VATTENFALL

Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Appendix 42 to Deadline 6 Submission: Thanet Offshore Wind Farm Collision Assessment of Proposed Extension

Relevant Examination Deadline: 6

Submitted by Vattenfall Wind Power Ltd

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Contents

1 Additional CRM Overview

1.1 Introduction

1 The Applicant, in the NRA submitted with the application, conducted a Collision Risk Model (Section 7.3 pg 77) to assess the relative change in collision risk (through vessel domain encounter likelihood) of vessels transiting within the study area between the project baseline condition (i.e. no TEOW in place) and several scenario's including with the application RLB (CRM Scenario 3).

2 The CRM showed that without inclusion of embedded or additional risk control measures, and with a conservative 33% human intervention factor (noting this number typically ranges from 33% up to 90% and is an allowance for the vessel bridge team to deconflict encounters) the encounter likelihood could be expected to increase by 54%. This is not a 54% increase in risk as it does not take into account the consequence element of the risk matrix. This relationship has been used in the quantitative element of hazard likelihood scoring for collision hazards, though within the NRA A hazard workshop the qualitative element was further increased – e.g. by another 50% in relation to Class 1 and 2 commercial vessel collisions.

3 Notwithstanding the results of the original CRM, that relate to the application RLB as at PEIR stage and which do not take into account the Structures Exclusion Zone (SEZ), the Applicant has commissioned a further CRM study, independent of the original CRM study, by a well-respected and experienced navigation risk consultant - Anatec Ltd - to investigate the relative change in risk between the baseline and the SEZ.

4 Anatec Ltd have exceptional experience in conducting CRM Assessments utilising their COLLRISK software. On this basis it is considered that COLLRISK has been accepted by the MCA and other key stakeholders as a suitable means by which to quantitatively assess collision risks of vessel traffic from offshore wind farms. UK Projects with applications supported by COLLRISK assessments which have subsequently gone on to be successfully consented include:

- Beatrice OWF
- Dogger Bank (Creyke Beck and Teesside) OWF
- Dudgeon OWF
- East Anglia One OWF
- East Anglia Three OWF
- European Offshore Wind Deployment Centre OWF

- Galloper OWF
- Greater Gabbard OWF
- Hornsea Project One OWF
- Hornsea Project Two OWF
- Hywind Demonstrator OWF
- Inchcape OWF
- Kincardine Demonstrator OWF
- Moray East OWF
- Race Bank OWF
- Rampion OWF
- Walney OWF
- Walney Extension OWF

5 The Anatec CollRisk CRM on the SEZ was undertaken entirely independent of the Application CRM undertaken by Marico Marine and used a different, but equally credible CRM methodology.

6 Based on concerns raised by IP's on the use of December data for the baseline application CRM, the input data used for the Anatec CollRisk CRM for the SEZ was AIS data from the month of September 2017. As with the NRA A, the additional Anatec CRM was focused in the area of most concern raised by interested parties, namely the sea area to the west of the TEOW (which includes the inshore route, the NE Spit pilot diamond, the NE Spit Racon and also the Tongue pilot boarding area). This aligns with the NRA A, however as the study areas differ, the results are not directly comparable with the original Marico CRM.

1.2 Purpose of the assessment

7 This independent assessment has been produced as a stand-alone piece of work to provide further evidence of the limited effect of Thanet Extension on shipping in the area of primary concern; the inshore area between NE Spit Racon and Elbow Buoy.

8 It does not relate directly back to the NRA or the NRA A but it provides confidence in the precautionary approach to scoring the increase in likelihood between the baseline and inherent risk scores.

9 The report has been deliberately commissioned independent of Marico Marine, the Applicant's navigation consultants, to allow for an independent assessment and corroboration of the broad conclusions of the NRA A; that the introduction of Thanet Extension will not lead to a significant increase in risk over the baseline and that there can be confidence in the conclusion that the project is ALARP.

1.3 Differences between the original CRM and this study

10 As stated above, this additional CRM does not, and was not intended, to directly correlate with the original CRM undertaken by Marico. As such, the quantum of collision return rates and the change associated with the introduction of TEOW differs.

11 The main differences can be broadly summed up as being due to:

- Reduced study area which, due to historical incident rates being lower in this area than the wider NRA study area, identifies a lower collision return rate.
- Introduction of the SEZ which has inherently reduced vessel density and therefore collision rates in the inshore area, when compared to the PEIR boundary on which the NRA CRM was undertaken.
- The Marico CRM looked at encounters between ship domains whereas the approach in this additional CRM identifies the increase in actual collisions, looking at a threshold of 'material damage'.

1.4 Key points of note

12 The results of the additional CRM conclude that the baseline collision return period in the reduced study area increased by 4% with the TEOW and SEZ in place.

13 When considering a 10% increase in traffic, the affect attributed to TEOW was also a 4% increase in collision rates, noting an overall 25% increase. This is still considerably below the increase attributed to inherent likelihood scores in the NRA A which were considered by IPs to be 50% more likely.

14 These increases can be compared with other approved wind farms including Hornsea Project One and Two which, using the same CollRISK model, were consented and presumably considered acceptable by statutory authorities, with collision rate increases far in excess of those identified for TEOW. The Applicant acknowledges that any increase must be set in context of the baseline risk, however it has been determined throughout the examination that the inshore area is not on the limited of tolerability and in purely quantitative terms, other offshore wind farms have been considered acceptable in areas of greater collision return periods than predicted for TEOW.

15 The report concludes that the increase over baseline incident rates is not considered significant.

Thanet Offshore Wind Farm Collision Assessment of Proposed Extension

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Presented to	Vattenfall
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00	17 May 2019	Initial Draft
01	23 May 2018	Updates following Internal Review
02	28 May 2018	Further updates

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Abbreviations Table

Abbreviation	Definition
AIS	Automatic Identification System
CCTV	Closed Circuit Television
DSC	Digital Selective Calling
ES	Environmental Statement
EU	European Union
m	Metres
MAIB	Marine Accident Investigation Branch
nm	Nautical Miles
NRA	Navigation Risk Assessment
RNLI	Royal National Lifeboat Institute
SEZ	Structures Exclusion Zone
TEOWF	Thanet Extension Offshore Wind Farm
TOWF	Thanet Offshore Wind Farm Site
UK	United Aberdeen
VHF	Very High Frequency
WFSV	Wind Farm Support Vessels

1 Introduction

This document presents a high level study into the potential impact of the modified Red Line Boundary (hereby referred to as the Option A site) for the proposed extension of the Thanet Offshore Wind Farm (TEOWF) on collision risk within the vicinity of the project. It should be noted that the Option A provides for the proposed extent of the area in which WTGs will be placed, and does not include the Structures Exclusion Zone (SEZ) in which the Applicant has committed to avoid installation of foundations

An increase in vessel to vessel collision frequency was identified as a potential risk within the Navigation Risk Assessment (NRA) (Marico, 2018) undertaken as part of the Environmental Statement (ES) submission. This has also been raised as an area of stakeholder concern noting the dense traffic levels in the area and the nearby pilot boarding locations. Given much of the concern has centred around vessel safety and manoeuvrability within the vicinity of the pilot boarding locations, this assessment has focused on the traffic inshore of the project (i.e., where the pilot boarding locations are positioned) to provide a more detailed level of quantification of risk as follows.

As part of the NRA a wider assessment than is considered within this report was undertaken to identify collision risk associated with the NRA boundary[1], third party vessels and wind farm support vessels (WFSVs). This collision risk assessment used historical collision incidents within area (Marine Accident Investigation Branch (MAIB) Data) and a calculation of encounters (with and without the wind farm) to factor a likely increase in risk. See section 7.3 of the NRA for details of this assessment. It estimated a return period of 1 collision per 6 years within the TEOWF and the surrounding area reducing to 1 in 4.5 with TEOWF in situ.

Within this report to further quantify the potential impact, collision risk has been assessed on a quantitative basis both pre and post TEOWF via the vessel to vessel collision function of Anatec's CollRisk modelling suite. This software model considers additional factors pertinent to collision including visibility conditions, historical incident rates per vessel type and size, and types of collision (e.g. head on, overtaking, crossing) (see section 4.2). A month of Automatic Identification System (AIS) data recorded during September 2017 has been used as the primary modelling input to ensure that the assessment is based on actual vessel movements, characteristics, and behaviours. Post extension risk has been assessed based on simulating likely deviations that will arise as a result of the Option A site. It has been identified by Estuary Services Limited that September is a busy month, and when considered as part of a wider 12 month data set is representative of a busier period

Additionally, historical incident data has been used to determine the types of marine incidents that typically occur in the area, and also the rates at which they occur. The findings in relation to vessel to vessel collision in particular have been compared against the findings of the modelling process.

[1] The NRA boundary is the red line boundary assessed as part of the Environmental Statement including within the NRA

2 Project Overview

The location of the project is shown in Figure 2.1. This includes the original Thanet Offshore Wind Farm (TOWF) and the proposed Option A site. Wind turbines will be placed within the entirety of the Option A. For reference, the locations of the local Pilot Boarding positions (based on the charted positions) are also shown.

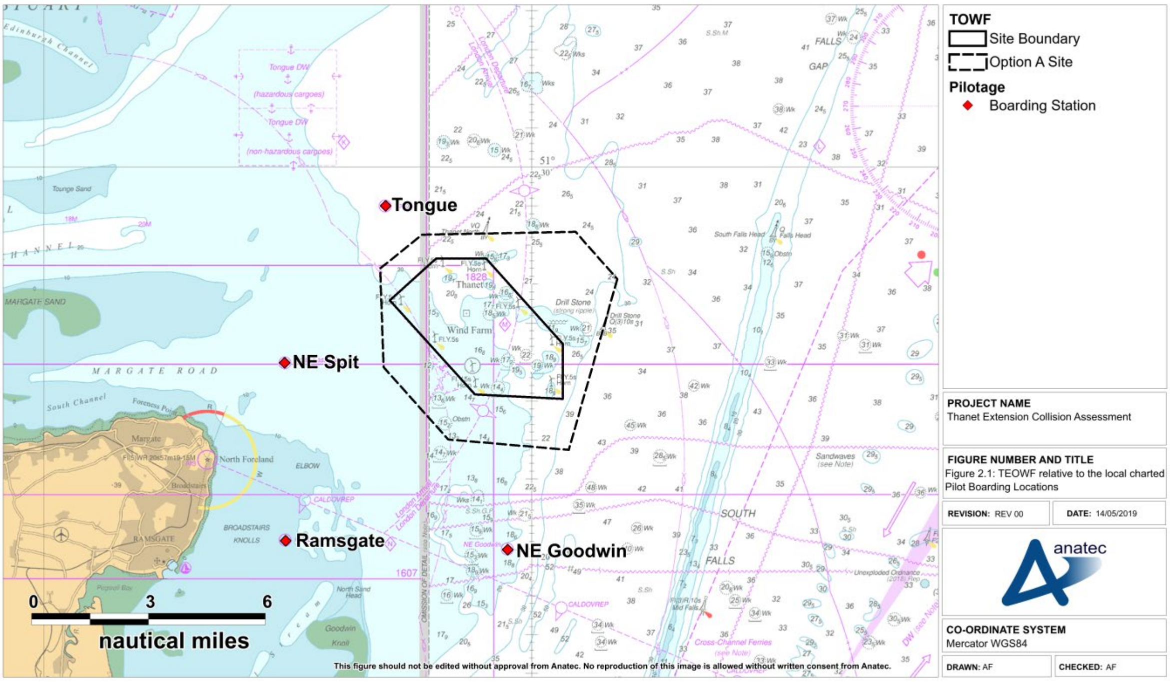

Figure 2.1 TEOWF relative to local charted Pilot Boarding Locations

Assessment of collision has been undertaken within an Area of Interest defined to align with the key stakeholder area of concern to the west of the Option A site. To accommodate the collision assessment, a 7 nautical miles (nm) buffer of the Option A site has been used as a study area to assess marine traffic. This radius ensured that the Area of Interest and all relevant routes were captured, noting that routes outwith the Area of Interest may still impact upon collision risk within it if wide enough.

Both the Area of Interest and the marine traffic study area are shown in Figure 2.2.

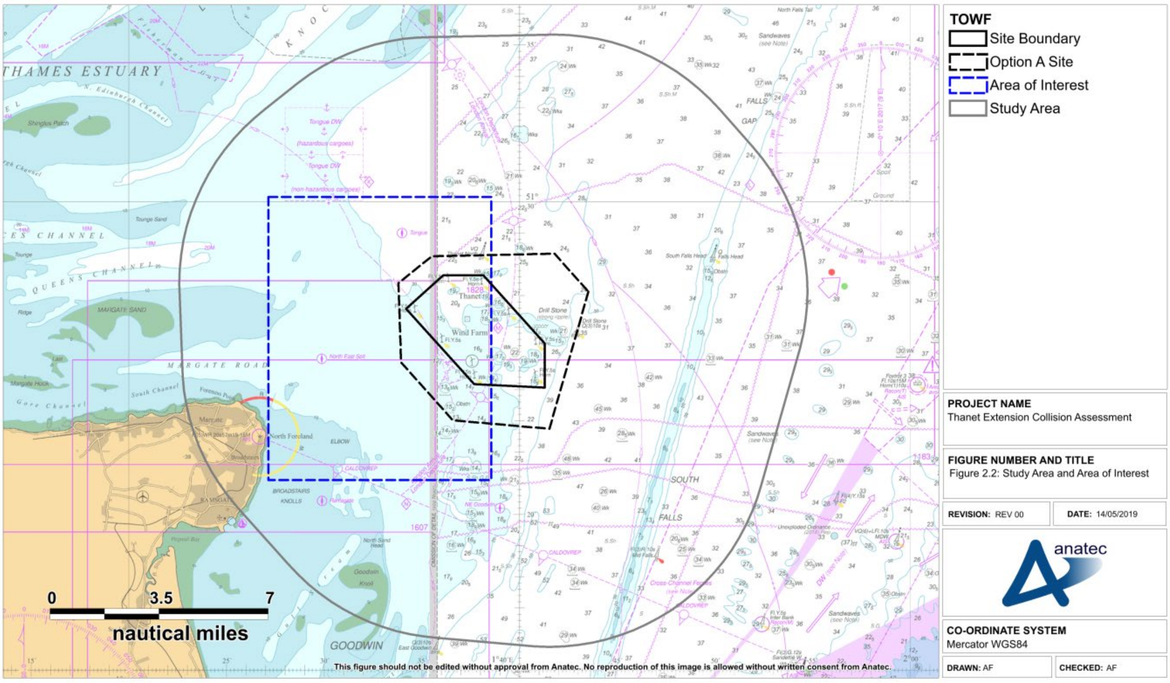

Figure 2.2 Study Area and Area of Interest

3 Data Sources

3.1 AIS

The primary input to this collision risk assessment is a month of AIS data recorded during September 2017 from coastal receivers. The period was chosen to match that of additional AIS data provided to Anatec by Vattenfall, which has been considered as part of this work for the purpose of validation.

As far as is practicable and for the purpose of ensuring accurate modelling input, additional research has been undertaken to identify vessel type and size where such information was not able to be determined via the data included with the AIS transmissions.

The month of AIS data is presented colour coded by type in Figure 3.1.

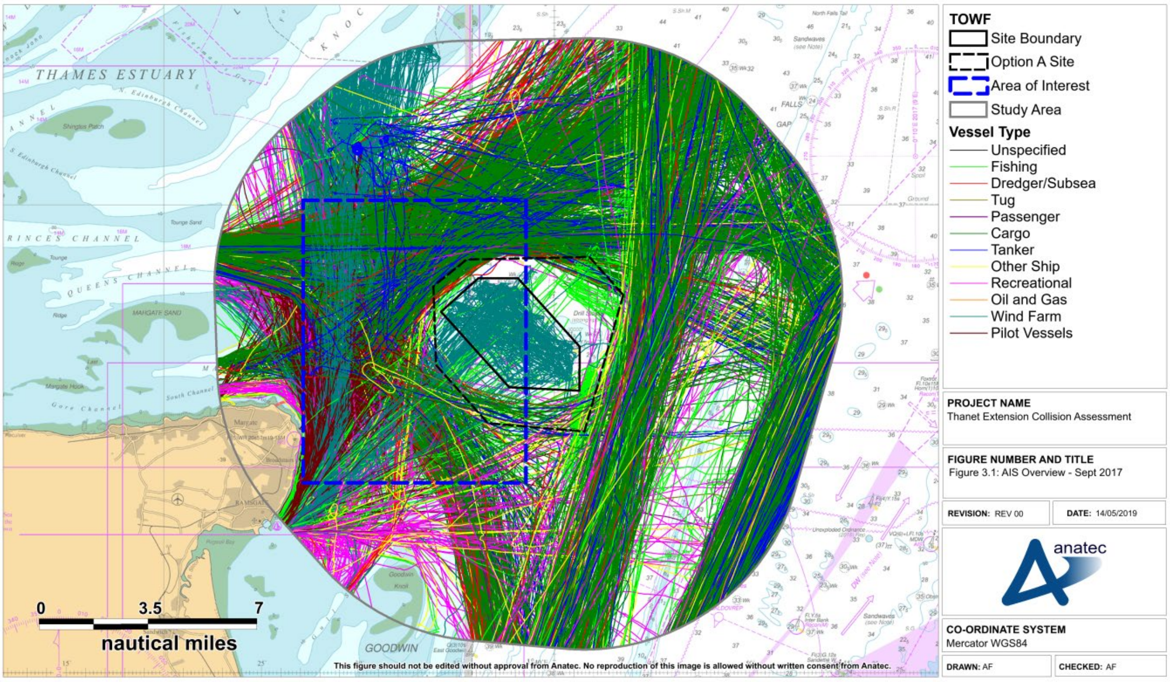

Figure 3.1 AIS Overview – Sept 2017

AIS covers all vessels of 300 gross tonnes and upwards engaged on international voyages and cargo vessels of 500 gross tonnes and upwards not engaged on international voyages and passenger vessels irrespective of size.

Fishing vessels of length 15 metres (m) and over have been required to carry AIS since 31st May 2014 under European Union (EU) Directive. Smaller fishing vessels are not required to broadcast on AIS, however it is noted that some still choose to do so on a voluntary basis given the safety benefits. There is also no requirement for recreational vessels to carry AIS, although again a minority do so voluntarily.

Consequently, it should be noted when viewing the AIS analysis that smaller fishing vessels and recreational vessels may be under-represented. However, it is noted that the purpose of this assessment is to quantify the change in risk from pre to post windfarm. Given the size and routeing of fishing and recreational vessels it is not considered likely that these vessels will change their habits and deviate or displace from the Option A site in notable numbers.

Finally, it should be noted that seasonal variations in vessel movements and routeing may not be fully represented by the September 2017 data set; however it is considered a robust data set in which to undertake this collision risk given it presents a varied level of seasonality including severe gales[2]. In order to account for increases in traffic a future case scenario (which also represents a busier period of traffic at the base case level by use of the busy September 2017 dataset as a baseline) has been considered in section 5.3.

It is also noted that Anatec's ShipRoutes is considered as part of the modelling process for the purpose of validating the AIS findings in terms of main routes and traffic levels. ShipRoutes is a vessel route database developed by Anatec to assist in identifying vessels passing in proximity to proposed offshore developments such as oil and gas platforms, windfarms and marine dredging areas. The database was developed in two main phases, notably a movement analysis (based on port calling data) and subsequent routeing analysis (passage between ports). This information was combined to create the ShipRoutes database which contains the majority of vessel routes passing through UK waters, with each route having a detailed distribution of vessel characteristics. This database was created over 15 years ago and is updated on a weekly basis by in house analysts.

3.2 Historical Incident Data

Maritime incidents that have occurred in the vicinity of the Option A site throughout ten year periods have been assessed using data collected by:

- MAIB (2005 to 2014); and
- The Royal National Lifeboat Institution (RNLI) (2008 to 2017).

The full assessment is given in Section 6.

3.2.1 MAIB

All United Kingdom (UK) commercial vessels are required to report accidents to the MAIB. Non-UK vessels do not have to report unless they are in a UK port or within 12nm territorial waters and carrying passengers to a UK port. There are also no requirements for non-commercial recreational craft to report accidents to the MAIB.

The MAIB aim for 97% accuracy when reporting the locations of incidents.

[2] Storm Aileen occurred mid-September 2017 with winds exceeding 50 miles per hour

3.2.2 RNLI

This data set includes details of incidents to which the RNLI have responded (i.e., mobilised at least one lifeboat) during the ten year period between 2005 and 2014. False alarms and hoaxes are not included.

4 Methodology

4.1 Deviations

4.1.1 Pre Extension

To ensure an accurate reflection of traffic pre extension, the collision pre wind farm has been based on the AIS data as it was recorded during September of 2017 (see Section 3.1). This ensured the pre extension case represented actual traffic patterns and densities; however it should be noted that anchored vessels were excluded from the analysis.

On this basis, the 30 days of AIS data was used as input to the vessel to vessel collision function of Anatec's CollRisk modelling suite (see Section 4.2). As can be seen in Figure 3.1, vessels in the area of the existing TOWF do set back from the structures in distances ranging from approximately 0.5nm upwards, with the majority weighted in excess of 1nm.

4.1.2 Post Extension

In order that the future case (i.e., post wind farm) could be accurately represented from a modelling perspective, it was necessary to identify the vessels that would be likely to deviate as a result of the proposed extension area. Based on experience of other operational wind farm projects (including the TOWF), it has been assumed that commercial vessels will deviate around the proposed extension, whereas smaller vessels (i.e., fishing and recreation) are likely to choose to transit though the array. However, given stakeholder concern over pilotage in the vicinity of the proposed extension, pilot vessels recorded within the proposed Option A site have been deviated.

4.1.2.1 Commercial (Regular Routed) Deviations

All vessels intersecting a 1nm buffer of the Option A site were isolated from the 30 days of AIS, noting that this excludes any vessels deemed as being unlikely to deviate as a result of TEOWF (i.e., fishing, recreation, and wind farm support). Pilot vessels were also excluded at this stage, and were considered separately as described in Section 4.1.2.2.

On this basis, Figure 4.1 shows the vessels considered as part of the regular routed deviation assessment. It should be considered that this includes certain vessels that are not necessarily "commercial" (e.g., military vessels), however the significant majority are cargo vessels or tankers on regular routes.

Each of these tracks was assigned to a "Route"[3] identified within the area of interest.

[3] Multiple vessels on a similar course.

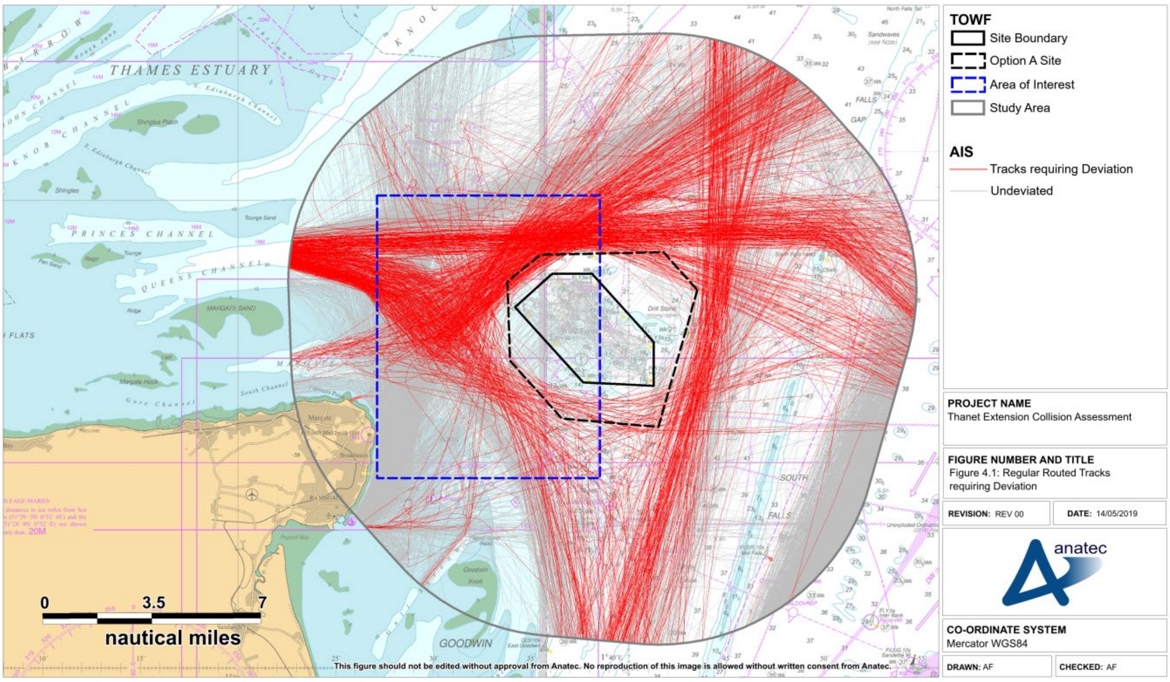

Figure 4.1 Regular Routed Tracks requiring Deviation

In line with standard practise for worst case vessel deviations, it has been assumed that mean route positions will deviate to a position 1nm from the wind farm boundary, which is considered a precautionary approach given a 0.5nm buffer has been recognised during the TEOWF examination as an appropriate distance for the prudent Mariner. The existing baseline indicates a range of setback distances as noted in section 4.1.1. The routes were deviated on this assumption, and then subsequently used as input to Anatec's AIS Simulator program, which outputs simulated AIS tracks based on input Mean Route Positions and standard deviations.

The simulated AIS output is shown in Figure 4.2.

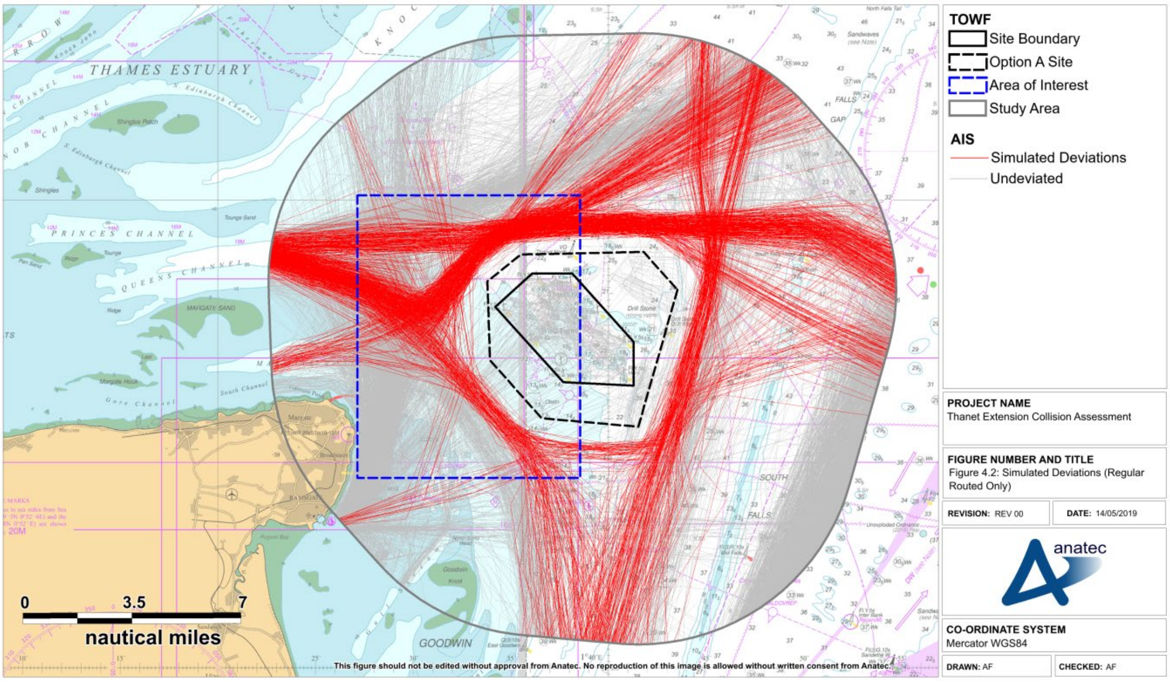

Figure 4.2 Simulated Deviations (Regular Routed Only)

4.1.2.2 Pilot Vessel Deviations

Given the nature of pilot vessel operations, and noting that the number of instances of pilot vessels intersecting the Option A site was limited (in comparison to the number of regular routed tracks requiring deviation as seen in Section 4.1.2.1), the associated deviations were implemented on a track by track basis, rather than via the use of grouping tracks into routes (i.e., the method used in Section 4.1.2.1).

The pilot vessel tracks intersecting a 1nm buffer of the Option A site (and therefore considered as requiring deviation) are shown in Figure 4.3. Each intersecting pilot vessel track was then deviated to keep its transit outside of the Option A site. These deviations are included in Figure 4.3. It is understood that this will misalign some pilot vessels with the commercial vessel they were attending however it is considered a worst case approach by estimating collision risk associated with displacement and increases in vessel activity (which may not occur).

It noted that sections of the pilot vessel tracks not intersecting the boundary have not been edited.

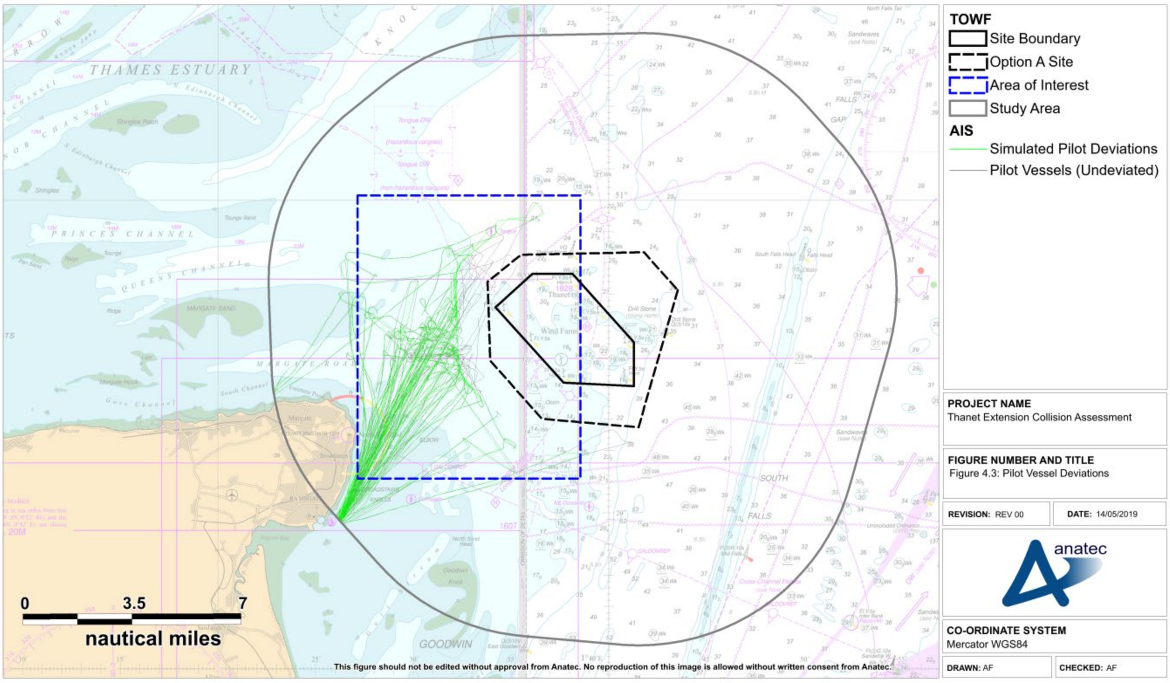

Figure 4.3 Pilot Vessel Deviations

4.2 CollRisk Overview

The vessel to vessel collision risk estimates the annual frequency at which a vessel will be involved in a collision within a given area. The risk of vessels colliding with other vessels is calculated using the Anatec CollRisk modelling suite which uses multiple stages to calculate the collision return period.

An encounter model uses a defined domain size for the area to identify encounters including head-on, overtaking or crossing situations.

Collision risk rates are then calculated using the exposure times stored within the input grid for the area (see section 4.3) as well as the main influencing factors:

- Site specific vessel type, size and speed information;
- Encounter situations (e.g., head-on, overtaking or crossing) including rates of likelihood of an encounter becoming a collision; and
- The model is calibrated against historical incident data within UK waters, and takes account of collision probability and consequences for various vessel types and sizes. The vessel to vessel collision function of Anatec's CollRisk modelling suite is calibrated against historic collision rates leading to at least "material damage[4]" to at least one of the vessels involved.

[4] The MAIB refer to material damage 'as damage to marine infrastructure external of a vessel that could seriously endanger the safety of the vessel, another vessel or any individual'.

The model also accounts for the potential of poor visibility (less than 1km) to increase the likelihood of a collision. The typical UK value of 3%[5] has been assumed within this assessment which is in line with other offshore renewable NRAs.

Any assessment of consequence is outside of the scope of this work.

Pilot vessel to pilot vessel collisions have been excluded from the assessment.

4.3 Durations

The vessel to vessel collision function of Anatec's CollRisk modelling suite (see Section 4.2) uses a vessel durations grid as input. Durations measure the number of hours (per year) that vessels were within that cell, split by the type and size categories utilised by the model.

For the purposes of the collision modelling for the TEOWF, a 250 x 250m resolution grid was defined covering the Area of Interest. Each cell of the grid was then populated with the pre and post extension durations via the AIS as follows:

- Pre extension: AIS data as it was recorded in September 2017, excluding anchored vessels; and
- Post extension: the pre extension data set with the tracks from any vessels deemed as requiring deviation replaced by the simulated data sets created as per Section 4.1.2.1 (regular routed) and 4.1.2.2 (pilot vessels).

Speeds of the simulated tracks have been based on average speeds of the input tracks.

As the vessel to vessel collision function of Anatec's CollRisk modelling suite estimates annual frequency, the durations were factored up to an annual value.

[5] Estimated based on All Year Weather Data - Central North Sea (Forties), 1st January 1975 to 31st December 1994, Norwegian Meteorological Institute, Weather Data Recorded at the Frigg Field from January 1981 to December 1997, and Met Office Data for Sea Area 52.7-54.3° North, 001-003° East, October 1854 to October 1992.

5 Collision Assessment

5.1 Pre Extension

The results of the collision modelling for the pre extension case are presented in Figure 5.1. Overall, it was estimated that the annual frequency at which a vessel would be involved in a collision within the Area of Interest pre extension was 2.11 x 10^{-2} which corresponds to once every 47 years.

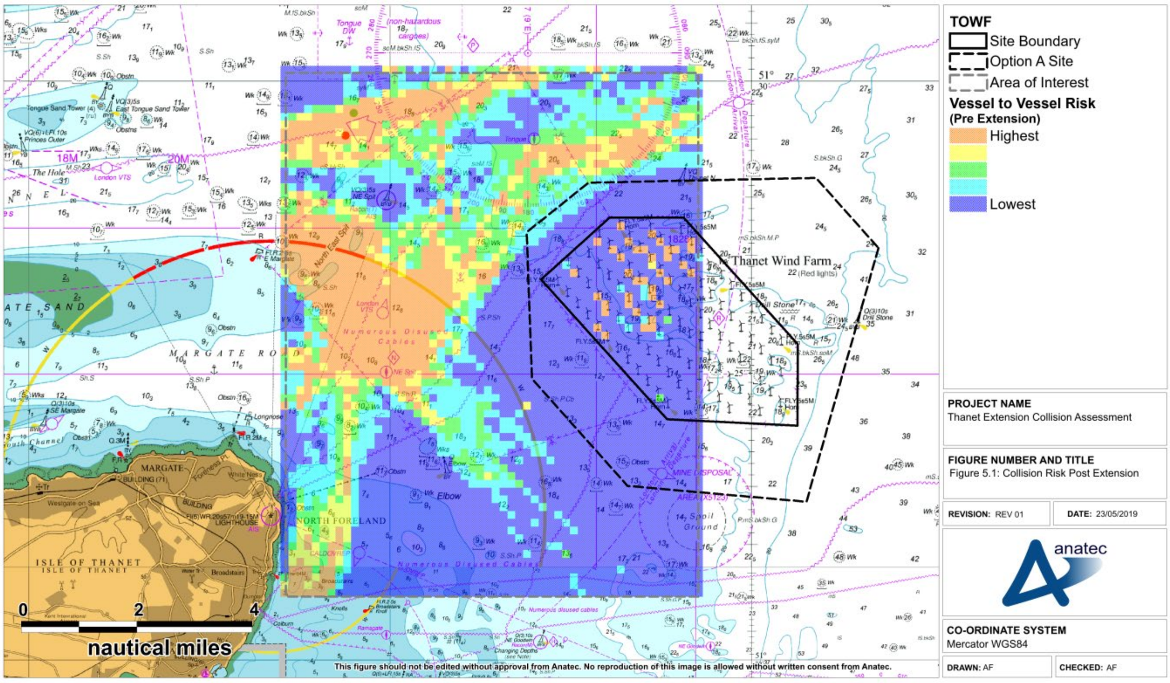

Figure 5.1 Collision Risk Pre Extension

The majority of the pre extension collision risk was observed to be within the area directly west of the Option A site, where busy routes intersected the area in the vicinity of the pilot boarding area. Vessels currently passing north of the existing TOWF boundary were observed to create an area of moderate to high risk within the immediate vicinity of the northern Option A site.

For reference, pilot vessels accounted for approximately 6% of the total risk.

5.2 Post Extension

The results of the collision risk assessment post extension are shown in Figure 5.2. Overall, it was estimated that the annual frequency at which a vessel would be involved in a collision within the Area of Interest post extension was 2.19 x 10^{-2} which corresponds to once every 46 years.

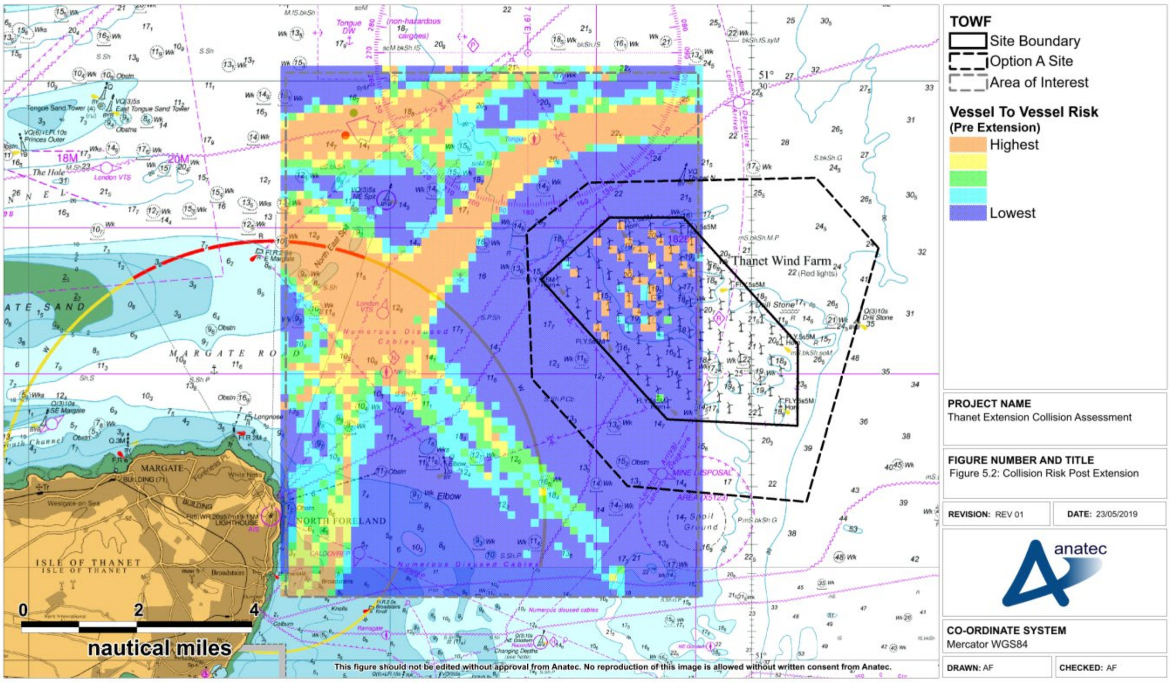

Figure 5.2 Collision Risk Post Extension

Based on the pre and post extension collision assessments, collision risk within the Area of Interest was estimated to rise by 4%, with the key difference being a reduction in risk in the immediate vicinity of the western Option A site, noting that the associated deviations resulted in an increase in risk further from the site. This change in risk within the Area of Interest is illustrated graphically in Figure 5.3, which shows where the risk is anticipated to increase, decrease, and remain unchanged, based on the results of the pre and post extension assessments.

As for the pre extension case, pilot vessels accounted for approximately 6% of the total risk post extension.

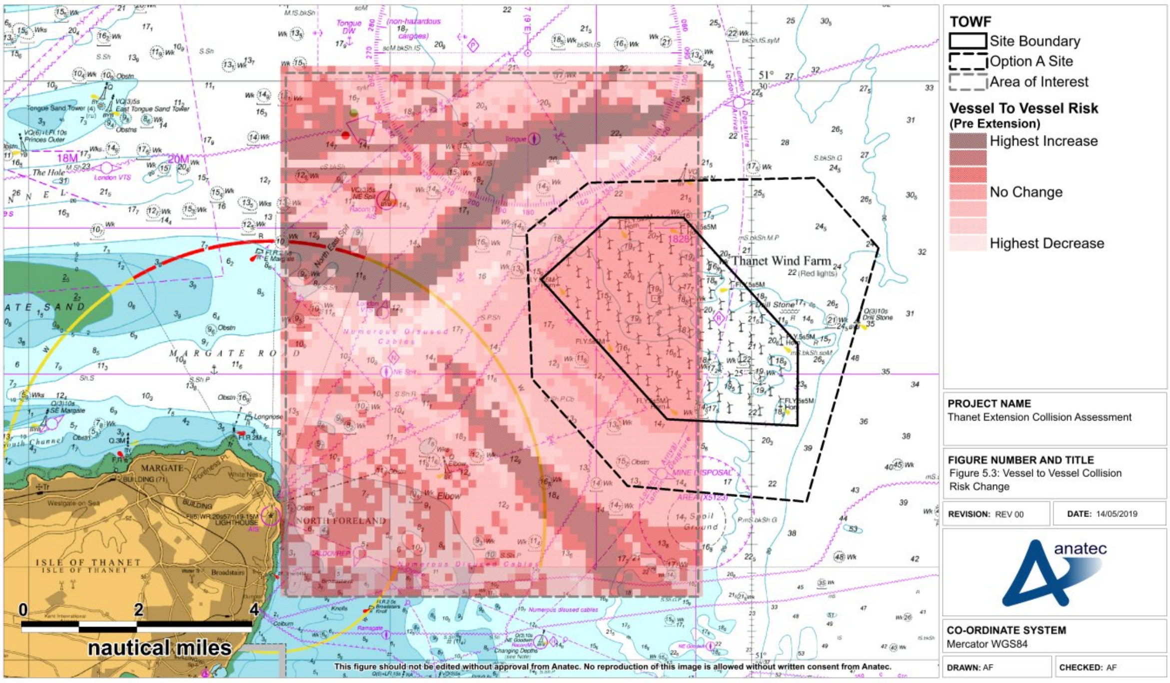

Figure 5.3 Vessel to Vessel Collision Risk Change

As indicated by Figure 5.3, the majority of the increase in risk is estimated to occur to the west/north-west of the Option A site. This increase was due to the deviation of regular routed vessels currently intersecting the Option A site further west, increasing the density of traffic and thus the collision risk.

There was a reduction in the immediate vicinity of the boundary noting the assumption that vessels will generally maintain a 1nm passing distance from the Option A site. A reduction was also observed around the charted pilot boarding area, which was due to the vessels on transit through the area being predicted to navigate in a more defined route, creating denser traffic to the north of the existing and continued pilot boarding activity. It is noted that this decrease was due to commercial traffic deviation; with the risk from pilot vessels remaining unchanged given the associated activity was assumed to remain as per the pre extension case, with the exception of within 1nm of the Option A site.

5.3 Future Case Traffic Growth

To ensure the potential for future traffic growth was incorporated into the assessment, an additional modelling process assuming increased vessel numbers has been undertaken. Changes in traffic trends are difficult to predict, and therefore a flat 10% increase has been considered. This value is in line with that assumed for the larger majority of NRAs undertaken for North Sea offshore renewables projects, including that undertaken for the Thanet Extension (Marico, 2018).

On this basis, the duration's grids created for the pre and post extension scenarios (see Section 4.3) were factored up by 10%, and the collision modelling was subsequently rerun to account for increased traffic growth.

The results of the future case traffic assessment are summarised in Table 5.1.

Table 5.1 Future Case Traffic Assessment

Scenario	Annual Frequency (Rtn Prd)	
	0% (Base Case)	10% (Future Case)
Pre Extension	2.11×10^{-2} (47 years)	2.55×10^{-2} (39 years)
Post Extension	2.19×10^{-2} (46 years)	2.64×10^{-2} (38 years)

Assuming future case traffic levels, it was estimated that post extension, a vessel would be involved in a collision once every 38 years, which represents an increase of 25% over that of the base case pre extension scenario.

It is important to view this result within the context of the results of the future case pre extension (i.e., the scenario in which the extension is not built and traffic levels rise by 10%). Under these conditions, it was estimated that the risk would rise by 21%, and it can therefore be concluded that the majority of the increase of the future case post extension (25% as above) is a consequence of the traffic levels and not the extension (which accounts for the additional 4% increase).

5.4 Other Wind Farms

To provide context to the collision modelling undertaken within this supplementary assessment, results of similar modelling processes undertaken as part of the applications for other wind farm projects are summarised in Table 5.2. Both the pre and post wind farm results are included in the table, as is the approximate percentage increase that the change represents.

It should be considered when viewing the results that the modelling within this assessment has focussed in on a specific Area of Interest, whereas the other projects were assessed within a larger study area (typically 10nm around the wind farm). On this basis the results are not directly comparable (in the sense that the risk estimated for the TEOWF would increase in an equivalent study area), however they are considered as providing context to this assessment at a high level.

Table 5.2 Collision Modelling Results for Other Recent Wind Farms[6]

Wind Farm Project	Vessel to Vessel Collision Return Period		Approximate % Increase
	Pre Wind Farm	Post Wind Farm	
Thanet Extension	1 every 47 years	1 every 46 years	4%
Hornsea Three *361 structures* Decision Phase	1 every 193 years	1 every 152 years	27%
Hornsea Project Two *368 structures* Consented	1 every 44 years	1 every 36 years	22%
Hornsea Project One *345 structures* Consented	1 every 74 years	1 every 60 years	23%
Rampion *175 structures* Commissioned	1 every 1.2 years	1 every 1.2 years	Negligible

The estimated future case collision risk for TEOWF is within consented wind farm parameters.

The 4% increase in collision risk (base and future) estimated for the TEOWF is low when considered against the other wind farms studied (with the exception of Rampion). This is reflective of the associated deviations being minor in comparison to the other projects, noting that rerouteing has already been established around the TOWF.

The CollRisk Modelling Suite was used for the constructing East Anglia One and consented East Anglia Three projects however given the projects opted for a cumulative approach to modelling the results are not comparable.

[6] Collrisk Modelling Suite used for each project

6 Historical Incident Assessment

6.1 MAIB

Incident data collected by the MAIB during the ten year period between 2005 and 2014 is shown in Figure 6.1. To provide an overview of incident types and rates in the area, all incidents detailed by the MAIB as occurring within the study area (as defined in Section 2) are shown, however the Area of Interest is included in Figure 6.1 for reference.

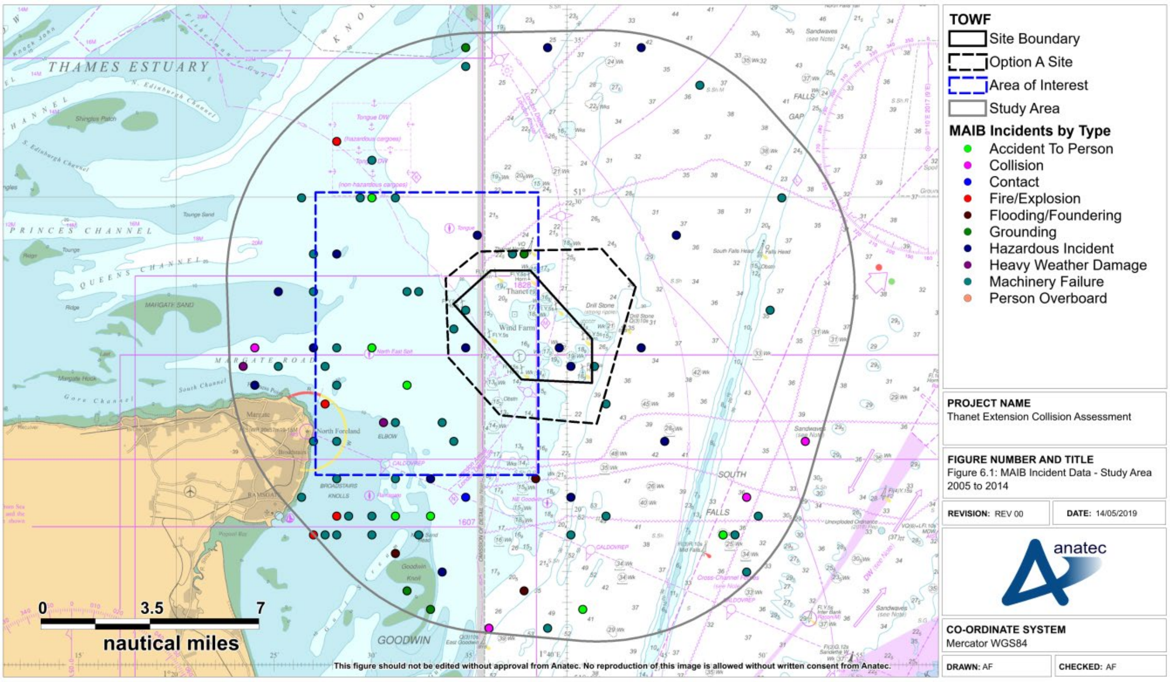

Figure 6.1 MAIB Incident Data within Study Area – 2005 to 2014

A total of 88 incidents were recorded by the MAIB within the study area between 2005 and 2014. Of these, 25 were within the Area of Interest. The most common incident type within the area was observed to be "Machinery Failure", with such incidents accounting for 50% of the total within the Study Area, rising to 60% within the Area of Interest.

In terms of collision incidents, a total of four were recorded by the MAIB as occurring within the study area, none of which were within the Area of Interest. The locations of these incidents are shown in Figure 6.2.

It should be noted that the modelling process (see Section 5) did not include consideration of anchored vessels, whereas no such filtering has been applied to the MAIB incident data. It should also be considered that the modelling process was based on study of AIS data, and therefore as is discussed in Section 3.1, smaller vessels (notably fishing vessels less than 15m and recreational vessels) may be underrepresented within the modelling relative to the MAIB data.

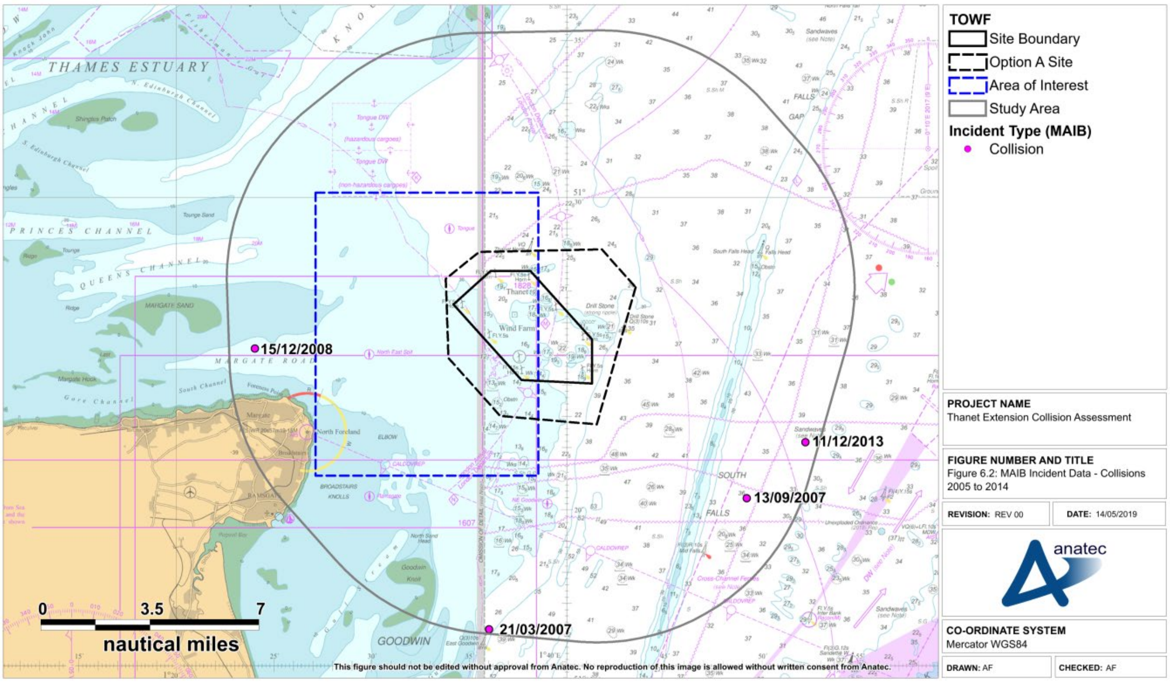

Figure 6.2 MAIB Collision Incident Data within Study Area – 2005 to 2014

Each of the four collision incidents are summarised as follows:

- **21st March 2007:** collision between a cargo vessel in transit and a beam trawler engaged in fishing. Cargo vessel was ruptured above the waterline and proceeded to port for repair, the fishing vessel suffered only superficial damage.
- **13th Sept 2007:** collision between a fishing vessel and a barge (being towed by a tug). Minor damage to the fishing vessel and the barge.
- **15th December 2008:** Collision between a tanker dragging anchor and a second nearby tanker. Both vessels suffered minor damage.
- **11th December 2013:** A cargo vessel altered course to avoid a collision with a fishing vessel crossing ahead (which was engaged in fishing at the time), and subsequently collided with an overtaking bulk carrier. Both the cargo vessel and the bulk carrier suffered “material damage”.

It is noted that only the latest of these four collisions has occurred since the TOWF became operational in 2010, and given the location of this incident (not in close proximity to TOWF) it is not considered likely as being a contributing factor, noting that that this incident involved a vessel engaged in fishing.

6.2 RNLI

Data collected by the RNLI for incident responses during the ten year period between 2008 and 2017 is shown in Figure 6.3. As for the MAIB analysis (see Section 6.1), all incidents occurring within the study area (as defined in Section 2) are shown, however the Area of Interest is included for reference.

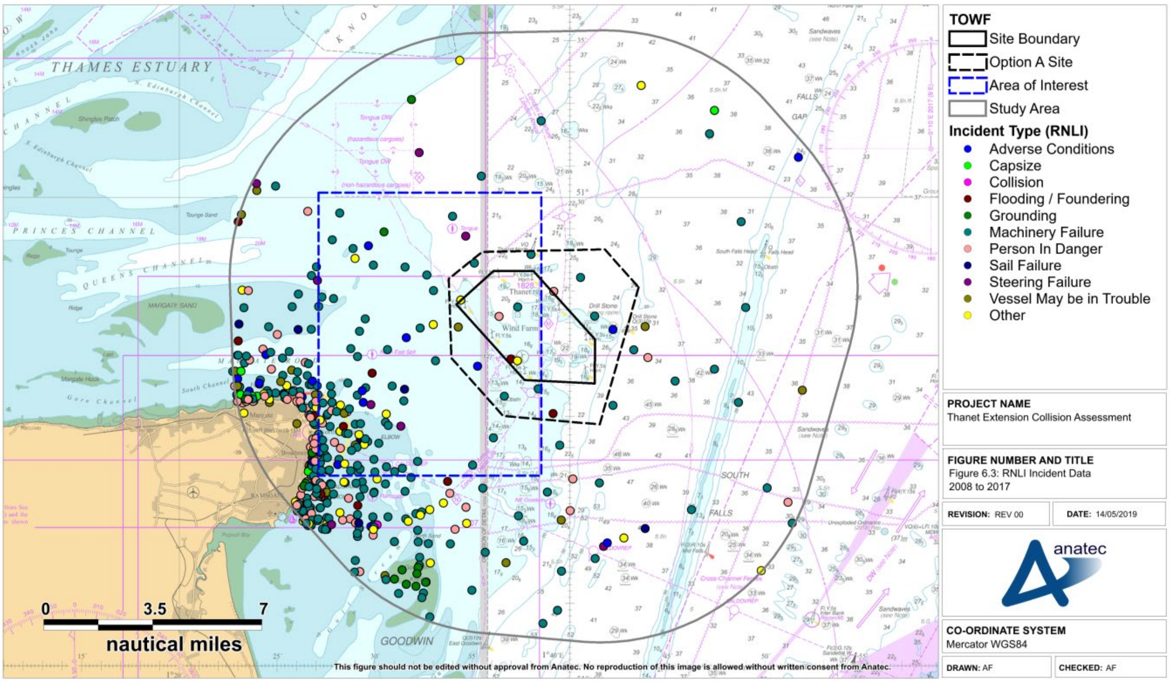

Figure 6.3 RNLI Incident Data within Study Area – 2008 to 2017

A total of 455 incidents were responded to by the RNLI within the study area, 112 of which occurred within the Area of Interest. As for the MAIB assessment (see Section 6.1), the majority of incidents were classed as "Machinery Failure" in both the study area as a whole (53% of the total) and the Area of Interest (70% of the total).

Only one collision was responded to during the ten year period studied (based on the available data), approximately 1.5nm south of the Area of Interest. This incident occurred on the 27th May 2012 and was responded to by a Trent class lifeboat mobilised from Ramsgate. The collision involved a sail training vessel, however further details were unavailable (including details of other vessels involved).

6.3 Modelling Context

As per Section 5, it was estimated that a vessel would be involved in a collision once every 47 years at base case traffic levels and patterns within the Area of Interest. No collisions were recorded as occurring within the Area of Interest in either of the MAIB or RNLI datasets for the ten year periods studied for each; however it should be considered that collisions were recorded in close proximity to the Area of Interest within both datasets.

The primary purpose of the additional MAIB and RNLI analysis was to determine whether the results of the modelling process were in line with actual incident data, and it is considered that both assessments show that a collision is likely to occur within the Area of Interest during the operational lifetime of the Project. However, it should be considered that the available data provides no indication that the TOWF has had any notable impact on collision frequency since it became operational (albeit noting that the timeframe within which data has been assessed is insufficient to draw firm conclusions).

Further in depth assessment of historic incident data over a longer period is available within the NRA (Marico, 2018).

It is noted that the CollRisk modelling suite does consider historical data which is not attributable to the development of wind farms.

6.4 Wind Farm Support Vessels

As noted within the NRA, WFSV will increase traffic volumes within the area and without mitigation could increase collision risk levels. The tracks from WFSV at established wind farms were accounted for within the modelling (see Section 4), however it should be noted that additional traffic associated with the TEOWF presents an unknown future case routeing scenario and has not been modelled.

7 Summary of Results

This assessment has estimated collision frequencies within the vicinity of the proposed TEOWF boundary, based on a month of AIS data recorded during September 2017. The data was used to demonstrate the collision risk prior to the extension being constructed, with a simulation of future activity then used to estimate the change in collision risk following construction.

Based on the results of the assessment, it was estimated that a vessel would be involved in a collision once per 47 years assuming base case traffic levels and patterns, rising to once every 46 years following construction of the extension. This represents a rise of approximately 4%. Within the context of baseline incident rates this is not considered as a significant increase. It is noted that the lifetime of the projects will be consented to be 30 years and although the modelling does not given any indication as to how soon an incident may occur given the overarching return period estimated it may not occur within that 30 year lifetime.

An additional analysis of potential rises in traffic estimated (assuming a 10% increase in traffic), that collision rates would rise by approximately 25%. However, the majority of this increase was observed to be from the rise in traffic rather than the deviations, given that simply increasing the traffic by 10% without deviating the traffic still raised collision rates by 21%.

The difference in the collision risk return period has increased (positively) to a collision one every 46 years within this assessment (base case levels of traffic with TEOW in place). This is attributed to the main factors as follows:

- Change in TEOWF boundary from the NRA to the Option A site (with SEZ in place) and therefore reduced impact of the TEOW is evident in the revised CRM.
- Smaller study area which necessarily focused on the specific risk attributed to change in traffic patterns around the western boundary of the TEOWF - rather than accounting, as an example, for the denser traffic routes to the east of the site and located within the 10nm study area considered within the NRA.
- In the CollRisk an assessment of encounters and then an assessment of collision risk using the CollRisk model (as defined in section 4.2) was undertaken, it is noted that an increase in encounters is not assumed to correlate in direct proportion to an increase in collision risk.
- A more detailed assessment was undertaken in the CollRisk compared to the original collision risk modelling as it calibrates collision likelihood against a wider statistical data set of UK waters - which considers incidents resulting in material damage.

8 References

Marico (2018). *Thanet Extension Offshore Wind Farm: Navigation Risk Assessment*. Hampshire: Marico.

Appendix A – Anatec's COLLRISK

Quantified risk assessments associated with the supplementary collision assessment for the proposed Thanet Extension were 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.

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 the following have been considered and justified:

- Tuning of parameters
- Consistency checks
- Behavioural reasonableness
- Sensitivity analysis
- Comparison with the real world

The COLLRISK software has been utilised 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.

UK Projects with applications supported by COLLRISK assessments which have subsequently gone on to be successfully consented include:

- Beatrice;
- Dogger Bank (Creyke Beck and Teesside)
- Dudgeon;
- East Anglia One;
- East Anglia Three;
- European Offshore Wind Deployment Centre;
- Galloper;
- Greater Gabbard;
- Hornsea Project One;
- Hornsea Project Two;
- Hywind Demonstrator;
- Inchcape;
- Kincardine Demonstrator;
- Moray East.
- Race Bank;
- Rampion;
- Walney;
- Walney Extension;
- West of Duddon Sands.

COLLRISK is recognised as industry-leading software in the specialist field of collision risk assessment. It is referenced to by International Oil and Gas Producers Association in the Risk Assessment Data Directory report for Vessel/Installation Collisions[7] under "Best practice collision risk modelling for passing vessels[8]".

[7] Allisions

[8] International Association of Oil & Gas Producers (IOGP), Risk Assessment Data Directory, Ship/Installation Collisions, Report No. 434-16, March 2010.