once the wind farm is constructing or constructed. However, there is considered sufficient space (in the region of 4.7 nm (8.7

km)) to accommodate the likely traffic levels within this area without compromising safe navigation in accordance with COLREGs.

Given there are no navigational obstructions east of the wind farm, any recreational vessels displacing to the east should have sufficient space to passage plan safely and it is noted that, based on the maritime traffic data, recreational traffic is comfortable utilizing this area for transit.

Given the minimum spacing between wind turbines (approximately 0.65 nm (1.2 km)) there are not expected to be any issues with structures blocking or hindering the view of other vessels underway. Further, it is noted that the Project is anticipated to have limited effects on communication and position fixing equipment (see Section 9).

For recreational vessels choosing to navigate internally within the array, there is an additional collision risk arising from vessels associated with the Project, particularly during the construction and decommissioning phases, or during periods of major maintenance which are all likely to require vessels which are RAM. Similar risk will also apply to any recreational vessel navigating in proximity to a cable laying vessel. However, mitigation measures outlined for Project vessels in relation to the equivalent impact for commercial vessels will be implemented including marine coordination, compliance with international and flag state regulations, and other operational procedures (e.g., site entry/exit points).

12.3.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring recreational vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts; and
- Lighting and marking (including via Private Aids to Navigation).

The following mitigations are of relevance to increased encounters and collision risk from Project vessels:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Compliance by vessels associated with the Project with international and flag state regulations including COLREGs and SOLAS;
- Marine coordination for vessels associated with the Project;
- Monitoring of third-party vessel traffic by AIS;
- Operational procedures for Project vessels such as entry/exit points and designated routes; and
- Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.

12.3.2.3 Impact Significance

Given compliance with COLREGs and SOLAS as per Section 14, the impact is considered to be **broadly acceptable** and within ALARP parameters given the low frequency and most likely consequences (low).

12.3.3 Vessel to Structure Allision Risk (Powered)

12.3.3.1 Impact Description

The presence of the array may create a risk of a recreational vessel under power experiencing an allision with one of the structures therein.

As discussed in Section 12.3.1, recreational users are able to transit the array if they chose to, or alternately may deviate around the structures. Therefore, there may be an increased allision risk to the structures internal to array (from vessels choosing to transit through), and to the periphery structures (from vessels deviating to avoid the array). It is noted that based on both the AIS and visual observation data (see Section 7.2.8), recreational vessels do currently transit through the Lease Area, and based on the minimum spacing that will be available, internal transits from recreational vessels may occur.

With regards to internal navigation and as per the Layout Rules, the array will maintain at least one line of orientation, the wind turbines and other structures will be arranged in a regular pattern (as far as is practicable), minimum spacing will 0.65 nm (1.2 km), and blade clearance will be at least 85 ft (26 m) above MHHW. These mitigations will allow recreational users including recreational fishermen to navigate safely within the array. Furthermore, embedded mitigation includes lighting and marking of the structures, ensuring they are visible during both day and nighttime hours. These measures will ensure the layout is designed such that allision risk to recreational users within or near the array is ALARP.

Additionally, recreational vessels are required to comply with international and flag state regulations that are applicable to them. Applicable regulations and/or good seamanship would require these vessels to take account of the structures both in advance (through passage planning) and when within or near the array. It is therefore anticipated that recreational vessels will be able to transit the array safely from any direction and in any weather conditions.

Should a recreational vessel under sail enter the proximity of a wind turbine, there is potential for effects such as wind shear, masking and turbulence to occur. From previous studies of offshore wind developments it has been concluded that turbines do reduce wind velocity downwind of the structure 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.

12.3.3.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Application and use of safety zones of up to 1,640 ft (500 m) radius during construction and decommissioning (see Section 14 bullet 1);
- Implementation of the Layout Rules;
- Use of a safety vessel where deemed appropriate by risk assessment; and
- Minimum blade clearance of 85 ft (26 m) above MHHW.

12.3.3.3 Impact Significance

Noting implementation of the Layout Rules and other embedded mitigation in place, the impact is assessed to be **broadly acceptable** and ALARP given that the frequency of recreational vessels within close proximity to the array is considered to be low, and most likely consequences will be low energy / low impact (i.e., minor or no damage to vessel and no injury to persons). It is noted that a high consequence could occur but that the frequency of the impact (based on incident statistics and lessons learnt) mean that the risk can be considered within ALARP parameters

12.3.4 Vessel to Structure Allision Risk (Drifting)

12.3.4.1 Impact Description

The presence of the array may create a risk of a recreational vessel NUC experiencing an allision with one of the structures therein in an emergency situation.

Recreational vessels transiting through or near the array are at an increased risk of an allision incident should they become NUC (noting that vessels under sail may have alternative means of maneuvering away from danger). Based on the AIS and visual observation data (see Section 7.2.8) studied, recreational traffic does transit the Lease Area (albeit at levels considered limited compared to coastal levels), and as such an NUC incident in proximity to the wind turbines may occur.

In the event that an NUC recreational vessel did drift towards the array (noting that the tidal or wind conditions may push it away from the array), it is likely that it would first initiate its own emergency plans which may include the use of anchors (or any alternate means available). Any such vessel is likely to drift at low speeds, and as such preventative action is more likely to be successful.

As per embedded mitigation (Section 14), blade clearance will be at least 85 ft (26 m) above MHHW which will reduce the allision risk. Furthermore, vessels associated with the Project that are on-site in the event of a potential drifting allision incident may be able to assist in liaison with USCG and assuming it was safe to do so as per SOLAS (IMO, 1974) (e.g., by taking the NUC vessel under tow).

Should a recreational vessel allide with a structure while NUC, it is anticipated that in the majority of cases this would be a low speed low energy allision given the size of a typical recreational vessel and the likely speed of a drifting vessel being low.

12.3.4.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Use of a safety vessel where deemed appropriate by risk assessment;
- Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation; and
- Provision of self-help capability.

12.3.4.3 Impact Significance

Assuming the compliance of recreational vessels with applicable regulations, the impact is assessed to be **broadly acceptable** and ALARP. It was considered that high consequence events (damage to vessel/structure or injury to persons) could occur but when considered against the very low frequency (low level of activity and low chance of engine failure combined with the high likelihood that emergency can be mitigated before a vessel allided with structure) the risk is within ALARP parameters.

12.4 Commercial Fishing Vessels

For the purposes of this assessment only navigational impacts on commercial fishing vessels in transit are considered; impacts on commercial fishing vessels engaged in fishing activities will be considered within the final submitted COP (Section 8.8), and are summarized in Section 12.4.6 of this NSRA.

12.4.1 Deviations

12.4.1.1 Impact Description

The presence of the array may lead to commercial fishing vessels deviating around the structures therein whilst in transit resulting in increased journey times and distances.

Based on the output of the maritime traffic data assessment, the majority of vessels intersecting the Lease Area during the period studied were in transit, rather than engaged in active fishing (i.e., with gear deployed). The significant majority of these intersecting vessels were associated with New Jersey. This is based primarily on assessment of AIS data, and therefore non-AIS vessels may be underrepresented, noting that further assessment of VMS data (see Section 7.2.7) and visual observation data (see Section 7.2.8) both indicated non-AIS fishing vessels may transit both within and near the Lease Area.

Fishing vessels would not be restricted from entering the Lease Area during construction (with the exception of into any active safety zones, see Section 4 item 1). However, they may choose to avoid the array (or at least areas where works were ongoing) given the likely presence of RAM vessels. As for recreational vessels, fishing vessels could deviate either east or west of the wind farm, with the route taken likely to be largely dependent on the destination fishing ground.

Once the wind farm is operational, fishing vessels could transit freely through the array if they chose to, noting that the minimum turbine spacing (0.65 nm (1.2 km) as per the Layout Rules, Section 5) is considered sufficient for safe navigation for fishing vessels.

As with commercial vessels, commercial fishing vessels are required to comply with international and flag state regulations (COLREGs and SOLAS) and should be able to passage plan in advance given the planned promulgation of information relating to the development. The array will also be marked on nautical charts, and lit and marked to ensure the structures therein are clear to approaching fishing vessels.

12.4.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Implementation of the Layout Rules; and
- Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on board equipment.

12.4.1.3 Impact Significance

On the basis of the embedded mitigation in place, the impact is assessed to be **broadly acceptable** and within ALARP parameters.

12.4.2 Adverse Weather Deviations

12.4.2.1 Impact Description

The presence of the array may lead to commercial fishing vessels deviating around the structures therein whilst in transit resulting in increased journey times and distances during periods of adverse weather.

During periods of adverse weather, or when such weather is forecast, there may be a necessity for fishing vessels to return to port or sheltered waters. The presence of the array may therefore lead to increased journey times to fishing vessels on such transits should they choose to avoid the array.

Based on the maritime data assessed, the majority of affected transits are those bound north east or east out of New Jersey, given that such transits currently intersect the Lease Area. As per the Layout Rules (see Section 5.2.6), minimum spacing will be 0.65 nm (1.2 km) as far as is practicable, and such spacing is likely to be sufficient for safe fishing vessel transit. However, it should be considered that in adverse conditions, a fishing vessel may choose to avoid the array structures despite this minimum spacing, given that the conditions may increase the allision risk whilst within the array.

In the event of adverse conditions being forecast, fishing vessels 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. Should they deem it unsafe to transit through the wind farm based on the conditions, then they would be required to either deviate, or choose an alternate port or area of shelter (noting New Jersey associated fishing vessels north of the array would have access to New York associated ports if adverse conditions dictated the need). However, it is likely that, in most cases, the vessels would simply deviate around the array to access their preferred port without significantly increased journey times.

Additionally, historical data on tropical cyclones suggests that the likelihood of a hurricane passing in proximity to the Lease Area is low, and should such an event occur the intensity of a storm is likely to have receded by the time it reaches the array, noting that as per Section 6.3.5, the sheltered location of the Lease Area means that storm exposure is lower in the area than in areas further offshore.

12.4.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation); and
- Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on board equipment.

12.4.2.3 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, and the impact is therefore assessed to be **broadly acceptable** and within ALARP parameters.

12.4.3 Increased Vessel to Vessel Encounters and Collision Risk

12.4.3.1 Impact Description

The presence of the array may lead to commercial fishing vessels deviating around the structures therein whilst in transit resulting in an increased number of vessel to vessel encounters and consequently an increased vessel to vessel collision risk.

Displacement of fishing activity may lead to increased vessel encounters given the potential for increased vessel densities to the east and west of the array peripheries. This may lead to an increased

It should be considered that there would be no restriction on access to the array, other than through active safety zones (see Section 4 item 1). However, it is likely that fishing vessels would avoid any ongoing construction or maintenance works, with the associated deviation dependent on the destination fishing ground. As for recreational vessels, should fishing vessels deviate west (between the array and the precautionary area) there is considered to be sufficient space (approximately 4.7 nm (8.7 km)) for safe navigation given existing traffic levels. Similarly, given no obstructions to the east, there is considered to be no significant impact to safe navigation to vessels choosing such a course. Given the relatively low number of vessels expected to alter transits in this way (noting that the construction area is still accessible) there is not expected to be any notable increase in encounters or subsequent collision risk. Details of vessel numbers are contained within Section 7.2.4.5.

As per Section 9.9, vessels within or passing the array may experience some effects on marine radar, notably interfering side lobes and reflected echoes (ghost targets). However, as is detailed in Section 9.9, such effects have proved manageable at other operational wind farms, with vessels quickly adapting to the presence of the structures. No associated effect on collision risk is therefore anticipated.

Vessels involved in construction, major maintenance or decommissioning operations for the Project may also present a collision risk for commercial fishing vessels. However, as included within the assumed embedded mitigation (see Section 14) the use of marine coordination and operational procedures such as entry/exit points and designated routes (that will be charted within weekly operation notices) will manage the movement of Project vessels to ensure they do not interact negatively with third party vessels, therefore ensuring that encounters are minimized. Also, both Project vessels and third-party vessels will comply with international and flag state regulations (COLREGs) which manage safe interactions with the additional mitigation of the marine coordination center being able to dictate to Project vessels to ensure impacts on third party vessels are minimized.

12.4.3.2 Relevant Embedded Mitigation

Embedded mitigation (see Section 14 for full details) deemed relevant to increased encounters and collision risk resultant of displacement is as follows:

- Promulgation of information, ensuring fishing vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation); and
- Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on board equipment.

The following mitigations are of relevance to increased encounters and collision risk from Project vessels:

- Promulgation of information, ensuring fishing vessels are able to account for the works when passage planning;
- Compliance by vessels associated with the Project with international and flag state regulations including COLREGs and SOLAS;
- Marine coordination for vessels associated with the Project;
- Monitoring of third-party vessel traffic by AIS;
- Operational procedures for Project vessels such as entry/exit points and designated routes; and
- Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.

12.4.3.3 Impact Significance

Noting the mitigation in place including those pertinent to Project traffic management, the impact is assessed to be **broadly acceptable** and within ALARP given that the frequency of fishing vessels within close proximity to the array is considered to be low and most likely consequences will be low energy low impact (i.e., minor or no damage to vessel and no injury to persons). 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.

12.4.4 Vessel to Structure Allision Risk (Powered)

12.4.4.1 Impact Description

The presence of the array may create a risk of a commercial fishing vessel in transit while under power experiencing an allision with a structure therein.

Given there will be no restriction on fishing vessel entry into the array (with the exception of through active safety zones (see Section 4 item 1), it will be up to the vessel whether to transit the array, or deviate around it.

The quantitative assessment of fishing vessel allision risk estimated a fishing vessel would allide (or make contact) with a structure once per 169 years, noting that this is an AIS only assessment (as the format of the available non AIS data did not facilitate quantitative assessment i.e., no track data). Given the smaller size of commercial fishing vessels they are likely to be more susceptible to material damage than commercial vessels in an allision incident, however the most likely consequences would be low, with minor damage (if any) sustained by the vessel.

With regards to internal navigation and as per the Layout Rules (see Section 5), the wind farm will maintain at least one line of orientation, the wind turbines and other structures will be arranged in a regular pattern (as far as is practicable), and turbine spacing will be at least 0.65 nm (1.2 km). Furthermore, embedded mitigation includes lighting and marking of the structures, ensuring they are visible during both day and nighttime hours. These measures will ensure the layout is designed such that allision risk to fishing vessels within or near the array is ALARP.

Additionally, fishing vessels are required to comply with international and flag state regulations (COLREGs and SOLAS). Taking this into consideration, it is anticipated that fishing vessels will be able to transit the array safely from any direction and in any weather conditions.

12.4.4.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Application and use of safety zones of up to 500 m radius during construction and decommissioning (see Section 14 bullet 1);
- Implementation of Layout Rules;
- Use of a safety vessel where deemed appropriate by risk assessment; and
- Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on board equipment.

12.4.4.3 Impact Significance

Noting the Layout Rules and other embedded mitigation in place, the impact is assessed to be **broadly acceptable** and ALARP given that the most likely consequences will be low energy low impact (i.e., minor or no damage to vessel and no injury to persons). It is noted that a high consequence could occur but that the frequency of the impact (based on incident statistics and lessons learnt) mean that the risk can be considered within ALARP parameters.

12.4.5 Vessel to Structure Allision Risk (Drifting)

12.4.5.1 Impact Significance

The presence of the array may create a risk of an NUC commercial fishing vessel experiencing an allision with a structure therein.

Commercial fishing vessels transiting through or near the array may be at an increased risk of an allision incident should they become NUC. Based on the AIS data studied, commercial fishing vessel traffic intersecting the Lease Area was in the majority from vessels in transit to either New Jersey, or fishing grounds outside the Lease Area. Activity levels were considered low (less than one vessel per day). However, it should be considered that fishing vessels not broadcasting via AIS are not accounted for.

Should a fishing vessel become NUC whilst in, or near the array, it may attempt to drop anchor to avoid an allision scenario. However, it should be noted that water depths in the area may prevent such an option for smaller vessels (78 to 132 ft [23.7 to 40.2 m]).

As per the assumed embedded mitigation (see Section 14), vessels associated with the Project that are on-site in the event of a potential drifting allision incident may be able to assist in liaison with USCG and assuming it was safe to do so as per SOLAS (IMO, 1974) (e.g., by taking the NUC vessel under tow). It is also noted that any allision involving a fishing vessel is likely to be low speed and therefore low energy.

12.4.5.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Use of a safety vessel where deemed appropriate by risk assessment;
- Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation; and
- Provision of self-help capability.

12.4.5.3 Impact Significance

Given the levels of fishing vessels identified as intersecting the Lease Area and the mitigations put in place, the impact is assessed to be **broadly acceptable** and ALARP. It was considered that high consequence events (damage to vessel/structure or injury to persons) could occur but when considered against the very low frequency (low chance of engine failure combined with the high likelihood that emergency can be mitigated before a vessel allided with structure) the risk is within ALARP parameters.

12.4.6 Summary of Actively Fishing Vessels

This section provides a high-level summary of the impact assessment undertaken within Section 8.8 of the COP in relation to actively fishing commercial vessels (i.e., vessels with gear deployed).

Actively fishing vessels may be towing mobile gear (nets, dredges, lines, etc.) or dropping off/loading pots, traps, or gillnets (COP Section 8.8). Some of these fishing gears may interact with the bottom of the seafloor and others may set their gear in the middle of the water column. The COP assessment was based off available AIS, VMS, Vessel Trip Report, fisheries-dependent, and fisheries-independent data. In addition, information acquired from outreach with more than 1,000 individuals, associations, companies, and agencies from Massachusetts to Maryland added context to potential impacts and appropriate mitigation actions. Heat maps of active fishing activity by fishery management plan/gear type are provided in Section 8.8.2.2 of the COP.

12.4.6.1 Impact Significance

Construction

Although analysis on risks to actively fishing commercial fishing vessels are provided in more detail in Section 8.8 of the COP, **the primary impact exclusive to actively fishing vessels during the construction phase of the Project is snagging risk between fishing gear and partially installed structures.**

Operation and Maintenance Phase

During the operations and maintenance phase of the Project, **the primary impacts to actively fishing vessels would be the long-term loss of access to traditional fishing grounds and modification of habitat and displacement of target commercial species. These modifications may include the potential long-term positive beneficial increases in species biodiversity and abundance during operations**

12.4.6.2 Relevant Embedded Mitigation

Construction

Proposed mitigation measures to be taken during the construction phase of the Project to minimize risks to actively fishing vessels include:

- Cable route planning to avoid areas of hard or steep seabed where burial is difficult, if those areas coincide with high fishing activity;
- Where feasible, planning the location and timing of construction activities that minimize overlap with areas or times of high activity;
- Continued active engagement with the fishing industry on the timing and location of construction so that they can, where possible, elect to fish in other areas and plan accordingly; and
- A CBRA to determine sufficient burial depth along the export cable route and, where target burial depth cannot be reached, secondary protection shall be considered.

Operation and Maintenance

Proposed mitigation measures to be taken during the operations and maintenance phase of the Project to minimize risks to actively fishing vessels include:

- The Project will utilize the Layout Rules (as described in Section 5 of this NSRA and Section 3 of the COP) to achieve wind farm layouts, wind turbine spacing and lines of orientation within the array that facilitate continued access to traditional fishing grounds;
- Export and interarray cables will be buried to a target burial depth of at least 6 ft (1.8 m) where clam dredging is known to occur in order to minimize the risk of snagging;
- Following installation of the export and interarray cables, the Project will conduct cable burial surveys at appropriate intervals to assess if target burial depth is being maintained;

- To minimize risk of anchors and fishing gear snagging the submarine export cable, the export cable route has been routed to target areas where chances of burial are improved; and
- Additionally, the use of concrete mattresses as surface cable protection will be limited.

These mitigation measures exclusively aid in actively fishing vessels, and the comprehensive list of mitigation for the commercial fishing industry is provided in COP Section 8.8.

12.5 Military Vessels

For the purpose of this assessment, military vessels are assumed to be any vessel associated with a branch of the US military, namely either the USCG, United States Navy or other visiting military vessels.

12.5.1 Displacement and Collision Risk

12.5.1.1 Impact Description

The array structures and associated construction/maintenance/decommissioning activity may cause displacement and increase in collision risk to military vessels in transit or engaged in military exercise.

Based on the maritime traffic data assessed, military vessel activity is considered low within the vicinity of the Lease Area. Only limited activity was observed within both the bordering TSS lanes, and within the Lease Area itself. It is therefore considered that any displacement or collision impact to military vessels in transit will be minimal given the low vessel levels involved.

It should be noted that, as per Section 6.1.8, the Lease Area does intersect the Narragansett Bay OPAREA, where national defense training exercises and system qualification tests are undertaken by the US Navy. However, the overlapping area accounts for less than 1% of the OPAREA, and therefore no notable impact to military exercise is anticipated, and it is noted that no associated stakeholder concerns have been raised to date.

12.5.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information, ensuring military vessels are able to account for the works when passage planning;
- Marking of structures on nautical charts; and
- Lighting and marking (including via Private Aids to Navigation).

12.5.1.3 Impact Significance

Noting low levels of military activity and the embedded mitigation in place, the impact is assessed as being **broadly acceptable** and within ALARP parameters.

12.5.2 Vessel to Structure Allision Risk (Powered and Drifting)

12.5.2.1 Impact Description

The presence of the array may create a risk of a military vessel under power or NUC experiencing an allision with a structure therein.

As discussed in Section 12.5.1, military vessel levels are very low within the TSS lanes bordering the Lease Area, and an allision (both drifting and powered) is therefore considered a low frequency event.

This is demonstrated via the allision modelling, which estimated allision frequency for vessels on regular routes as one powered allision per 976 years and one drifting allision per 7,400 years assumed base case traffic levels. This includes military vessels (where such vessels were recorded on a main route). However, any associated risk will be minimal given the low vessel numbers.

12.5.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information;
- Marking of structures on nautical charts;
- Lighting and marking (including via Private Aids to Navigation);
- Application and use of safety zones of up to 500 m radius during construction and decommissioning (see Section 14 bullet 1);
- Implementation of the Layout Rules;
- Use of a safety vessel where deemed appropriate by risk assessment;
- Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation; and
- Provision of self-help capability.

12.5.2.3 Impact Significance

Noting the embedded mitigation in place, the impact is assessed as being **broadly acceptable** and within ALARP parameters.

12.6 Emergency Response Resource Capability

12.6.1 Impact Description

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

As per COMDTINST M16130.2 (USCG, 2018), each USCG sector should provide for a response time of no more than two hours, inclusive of 30 minutes of preparation time following initial notification of an incident. As was shown in Section 11.1, there are numerous active USCG stations on the New York and New Jersey coasts from which assets could be mobilized in the event of an incident. This includes USCG Air Stations located at Cape Cod and Atlantic City, and given their proximity to the Project it is likely that in the event of airborne assets being required in the event of an emergency situation, one or both of these stations would be used for mobilization.

The array itself is not considered as having the potential to delay response times to incidents offshore, given that the TSS lanes would be available for use, and there is sufficient sea room to the east or west if alternate routes were required. The Layout Rules (see Section 5) will ensure that assets (airborne or surface) would be able to find and access any incidents occurring within the array itself, or transit through if that was preferable.

Furthermore, any vessels on-site associated with the Project may be able to assist in emergency situations if required (in liaison with USCG), noting that the Project will have its own SMS in place, as per embedded mitigation (see Section 14). As per Section 11.1, a total of 922 SAR incidents were responded to by the USCG within the Study Area. This corresponds to approximately one incident every four days. However, the majority of these were coastal (and therefore unlikely to have been affected by the Project).

12.6.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation;
- Closed circuit television installed on certain structures within the array for the purpose of monitoring activity within the site;
- Implementation of the Layout Rules;
- Provision of self-help capability; and
- Facilitation of USCG SAR trials within and near the Lease Area.

12.6.3 Impact Significance

Noting the embedded mitigation in place and to the extent that the Project is able consider (i.e., publicly available information on SAR resources and incidents, information within guidance documents) the impact of Empire (OCS-A 0512) should be within ALARP parameters noting that the Project has committed to working with the USCG to develop operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation.

12.7 Anchored Vessels

12.7.1 Displacement of Anchoring

12.7.1.1 Impact Description

The installation or operational presence of the export cables may displace existing anchoring activity.

As observed in Section 7.4.3, the busiest areas in terms of anchoring are the preferred unofficial anchorage area to the north of the Nantucket to Ambrose TSS lane (the USCG Proposed Ambrose Anchorage (86 Fed. Reg. 17090), see Section 6.1.7), and the charted anchorage within Gravesend Bay. 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.

The majority of anchoring identified occurred within the preferred unofficial anchorage area to the north of the Nantucket to Ambrose TSS lane. However, the cables do not come within 2 nm (3.7 km) of this activity.

High levels of anchoring were also recorded within the charted anchorage in Gravesend Bay, and it should also be considered that anchoring was prevalent north of the Verrazzano-Narrows Bridge. However, this activity has not been quantitatively identified or assessed given the scope of the NSRA. The potential levels of displacement and the required mitigation will instead be considered further in a cable burial risk assessment (as per Section 14), including the required burial depths and any need for additional external protection.

Details of the installation works will be promulgated in advance to stakeholders including the USCG and Port of NY/NJ to ensure any disruption is minimal.

With regards to the Lease Area, it is considered highly unlikely that a vessel would anchor within the array once operational, noting the subsea and surface infrastructure. However, given very low levels of anchoring observed within the Lease Area during the baseline surveys, there is considered to be negligible impact in terms of anchoring displacement from the array. The potential impact for anchoring within or in the vicinity of the array is therefore assessed to be negligible and within ALARP parameters given the limited displacement and available sea room.

As noted above, within port and harbor limits, impacts on anchoring is more complex and therefore will require further consultation (including harbor representatives and the U.S. Army Corps of Engineers) and a detailed analysis as part of a cable burial risk assessment. This will be able to demonstrate what mitigations (such as burial depth) are required to ensure anchoring options are available to vessels and the risk remains ALARP.

12.7.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Cable burial risk assessment;
- Cable Installation Plan;
- Information will be provided to NOAA so that charts (nautical and electronic) can be updated with the location of applicable Project infrastructure;
- Ongoing consultation and stakeholder engagement, particularly in relation to the export cable(s); and
- Periodic monitoring of cable burial and protection measures.

12.7.1.3 Impact Significance

When considering both the Lease Area and export cable this impact is considered to be **tolerable with mitigation** given the potential for anchored vessels to be displaced, noting 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.

12.7.2 Interaction with Subsea Installations (including cables)

12.7.2.1 Impact Description

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

There is potential that a vessel may interact with the subsea structures or export cables via its anchor, for example in one of the following scenarios:

- A vessel deliberately drops anchor over the cables in an emergency including within the precautionary area during sensitive operations;
- 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 negligently, 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 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 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 12.7.1, the busiest area in proximity to the cables in terms of anchoring is the charted anchorage within Gravesend Bay. This area will therefore be at the highest exposure to vessel anchors, and at the greatest risk of contact. As per Section 14, the locations and levels of anchoring activity will be taken into account when defining the necessary cable protection. Burial will form the primary method of protection were feasible, with additional external protection utilized where target depths cannot be met. Furthermore, the cable protection will be monitored periodically to ensure it remains effective.

Cable burial depths and anchoring within proximity to known charted anchorages and within port/harbor limits shall be assessed within the cable burial risk assessment (as per Section 14) and this will require additional consultation with the U.S. Army Corps of Engineers and the USCG.

Exposed sections of cable may exist in areas where burial depth may not have been achieved (e.g., asset crossing), prior to the installation of cable protection. This will be addressed in the cable installation plan and cable burial risk assessment, prior to installation (see Section 14).

Given very low levels of anchoring observed within the Lease Area, and noting that no foundation types under consideration include mooring/anchor lines, good seamanship will ensure that vessels maintain safe distances when anchoring. Therefore, the potential for interaction with structures, including J-tubes[28] or other types of cable connection points is considered negligible.

12.7.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Cable burial risk assessment;
- Information will be provided to NOAA so that charts (nautical and electronic) can be updated with the location of applicable Project infrastructure;
- Ongoing consultation and stakeholder engagement, particularly in relation to the export cable(s); and
- Periodic monitoring of cable burial and protection measures.

12.7.2.3 Impact Significance

Given that the export cable routes do run in close proximity to a number of chartered and preferred anchorages, the impact is assessed to be **Tolerable with Mitigation** when considering both the Lease Area and export cable combined however this 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.

[28] A tube which is external to the main body of a foundation and allows an entry point for cables into the internal connection points.

12.8 Ports

12.8.1 Access Disruption – Project Vessels

12.8.1.1 Impact Description

During the construction and decommissioning phases there may be restricted access[29] at those ports being used for operations relating to the development.

The key port facilities in the area are considered to be those associated with the Port of NY/NJ, with the primary access point being the precautionary area upon which the TSS lanes converge. Given that navigation for deeper drafted vessels is restricted to the dredged channels within the precautionary area, increased levels of Project associated vessels may lead to disruption within these channels and the precautionary area, affecting access to the port facilities.

Levels of construction vessel traffic will depend on the construction scenario 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.

During operation, vessel activity will be reduced over that of the construction phase, with activity limited in the majority to Service Operation Vessels (SOV) working within the array on between two and four-week cycles, and CTVs. Larger vessels may be required during periods of maintenance. However, such activity would be temporary.

Throughout all phases, Project vessel movements would be managed via a central marine coordination center, which will be responsible for ensuring such movements comply with the International and Inland Navigation Rules at all times, and create minimal disruption (as far as is feasible) to third party traffic. Furthermore, Project details including vessel transit routes and array exit/entry points will be promulgated in advance to the key stakeholders, notably the relevant ports, USCG VTS NY, and appropriate USCG Sector and District individuals. These routes and exit/entry points will be defined in consultation with the key stakeholders, notably the relevant ports, New York Harbor VTS and the USCG.

12.8.1.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Compliance by vessels associated with the Project with international and flag state regulations including COLREGs and SOLAS;
- Marine coordination for vessels associated with the Project;
- Operational procedures for Project vessels such as entry/exit points and designated routes;
- Promulgation of information; and

[29] Access to the ports is prevented by the placement of structures i.e., a physical restriction.

- Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.

12.8.1.3 Impact Significance

The impact is assessed to be **broadly acceptable** and within ALARP parameters with the above mitigations in place noting that outside of component movements which will need further consultation with the Port there are not expected to any impacts on vessel movements within the study area and port operations.

12.8.2 Access Disruption – Cable Installation

12.8.2.1 Impact Description

The installation, maintenance, or decommissioning of the export cables may lead to disruption to port associated traffic.

Given the close proximity of the export cable routes to certain dredged channels, the construction, maintenance, or decommissioning activity associated with the cables may cause disruption to third party vessels utilizing the channels. In particular, it should be considered that deeper drafted vessels are restricted to the channels given surrounding water depths, and that overall navigable width falls to less than 1 nm (1.9 km) between Upper and Lower Bay, an area through which a proposed export cable route runs. This will be considered within the Cable Installation Plan (see Section 14), which will ensure any disruption is minimal.

The area affected by cable installation would be limited geographically as the associated vessels move along the export cable route, and temporary in nature. Furthermore, the activity will be promulgated in advance, and the cable burial risk assessment and Cable Installation Plan will be undertaken in consultation with U.S. Army Corps of Engineering and the USCG.

12.8.2.2 Relevant Embedded Mitigation

Relevant embedded mitigation (see Section 14 for full details) is as follows:

- Promulgation of information;
- Cable burial risk assessment;
- Cable Installation Plan;
- Information will be provided to NOAA so that charts (nautical and electronic) can be updated with the location of applicable Project infrastructure;
- Ongoing consultation and stakeholder engagement, particularly in relation to the export cable(s); and
- Periodic monitoring of cable burial and protection measures.

12.8.2.3 Impact Significance

Given that the Cable Installation Plan and ongoing consultation will detail how cable installation will be managed within port/harbor limits, the impact is assessed to be **Tolerable**

with Mitigation; noting the associated mitigations require extensive planning and promulgation of information. It is noted that the presence of installation activities will be of a short term duration and once buried in line with the outputs of the Cable Burial Risk Assessments will not impact the movement of vessel in and out of the port outside of maintenance activities.

13 Cumulative Impact Assessment

13.1 Deviations

The presence of wind farms at the cumulative level may lead to vessels deviating around the arrays resulting in increased journey times and distances.

The cumulative routing assessment (Section 10.4) indicated that vessels on routes approaching New York from the south may be required to deviate to avoid the US Wind and Ocean Wind sites off New Jersey. Deeper drafted vessels are likely to pass offshore of these sites given limited water depths. However, shallower drafted vessels or vessels with limited weather capability (i.e., recreational) could pass inshore if they chose to. None of these routes are affected by the Project, given that they all either utilize coastal transit, or one of the TSS lanes converging on the precautionary area.

The effect of the now executed New York Bight Lease Areas (auctioned during the Feb 23, 2022 New York Bight Wind Sale) on cumulative routing was also considered, albeit not on a quantitative basis given lower data confidence at this stage. These Lease Areas do not infringe on the TSS lanes or fairways proposed under the NNYBPARS (USCG, 2021) and therefore would not affect the associated traffic. However, vessels on north east / south west transits either through or east of the Empire OCS-A 0512 site may be required to deviate further east.

Given the limited effect of the Project on routing when considered against the higher tiered cumulative projects, the impact is assessed to be **broadly acceptable** and ALARP.

13.2 Increased Vessel to Vessel Encounters and Collision Risk

The presence of wind farms at the cumulative level may lead to increased encounters and hence collision risk.

Of the projects considered on a cumulative level, the only wind farms anticipated as having the potential to increase encounter levels when considered with the Project are the New York Bight Call Areas. It is possible that vessel numbers within the existing TSS lanes may increase during or following construction of the Projects. Similarly, vessels on north east / south west transits (and therefore outside of the TSS lanes) may be pushed into a smaller area, noting plans for an application for an IMO adopted routing measure for such transits as raised by the USCG during consultation (see Section 3). Therefore, the existing (and potential) TSS lanes and routing measures are considered to be the most likely areas within which encounter rates will increase.

However, given the existing vessel numbers in the TSS lanes and on north east / south west transits through or east of the site, any encounter rate increase is not anticipated to lead to a significant increase in collision rates.

Assuming that vessels will comply with applicable international and flag state regulations, the effect is not considered to be significant. Therefore, the impact is assessed to be **broadly acceptable** and ALARP.

13.3 Powered and Drifting Vessel to Structure Allision Risk

Of the projects considered on a cumulative level, the only wind farms anticipated as having the potential to increase allision risk when considered with the Project are the New York Bight Call Areas. However, the level to which allision risk will increase will depend on the build out scenarios and therefore cannot be assessed at this stage.

As per the Layout Rules (see specifically Section 5.2.5), Empire is maintaining a 1 nm (1.9 km) separation distance between the TSS lanes and the wind warm periphery, with the periphery structures in straight line edges parallel to the lanes (i.e., no isolated or protruding turbines). This will ensure the allision risk associated with the array including at a cumulative level are minimized.

Other mitigations (as per Section 14) including lighting and marking (including AtoN), promulgation of information and compliance with applicable international and flag state regulations will also be in place.

Therefore, the impact is assessed to be **broadly acceptable** and ALARP.

14 Mitigations

As referenced throughout Section 12 and 13, there are a variety of embedded mitigation measures which have been assumed within the impact assessment undertaken within this NSRA to bring impacts to ALARP parameters.

These measures are as summarized below for ease of reference and completeness:

1. Application and use of safety zones of up to 1,640 ft (500 m) radius during construction and decommissioning. During construction, Empire proposes to utilize 1,640-ft (500-m) safety zones around relevant structures, activities, and vessels in a dynamic approach, as previously defined for the Block Island Wind Farm (81 FR 31862). Should USCG safety zone authorities not extend beyond 12 nm (22.2 km) at the time of construction, Empire will utilize a combination of safety vessels, LNMs, and COLREGs to promote both awareness of activities and ensure the safety of the construction equipment and personnel, as well as third party users.
2. Cable burial risk assessment undertaken prior to the commencement of construction taking into account locations of existing anchoring and fishing activity. This should also include further consultation with stakeholders most notably USCG, New York VTS, Port of NY/NJ, Harbor Operations Committee and the U.S. Army Corps of Engineers;
3. Cable Installation Plan, detailing how cable installation will be managed to ensure disruption is minimized, in particular within port approaches;
4. Closed circuit television installed on certain structures within the array for the purpose of monitoring activity within the site;
5. Information will be provided to NOAA so that charts (nautical and electronic) can be updated with the location of applicable Project infrastructure;
6. Compliance by vessels associated with the Project with international and flag state regulations including COLREGs and SOLAS;
7. Implementation of the Layout Rules (see Section 5) during layout design process, most notably:
    a. 1 nm (1.9 km) separation between wind farm and TSS lanes
    b. Straight line edges parallel to TSS lanes (no isolated or protruding turbines)
    c. At least one line of orientation in final layout
8. Creation and implementation of a SMS (Appendix G);
9. Facilitation of USCG SAR trials within and near the Lease Area;
10. Lighting and marking of the array in compliance with relevant guidance including FAA Advisory Circular 70/7460-1L (FAA, 2018), BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (2021), and International Association of Marine Aids (IALA) to Navigation and Lighthouse Authorities Recommendation O-139 on The Marking of Man-Made Offshore Structures (IALA 2013);
11. Locations of the wind farm structures will be provided directly to fishermen for the purpose of displaying the wind farm electronically via their on-board equipment;

12. Marine coordination for vessels associated with the Project (i.e., a central coordination hub from which all Project vessel movements will be managed, and third-party traffic will be monitored, see Section 4.4);
13. Marine pollution contingency planning (e.g., Oil Spill Response Plan, Appendix F);
14. Minimum blade clearance of 85 ft (26 m) above MHHW;
15. Minimum advisory safe passing distances for cable laying vessels (where feasible);
16. Monitoring of third-party vessel traffic by AIS during the construction and decommissioning phases;
17. Ongoing consultation and stakeholder engagement, particularly in relation to the export cable(s);
18. Operational procedures for Project vessels such as entry/exit points and designated routes;
19. Operational SAR Procedures in place that detail how the Project will cooperate with USCG in the event of an emergency situation;
20. Periodic monitoring of cable burial and protection measures to ensure they remain effective, with regular monitoring of protection in vicinity of areas of existing anchoring as identified within the cable burial risk assessment;
21. Promulgation of information via Notice to Mariners and other appropriate means;
22. Provision of self-help capability (i.e., any onshore or vessel/turbine-based resources or facilities available to Empire that may assist in the event of an emergency);
23. Completion of a Construction Method Statement, detailing specific construction logistics between New York ports and the Lease Area, inclusive of transport configuration, vessels, and schedule of transport operations.
24. Use of a safety vessel[30] during the construction and decommissioning phases where deemed appropriate by risk assessment;
25. Use of Private Aids to Navigation during the construction, operation and decommissioning phases to mark the working or Lease Area (based on risk assessment of need); and
26. Empire will include a requirement in contracts that all construction vessels be equipped with working AIS transceivers at all times.

[30] Note these safety vessels will have no law enforcement authority and will contact USCG on VHF-CH 16 if necessary.

15 Conclusion

This NSRA has assessed the impact of the major hazards associated with the development of the Project based upon waterway, maritime traffic and vessel and facility characteristics as well as key responses received during consultation with stakeholders, lessons learned from trials and existing offshore wind farm developments and collision and allision risk modelling.

Table 15.1 summarizes the potential impacts identified for shipping and navigation which were assessed within the NSRA. Other impacts, such as those relating to navigation and communication position fixing equipment, and tropical cyclones and ice which were not deemed significant enough to be carried forward to the impact assessment have not been included in Table 15.1.

It can be seen that with embedded mitigation in place, all impacts have been considered to be within at most **tolerable with mitigation** limits. As per the definitions given in Section 2.1, each impact is therefore within ALARP parameters.

Table 15-1 Summary of potential impacts identified for shipping and navigation

User	Impact	ALARP Risk Level	Key Embedded Mitigation	Additional Mitigation
Commercial vessels	Deviations	Broadly Acceptable	Compliance with COLREGs and SOLAS, promulgation of information.	n/a
	Increased vessel to vessel encounters and collision risk	Broadly Acceptable	Compliance with COLREGs and SOLAS.	n/a
	Powered vessel to structure allision risk	Tolerable with Embedded Mitigation	Construction and decommissioning buoyage, promulgation of information, lighting and marking of array and compliance with Layout Rules.	n/a
	Drifting vessel to structure allision risk	Broadly Acceptable	Provision of self-help capability, compliance with Layout Rules.	n/a
Commercial fishing vessels	Deviations	Broadly Acceptable	Compliance with COLREGs and SOLAS, promulgation of information.	n/a

User	Impact	ALARP Risk Level	Key Embedded Mitigation	Additional Mitigation
	Increased vessel to vessel encounters and collision risk	Broadly Acceptable	Compliance with COLREGs and SOLAS where applicable, advisory minimum safe passing distance for cable laying vessels.	n/a
	Powered vessel to structure allision risk	Broadly Acceptable	Construction and decommissioning buoyage, lighting and marking of array and coordination with other offshore wind farm developments in the region, promulgation of information, compliance with COLREGs and SOLAS where applicable, compliance with Layout Rules.	n/a
	Drifting vessel to structure allision risk	Broadly Acceptable	Provision of self-help capability, compliance with COLREGs and SOLAS where applicable, compliance with Layout Rules.	n/a
Recreational vessels	Deviations	Negligible (no impact)	Compliance with COLREGs and SOLAS.	n/a
	Increased vessel to vessel encounters and collision risk	Broadly Acceptable	Compliance with COLREGs and SOLAS. Advisory minimum safe passing distance for cable laying vessels.	n/a
	Powered vessel to structure allision risk	Broadly Acceptable	Minimum blade clearance of 85ft (26m) above MHHW, lighting and marking of array and coordination with other offshore wind farm developments in the region, promulgation of information, compliance with COLREGs and SOLAS.	n/a

User	Impact	ALARP Risk Level	Key Embedded Mitigation	Additional Mitigation
	Drifting vessel to structure allision risk	Broadly Acceptable	Provision of self-help capability, minimum blade clearance of 85 ft (26 m) above MHHW, compliance with COLREGs.	n/a
Military Vessels	Displacement and Collision Risk	Broadly Acceptable	Compliance with COLREGs and SOLAS.	n/a
	Vessel to structure allision risk (powered and drifting)	Broadly Acceptable	Construction and decommissioning buoyage, promulgation of information, lighting and marking of array and coordination with other offshore wind farm developments in the region, compliance with Layout Rules, provision of self-help.	n/a
	Emergency Response Resource Capability	Broadly Acceptable	Provision of self-help capability, creation and implementation of an SMS, marine pollution contingency planning, Layout Rules (those relevant to SAR).	n/a
Anchored vessels	Displacement of Anchoring Activity	Tolerable with Embedded Mitigation	Cable burial risk assessment undertaken prior to construction and periodic monitoring of protection measures, promulgation of information and consultation with stakeholders.	Cable burial risk assessment may identify additional mitigations required.

User	Impact	ALARP Risk Level	Key Embedded Mitigation	Additional Mitigation
	Anchor snagging	Tolerable with Embedded Mitigation	Cable burial risk assessment undertaken prior to construction and periodic monitoring of protection measures, use of a guard vessel during construction and decommissioning when deemed appropriate, promulgation of information, charting of infrastructure on relevant nautical and electronic charts and consultation with stakeholders.	Cable burial risk assessment may identify additional mitigations required as well as a target burial depth.
Ports	Restricted port access[31] by increased levels of Project Vessels	Broadly Acceptable	Marine pollution contingency planning, promulgation of information.	n/a
	Restricted port access[29] by Cable Installation	Tolerable with Embedded Mitigation	Promulgation of information and marine coordination	Cable burial risk assessment may identify additional mitigations required.
All users (cumulative)	Deviations	Broadly Acceptable	Compliance with COLREGs and SOLAS.	n/a
	Increased vessel to vessel encounters and collision risk	Broadly Acceptable	Compliance with COLREGs and SOLAS.	n/a
	Vessel to structure allision risk (powered and drifting)	Broadly Acceptable	Construction and decommissioning buoyage, lighting and marking of array and coordination with other offshore wind farm developments in the region, promulgation of information, compliance with COLREGs and SOLAS, provision of self-help capability, compliance with Layout rules.	n/a

[31] Restricted port access: some aspect of the Project hindering third party vessels ability to access a port.

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Attachment A Consequences

This appendix 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, based on the quantitative assessment of allision and collision risk undertaken within the NSRA.

It is noted that the quantitative assessment within this appendix is based on the allision and collision modelling undertaken in Section 10 of the NSRA, and therefore only considers AIS traffic (as the format of the available non-AIS data did not facilitate quantitative assessment). Impacts to non AIS traffic are considered within the NSRA on a qualitative basis in Sections 12.3 (recreational vessels) and 12.4 (fishing vessels).

A.1 Risk Evaluation Criteria

A.1.1 Risk to People

With regard to the assessment of risk to people two measures are considered, namely:

- Individual risk; and
- Societal risk.

A.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 A.1, which also includes the upper and lower bounds for risk acceptance criteria as suggested in IMO Maritime Safety Committee (MSC) 72/16 (IMO, 2000). The annual individual risk to crew falls within the ALARP region for each of the vessel types presented.

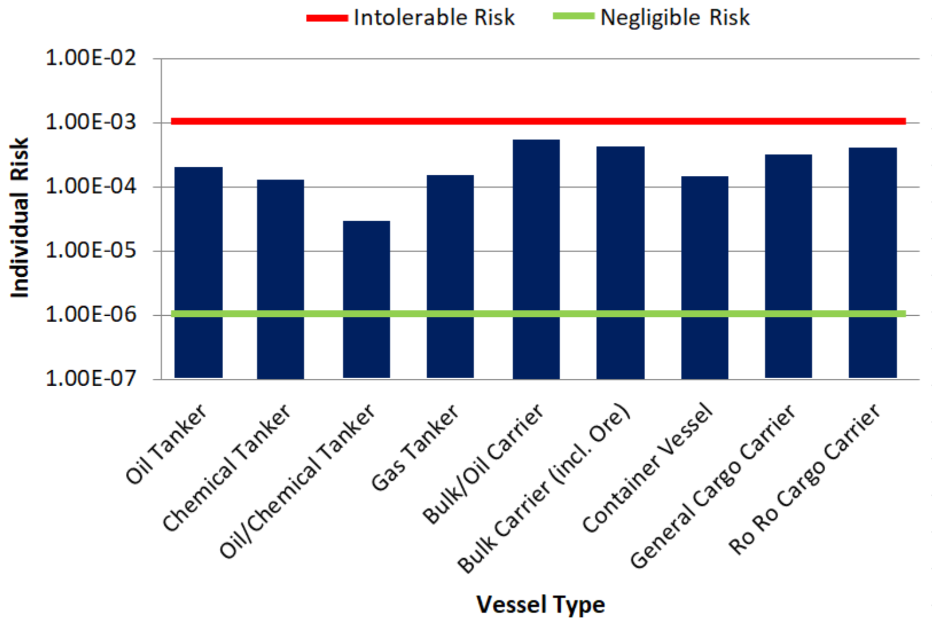

Figure A.1 Individual risk levels and acceptance criteria per vessel type (IMO, 2000)

Typical bounds defining the ALARP regions for RBDM within shipping are presented in Table A.1.

Table A.1 Individual risk ALARP criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
Crew member	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

A.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.

A.1.4 Risk to 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.

A.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.

A.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 (22.2 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, harbour authorities and inland waterway authorities also have a duty to report accidents to the MAIB. Therefore, whilst 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, a total of 13,374 accidents, injuries and hazardous incidents were reported to the MAIB between 1994 and 2014 involving 15,212 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 A.2, color-coded by incident type. This attachment uses this data, and in particular the data for collision and allision incidents to determine the fatality probability for different vessel categories.

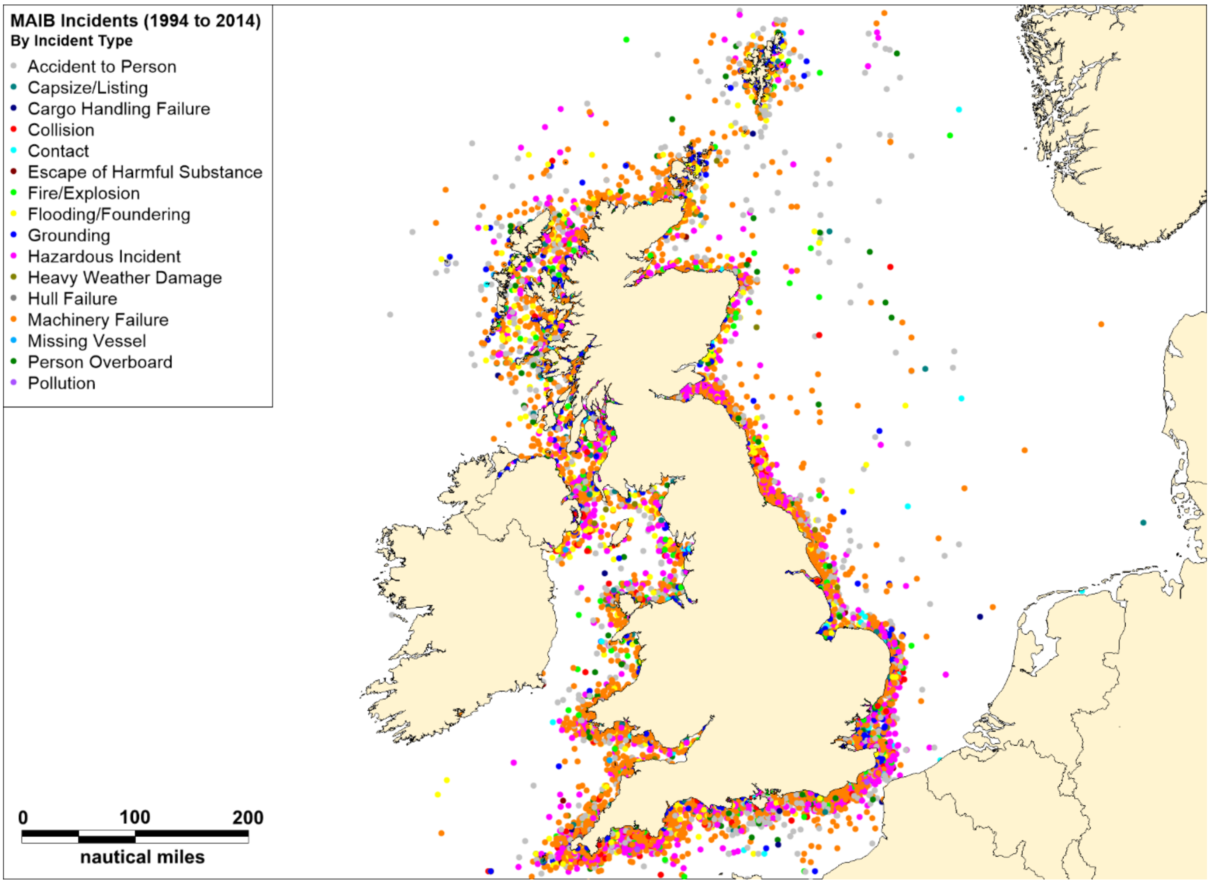

Figure A.2 MAIB Incident Locations by Incident Type (1994 to 2014)

A.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 probability has 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 A.1.

Table A.2 MAIB fatality probability per collision per vessel category[32]

Vessel Category	Subcategories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	1	9.718	1.0×10^{-4}
Fishing	Trawler, potter, dredger, etc.	1	708	1.4×10^{-3}
Pleasure craft	Yacht, small commercial motor vessel, etc.	2	2,540	7.9×10^{-4}

It can be seen that the risk is up to one order of magnitude higher for people onboard small craft compared to larger commercial vessels.

A.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 A.3. Background into the methodology by which these values were calculated is provided in Section 10 of the NSRA.

Table A.3 Summary of Annual Collision and Allision Frequency Results

Scenario	Base Case (0% Traffic Increase)			Future Case (10% Traffic Increase)		
	Pre Wind Farm	Post Wind Farm	Change	No Wind Farm	Post Wind Farm	Change
Collision	7.31×10^{-3} (137 years)	7.31×10^{-3} (137 years)	0	8.80×10^{-3} (114 years)	8.80×10^{-3} (114 years)	0
Powered allision	0	1.02×10^{-3} (976 years)	1.02×10^{-3}	0	1.13×10^{-3} (888 years)	1.13×10^{-3}
Drifting allision	0	1.36×10^{-4} (7,400 years)	1.36×10^{-4}	0	1.50×10^{-4} (6,700 years)	1.50×10^{-4}
Fishing Allision	0	5.93×10^{-3} (169 years)	5.93×10^{-3}	0	6.53×10^{-3} (153 years)	6.53×10^{-3}
Total	**7.31×10^{-3} (137 years)**	**1.44×10^{-2} (69 years)**	**7.09×10^{-3}**	**8.80×10^{-3} (114 years)**	**1.66×10^{-2} (60 years)**	**7.80×10^{-3}**

Table A.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 marine traffic data, given that this information is readily available for the majority of passenger vessels. POB

[32] Note this data has been used for the purpose of calibrating Anatec's collision and allision models. The data is UK based. However, it is considered as being representative of worldwide incident rates, and therefore fit for the purposes of model calibrations within this NSRA.

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 A.4 Vessel types, incidents and average number of POB

Vessel Type	Collision/Allision Incidents	Average Numbers of POB
Cargo/freight	▪ Vessel to vessel collision; ▪ Powered vessel to structure allision; and ▪ Drifting vessel to structure allision.	15
Tanker		20
Passenger		2,400
Fishing vessel		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 development for the base (0% increase in traffic) and future (10% increase in traffic) cases are presented in Figure A.3.

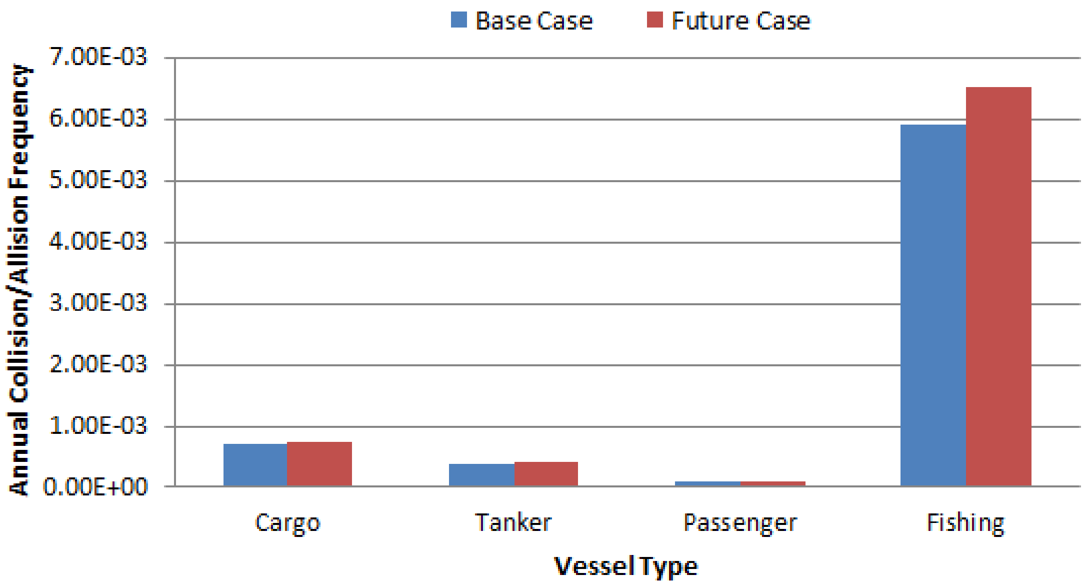

Figure A.3 Change in annual collision and allision frequency by vessel type

The majority of change in allision and collision risk is associated with fishing vessels, which accounted for approximately 80% of the overall change. This was due to the allision risk to fishing vessels within the array, which (as per Section 10.3.4) was estimated at one allision per 169 years. It is important to note that this represents one "contact" incident per 169 years, which will most likely be low impact / low consequence.

Combining the annual collision and allision frequency (Table A.3), estimated POB each vessel type (Table A.4) and the estimated fatality probability for each vessel category (Table A.2), the annual increase in PLL due to the impact of the development for the base case is approximately 4.69×10^{-5}, which equates to one additional fatality in approximately 21,300 years. The annual increase in PLL due to the impact of the development for the future case is estimated to be approximately 5.17×10^{-5}, which equates to one additional fatality in approximately 19,400 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 A.4.

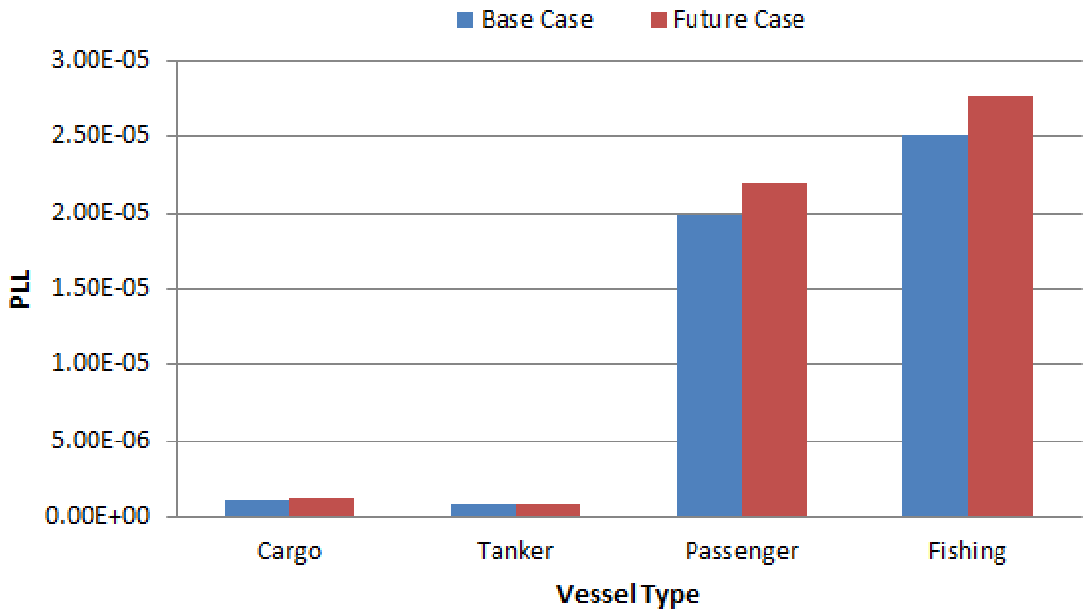

Figure A.4 Estimated change in Annual PLL by Vessel Type

The majority of increase in PLL was observed to be associated with fishing vessels, which accounted for approximately 54% of the total, which is reflective of the change in allision risk to these vessels. It is noted that while fishing vessels accounted for the majority of the total change, the actual change in PLL for fishing vessels is still low (an additional one in 40,000 years).

Passenger vessels accounted for approximately 42% of the total, which is due to the high levels of POB of passenger vessels within the TSS lanes when compared against the other vessel types considered.

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 A.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.

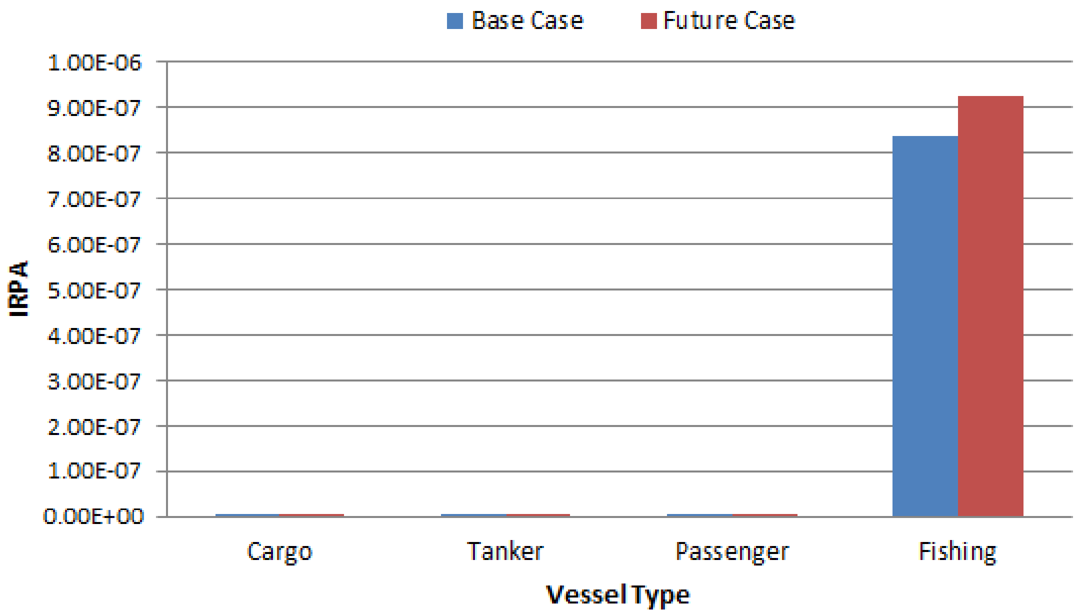

Figure A.5 Estimated Change in Individual Risk by Vessel Type

IRPA was observed to be greatest to fishing vessels, which is reflective of the change in allision risk and small number of crew exposed (based on POB) when compared to the other vessel types (in particular passenger vessels). However, while IRPA was greatest to fishing vessels, the actual IRPA magnitude was still low (estimated at 8.38×10^{-7} for fishing vessels assuming base case traffic levels).

A.2.4 Significance of Increase in Fatality Risk

The overall increases in PLL and individual risk for the future-case are summarized in Table A.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.

Table A.5 Summary of Fatality Risk for Future Case

Fatality Risk	Change in Frequency
PLL	4.69×10^{-5} (0.0000469)
Individual risk	8.50×10^{-7} (0.000000850)

Each of these changes in frequency is considered very low and indicates that the increase in fatality risk resulting from the development is not significant.

A.3 Pollution Risk

A.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 (DfT) Marine Environmental High Risk Areas (MEHRA) project (DfT, 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 A.6.

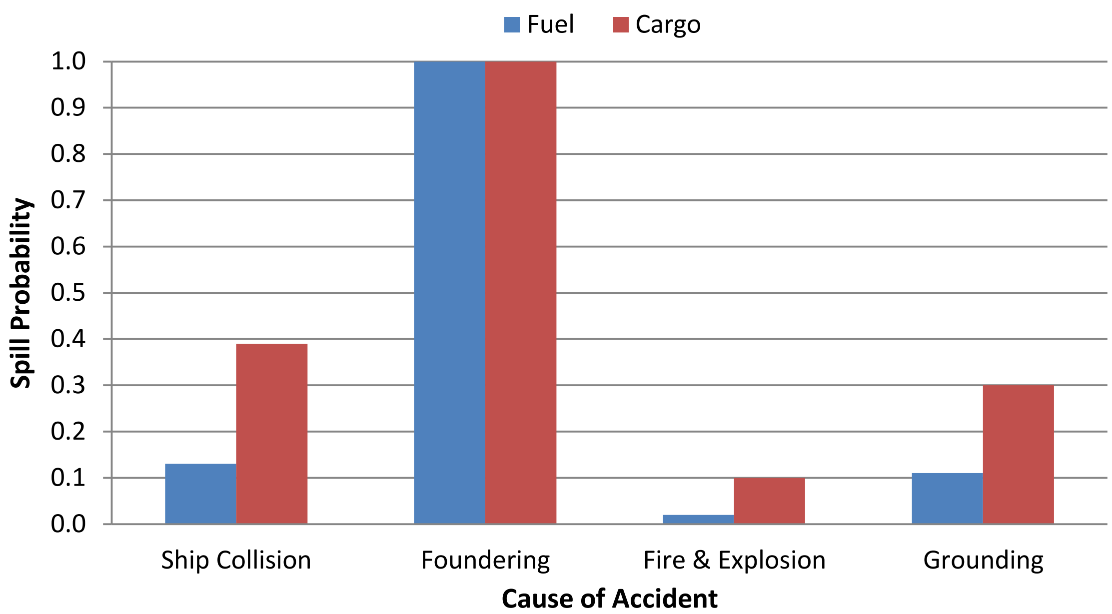

Figure A.6 Probability of an oil spill resulting from an accident

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 (ITOPF) 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).

A.3.2 Pollution Risk due to the Project

Applying the probabilities from Section A.3.1 to the annual collision and allision frequency by vessel type presented in Table A.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 25 gallons per year for the base case and approximately 28 gallons per year for the future case.

The estimated increase in gallons of oil spilled distributed by vessel type for the base and future case are presented in Figure A.7.

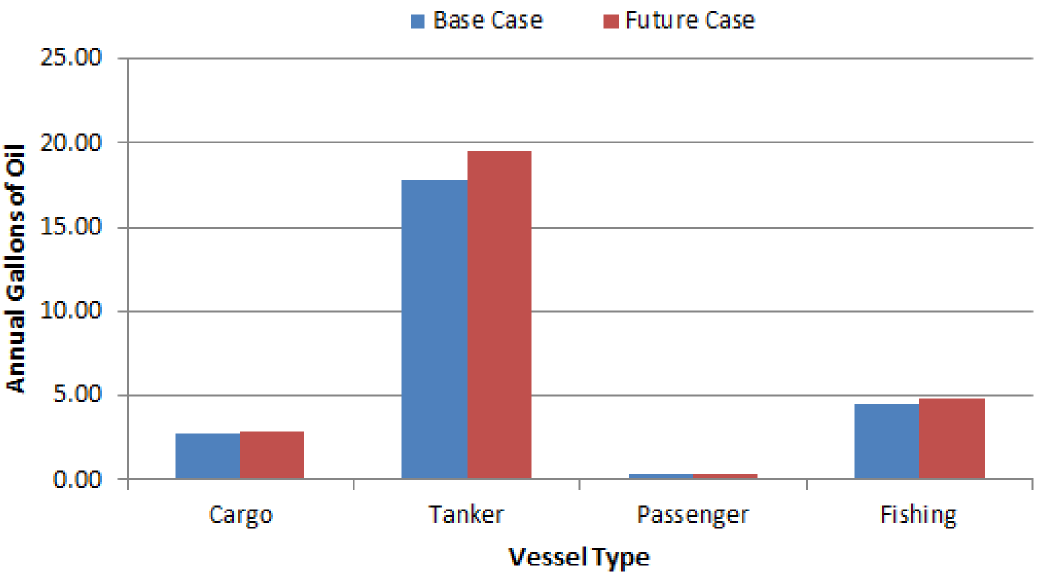

Figure A.7 Estimated change in pollution by vessel type

The majority of increase in oil spilled was observed to be associated with tankers (approximately 70%). This was due to the allision risk to tanker traffic within the TSS lanes combined with the estimated spill volumes and probability being higher than that of the other vessel types considered.

A.3.3 Significance of Increase in Pollution Risk

Based upon data available from the BTS (BTS, 2018), the annual average volume of petroleum oil spilled from all vessels impacting navigable US waterways between 1995 and 2016 was approximately 629,000 gallons. During this period there were 2,885 oil spill incidents reported.

The overall change in pollution estimated due to the Project (approximately 25 gallons per year for the future case) represents a negligible increase in the total annual average gallons of oil spilled which impact navigable US waterways. This indicates that the increase in pollution risk resulting from the development is not significant.

Attachment B NVIC Checklist

As noted in Section 1.2, NVIC 01-19 provides guidance on information and factors USCG will consider when reviewing an application for a permit to build and operate an OREI in US navigable waters. Table B.1 presents a summary of the information and analysis which NVIC 01-19 requires and where it has been covered within this NSRA, or a description as to how/ where addressed if outside of the NSRA.

Table B.1 NVIC Checklist

Issue	Yes/ No	Comments
1. Site and installation coordinates		
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	12 months of AIS data (August 2017 to July 2018) has been assessed, and the NSRA was submitted in early 2019.
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 7. Detailed analysis of the main vessel types is provided in Section 7.2.4
Is the time period of the survey at least 28 days duration?	Yes	A year of data has been assessed as per Section 7.1.
Does the survey include consultation with recreational vessel organizations?	Yes	Consultation with recreational representatives has been undertaken and is summarized in Section 8.8 of the COP.
Does the survey include consultation with fishing vessel organizations?	Yes	Consultation with fishing representatives has been undertaken and is summarized in Section 8.8 of the COP.
Does the survey include consultation with pilot organizations?	Yes	Sandy Hook Pilots have been consulted with as per Section 1.2.4.

Issue	Yes/ No	Comments
Does the survey include consultation with commercial vessel organizations?	Yes	Consultation has been undertaken with the AWO, WSC, and CSA with key points summarized in Section 3.1. Regular operators of the area were also given opportunity to comment as per Section 3.2.
Does the survey include consultation with port authorities?	Yes	Consultation has been undertaken with the PANYNJ with key points summarized in Section 3.1.
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 / or Offshore Export Cable Route Corridor throughout Section 7.
Does the survey include numbers, types, sizes and other characteristics of vessels presently using such areas?	Yes	Vessel numbers are assessed within Section 7.2.1, sizes in Section 7.2.2, and types in Section 7.2.4.
Does the survey include types of cargo carried by vessels presently using such areas?	Yes	Section 7.2.4.2 provides assessment of commercial vessels (i.e., cargo and tanker). This includes vessel sub-category breakdowns by cargo type.
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	Recreational vessels are assessed within Section 7.2.4.6, and fishing vessels within Section 7.2.4.5. 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), noting that a high level summary has been provided in Section 12.4.6 of this NSRA.
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 7.2.2.2, and commercial vessel routing is assessed within Section 7.2.6. Fishing vessel activity is assessed within Section 7.2.4.5.
Does the survey include alignment and proximity of the site relative to adjacent shipping routes?	Yes	Commercial vessel routing is assessed within Section 7.2.6.
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 6.1.1.
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 6.1.1.

Issue	Yes/ No	Comments
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 6.1.
Does the survey include the feasibility of allowing vessels to anchor within the vicinity of the structure field?	Yes	Impacts on anchored vessels are assessed in Section 12.7.
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 7.2.4.5, noting that additional assessment is available within Section 8.8 of the COP.
Does the survey include whether the site lies within the limits of jurisdiction of a port and/or navigation authority?	Yes	See Section 6.1.2.
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	Military areas of relevance are presented in Section 6.1.8.
Does the survey include the proximity of the site to existing or proposed offshore OREI/gas platform or marine aggregate mining?	Yes	No relevant marine aggregate mining or oil and gas platforms have been identified, noting that dumping areas are shown in Section 6.1.6.
Does the survey include the proximity of the site to existing or proposed structure developments?	Yes	A cumulative overview is provided in Section 2.3.1, with associated assessment in Sections 10.5 and 13.
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	Relevant dumping / disposal areas are shown in Section 6.1.6.
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	See Section 6.1.2 for VTS and Section 6.1.5 for AtoNs. Associated assessment is available in Sections 12.8 for VTS and 9.12 for AtoNs.
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	Assessment of potential changes in encounter rates (based on computer simulation) is provided in Section 10.3.1.
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 7.5.4.

Issue	Yes/ No	Comments
Does the survey include seasonal variations in traffic?	Yes	A year of data has been assessed as per Section 7.1, and as such is considered to capture seasonal variations.
3. Offshore above water structure		
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 surface structures (allision risk) and cables (underwater snagging or contact risk) have been assessed for relevant vessel types in Section 12. The WTG blade clearance has been considered in the assessment of allision risk to recreational vessels in Sections 12.3.3 and 12.3.4. The burial depth of cables has been considered in the assessment of underwater snagging or contact risk in Section 12.7.2. As per Section 4.2.2, floating foundations are not under consideration.
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 WTG blade clearance has been considered in the assessment of allision risk to recreational vessels in Sections 12.3.3 and 12.3.4. No characteristics of individual structures have been identified as potentially affecting navigational safety in relation to USCG missions, noting that as per Section 14, operational SAR Procedures that detail how the Project will cooperate with USCG in the event of an emergency situation will be discussed and agreed with the USCG.
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 considered in Section 12.6, noting that operational SAR Procedures that detail how the Project will cooperate with USCG in the event of an emergency situation will be discussed and agreed with the USCG.
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	WTG shut down procedures have been outlined in Section 8.1. 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 9.11.

Issue	Yes/ No	Comments
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 is considered in Section 10.4.2. Additionally, Equinor is undertaking foundation allision assessments.
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 10.3.5.
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 10.3.5.
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% 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 10.3.5., 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 Section 12. 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 10.3.3.
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 considered within Section 10.3.1, and assumes in line with experience of other operational wind farms that commercial vessels will avoid the Lease Area. Collision risk is then considered in Section 10.3.2.

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 6.3.4.
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 noted in Section 6.3.4.
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 6.3.4.
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 6.3.4.
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 6.3.4.
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 6.3.4.
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 10.3.3.
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 6.3.4. Grounding risk is assessed within Section 10.3.5, 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 Sections 4.1, 4.2, and 4.3 of the COP.

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 10. Adverse weather transits have been considered in Section 12.4.2.
The structures could create problems in the area for vessels under sail, such as wind masking, turbulence, or shear?	Yes	This is considered in Section 12.3.3.
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 10.3.3.
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	Effects associated with icing are considered in Section 6.3.6.
An analysis of the ability for structures to withstand anticipated ice floes should be conducted by the applicant?	Yes	Effects associated with icing are considered in Section 6.3.6.
An analysis of the likelihood that ice may form on the structure, especially those types that have rotating blades such as a WTG, 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	Effects associated with icing are considered in Section 6.3.6.

Issue	Yes/ No	Comments
8. Configuration and collision avoidance		
The Coast Guard will provide SAR services in and around OREIs in US 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 considered in Section 12.6, noting that operational SAR Procedures that detail how the Project will cooperate with USCG in the event of an emergency situation will be discussed and agreed with the USCG.
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 4.6. The final layout will be agreed following acceptance of the COP.
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	As per Section 5.3.2, a preliminary assessment of appropriate setback distance was undertaken prior to the NSRA.
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	The impact on emergency response capability including SAR services has been considered in Section 12.6, noting that operational SAR Procedures that detail how the Project will cooperate with USCG in the event of an emergency situation will be discussed and agreed with the USCG. The final layout will be discussed with the USCG following approval of the COP.

Issue	Yes/ No	Comments
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 final layout will be discussed with the USCG following approval of the COP, noting that packed boundaries are not under consideration.
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 considered in Section 12.2.2.
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 9.12.
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 considered in Sections 10.3.1 and 10.3.2,with associated impact assessment then provided in Section 12.
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 9.1 and Section 9.2), AIS (Section 9.4), NAVTEX (Section 9.5), GPS (Section 9.6) and Loran-C (Section 9.7) have been assessed.
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 9.9.
Structures, in general, would comply with current recommendations concerning electromagnetic interference?	Yes	Impacts relating to electromagnetic interference have been assessed in Section 9.8.
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 Project relating to noise have been assessed in Section 9.11.

Issue	Yes/ No	Comments
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 9.8.
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 relating to noise have been assessed in Section 9.11.
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 within Sections 10.3.1 and 10.3.2, with associated impact assessment then undertaken for key vessel types in Section 12. Allision risk has been assessed on a quantitative basis within Section 10.3.3, with associated impact assessment then undertaken for key vessel types in Section 12. Grounding risk is considered in Section 10.3.5. Consequences of potential incidents are assessed in Attachment A.
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?		

Issue	Yes/ No	Comments
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 11.1. The impact on emergency response capability including SAR services has been considered in Section 12.6, noting that operational SAR Procedures that detail how the Project will cooperate with USCG in the event of an emergency situation will be discussed and agreed with the USCG.
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 data provided by the USCG has been assessed in Section 11.1, including cases of pollution. Potential additional pollution resultant of the Project is assessed on a quantitative basis in Attachment A.
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	As per Section 14, lighting and marking of the array will agreed in consultation with USCG and BOEM, including compliance with USCG First District LNM Entry 33-20 (2020) and IALA Recommendations O-139 (IALA, 2013). Further details are provided in Section 8.
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	Marking details are provided in Section 8, noting that as per Section 14, final lighting and marking of the array will agreed in consultation with USCG and BOEM.

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	Marking details of individual structures are provided in Section 8, noting that as per Section 14, final lighting and marking of the array will agreed in consultation with USCG and BOEM.
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	The need for additional AtoNs will be discussed with USCG, noting that as per Section 8, the Project's Lighting and Marking plan will comply with USCG LNM 4420.
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	Indicative details of proposed approach to sound signals are provided in Section 8, noting that as per Section 14, final lighting and marking of the array will agreed in consultation with USCG and BOEM.
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	As per Section 8, obstruction lights fitted to the tops of turbines will not be visible below their horizontal plane. As per Section 14, final lighting and marking of the array will agreed in consultation with USCG and BOEM.
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	As per Section 14, lighting and marking of the array will agreed in consultation with USCG and BOEM, including compliance with USCG First District LNM Entry 33-20 (2020).
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	As per Section 8, the Project's Lighting and Marking plan will comply with USCG LNM 4420.
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	As per Section 8, the Project's Lighting and Marking plan will comply with USCG LNM 4420.
How the marking of the structure will impact existing Federal aids to navigation in the vicinity of the structure?	Yes	Impacts on existing AtoNs are considered in Section 9.12.
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?		

Issue	Yes/ No	Comments
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	Indicative marking details of individual structures including identification characters are provided in Section 8, noting that as per Section 14, final lighting and marking of the array will agreed in consultation with USCG and BOEM.
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 8.1. 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	Further details will be outlined within the SMS following further consultation with the USCG.
The control mechanisms should allow the operations center personnel to fix and maintain the position of the WTG 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	Control mechanism procedures will be provided within the SMS. Consultation with USCG will be ongoing in relation to SAR requirements in terms of structure access.

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	Details relating to the location of access ladders will be determined later in the COP process but will take into account the meteorological conditions outlined in Section 6.3.
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 14, 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	Wind turbine shut down procedures have been outlined in Section 8.1. 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 C Use of Impact Assessment Methodology (including models) for other consented wind Farms.

As per Section 2.1, this NSRA has utilized the internationally recognized standard for marine risk assessment, the IMO FSA approach. This standard and established methodology within the UK is the FSA approach, and it is well recognized and accepted as a robust assessment technique by the MCA, the key UK regulator.

The following UK projects have all been successfully consented via applications where the shipping and navigation impact assessment was undertaken using the FSA approach:

- Beatrice;
- Dogger Bank (Creyke Beck and Teesside)
- Dudgeon;
- East Anglia One;
- East Anglia Three;
- European Offshore Wind Deployment Centre (Aberdeen);
- Galloper;
- Greater Gabbard;
- Hornsea Project One;
- Hornsea Project Two;
- Hywind Demonstrator;
- Inchcape;
- Kincardine Demonstrator;
- Moray East.
- Race Bank;
- Rampion;
- Walney;
- Walney Extension; and
- West of Duddon Sands.

The applications including Navigation Risk Assessments (the UK equivalent of an NSRA) for these projects can be found (where publicly available) by searching by project name within the below links.

Scottish Projects:

https://marine.gov.scot/mslot-all-application-and-project-documentation

English Projects

https://infrastructure.planninginspectorate.gov.uk/

Attachment D Anatec Modelling Background and Overview

COLLRISK

Quantified risk assessments associated with the NSRA for Empire OCS-A 0512 were primarily carried out using Anatec's COLLRISK software which conforms to the MCA Methodology for Assessing the Marine Navigational Safety & Emergency Response Risks of Offshore Renewable Energy Installations (MCA, 2016), in particular Annex D3 which sets out how developers must demonstrate that assessment techniques are suitable for application purposes. It is noted that this represents UK guidance and standards. However, given that the offshore renewable consent process is now well established within the UK, the standards are considered acceptable for the purposes of this NSRA.

In line with this, Anatec makes the declaration that the models used within this work have been validated and are appropriate for the intended use. As required by the MCA guidance (MCA, 2016) the following have been considered and justified:

- Tuning of parameters;
- Consistency checks;
- Behavioral reasonableness;
- Sensitivity analysis; and
- Comparison with the real world.

The COLLRISK software has been utilized for multiple successful wind farm applications for projects within UK waters. On this basis it is considered that COLLRISK is accepted by the MCA and other key stakeholders as a suitable means by which to quantitatively assess collision and allision risks to marine traffic from offshore wind farms. As above, and noting that NVIC 01-19 references MCA guidance, it is considered that given the offshore renewable consent process is now well established within the UK, MCA acceptance of COLLRISK is considered as demonstrating that the models therein are robust for assessment of OREIs.

COLLRISK is recognized as industry-leading software in the specialist field of collision risk assessment. It is referenced to by IOGP in the Risk Assessment Data Directory report for Ship/Installation Collisions under "Best practice collision risk modelling for passing vessels". It has been calibrated using 20 years of historical incident data to ensure results are in line with actual incident rates.

Encounters

Unlike COLLRISK, it is considered an analysis tool rather than a predictive model, given that its function is to identify recorded cases of multiple vessels passing in close proximity within a given dataset. Anatec makes the declaration that the methodology of the Encounters program has been validated and is appropriate for the intended use within this NSRA.

AIS Simulator

The AIS Simulator software was created for the purpose of providing means to visualize potential future traffic patterns that may arise following a change to the baseline environment (e.g., the construction of a wind farm). The software therefore has a predictive element. However, the process is not complex given that the software simply randomizes track locations from a given mean route position and standard deviation. On this basis, Anatec makes the declaration that the methodology has been validated and is appropriate for the intended use within this NSRA.

Attachment E Consultation Log

Key meetings held for the purpose of consulting on the Empire OCS-A 0512 Project with stakeholders relevant to shipping and navigation include:

- Oct 2, 2017: USCG;
- May 2, 2018: New York Harbor Operations Safety Committee;
- May 16, 2018: New York Harbor Operations Safety Committee;
- Aug 7, 2018: USCG (via teleconference);
- Sept 17, 2018: USCG;
- Sept 18, 2018: McAllister Towing of New York including preliminary hazard discussions;
- Sept 18, 2018: New York VTS including preliminary hazard discussions;
- Sept 19, 2018: New York Harbor Operations Safety Committee;
- Sept 20, 2018: PANYNJ including preliminary hazard discussions;
- Oct 3, 2018: New York Harbor Operations Safety Committee including preliminary hazard discussions;
- Nov 1, 2018: Cruise Line Industry Association (via email);
- Jan 17, 2019: World Shipping Council (via email);
- March 27, 2019: Responsible Offshore Development Alliance;
- April 4, 2019: USCG;
- April 20, 2019: USCG;
- April 30, 2019: Hudson River Safety Committee;
- June 12, 2019: New York Harbor Operations Safety Committee;
- Aug 7, 2019; USCG and New York Harbor Operations Safety Committee;
- Sept 17, 2019: USCG;
- Oct 7, 2019: USCG;
- Nov 21 and 22, 2019: Responsible Offshore Development Alliance;
- Dec 13, 2019: U.S. Department of Defense Fleet Forces;
- Jan 1, 2020: USCG;
- Jan 14, 2020: Responsible Offshore Development Alliance;
- April 1, 2020: New York Harbor Operations Safety Committee;
- April 17, 2020: PANYNJ;
- May 14, 2020: Hudson River Safety, Navigation, and Operations Committee ;
- June 1, 2020: USCG and BOEM;
- June 22, 2020: American Waterways Operators;
- June 23, 2020: Chamber of Shipping of America;
- June 29, 2020: USCG;
- June 29, 2020: World Shipping Council;
- July 16, 2020: USCG SAR;
- July 30, 2020: USCG;
- Aug 11 and Aug 14, 2020: New York Maritime Technical Working Group Navigation Roundtable;
- August 12, 2020: Responsible Offshore Development Alliance;
- Sept 17, 2020: USCG;

- Oct 7, 2020: New York Harbor Operations Safety Committee;
- Oct 9, 2020: USCG;
- Nov 16, 2020: New York Harbor Operations Safety Committee;
- Nov 25, 2020: USCG and BOEM;
- Jan 26, 2021: USCG;
- March 2, 2021: USCG;
- March 4, 2021: USCG and BOEM; and
- March 23, 2021: USCG and BOEM.

A summary of engagement with agencies is available in Appendix B of the COP.

Attachment F Regular Operator Letter Template

A template version of the letter issued to Regular Operators (as per Section 3.2), with information redacted as appropriate, is shown below.

equinor

[CONTACT NAME]
[ADDRESS LINE 1]
[ADDRESS LINE 2]
[ADDRESS LINE 3]
[ADDRESS LINE 4]

Our reference: A4101-LSX
Your reference: A4101-LRX
[DATE]

Dear [CONTACT NAME],

You may be aware that Equinor, a leading international energy company, are intending to construct and operate the [redacted] offshore wind farm south of Long Island in the approach to the Port of New York and New Jersey (PANYNJ). The commercial lease for the project was signed by Equinor in March 2017, following the Department of the Interior's Bureau of Ocean Energy Management (BOEM) successful auction in December 2016, and it is anticipated that the project will generate its first power by the mid-2020s. Currently, Equinor are in the pre-application stage of the project, and are preparing the formal application for submission to BOEM.

The location of the Lease Area, within which all surface piercing offshore structures associated with the project will be located, is shown in Figure 1 for your reference. Based on the current Design Envelope, there will be up to 200 wind turbines installed within this Lease Area, and up to three offshore substations.

Anatec Ltd have been contracted by Equinor to manage the aspects of the application pertinent to shipping and navigation. Most notably this includes the production of a Navigation Safety Risk Assessment (NSRA), which represents the primary input into the assessment of potential impacts to shipping and navigation receptors undertaken as part of the application. A key step of this NSRA process is to gather consultation input from local and national marine stakeholders who may have an interest in, or be affected by, the project.

Therefore, I am writing on behalf of Equinor to provide you (or another representative of your organization) with an opportunity to input into the project at this stage, should you seek to do so. Your organization has been identified as a potential stakeholder on the basis that a study of marine traffic data has indicated that multiple vessels you operate transit within the approaches to PANYNJ, and hence in the area within which the project will be constructed. Should you require further information on these marine traffic studies undertaken, please get in touch.

We are particularly interested in how the project may impact upon vessel routeing in the area, noting the location of the Lease Area between the inbound lane of the Hudson Canyon/Ambrose Traffic Separation Scheme (TSS) and the outbound lane of the Ambrose/Nantucket TSS (as illustrated in Figure 1). Therefore, answers to the following specific questions would be helpful, should you deem them relevant to your organization:

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Equinor Wind US LLC www.equinor.com

equinor

- What impacts would you foresee on vessels currently utilizing the TSS lanes should the project be constructed? Would you change the way your vessels operate in the area?
- What measures would you like to see in place for the operational wind farm, for example navigational aids such as AIS transmitters?
- Do vessels you operate regularly transit past operational or constructing wind farm projects in other areas (for example, the Southern North Sea); if so do you have any comments from these wind farms that would be of interest to the developers of [redacted] Wind?

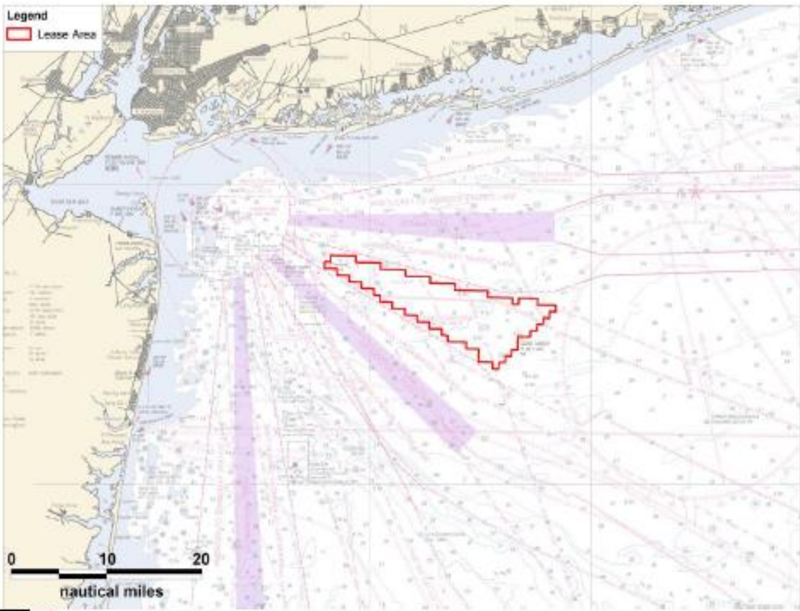

Figure 1 [redacted] Wind Lease Area

Please note that consultation input is not limited to the above questions, and we would welcome any additional feedback you may have. Consultation responses and any queries should be sent to [redacted]@[redacted].com. To aid the timeframe within which the NSRA must be completed, I would be grateful if all responses are received by ourselves prior to the 4th January 2019.

Should you require any further information on the project, or have any queries on the NSRA process, then please feel free to get in touch with myself at any point.

Yours sincerely,

[redacted]

On behalf of [redacted], Equinor Wind US LLC

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Attachment G Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm

This report has been supplied as a separate attachment. However, the following points are noted following consultation on the use and provision of a reference Buoy.

The Spaniard Buoy (an existing AtoN) to the southwest of Kentish Flats Offshore Wind Farm was used as a reference target throughout the Radar trials. When technicians are assessing the impacts of the wind farm on Radar any trial would need a fixed point off which the tests could be referenced against – it is noted throughout the report that the Spaniard buoy remains visible and the report concluded that 'The Spaniard Buoy was used as a reference target by observers and it was also notable that when on the opposite side of the wind farm array the quality of its returned echo did not appear to be adversely affected'.

During the trials it was also noted that the positioning of the Spaniard Buoy; fitted with a radar reflector, adjacent to the wind farm, provided operators with a reference target for performance indication and gain setting when 'Tracking Small Craft within the Array from Outside at Close Ransge with Gain Adjustment'. In the summary of observations it was stated also that 'The availability of the Spaniard Buoy provided a reference target and assisted in the adjustment of the radar for particular circumstances' and for wind farm specific mitigation it was 'suggested' (section 10.2) that to assist mariners and possible SAR operations, "reference" buoys could be provided adjacent to and within wind farms to be used when adjusting gain and other control levels to assist in the detection of smaller targets. In the same mitigation section, it also notes (10.1) that although it was not envisaged originally as a part of this research, the observations forced the technicians to conclude that it could be highly beneficial for maritime operations to improve the performance of marine radar generally (report concluded that 'Modern commercial cargo vessels in particular are regularly fitted with radar scanners that may not be optimally sited in relation to obstructions onboard the vessel and other considerations'). They believe that improvements could be achieved by the industry addressing problems related to the inappropriate siting of scanners off the fore and aft line.

In summary, the reference buoy was part of the trial methodology but was noted to have benefits to help the mariner adjust controls when tracking small targets inside the array, the report did not conclude a reference buoy was essential to mitigate risks nor have they been installed at UK wind farms constructed on the basis of these findings.

Attachment H Port Addendum

ATTACHMENT H

Port Overview

INTRODUCTION

Construction, assembly, and provision of certain major infrastructure components (e.g., wind turbine towers and transition pieces) may be based out of one or more local ports or terminals within the New York region. Additionally, submarine cables may be obtained from a factory located in South Carolina and offshore substation topsides may be obtained from a factory located in Texas. Empire Offshore Wind LLC (Empire) has not yet finalized selection of these local ports; however, the following provides an overview of the locations that are under consideration.

Upgrades and improvements by local port facilities that may be utilized by Empire for the Empire Wind Project (Project) are not assessed within Section 3 of the Construction and Operations Plan (COP) as any such upgrades are the responsibility of the port or terminal facility owners. Local port areas will be appropriately permitted and governed by applicable environmental standards; the use of these facilities by Empire in support of the proposed Project will be consistent with the existing facilities' activities for which these sites were permitted and developed. In an effort to assess the highest level of impact to waterways at this stage, Empire has presented values under the maximum design scenario as described in Section 3 of the COP.

NEW YORK PORTS

Port of Albany

Upstate New York's Port of Albany is assumed to be the starting point for transporting wind turbine tower components to a local staging area at South Brooklyn Marine Terminal (SBMT) in Brooklyn, New York, from where they will be transported to their installation locations in the Lease Area (**Figure 1**). In January 2019, companies Marmen and Welcon announced their plans to develop the Port of Albany following a 2019 memorandum of understanding[1] with intent to support the offshore wind industry in the United States.[2]

Currently, it is estimated that the transport configuration will consist of one barge (300-400 feet) and two tugs. Each barge and tug configuration will transit up to three towers at once down the Hudson River, with the assistance of local operators. Under this configuration, the anticipated transport schedule will be one barge every 14 days (**Table 1**). Distance for this operation includes an approximate 124 nautical miles from Port of Albany to New York Harbor, followed by an approximate 32 nautical miles out to the Lease Area.

Table 1 Port of Albany Transport Overview

Port	Transport Configuration	Anticipated Schedule
Port of Albany (Albany, NY)	Transportation of wind turbine towers Utilization of a single (300-400 feet) barge and two tugs	Three towers per barge and tug configuration One transport every 14 days Transport would begin at Port of Albany and transit to SBMT before heading to the Lease Area for installation.

[1] January 13, 2021 press release from Marmen and Welcon is available here: https://www.welcon.dk/news/marmen-and-welcon-will-build-a-new-plant-for-the-fabrication-of-offshore-wind-towers-in-new-york-state/

[2] Noting that the Port of Albany has completed their own Generic EIS process which included both federal and state engagement. In June 2020, following the EIS process, the Port received full State Environmental Quality Review Act (SEQRA) review and approval, achieving a Final Generic Environmental Impact Statement (FGEIS) for the site development.

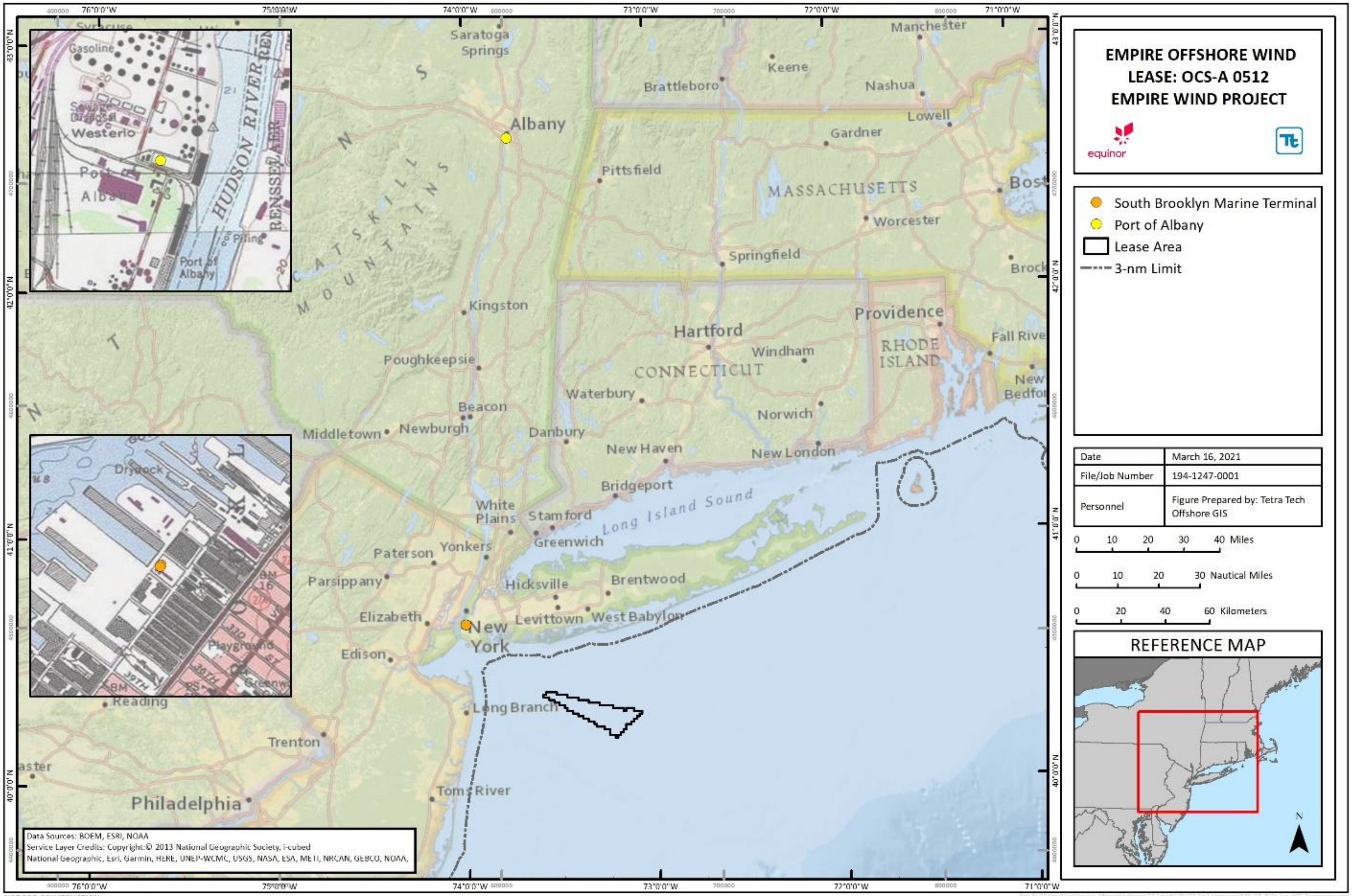

Figure 1 Overview of Port of Albany, SBMT, and the Lease Area

In 2018, the U.S. Army Corps of Engineers' (USACE) Waterborne Commerce Statistics Center (WCSC) counted a total of 292,748 vessel trips up and down the Hudson River (**Table 2**).[3] With a maximum design scenario assumption of 98 total trips[4] for build out of the entire Lease Area (Empire Wind [EW] 1 and Empire Wind 2) would represent an annual increase of existing traffic levels equal to 0.05%.[5] Marine logistics reports for this transport route will continue to be refined. Initial reports and consultations regarding transit of other Project components on the Hudson River show that the proposed tower transport operation is consistent with current vessel presence and use of the waterway and the Hudson River M-87 Blue Highway program.[6]

Table 2 USACE Waterborne Commerce Statistics Center Hudson River Trips 2018

Vessel Type	Number of Hudson River Trips (2018)
Dry Cargo Barge	8,859
Liquid Barge	3,823
Other	3
Self-Propelled Dry Barge	277,904
Tanker	172
Towboat	1,987
Total	**292,748**

Since the transit described is consistent with existing use and results in a minimal increase in traffic, Empire does not foresee this proposed usage to cause significant adverse impact to marine traffic or safety. However, Empire has committed to the following measures for transit of wind turbine tower components from the Port of Albany:

- Continued consultation with relevant stakeholders and agencies (ex. Hudson River and New York Harbor Operations, U.S. Coast Guard (USCG) Vessel Traffic Service (VTS), New York State Energy Research & Development (NYSERDA) Maritime Technical Working Group (M-TWG), pilot associations, The Towboat and Harbor Carriers Association, etc.);
- Vessels associated with the Project will provide notice to mariners (LNM) to alert them to the transport presence and estimated schedule on the waterway;
- Vessels associated with the Project will provide regular communications with USCG VTS regarding vessel movements and schedules, during execution as per port/VTS requirements; and
- Empire will continue to refine marine logistics reports, including the submission of a Construction Method Statement (CMS) to applicable agencies in advance of the construction phase. An example of a CMS has been provided to USCG for review. Empire will work with USCG to determine the necessary components to be included in the CMS.

Port of Coeymans

Upstate New York's Port of Coeymans is under consideration as a possible location for loading rock for foundation scour protection, from where it will be transported directly to the installation locations in the Lease Area (**Figure 2**). The transport of rock to the Lease Area will be conducted by a contractor who may

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[3] The number shown is representative of all trips within all Hudson River segments recorded by the USACE WCSC.
[4] 98 trips calculated with a maximum design of 147 turbines, 3 towers per trip, each trip to the Lease Area and back.
[5] Of note, the Empire recognizes, that transit of all towers for build out is not anticipated to occur within one full year and, therefore, this percentage is considered to be conservative.
[6] The America's Marine Highway Program was established under Section 1121 of the Energy Independence and Security Act of 2007 to reduce landside congestion through the designation of Marine Highway Routes. https://www.maritime.dot.gov/grants/marine-highways/marine-highway

use the Port of Coeymans. Empire has not entered into and does not intend to enter into any agreement directly with Port of Coeymans or the owner of the port.

Currently, it is estimated that the transport configuration will consist of one fall pipe vessel. The anticipated maximum design scenario for transport schedule for both EW 1 and EW 2 will be approximately eight trips spread across approximately 26 weeks in 2025 and approximately seven trips spread across approximately 26 weeks in 2026 (**Table 3**). The distance for each trip is approximately 147 nautical miles from Port of Coeymans to the Lease Area.

Table 3 Port of Coeymans Transport Overview

Port	Transport Configuration	Anticipated Schedule
Port of Coeymans (Ravena, NY)	Transportation of rock for scour protection One fall pipe vessel	Approximately 8 trips spread across approximately 26 weeks in 2025 and approximately 7 trips spread across approximately 26 weeks in 2026. Transport would begin at Port of Coeymans and proceed directly to the Lease Area for installation.

In 2018, the USACE WCSC counted a total of 292,748 vessel trips up and down the Hudson River (**Table 2**). With a maximum design scenario assumption of eight round trips in 2025 and seven round trips in 2026, Project-associated vessels would represent a negligible increase over existing annual traffic levels.

Since the transit described is consistent with existing use and results in a negligible increase in traffic, Empire does not foresee this proposed usage to cause significant adverse impact to marine traffic or safety. However, Empire has committed to the following measures for transit of rock scour protection from the Port of Coeymans:

- Continued consultation with relevant stakeholders and agencies (e.g., Hudson River and New York Harbor Operations, USCG VTS, NYSERDA M-TWG, pilot associations, The Towboat and Harbor Carriers Association, Riverkeeper, etc.);
- Vessels associated with the Project will provide LNM to alert them to the transport presence and estimated schedule on the waterway;
- Vessels associated with the Project will provide regular communications with USCG VTS regarding vessel movements and schedules, during execution as per port/VTS requirements; and
- Empire will continue to refine marine logistics reports, including the submission of a CMS to applicable agencies in advance of the construction phase. An example of a CMS has been provided to USCG for review. Empire will work with USCG to determine the necessary components to be included in the CMS.

South Brooklyn Marine Terminal

As described in Section 3.3.2.1 of the COP, SBMT has been selected as the location for export cable landfall and the onshore substation (see **Figure 3**). In order to contribute to development and build-out the offshore industry in the State of New York, SBMT is proposing to conduct upgrades to the port facility that would allow offshore wind developers to utilize the facility as a construction and staging area. Planned upgrades at SBMT include bulkhead replacement, foundation and groundwork, and dredging.

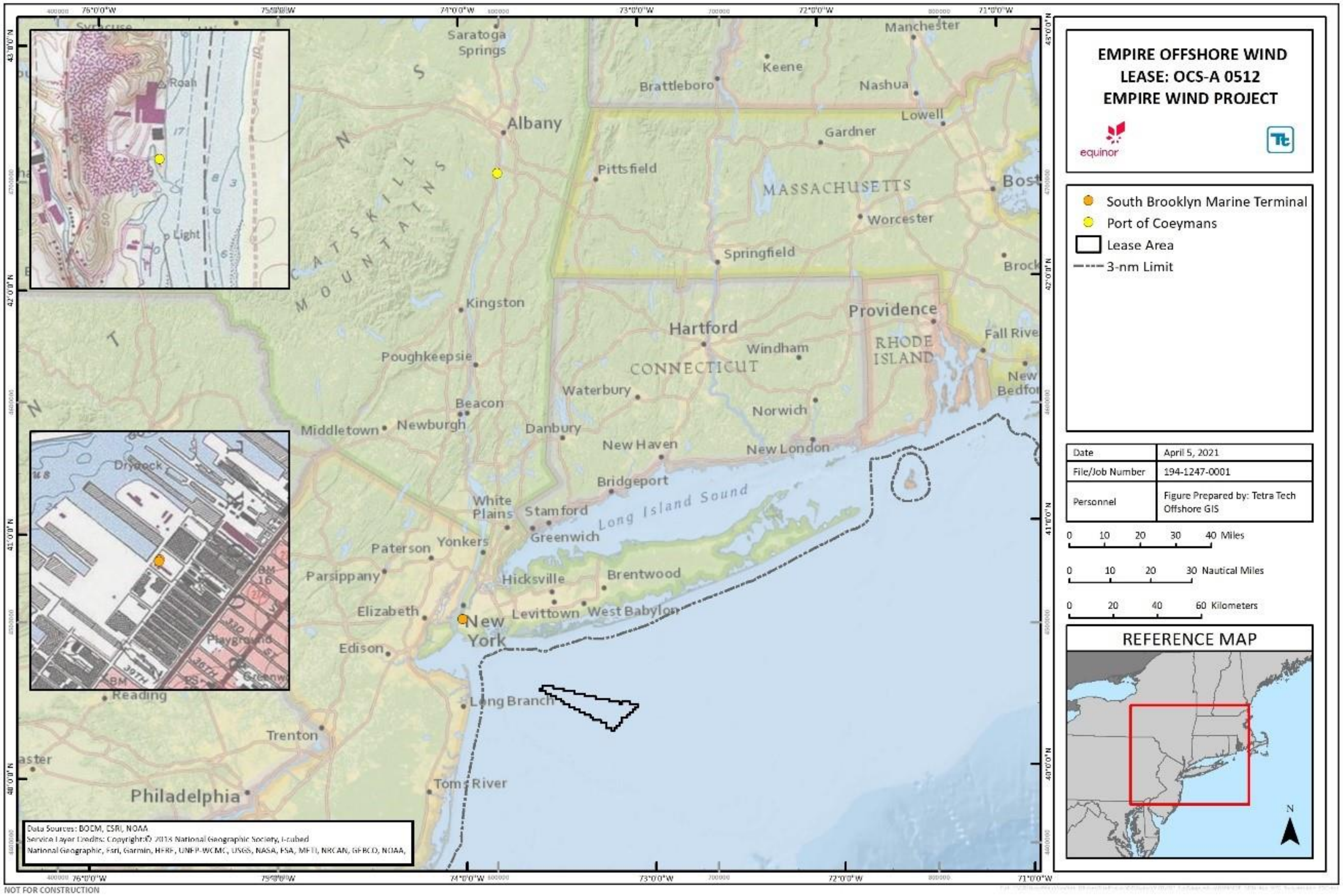
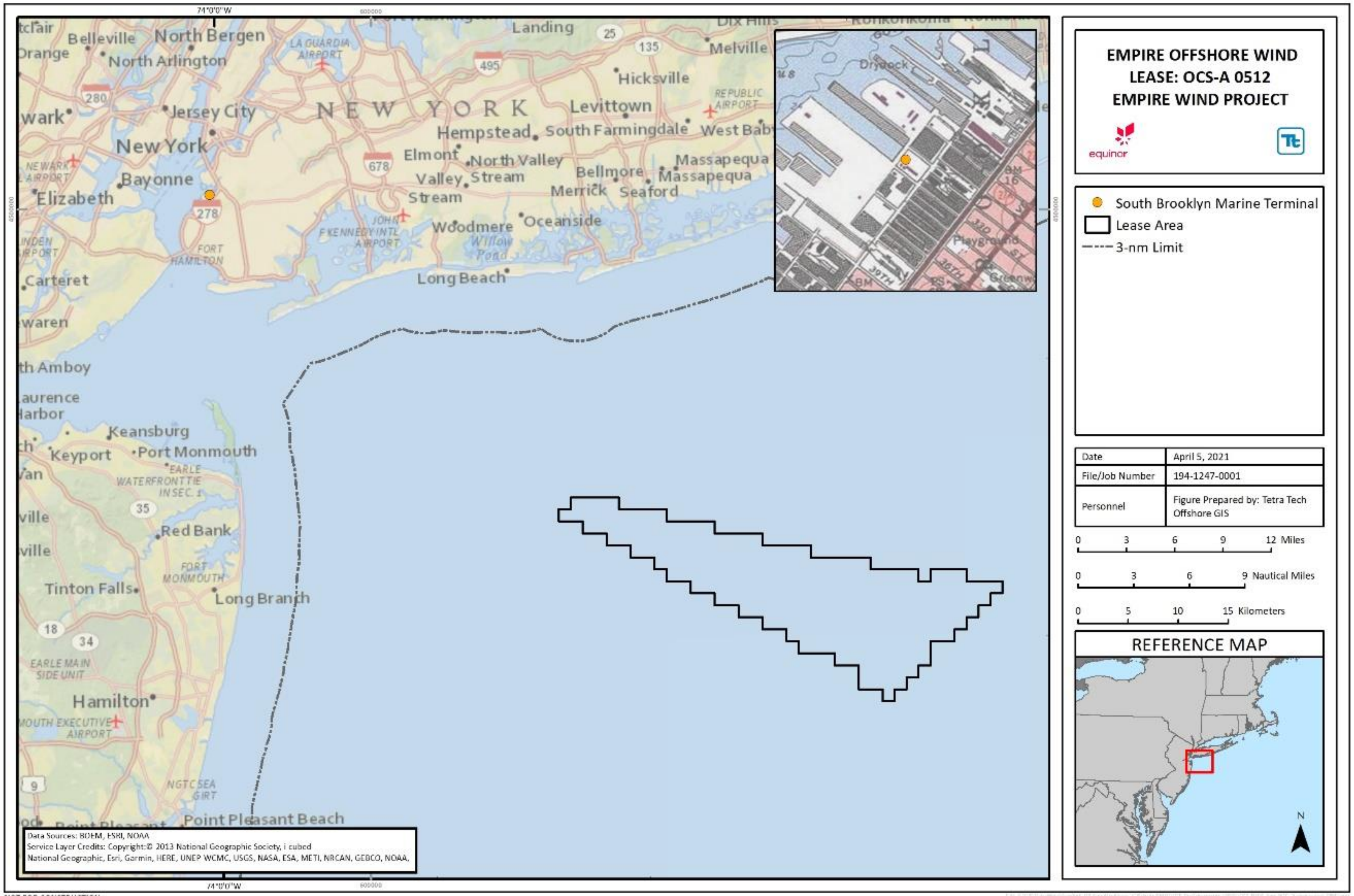


Figure 2 Overview of Port of Coeymans, SBMT, and the Lease Area



NOT FOR CONSTRUCTION

Figure 3 Overview of SBMT and the Lease Area

Empire also proposes to lease portions of SBMT for the following: laydown and staging for wind turbine blades, turbines, nacelles; foundation transition pieces; or other facility parts during construction of the offshore wind farm. During this time, SBMT would receive, store, assemble, and export Project components via marine vessels and onshore cranes and other equipment.

In an effort to categorize the surrounding waterways of SBMT, **Table 3** provides an overview of vessel trip data from the 2018 USACE WCSC for the Upper Bay, Bay Ridge and Red Hook Channels, and New York Harbor Lower Entrance Channels. Marine logistics reports for SBMT will continue to be refined as the Project continues to define the use of this area. Initial reports and consultations regarding the use of this area show that the proposed transport operations are consistent with current vessel presence and use of the waterway.

Table 3 USACE WCSC Upper Bay, Bay Ridge and Red Hook Channels, and New York Harbor Lower Entrance Channels Trips 2018

Vessel Type	Number of Upper Bay Trips (2018)	Number of Red Hook and Bay Ridge Channel Trips (2018)	Number of New York Harbor Lower Entrance Channels Trips (2018)
Dry Cargo Barge	5,758	54	537
Liquid Barge	1,315	0	1,101
Other	2	0	18
Self-Propelled Dry Barge	50,340	5	12,310
Tanker	519	0	1,951
Towboat	10,303	455	424
Total	**68,237**	**514**	**16,341**

Since the transit described is consistent with existing use of the waterway, Empire does not foresee this proposed usage to cause significant adverse impact to marine traffic or safety. However, Empire has committed to the following measures for transport use of the SMBT area:

- Continued consultation with relevant stakeholders and agencies (ex. New York Harbor Operations, USCG VTS, NYSERDA M-TWG, pilot associations, The Towboat and Harbor Carriers Association, etc.);
- Vessels associated with the Project will provide LNM to alert them to the transport presence and estimated schedule on the waterway;
- Vessels associated with the Project will provide regular communications with USCG VTS regarding vessel movements and schedules, during execution as per port/VTS requirements; and
- Empire will continue to refine marine logistics reports, including the submission of a CMS to applicable agencies in advance of the construction phase. An example of a CMS has been provided to USCG for review. Empire will work with USCG to determine the necessary components to be included in the CMS.

SOUTH CAROLINA PORT

Cable Manufacturing Facility

The Nexans high voltage subsea cable plant located on the Cooper River just north of Charleston, South Carolina is assumed to be the submarine cable manufacturing facility for the Project and is assumed to be the starting point for the transit of submarine cables to the Lease Area (**Figure 4**). The distance from the cable facility to the Lease Area consists of approximately 23 nm (43 km) of South Carolina state waters and approximately 620 nm (1,148 km) of federal waters. The total one-way distance is approximately 643 nm (1,191 km).

The Project-related traffic associated with transit between the Nexans cable facility and the Lease Area is expected to consist of a total of 10 round trips starting from South Carolina. For EW 1, these trips will consist of two round trips for an export cable lay vessel and three round trips for an interarray cable lay vessel. For EW 2, these trips will consist of one round trip for the export cable lay vessel and four round trips for the interarray cable lay vessel (**Table 4**).

Table 4 Submarine Cable Transit Overview

Vessel Type	Number of Round Trips	Anticipated Schedule
Export Cable Lay Vessel	2 (EW 1) 1 (EW 2)	2 trips spread across approximately 26 weeks in 2025 and 1 trip in 2026. Transport would begin at the Nexans cable facility on the Cooper River just north of Charleston, South Carolina and proceed directly to the Lease Area.
Interarray Cable Lay Vessel	3 (EW 1) 4 (EW 2)	3 trips spread across approximately 26 weeks in 2025 and 4 trips spread across approximately 26 weeks in 2026. Transport would begin at the Nexans cable facility on the Cooper River just north of Charleston, South Carolina and proceed directly to the Lease Area.
Total	**10**	

Since the transit described is consistent with existing use and results in a negligible increase in traffic, Empire does not foresee this estimated transit associated with submarine cable transport to cause significant adverse impact to marine traffic or safety. However, Empire has committed to the following measures for transport of submarine cables:

- Vessels associated with the Project will provide LNM to alert them to the transport presence and estimated schedule on the waterway; and
- Vessels associated with the Project will provide regular communications with USCG VTS regarding vessel movements and schedules, during execution as per port/VTS requirements.

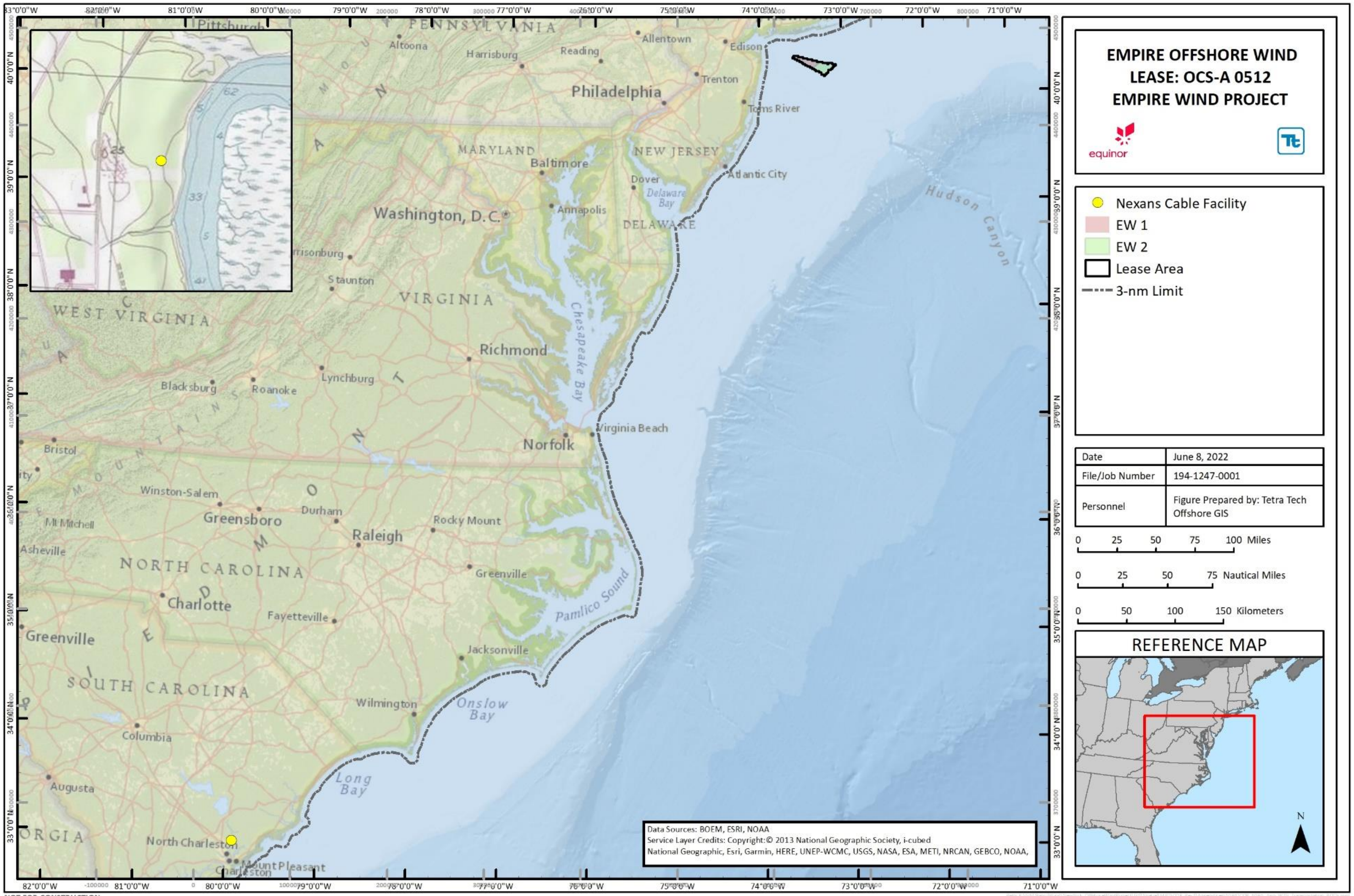


Figure 4 Overview of Nexans Cable Facility and the Lease Area

TEXAS PORT

Offshore Substation Topsides Manufacturing Facility

A yet-to-be-determined port in the Corpus Christi, Texas area is assumed to be the starting point for transporting the offshore substation topsides for EW 1 and EW 2 to the installation locations in the Lease Area. These will be brought directly to their offshore construction locations by a heavy transport vessel. The one-way distance from Corpus Christi to the Lease Area consists of approximately 30 nm (56 km) of Texas state waters and approximately 1,970 nm (3,648 km) of federal waters. The total one-way distance is approximately 2,000 nm (3,704 km) per trip.

The Project-related traffic associated with transit between Texas and the Lease Area is expected to consist of a total of two round trips of a heavy transport vessel starting from Texas. Transport would begin at a port in the Corpus Christi, Texas area and proceed directly to the Lease Area.

Since the transit described is consistent with existing use and results in a negligible increase in traffic, Empire does not foresee this estimated transit associated with offshore substation topsides transport to cause significant adverse impact to marine traffic or safety. However, Empire has committed to the following measures for transport of offshore substation topsides:

- Vessels associated with the Project will provide LNM to alert them to the transport presence and estimated schedule on the waterway; and
- Vessels associated with the Project will provide regular communications with USCG VTS regarding vessel movements and schedules, during execution as per port/VTS requirements.

Attachment I Updated Project Base Case Layout Assessment

Updated Project Base Case Layout Assessment

Prepared by	Anatec Limited
Presented to	Tetra Tech / Empire
Date	March 08, 2023
Revision Number	03
Document Reference	A4677-TT-NSRA-AttI

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Revision Number	Date	Summary of Change
00	November 21, 2022	Initial Draft
01	November 29, 2022	Updates
02	February 22, 2023	Addition of EW2
03	March 08, 2023	Final for review

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Abbreviations Table

Abbreviation	Definition
AIS	Automatic Identification System
BOEM	Bureau of Ocean Energy Management
FSA	Formal Safety Assessment
IMO	International Maritime Organization
nm	Nautical Mile
NSRA	Navigation Safety Risk Assessment
SAR	Search and Rescue
TSS	Traffic Separation Scheme
USCG	United States Coast Guard
VMS	Vessel Monitoring System

1 Introduction

The initial Empire Wind (EW) Navigation Safety Risk Assessment (NSRA) undertook quantitative allision assessment of a layout comprising 174 turbines and two substation locations for the purposes of informing the qualitative impact assessment (i.e., the key NSRA output). The layout was chosen to represent a worst case from a shipping and navigation perspective in that it contained the maximum number of structures and full build-out of the periphery.

The project has refined the layout from the worst case layout assessed in the NSRA. This attachment provides additional assessment of the new layout, referred to as the project base case, in relation to the existing NSRA findings. This includes:

- Comparison against the NSRA layout;
- Vessel traffic assessment; and
- Discussion of project base case layout in relation to the impacts assessed within the Formal Safety Assessment (FSA) undertaken in the NSRA.

2 Layout

The project base case comprises 138 turbines in total (54 within EW1 and 84 within EW2) and two substation locations as shown in Figure 2.1 (which also shows the ID system). The layout assessed in the main NSRA is shown in Figure 2.2.

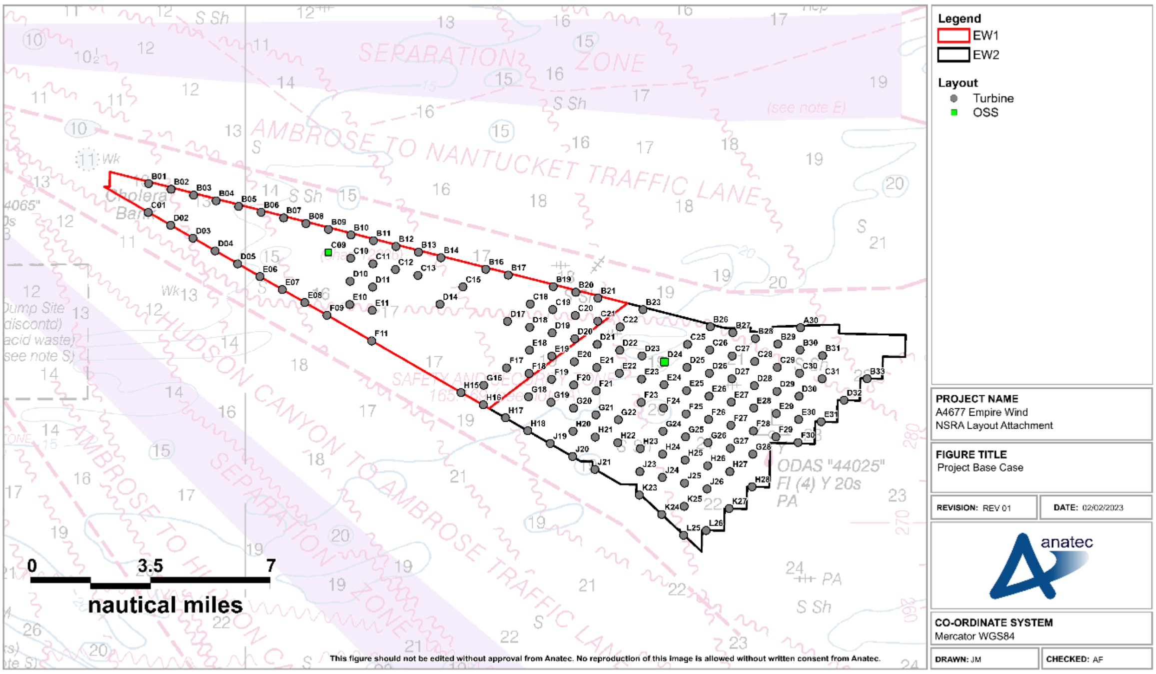

Figure 2.1: Project Base Case Layout

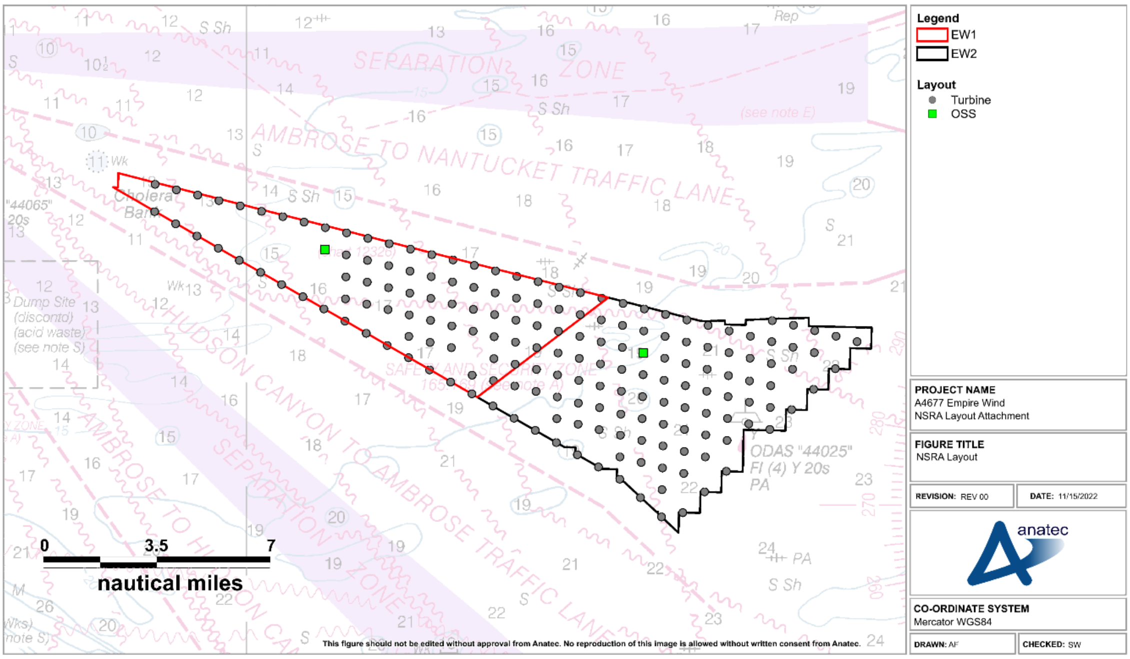

Figure 2.2: NSRA Layout

The parameters deemed of primary relevance to the NSRA are compared between the two layouts in Table 2.1. As shown, the overall number of structures has decreased; no new positions have been added. In addition, both the minimum spacing (with one minor exception) and Search and Rescue (SAR) access via a single line of orientation has been maintained.

Table 2.1: Comparison of NSRA Layout against Project Base Case Layout

Parameter	NSRA	Project Base Case Layout
Number of turbines	174	138
Number of substations	2	2
Minimum spacing	0.65 nautical miles (nm)	0.65 nm (with the single exception discussed below in Section 4.3)
Lines of orientation	Single	Single

3 Vessel Traffic Summary

The NSRA assessed 12 months of Automatic Identification System (AIS) data covering the period between August 2017 and July 2018. This data has therefore also been considered within this attachment to ensure direct cross comparison with the NSRA analysis. The 12 months of data is shown relative to the project base case layout in Figure 3.1, colour coded by vessel type. It is noted that AIS data is not comprehensive of all vessels. This is discussed further in the NSRA.

The NSRA analysis was based on assessment within the Bureau of Ocean Energy Management's (BOEM) offshore lease area OCS-A 0512 (referred to as the Lease Area within the NSRA and this attachment). The positions of structures within the project base case layout are all located within the Lease Area.

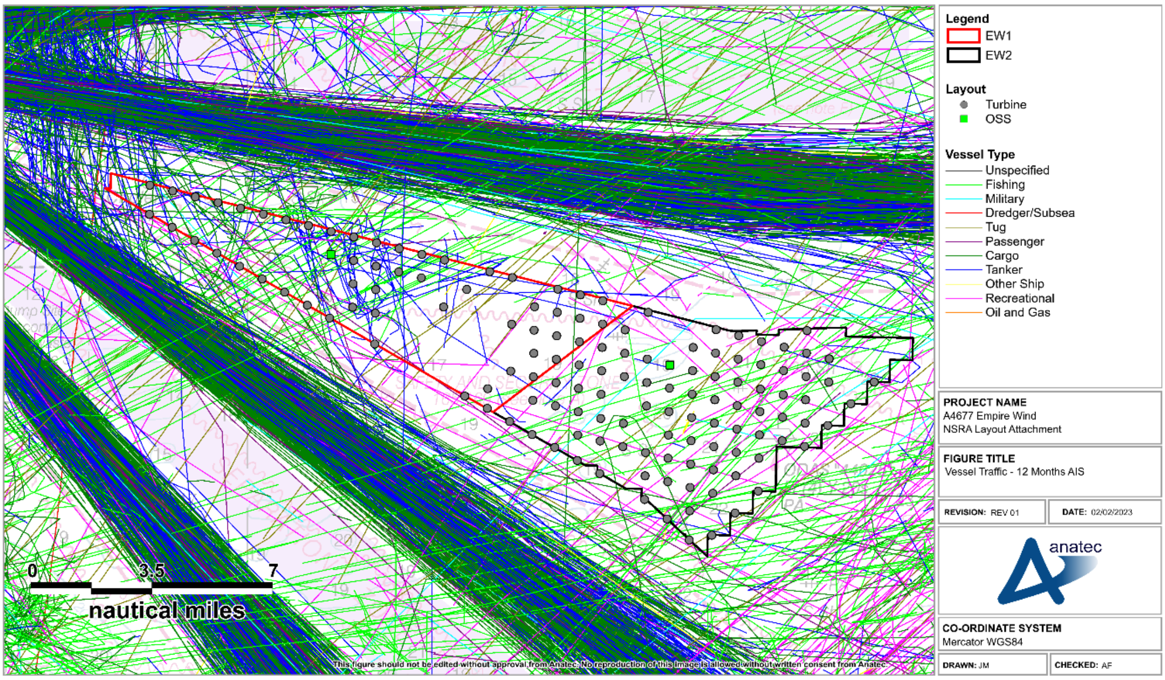

Figure 3.1: Vessel Traffic 12 Months AIS

Based on the assessment of the AIS data undertaken in the NSRA, an average of between one and two vessels per day intersected the Lease Area over the 12 months. Fishing vessels were the most common vessel type intersecting the Lease Area, accounting for approximately 37% of the total, followed by tankers (19%) and cargo vessels (16%). A limited volume of recreational traffic was also recorded transiting through.

High level behavioural analysis within the NSRA indicated the fishing vessels within the Lease Area tended to be in transit as opposed to actively engaged in fishing (i.e., gear deployed). It is likely that the fishing vessels recorded were in transit to or from fishing grounds further afield. The NSRA also considered Vessel Monitoring System (VMS) data collected during 2015 and 2016. This showed that fisheries including pelagics, scallops and surfclam / ocean quahog operated in the Lease Area during 2015 and 2016.

The commercial traffic intersecting the Lease Area was observed to primarily comprise vessels exiting the inbound lane of the Hudson Canyon / Ambrose Traffic Separation Scheme (TSS) before the precautionary area to access the Ambrose Anchorage. Limited instances of vessels engaged in potential "waiting" manoeuvres within the Lease Area were also observed.

4 Impact Discussion

The NSRA included an International Maritime Organization (IMO) FSA of the relevant impacts identified, with a significance ranking assigned to each. This section provides discussion of any aspects of the project base case layout which may be of potential relevance to the FSA findings, in particular:

- The opening of an irregular gap through the project base case layout which may be used by vessels; and
- Risks associated with isolated structures.

Following this, Section 4.3 provides a summary of the FSA in addition to any potential influencing factor associated with the project base case layout.

4.1 Peripheral Gaps

As shown in Figure 4.1, the project base case layout includes gaps on its periphery, the largest of which is approximately 3 nm on the southern periphery.

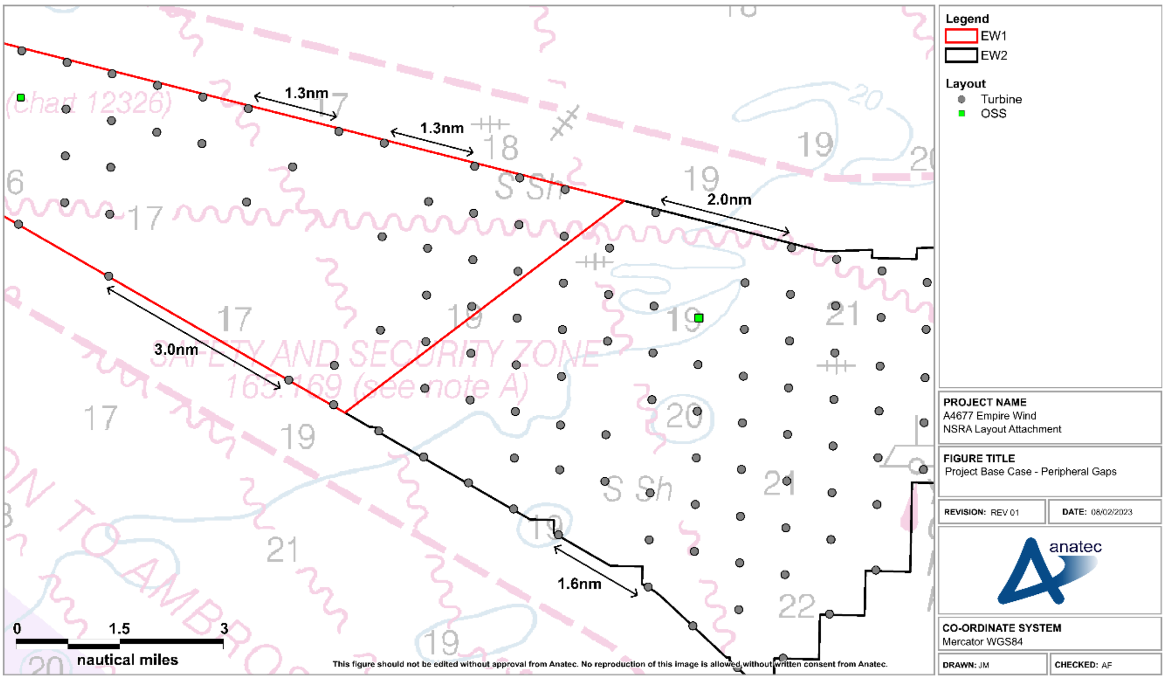

Figure 4.1: Peripheral Gaps

As per Section 3, vessels currently do transit through the Lease Area on broadly north / south transits, and it should therefore be considered that where peripheral gaps appear through the Lease Area (EW1) vessels may use them for the purposes of transiting through the array once operational. It is considered unlikely that commercial vessels accessing the Ambrose anchorage (see Section 3) would use these gaps for that purpose based on the gap widths and bearing, however smaller vessels (e.g., fishing and recreational) may still choose to utilize them for transit purposes.

There are also peripheral gaps which do not continue through the Lease Area (EW2). Although these gaps do create space internally within the Lease Area, the lack of a clear passage through the array may mean it is less likely that vessels would choose to utilize them for transit purposes than the gaps in EW1.

Appropriate lighting and marking will be necessary in consultation with United States Coast Guard (USCG) and BOEM to ensure that all structures which may be encountered by vessels choosing to transit through are clearly identified. This will ensure compliance with the Layout Rules which state that potential visual confusion to any vessel navigating through the Lease Area should be minimized.

There may be increased vessel density within any gap used for navigation, with the potential for increased encounters. However, as per Section 3, baseline traffic volumes through the Lease Area are already low based on the available data, noting that not all vessels currently intersecting would be expected to transit through the operational wind farm.

It is noted that the NSRA layout included the option of a transit lane via removal of the turbines closest to the boundary between EW 1 and EW 2. Such a transit lane is no longer an option with the project base case layout, which requires the use of positions along the boundary between EW 1 and EW 2.

4.2 Isolated Structures

The Layout Rules state that the perimeter structures shall "*be arranged in straight or curved lines in an understandable pattern… without any dangerously projecting or peripheral structures*" (Rule 2). The project base case layout maintains straight line edges on the perimeter which are parallel to the TSS lanes, thus avoiding protruding structures.

Where there are peripheral gaps in the perimeter of the project base case layout (see Section 4.1), these gaps and the internal space may result in certain peripheral turbines being viewed as isolated. However, such turbines do conform to the straight line edges maintained in parallel with the TSS lanes. Therefore, it is considered that the associated risks can be managed via the implementation of appropriate lighting and marking in consultation with USCG and BOEM.

Consideration will also need to be given to appropriate management procedures to mitigate the risk of aid to navigation (AtoN) failure, in particular in cases where a turbine may be viewed as isolated. An example is position A30 (see Figure 2.1), noting that while this turbine aligns with the northern periphery in terms of the separation from the outbound lane of the Ambrose / Nantucket TSS to the north, it may be viewed as isolated in terms of the layout "rows", noting all other turbines on the northern periphery are labelled as being part of the "B" row (i.e., positions B01 to B33 as per Figure 2.1).

Passing traffic in close proximity to this turbine (A30) is likely to consist primarily of smaller vessels (e.g., fishing and recreational) choosing to navigate internally within the array. However, consideration should be given to commercial traffic utilising the outbound lane of the Ambrose / Nantucket TSS to the north. The majority of this traffic passes in excess of 3 nm from position A30, however limited instances of vessels passing closer were identified in the vessel traffic data (see Section 3). This included commercial vessels leaving the lane early (i.e., prior to its charted terminus). It also should be noted that BOEM Lease Area OCS-A 0544 is adjacent to the eastern boundary of, and extends northward of, the Empire Wind Lease, OCS-A 0512. Placement of structures in the northern portion of Lease Area OCS-A 0544 may mitigate the perceived isolation of position A30.

Allision risk associated with this isolated turbine is therefore likely to be greater than other structures in this portion of the array. Appropriate lighting and marking will be necessary in consultation with USCG and BOEM noting that this will need to include consideration of appropriate redundancy, management, availability and maintenance/repair procedures to mitigate the risk of AtoN failure. The project will work with the USCG to identify any additional mitigation measures that may be necessary for this location.

4.3 Row Alignment and Spacing

The Layout Rules include objectives to ensure a clear and regular layout with a minimum structure spacing that includes at least one line of orientation, while creating understandable and predictable Project perimeters.

Reflecting these objectives, the Project base case has rows of structures with a north-south line of orientation, as well as perimeter rows on the northern and southern boundaries of the Lease Area that parallel the existing TSSs. The base case layout also includes rows of structures oriented in an approximately southeast-to-northwest (SE-NW) direction to accommodate the predominant trawling direction of the commercial fishing industry; however, these SE-NW rows contain several instances of deviation, largely to reflect the irregular shape of the Lease Area (while still preserving the clear north-south line of orientation).

The spacing between adjacent structures is no less than 0.65 nm (1.2 km) in all instances, except one. Specifically, position H16, located along the southern border of the Lease Area, is spaced 0.57 nm (1.06 km) from the position due north, G16, as depicted in Figure 4.2. Position H16 is located in the perimeter row parallel to the TSS, in conformance with the Layout Rules, to define clearly the Project perimeter. Siting position G16 0.65 nm to the north of position H16 would have preserved the minimum spacing but would have caused position G16 to be misaligned with the nominal SE-NW row. Empire sited G16 to preserve the SE-NW row and maintain the clearly defined, regularly spaced, perimeter positions. As a result, the distance between G16 and H16 is 0.57 nm (1.06 km), approximately 150 meters less than the 0.65-nm spacing minimum throughout the remainder of the layout.

The single instance of the 0.57 nm spacing between positions G16 and H16 does not appreciably change the risk of allision and as such does not change the findings of the NSRA.

The spacing is reduced only modestly, by approximately 150 meters, but the layout maintains the north-south line of orientation and places position G16 in a row aligned SE-NW. In addition, the 0.57 nm distance affects only an interior spacing, while preserving position H16 along the boundary of the Project to ensure a clearly defined perimeter. Empire will work with the USCG to identify any additional mitigation measures that may be necessary for this location.

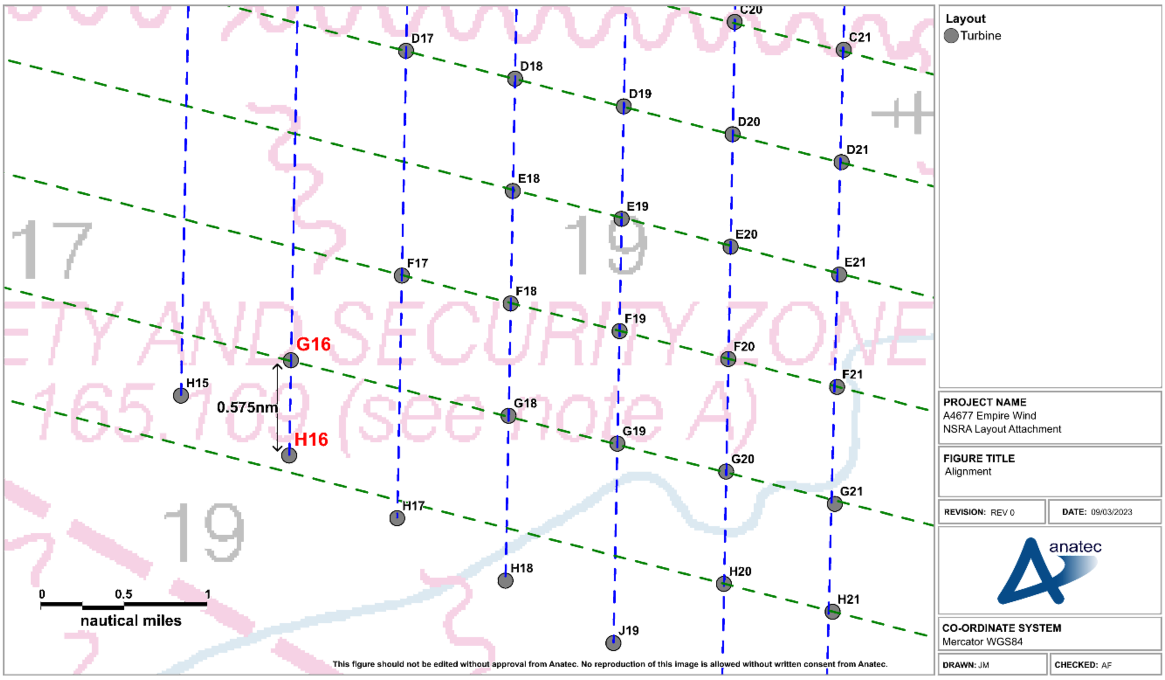

Figure 4.2: Lines of Orientation and Spacing Between Positions G16 and H16

4.4 FSA Summary

The output of the FSA is summarized in Table 4.1. This includes a summary of whether the implementation of the project base case could have any effect on the NSRA findings.

Table 4.1: FSA Summary Relative to Project Base Case

Impact	FSA Ranking in NSRA	Influence of New Layout
Deviations	▪ **Commercial vessels:** Broadly acceptable. ▪ **Recreational vessels:** Negligible (no impact). ▪ **Commercial fishing vessels:** Broadly acceptable. ▪ **Military vessels:** Broadly acceptable.	▪ Given the project base case layout contains fewer structures than the NSRA layout (and by extension greater average spacing), it is considered unlikely that the project base case layout would lead to increased deviation or displacement for any vessel type. Therefore, the significance ratings remain the same.
Increased encounters and collision risk	▪ **Commercial vessels:** Broadly acceptable. ▪ **Recreational vessels:** Broadly acceptable. ▪ **Commercial fishing vessels:** Broadly acceptable. ▪ **Military vessels:** Broadly acceptable.	▪ As detailed for the deviation impact, it is considered unlikely that the project base case layout would lead to increased deviation / displacement. On this basis it is unlikely that there would be increased collision based on increased deviation. ▪ Presence of a perceived or intentional corridor may lead to increased internal vessel to vessel encounters. However, expected vessel numbers are low based on the NSRA findings. Therefore, the significance ratings remain the same.
Powered allision	▪ **Commercial vessels:** Tolerable with embedded mitigation. ▪ **Recreational vessels:** Broadly acceptable. ▪ **Commercial fishing vessels:** Broadly acceptable. ▪ **Military vessels:** Broadly acceptable.	▪ Lower number of structures. ▪ The project base case layout maintains straight line edges with the TSS lanes including a 1 nm setback. ▪ Lighting and marking will be necessary to ensure all structures are clear. This should include consideration of appropriate redundancy, management, availability and maintenance/repair procedures to mitigate the risk of AtoN failure. The project will work with the USCG to identify any additional mitigation measures that may be necessary in particular for position A30. ▪ Assuming appropriate lighting and marking are employed through consultation with USCG and BOEM (including suitable AtoN management procedures), the significance ratings remain the same.
Drifting allision	▪ **Commercial vessels:** Broadly acceptable.	▪ Lower number of structures.

Impact	FSA Ranking in NSRA	Influence of New Layout
	▪ **Recreational vessels:** Broadly acceptable. ▪ **Commercial fishing vessels:** Broadly acceptable. ▪ **Military vessels:** Broadly acceptable.	▪ The project base case layout maintains straight line edges with the TSS lanes including a 1 nm setback. ▪ Lighting and marking will be necessary to ensure all structures are clearly identified, in particular structures which may be encountered by vessels transiting through. ▪ Assuming appropriate lighting and marking are employed through consultation with USCG and BOEM, the significance ratings remain the same.
Impact on emergency response capability	Broadly acceptable.	▪ The project base case layout maintains a single line of orientation and as such SAR access is equivalent to the NSRA layout.
Displacement of anchoring	Tolerable with embedded mitigation.	Layout is not relevant to this impact
Interaction with subsea cables	Tolerable with embedded mitigation.	Layout is not relevant to this impact
Port access disruption from project vessels	Broadly acceptable.	Layout is not relevant to this impact
Port access disruption from cable installation	Tolerable with embedded mitigation.	Layout is not relevant to this impact

5 Summary

This attachment to the Empire Wind NSRA has considered an updated project base case layout in terms of any impact on the NSRA findings taking account of the baseline traffic patterns based on assessment of 12 months of AIS data. The project base case layout is not considered as impacting the worst-case assessment within the NSRA on the basis that:

- Displacement is unlikely to increase given number of structures (and therefore occupied searoom) is decreasing;
- Collision risk is unlikely to increase given displacement is unlikely to increase;
- Allision risk is still considered tolerable assuming suitable lighting and marking is agreed with USCG (including consideration of appropriate AtoN management procedures to mitigate risk of AtoN failure); and
- SAR access via a Single Line of Orientation has been maintained.