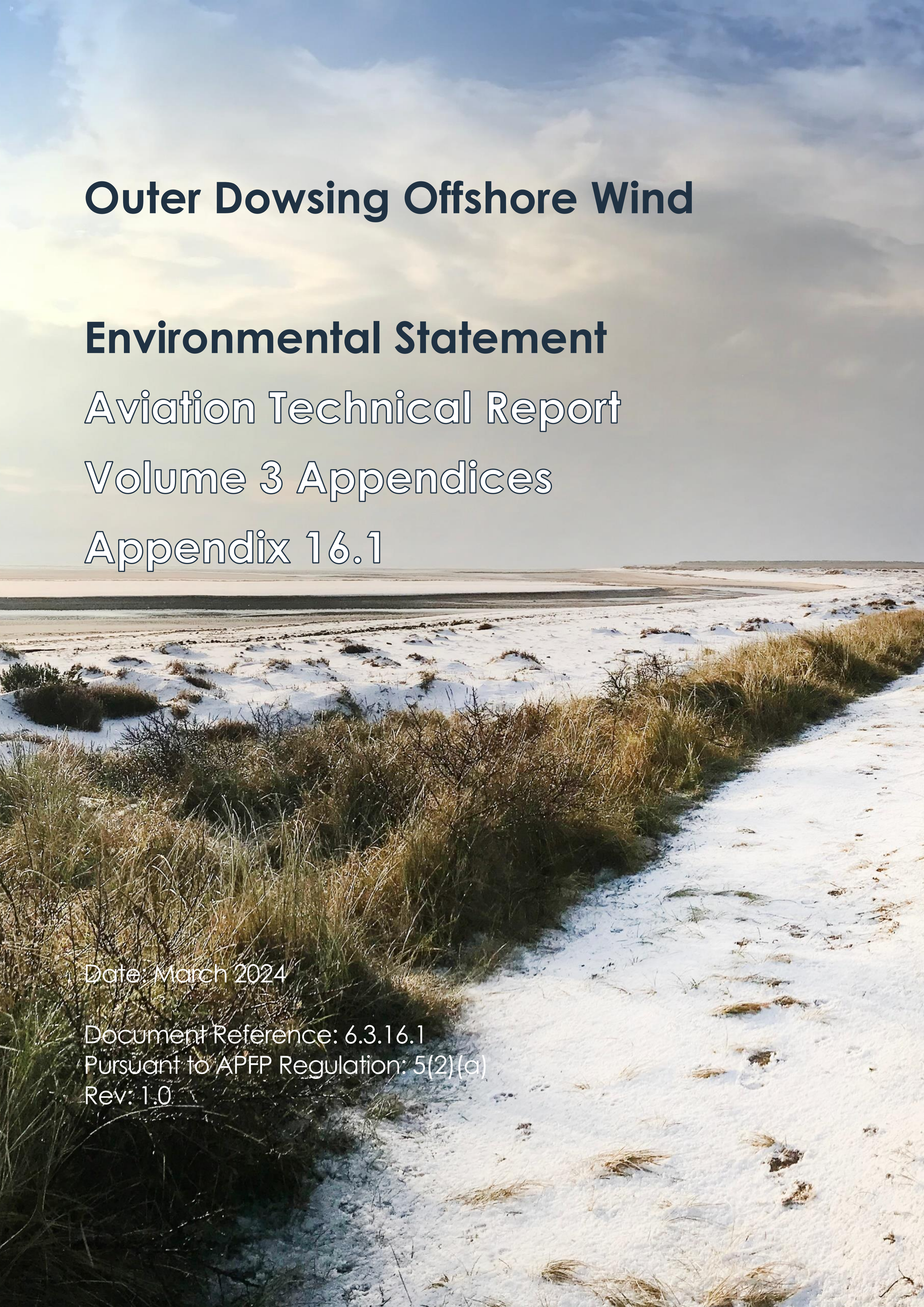

Outer Dowsing Offshore Wind

Environmental Statement

Aviation Technical Report

Volume 3 Appendices

Appendix 16.1

Date: March 2024

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Airspace Analysis and Radar Modelling

Outer Dowsing Offshore Wind

March 2024

CL-5685-RPT-005 V2.0

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Abbreviations

AARA	Air to Air Refuelling Area
AD	Air Defence
AD&OW	Air Defence and Offshore Wind
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
ATA	Aerial Tactics Area
ATC	Air Traffic Control
ATS	Air Traffic Service
BEIS	Department for Business, Energy and Industrial Strategy
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CTA	Control Area
DA	Danger Area
DASA	Defence and Security Accelerator
DESNZ	Department for Energy Security and Net Zero
DOC	Designated Operational Coverage
DTM	Digital Terrain Model
FIR	Flight Information Region
FL	Flight Level
ft	feet
GIS	Geographic Information System
HMRI	Helicopter Main Routing Indicator
IFR	Instrument Flight Rules
km	kilometres
LARS	Lower Airspace Radar Service
LAT	Lowest Astronomical Tide
m	metres
MDA	Managed Danger Area
MHWS	Mean High Water Springs
MOD	Ministry of Defence
MRT	Multi Radar Tracking
MW	Mega Watt
NAIZ	Non-Auto Initiation Zone

NERL	NATS En Route plc
nm	nautical miles
ODOW	Outer Dowsing Offshore Wind
OSA	Offshore Safety Area
PEIR	Preliminary Environmental Impact Report
PSR	Primary Surveillance Radar
RAF	Royal Air Force
RLoS	Radar Line of Sight
RRH	Remote Radar Head
S&IP	Strategy and Implementation Plan
SAR	Search and Rescue
SSR	Secondary Surveillance Radar
SUA	Special Use Airspace
TRA	Temporary Reserved Area
TMZ	Transponder Mandatory Zone
UK	United Kingdom
VFR	Visual Flight Rules
WTG	Wind Turbine Generator

References

[1] CAP 032 UK Aeronautical information Publication (CAA, 2023)

[2] CAP 764 Policy and Guidelines on Wind Turbines (CAA, 2016)

Contents

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1. Introduction

1.1. Overview

1.1.1. This document is the appendix to Volume 1, Chapter 16: Aviation, Radar, Military and Communication of the Outer Dowsing Offshore Wind ("the Project") Environmental Statement (ES). It provides detailed airspace analysis and radar modelling and outlines potential mitigation options.

1.1.2. The proposed windfarm array area is approximately 54 kilometres (km) off the coast of Lincolnshire and covers an area of 436 square kilometres (km^2).

1.2. Effects of Wind Turbine Generators on Aviation

1.2.1. Wind turbine generators (WTGs) can be problematic for aviation Primary Surveillance Radars (PSRs) as the characteristics of a moving WTG blade are like an aircraft. The PSR is unable to differentiate between wanted aircraft targets and clutter targets introduced by the presence of WTGs.

1.2.2. Potential impacts on the NATS En Route plc (NERL) PSR facilities at Cromer and Claxby, and the Ministry of Defence (MOD) Air Defence (AD) PSRs at Trimingham and Staxton Wold were identified at the Scoping stage.

1.2.3. The significance of any radar impacts depends on the airspace usage and the nature of the Air Traffic Service (ATS) provided in that airspace. The classification of the airspace in the vicinity of the array area and the uses of that airspace (civil and military) are set out in this appendix.

1.2.4. Radar impacts may be mitigated by either operational or technical solutions or a combination of both. In either case, the efficacy and acceptability of any operational and/or technical mitigation options available can only be determined through protracted consultation with the radar operators/ATS providers.

1.3. Technical Data

1.3.1. Radar Data

1.3.1.1. Radar parameters used in the assessment have been taken from data held on file by Cyrrus, and from the following documents:

- Raytheon ASR-10SS equipment brochure (Raytheon, 2007);
- Raytheon ASR-23SS equipment brochure (Raytheon, 2007); and
- Lockheed Martin AN/TPS-77 Factsheet B013-03 (Lockheed Martin, 2013).

1.3.2. The Project Array Area Boundary

1.3.2.1. The array area boundary for the ES was supplied as a geo-referenced Shapefile:

- ODOW_AmendedArrayArea_Option1_revised.shp.

1.3.3. WTGs

1.3.3.1. Five categories of WTG are under consideration with various rotor diameters. The design parameters for these WTGs are shown in Table 1.

Table 1: WTG design parameters

Parameter	WTG1	WTG2	WTG3	WTG4	WTG5
Rotor blade diameter	236m	242m	265m	300m	340m
Minimum height of lowest blade tip Above Mean Sea Level (AMSL)	40m	40m	40m	40m	40m
Minimum WTG spacing	841m	847m	870m	905m	945m
Number of WTGs	100	93	75	60	50

1.3.3.2. For the Project, a maximum blade tip height of 403m above Lowest Astronomical Tide (LAT) is to be retained for consideration. The difference between MSL and LAT is between -2.42m and -2.22m within the array area, therefore a maximum tip height of 400m AMSL will be assessed. For the smallest rotor diameter a minimum blade tip height of 276m AMSL will be assessed.

1.3.3.3. Indicative layouts for the five WTG categories are shown in Figure 1, Figure 2, Figure 3, Figure 4 and Figure 5.

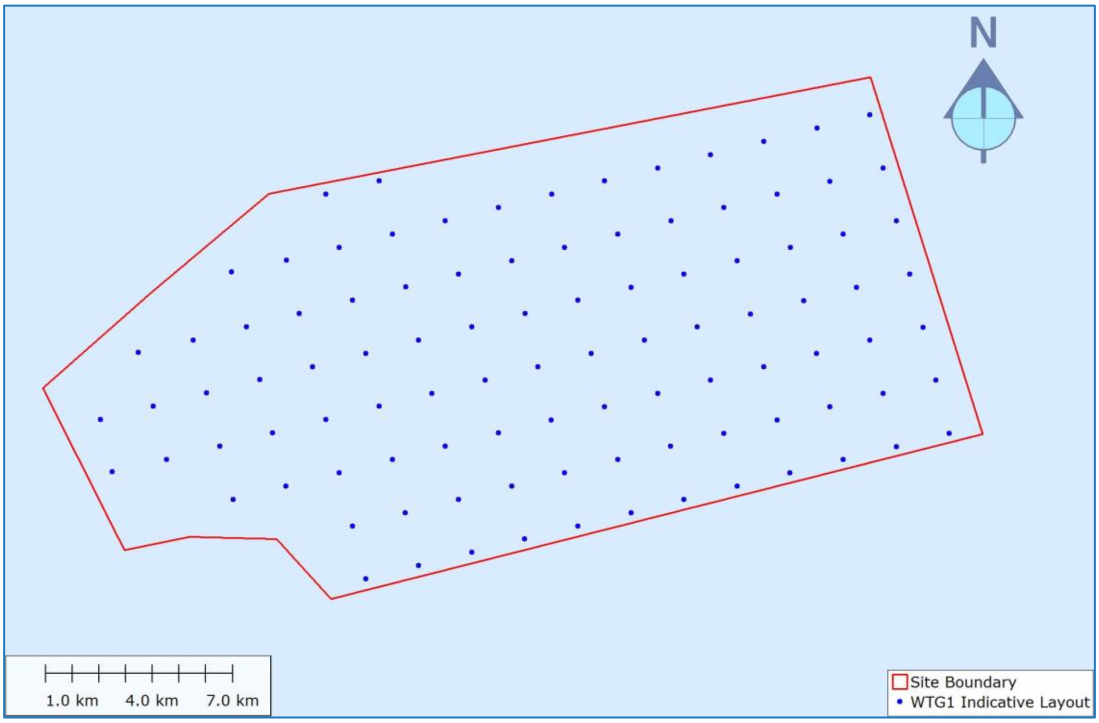

Figure 1: WTG1 indicative layout – 100 WTGs

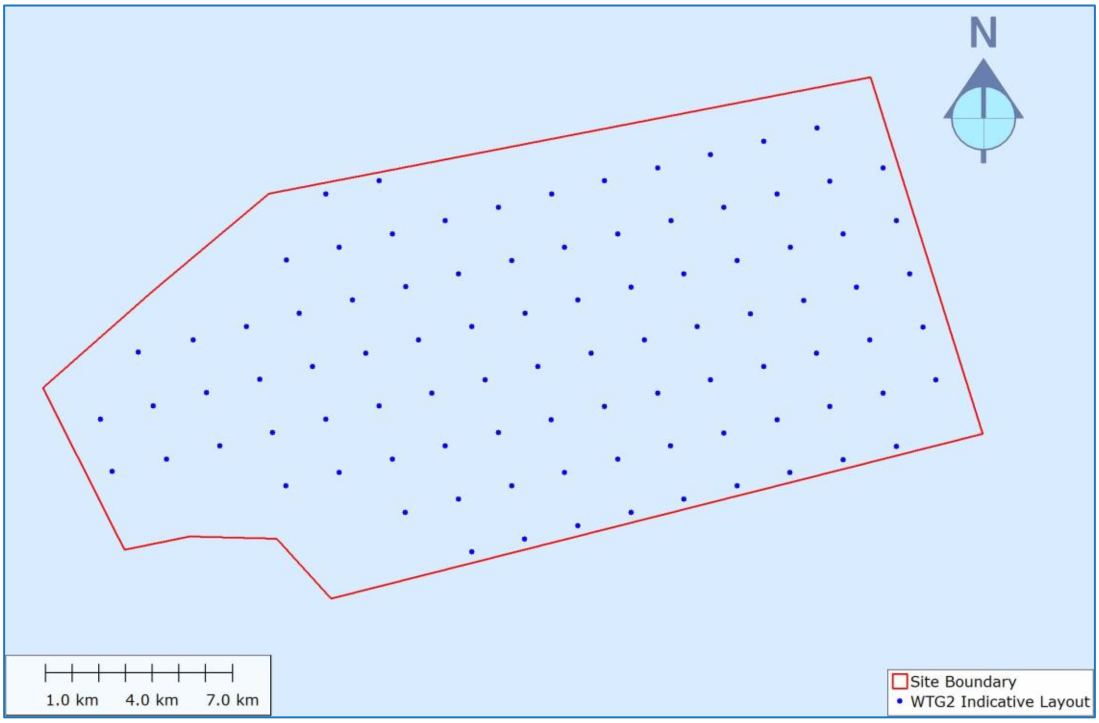

Figure 2: WTG2 indicative layout – 93 WTGs

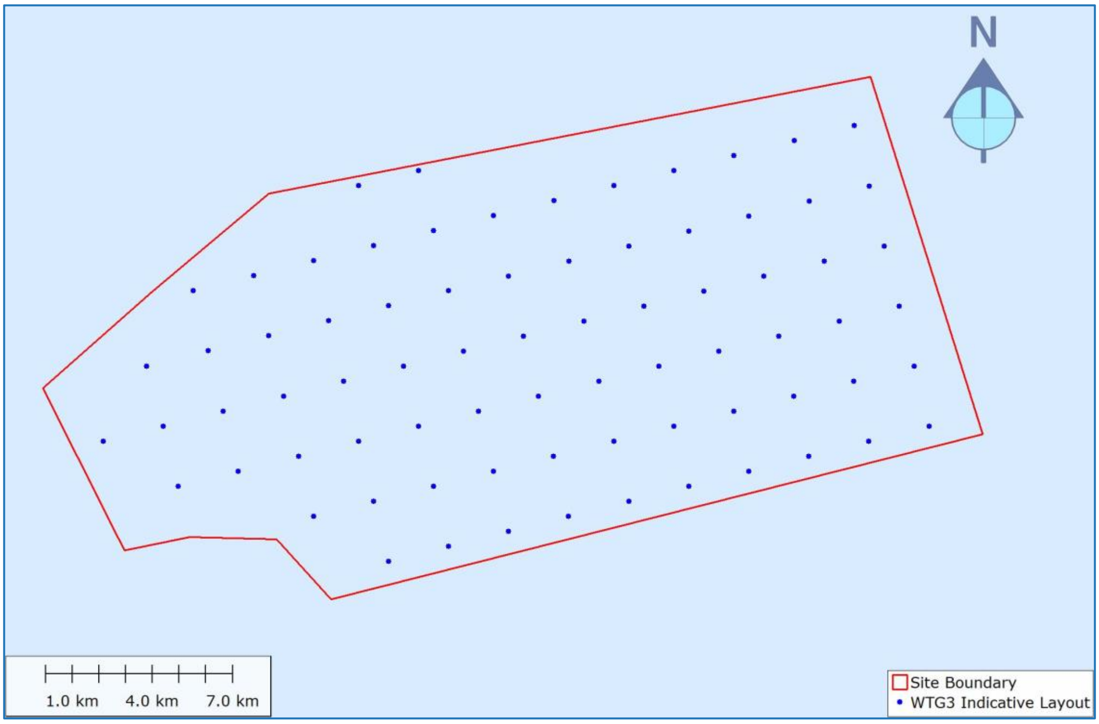

Figure 3: WTG3 indicative layout – 75 WTGs

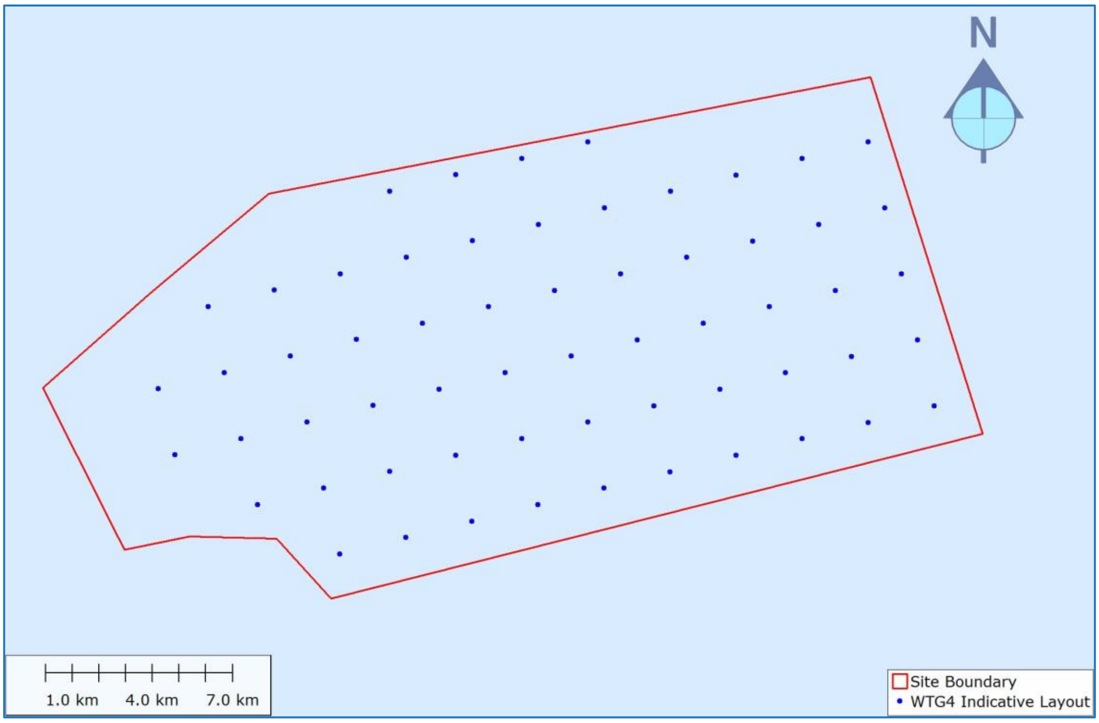

Figure 4: WTG4 indicative layout – 60 WTGs

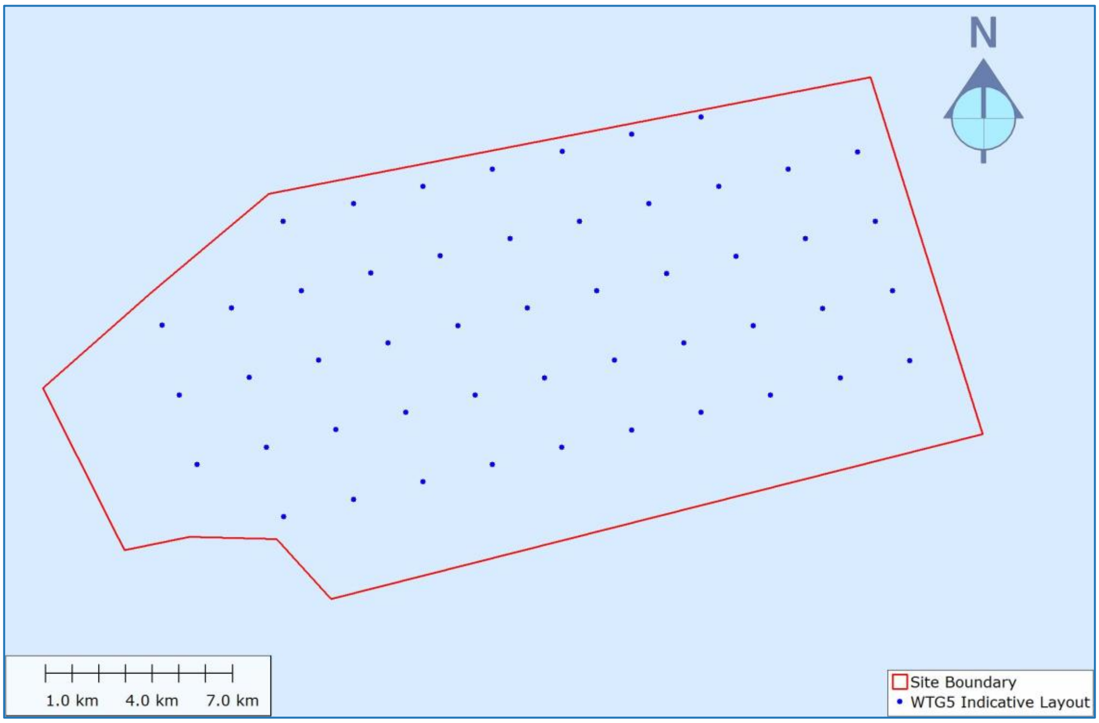

Figure 5: WTG5 indicative layout – 50 WTGs

1.3.4. Terrain Data

- ATDI UK 25m Digital Terrain Model (DTM).

1.3.5. Analysis Tools

- ATDI HTZ communications v2022.10.1 release 1484 radio planning tool; and
- Blue Marble Global Mapper V21.1.1 Geographic Information System (GIS).

1.3.6. Mapping Datum

1.3.6.1. UTM31 (WGS84 datum) is used as a common working datum for all mapping and geodetic references.

1.3.6.2. Where necessary, mapping datum transformations are made using Global Mapper or Grid Inquest II Coordinate Transformation Program.

1.3.6.3. All heights stated in this document are AMSL (Newlyn datum) unless otherwise stated.

2. Airspace Analysis

2.1. Introduction

2.1.1. This assessment is a review of potential impacts on aviation arising from the presence of operating wind turbines located in the Project array area. For the purposes of this assessment a maximum tip height of 1,400 feet (ft) AMSL for the WTGs has been assumed, the equivalent of 400m rounded up to the nearest 100ft.

2.1.2. All information has been referenced from the United Kingdom (UK) Aeronautical Information Publication (AIP) available online from source and is therefore the latest information available. Additional information has been sourced from UK Civil Aviation Authority (CAA) publications, as appropriate.

2.1.3. The assessment does not draw any conclusions but merely identifies areas of potential impact.

2.2. Study Area

2.2.1. The scope of the assessment includes the array area and the surrounding airspace relating to aviation, its use and potential impact. The types of airspace and limitations on its use are identified.

2.3. Airspace Classification

2.3.1. In general, airspace can be characterised as either controlled or uncontrolled airspace. Aircraft in controlled airspace are being positively managed by Air Traffic Control (ATC) the entire time they are within that designated area. This type of airspace is generally used by airlines and corporate aviation. Aircraft in uncontrolled airspace are operating within a framework of rules but are not being controlled by ATC, although many pilots flying in this environment may choose to report their position, altitude, and intentions to ATC to benefit from the enhanced situational awareness that brings. Users of this airspace tend to be small aircraft engaged in training or private (social) flying.

2.3.2. In addition, Special Use Airspace (SUA) is airspace designated for specific activities such that limitations on airspace access may be imposed on other non-participatory aircraft. An example of such airspace would be a Danger Area (DA) established for military flight training.

2.3.3. There are five classes of airspace in the UK, namely classes A, C, D, E and G. Classes A to E are types of controlled airspace, while class G is uncontrolled airspace. Class A is the most strictly regulated controlled airspace whereby aircraft are positively controlled by ATC, compliance with ATC clearance is mandatory, and aircraft are flown and navigated solely with reference to aircraft instruments. Certain onboard equipment is also a prerequisite. Flight in class G airspace is generally visual, meaning pilots fly and navigate with reference to the natural horizon and terrain features they see outside. Pilots are required to maintain minimum distances from notified obstacles, including WTGs, and may only fly within the minimum weather and visibility criteria.

2.4. Aircraft Vertical Reference

2.4.1. An aircraft's vertical reference above the ground or sea can either be an altitude AMSL or, above a designated altitude, a Flight Level (FL). An aircraft's altitude, expressed in feet, is based on the last known verified local barometric pressure while a FL, expressed in 100ft increments, is based on a common international barometric pressure setting of 1013.2 hectopascals. With aircraft using a common vertical datum safe separation can be achieved by either ATC or between pilots of different aircraft.

2.4.2. The airspace where vertical reference changes from altitude to FL and vice versa is known as the Transition Layer and consists of a (lower) Transition Altitude and (higher) Transition Level. In UK airspace the Transition Altitude is set at 3,000ft AMSL except in certain specified airspace where it is higher.

2.4.3. The vertical limits of airspace are defined in terms of either altitudes or FLs, with airspace commonly having a lower limit expressed as an altitude and an upper limit expressed as a FL.

2.5. Current Airspace Baseline

2.5.1. The Project array area lies within the London Flight Information Region (FIR), airspace regulated by the UK CAA. The boundary between the London FIR and the adjacent Amsterdam FIR, regulated by the Netherlands Aviation Authority, is approximately 126km to the southeast of the array area at its closest point. Immediately surrounding the array area is uncontrolled class G airspace, extending from sea level to FL195, approximately 19,500ft AMSL.

2.5.2. This airspace is used by both civil and military aircraft, predominantly for low-level flight operations and generally by aircraft flying under Visual Flight Rules (VFR). Aircraft operate under one of two flight rules: VFR or Instrument Flight Rules (IFR). VFR flight is conducted with visual reference to the natural horizon while IFR flight requires reference solely to aircraft instrumentation. Under VFR flight the pilot is responsible for maintaining a safe distance from terrain, obstacles, and other aircraft.

2.5.3. Above FL195 is class C controlled airspace in the form of a Temporary Reserved Area (TRA). This airspace, specifically TRA 006, has an upper vertical limit of FL245, approximately 24,500ft AMSL, and is available for use by both military and civil aircraft, though its main use is to accommodate VFR military flying activity.

2.5.4. The North Sea Control Area (CTA), comprising CTA 1, 25km to the south, and CTAs 2 and 3 to the east of the array area, is shown in Figure 6. This CTA is class A controlled airspace from a lower vertical limit of FL175, approximately 17,500ft AMSL, to an upper limit of FL195, and class C airspace from FL195 up to FL245. CTA 2 (GODOS) and CTA 3 (MOLIX) are 96km and 67km respectively from the array area and the provision of ATS within them is delegated to Amsterdam Area Control. The North Sea CTA is mainly used for routing airline traffic from the Netherlands and Germany to the UK's central belt airports such as Humberside, Leeds, Manchester, and Liverpool.

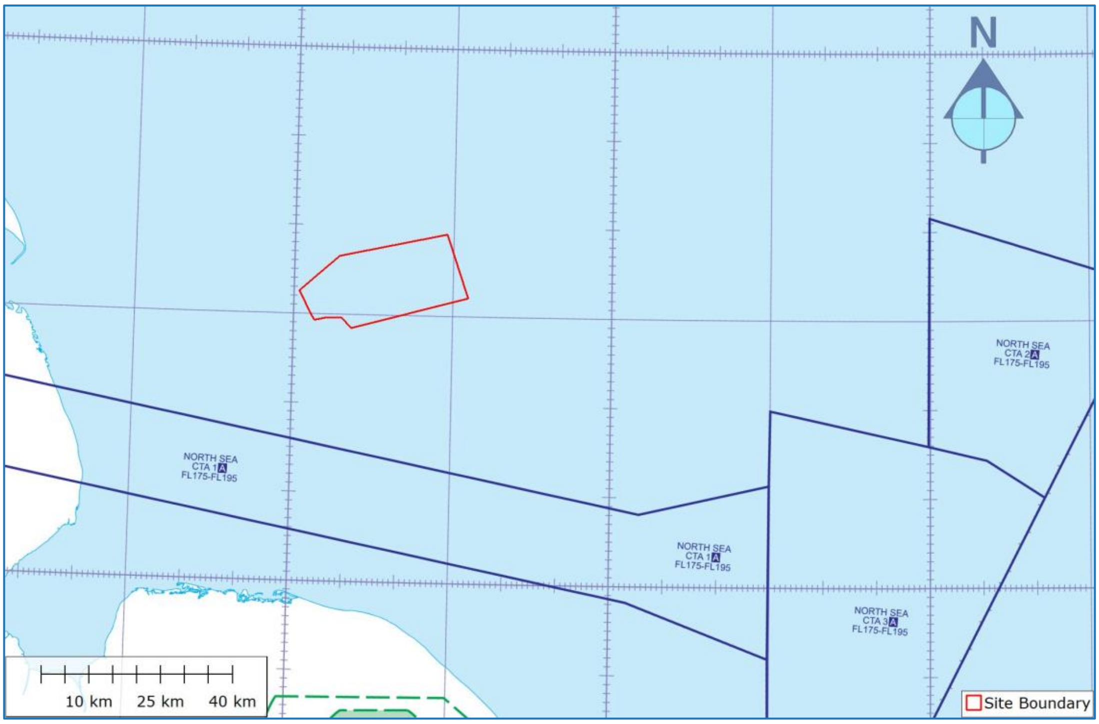

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Figure 6: Array area and North Sea CTA

2.6. Special Use Airspace

2.6.1. The northern half of the array area lies beneath the Southern Managed Danger Area (MDA), one of four MDA complexes in UK airspace that provide segregated airspace for military flying training. Specifically, the array area is beneath Danger Area (DA) EGD323E, as shown in Figure 7. When activated, the airspace has vertical limits from FL50 (approximately 5,000ft AMSL) up to FL660 (approximately 66,000ft AMSL). Activities within EGD323E include high energy manoeuvres, ordnance, munitions and explosives, and electrical/optical hazards.

2.6.2. DAs associated with Air Weapons Range activities off the Lincolnshire coast at Donna Nook (EGD307) and Holbeach (EGD207) lie approximately 44km to the west and 79km to the southwest respectively of the array area. When active, Donna Nook has vertical limits from the surface up to 20,000ft AMSL (occasionally notified to 23,000ft AMSL) while Holbeach has vertical limits from the surface up to 23,000ft AMSL.

2.6.3. The southern half of the array area lies beneath an Air-to-Air Refuelling Area (AARA) designated Area 8, with vertical limits of FL70 (approximately 7,000ft AMSL) to FL170 (approximately 17,000ft AMSL). Within AARA airspace, fuel is transferred from tanker aircraft to receiver aircraft under a radar control service provided by military controllers based at Swanwick.

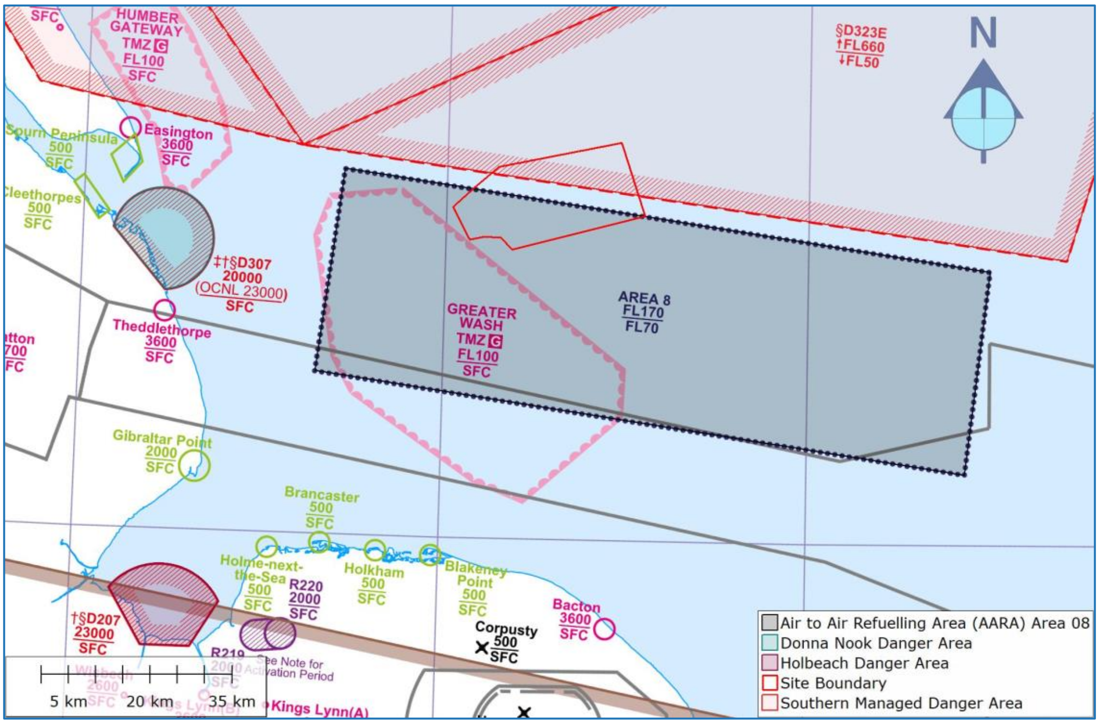

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Figure 7: Danger Areas and Air-to-Air Refuelling Area 8

2.6.4. Less than 5km south of the array area are The Wash North and South Aerial Tactics Areas (ATAs), as shown in Figure 8.

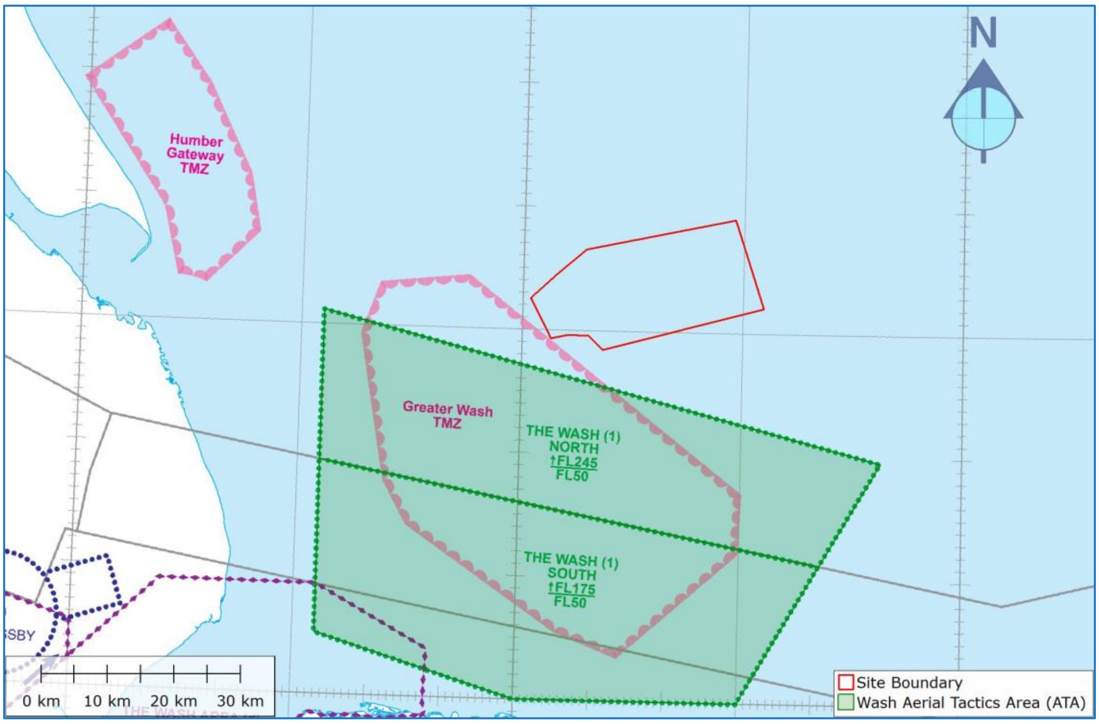

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Figure 8: Aerial Tactics Areas

2.6.5. ATAs are defined within the AIP as "an airspace of defined dimensions designated for air combat training, within which high energy manoeuvres are regularly practised by aircraft formations". These ATAs are areas of intense military air activity and pilots are strongly advised to avoid the areas. Both ATAs have a lower limit of FL50 or approximately 5,000ft AMSL.

2.7. Transponder Mandatory Zones

2.7.1. Immediately west and south of the array area is the Greater Wash Transponder Mandatory Zone (TMZ), as shown in Figure 8. Within a TMZ the carriage and operation of aircraft transponder equipment is mandatory. This enables such aircraft to be detected and tracked by Secondary Surveillance Radar (SSR) systems.

2.7.2. The Greater Wash TMZ encompasses a large offshore windfarm complex consisting of the Race Bank, Triton Knoll, Dudgeon and Sheringham Shoal offshore windfarms and is used to mitigate the impact the associated WTGs have on the NERL Claxby and Cromer PSRs.

2.7.3. Also shown in Figure 8 is the Humber Gateway TMZ, 42km west of the array area. This TMZ encompasses the Westermost Rough and Humber Gateway offshore windfarms, and again is used to mitigate the impact of WTGs on the Claxby and Cromer PSRs.

2.7.4. The establishment of a TMZ over the array area is one of the potential mitigation measures to be considered during the Project design process.

2.8. Southern North Sea Offshore Operations

2.8.1. To enhance flight safety and expedite SAR operations over the southern North Sea, various Flight Information Services are provided by Anglia Radar based at Aberdeen Airport. These services are available to both helicopters operating in support of the offshore oil and gas and renewables industries and other civil and military aircraft transiting the airspace.

2.8.2. The Anglia Radar Area of Responsibility in which these services are available is depicted in Figure 9, and extends from sea level to FL65 (approximately 6,500ft AMSL). Also shown within this area is the Anglia Offshore Safety Area (OSA), the boundary of which is approximately 12km southeast of the array area at its closest point. The Anglia OSA consists of the airspace from the surface to 3,500ft AMSL and is the busiest airspace in terms of offshore platform helicopter traffic. Military and civil pilots of fixed-wing aircraft are recommended to avoid the Anglia OSA.

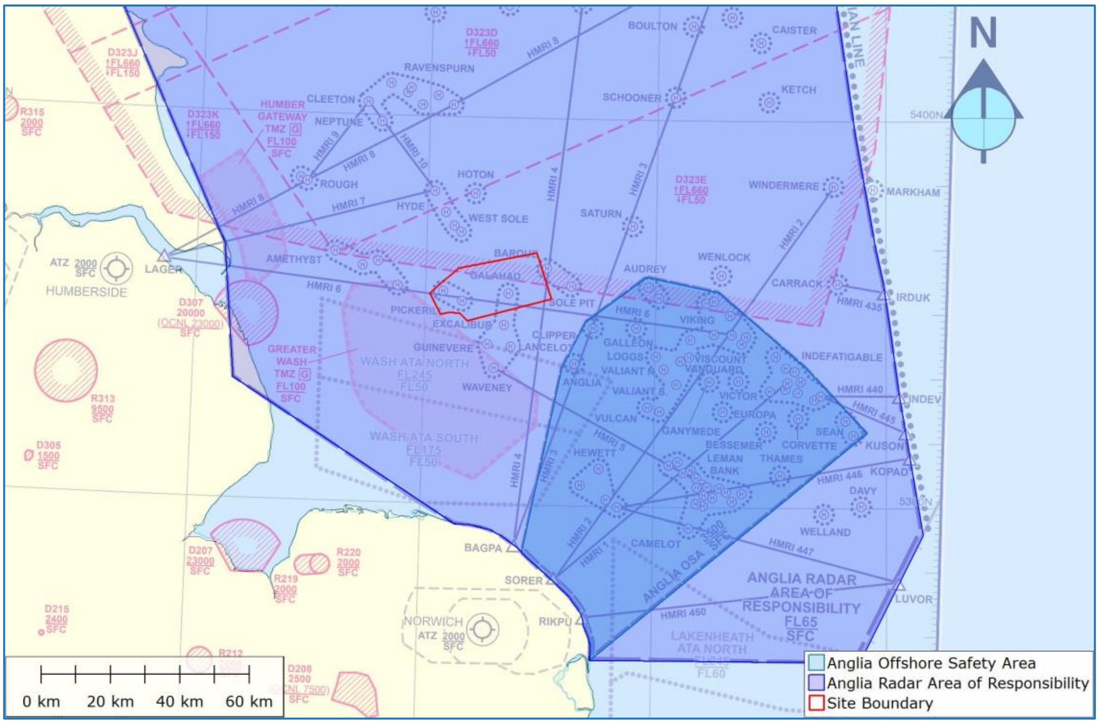

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Figure 9: Anglia Radar Area of Responsibility

2.9. Helicopter Main Routing Indicators

2.9.1. A network of offshore routes over the southern North Sea are flown by civilian helicopters in support of offshore oil and gas installations. The routes typically and routinely flown are published on charts as Helicopter Main Routing Indicators (HMRIs) to alert other airspace users of the potential for frequent low-level helicopter traffic.

2.9.2. These routes have no lateral dimensions and assume the background airspace classification within which they lie. HMRIs over the southern North Sea generally extend vertically from 1,500ft AMSL to FL60 (approximately 6,000ft AMSL), although icing conditions or other flight safety considerations may require helicopters to operate below 1,500ft AMSL.

2.9.3. The CAA publication Civil Aviation Publication (CAP) 764 Policy and Guidelines on Wind Turbines (CAA 2016) advises that planned obstacles within 2 nautical miles (nm) of an HMRI route centreline should be consulted upon with helicopter operators and the Air Navigation Service Provider (Anglia Radar).

2.9.4. 2nm buffers around the HMRIs in the vicinity of the array area are depicted in Figure 10, which shows that both HMRI 4 and HMRI 6 pass overhead the Project array area. HMRI 4 routes from the coast north of Norwich Airport to the Trent offshore platform, while HMRI 6 routes from the coast east of Humberside Airport to the Viking ‘B’ offshore platform.

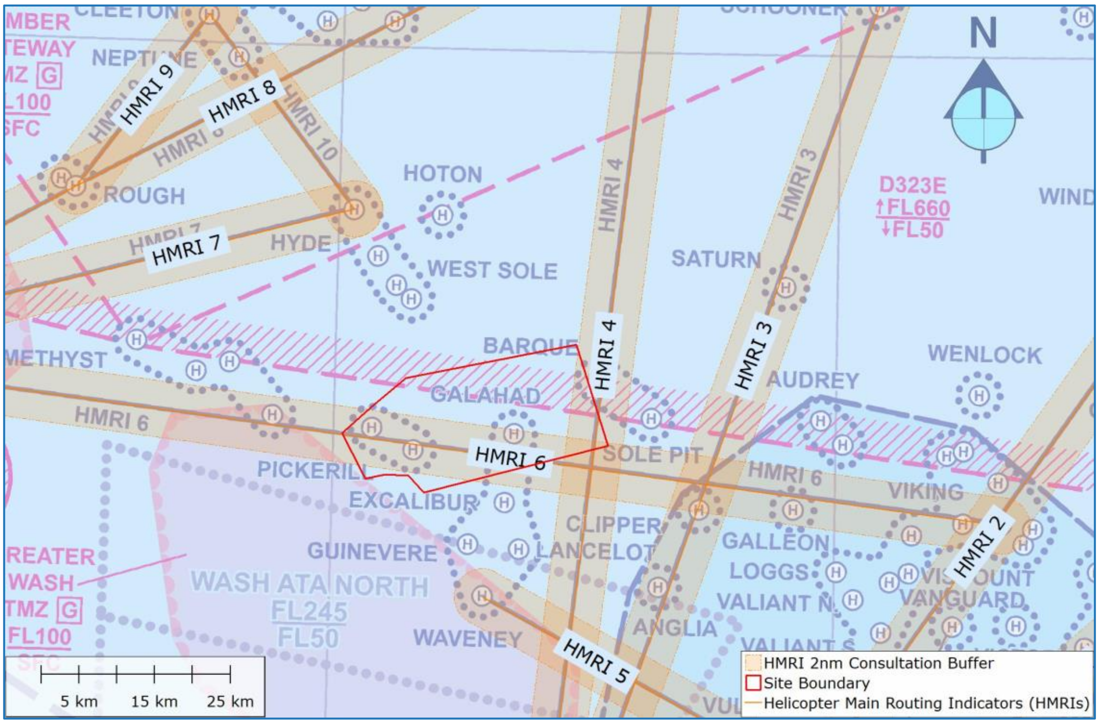

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Figure 10: Helicopter Main Routing Indicators

2.9.5. Helicopters operating under IFR must maintain at least 1,000ft vertical clearance above the highest obstacles within 5nm, and would therefore need to transit the array area at a minimum of 2,400ft AMSL for the maximum WTG tip height of 1,400ft AMSL. Under VFR, helicopters must maintain a minimum of 500ft separation from obstacles.

2.9.6. The ability of a helicopter to fly higher over WTGs depends on the icing level, and on days of low cloud base helicopters could be required to fly lower and extend their routings around WTG obstacles.

2.10. Offshore Helidecks

2.10.1. To help achieve a safe operating environment, a 9nm consultation zone for planned obstacles exists around offshore helicopter destinations. Within 9nm, obstacles such as WTGs can potentially impact upon the feasibility of helicopters to safely fly low visibility or missed approach procedures at the associated helideck site. There are 13 offshore helidecks within 9nm of the array area, as depicted in Figure 11 and listed in Table 2. Of these, the Malory and Galahad platforms are within the array area. The Galahad platform is now carbon free and due to be decommissioned prior to construction of the Project. The Pickerill A and B platforms are also shown within the array area but are in the process of being decommissioned, the topsides having already been removed leaving jacket structures with no helidecks.

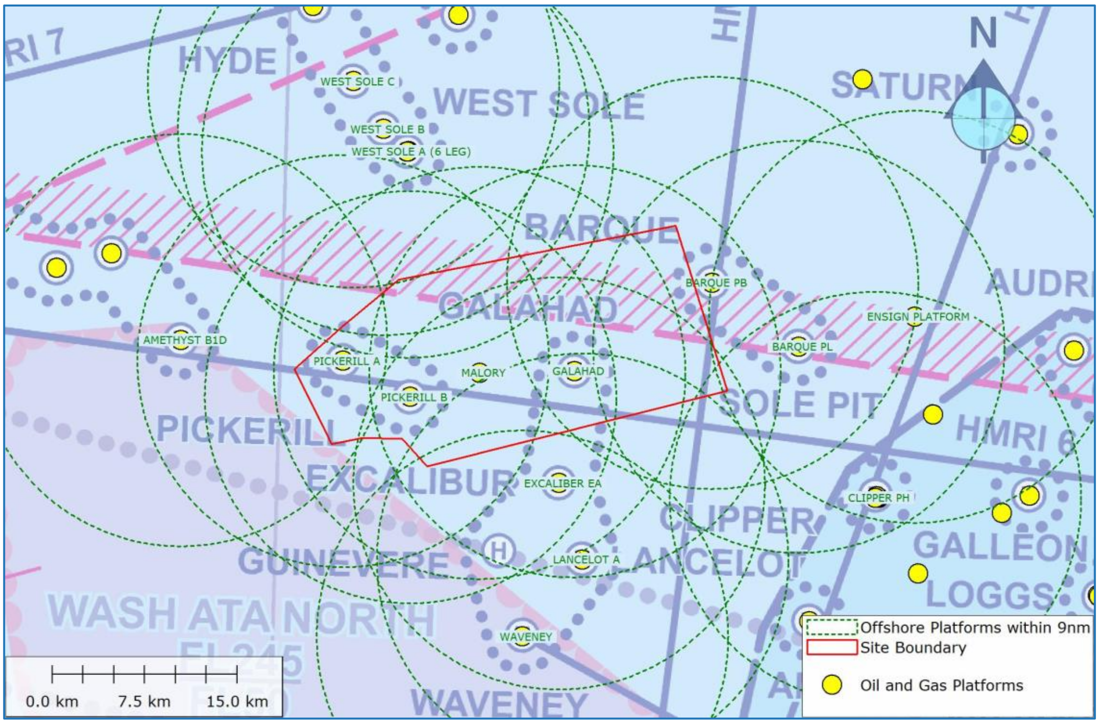

Figure 11: Oil and gas platforms within 9nm of array area

Table 2: Oil and gas platform ranges from array area

Platform	Operator	Range from array area (nm)
Amethyst B1D	Perenco	5.11
Barque PB	Shell	0.75
Barque PL	Shell	3.55
Clipper PH	Shell	7.99
Ensign Platform	Spirit Energy	8.77
Excalibur EA	Perenco	2.13
Galahad	Perenco	Within array area
Lancelot A	Perenco	5.60
Malory	Perenco	Within array area
Waveney	Perenco	8.22
West Sole A (6 Leg)	Perenco	5.41
West Sole B	Perenco	6.58
West Sole C	Perenco	8.88

2.10.2. CAP 764 states that the 9nm zone does not prohibit development but is a trigger for consultation with offshore helicopter operators, the operators of existing installations and exploration and development locations to determine a solution that maintains safe offshore helicopter operations alongside proposed developments. The CAA advises wind energy lease holders, oil and gas developers, and petroleum licence holders to discuss their development plans with each other to minimise the risks of unanticipated conflict.

2.10.3. Helicopter Traffic Zones (HTZs) are established around individual and groups of offshore platforms to notify of helicopters engaged in platform approaches, departures and inter-platform transits. HTZ airspace extends vertically from sea level to 2,000ft AMSL and laterally to 1.5nm from the platform helidecks.

2.11. Search and Rescue

2.11.1. Search and Rescue (SAR) operations are a highly specialised undertaking involving not only aviation assets, but also small boats, ships, and shore-based personnel. SAR operations are generally carried out in extremely challenging conditions and at all times of the day and night. There are 10 helicopter SAR bases, incorporating 22 aircraft, around the UK with Bristow Helicopters currently providing helicopters and aircrew on behalf of the Maritime and Coastguard Agency.

2.11.2. The nearest SAR base is at Humberside Airport, approximately 90km west of the array area. Its helicopters provide rescue services for both offshore and land-based incidents up to approximately 460km from their base.

2.11.3. The random nature of people, watercraft or aircraft in distress makes it very difficult to determine the routes taken by SAR aircraft. Fixed wing SAR aircraft would tend to stay at higher altitudes in a command-and-control role during major incidents, whilst helicopters would be used in a low-level role, sometimes in support of small rescue boats.

2.12. Area Minimum Altitudes

2.12.1. A chart of Area Minimum Altitudes (AMAs) across the London and Scottish FIRs is published in the AIP. An AMA provides a minimum obstacle clearance of 1,000ft within a specified area formed by lines of latitude and longitude in half degree steps. This allows pilots of aircraft flying under IFR the reassurance of properly designated obstacle and terrain clearance protection in poor weather conditions.

2.12.2. The array area infringes an AMA area of 1,700ft AMSL, as shown in Figure 12.

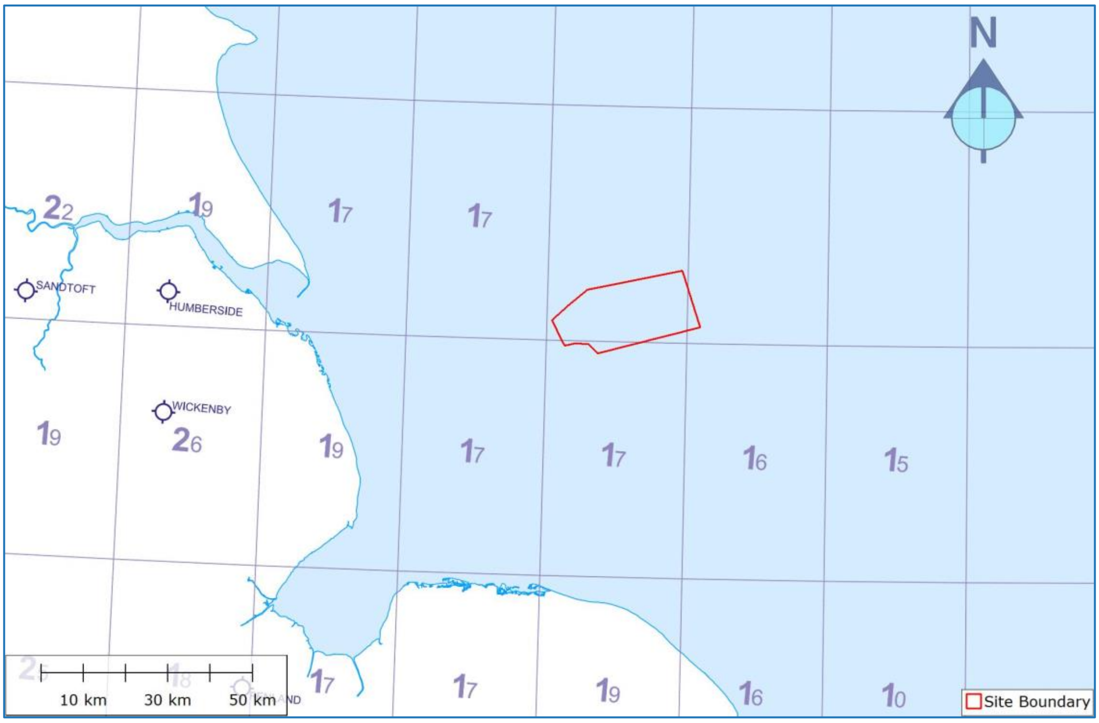

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Figure 12: AMAs over the array area

2.12.3. WTGs with a maximum tip height exceeding 213m (700ft) AMSL would require the 1,700ft AMA to be increased to maintain the necessary 1,000ft obstacle clearance protection.

3. Radar Line of Sight Assessment

3.1. Methodology

3.1.1. Radar Line of Sight (RLoS) is determined by use of a radar propagation model (ATDI HTZ communications) using 3D DTM data with 25m horizontal resolution. Radar data is entered into the model and RLoS to the WTGs from the radar is calculated.

3.1.2. Note that by using a DTM no account is taken of possible further shielding of the WTGs due to the presence of structures or vegetation that may lie between the radar and the WTGs. Thus, the RLoS assessment is a worst-case result.

3.1.3. For PSR the principal source of adverse windfarm effects are the WTG blades, so RLoS is calculated for the maximum blade tip heights of the WTGs.

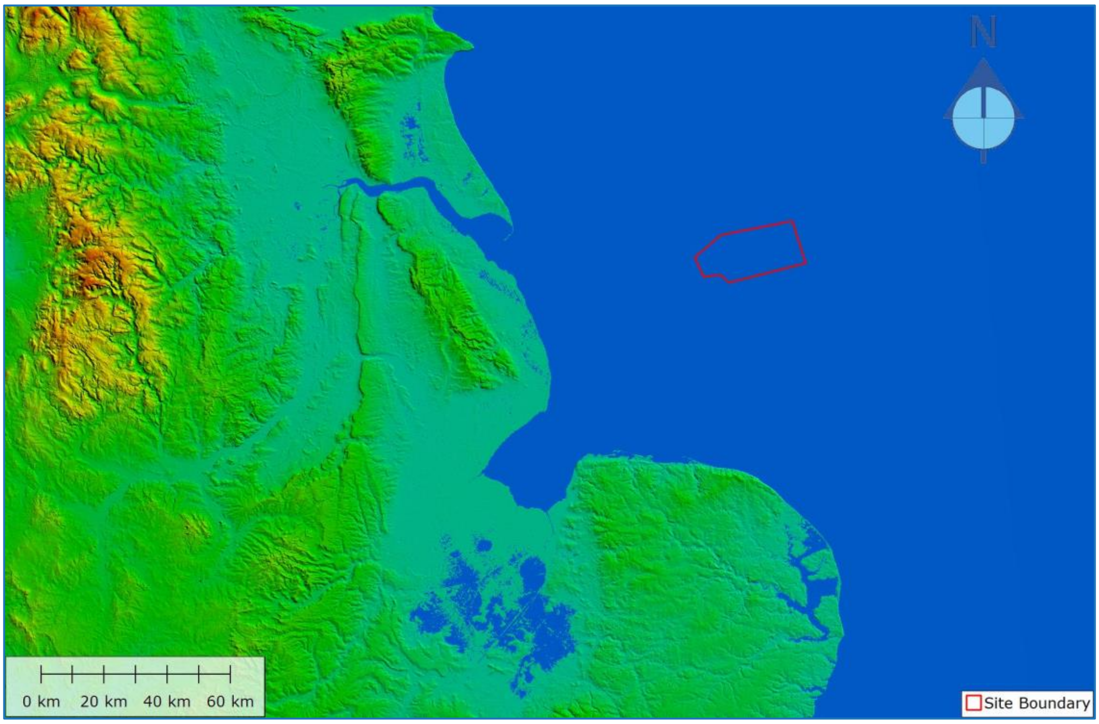

Figure 13: 25m resolution DTM used for RLoS modelling

3.2. Licensed Airfields with Surveillance Radar

3.2.1. Closest to Array Area

3.2.1.1. The closest radar-equipped airfields to the array area are Humberside Airport, 90km to the west, and Norwich Airport, 90km south of the array area. CAP 764 recommends consultation with any aerodromes with a surveillance radar facility that are within 30km of WTGs, however this distance can be greater depending on the type and coverage of the radar and the particular operations at the aerodrome. Controllers at both these airports may provide a Lower Airspace Radar Service (LARS) to aircraft operating outside controlled airspace at a maximum range of 30nm (56km) from the facility.

3.2.2. Humberside

3.2.2.1. Humberside RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 14.

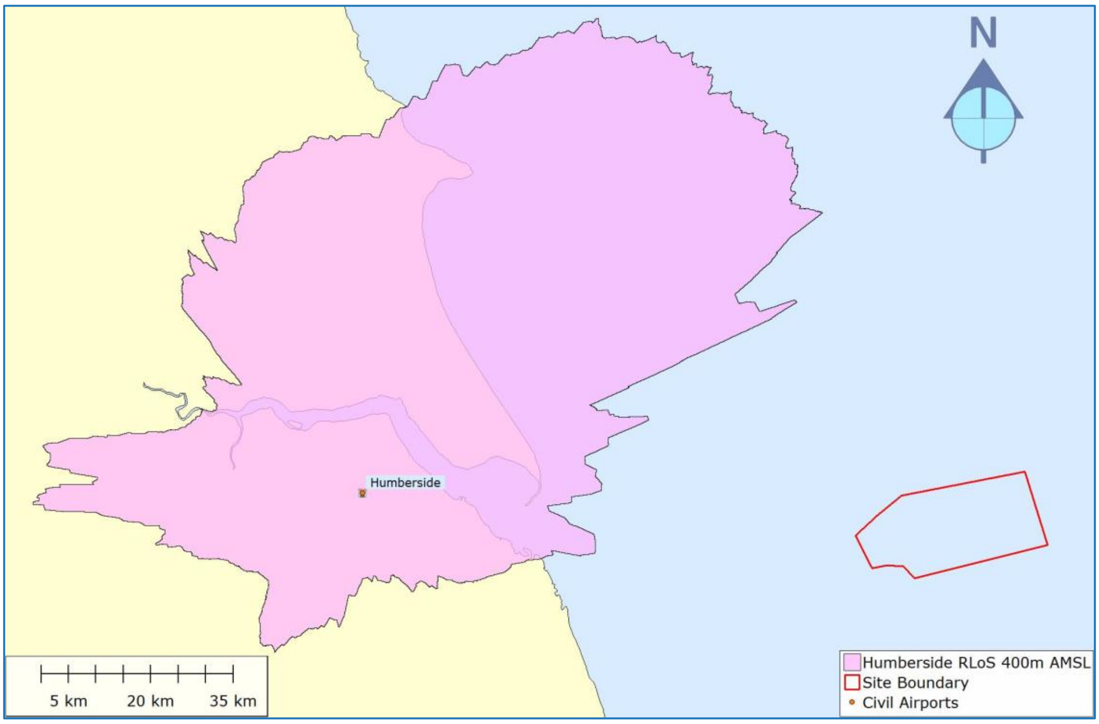

Figure 14: Humberside RLoS 400m AMSL

3.2.2.2. At a maximum blade tip height of 400m AMSL, none of the WTGs would be in RLoS of the Humberside Watchman PSR. It is highly unlikely that any of the WTG categories proposed to be installed within the array area would be detected by Humberside PSR.

3.2.2.3. The Designated Operational Coverage (DOC) for Humberside's ATC radar service is 40nm (74km); so, at a minimum range of 90km, it is considered unlikely that Humberside ATC would be providing a radar control service for aircraft in the vicinity of the array area.

3.2.3. Norwich

3.2.3.1. Norwich RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 15.

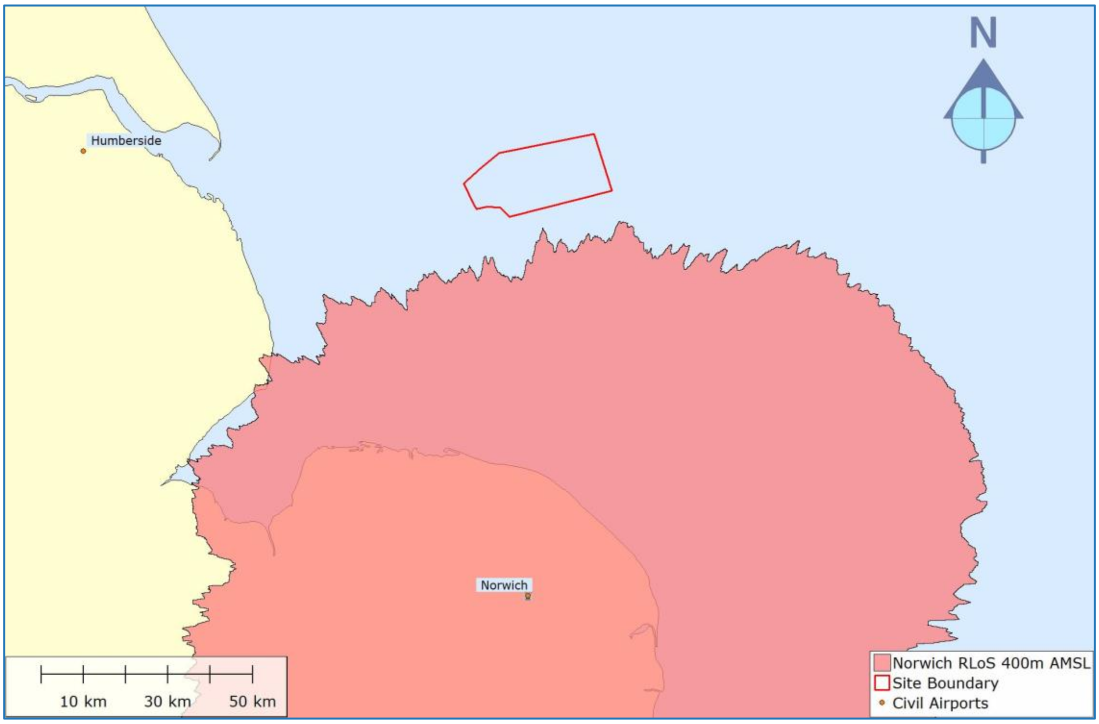

Figure 15: Norwich RLoS 400m AMSL

3.2.3.2. At a maximum blade tip height of 400m AMSL, none of the WTGs would be in RLoS of the Norwich Star 2000 PSR. It is unlikely that any of the WTG categories proposed to be installed within the array area would be detected by Norwich PSR.

3.2.3.3. The DOC for Norwich's ATC radar service is 40nm (74km); so, at a minimum range of 90km, it is considered unlikely that Norwich ATC would be providing a radar control service for aircraft in the vicinity of the array area.

3.3. Military Airfields with Surveillance Radar

3.3.1. Closest to Array Area

3.3.1.1. The closest radar-equipped military airfields to the array area are Royal Air Force (RAF) Coningsby and RAF Waddington, 92km and 109km respectively to the west, and RAF Marham, 100km to the southwest. Controllers at these stations offer a LARS service to a range of 30nm (56km).

3.3.2. Coningsby

3.3.2.1. Coningsby RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 16.

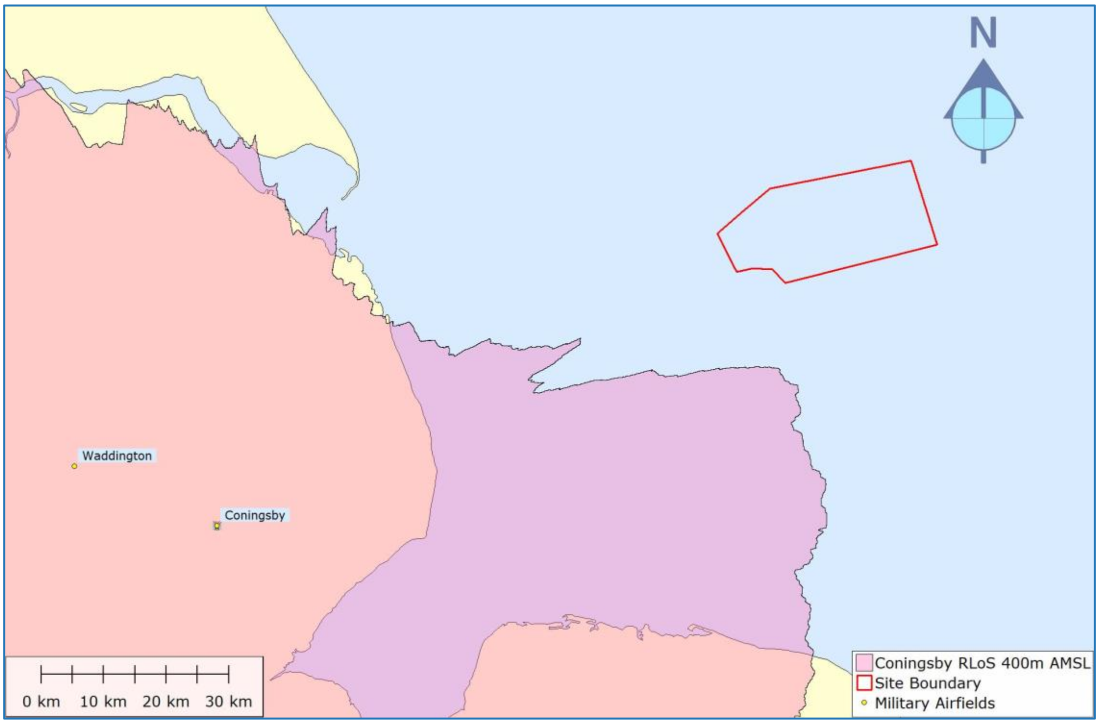

Figure 16: Coningsby RLoS 400m AMSL

3.3.2.2. No WTGs within the array area, irrespective of blade tip height, would be in RLoS of Coningsby PSR. It is unlikely that any of the WTG categories proposed to be installed within the array area would be detected by Coningsby PSR.

3.3.3. Marham

3.3.3.1. Marham RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 17.

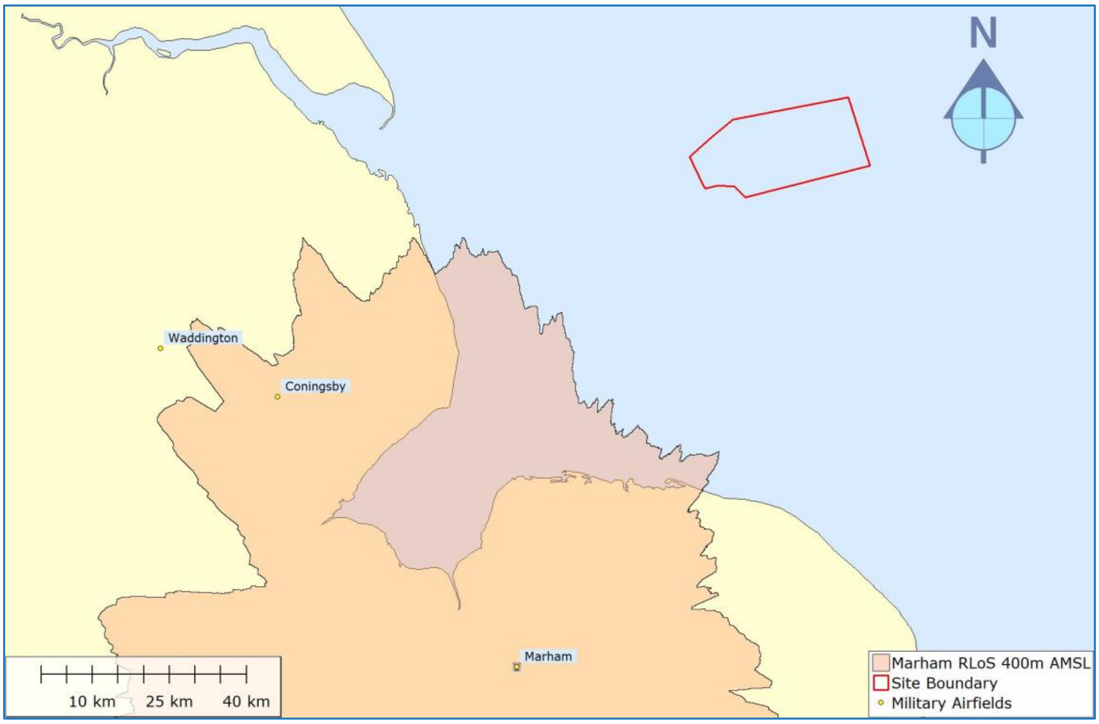

Figure 17: Marham RLoS 400m AMSL

3.3.3.2. No WTGs within the array area, irrespective of blade tip height, would be in RLoS of Marham PSR. It is highly unlikely that any of the WTG categories proposed to be installed within the array area would be detected by Marham PSR.

3.3.4. Waddington

3.3.4.1. Waddington RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 18.

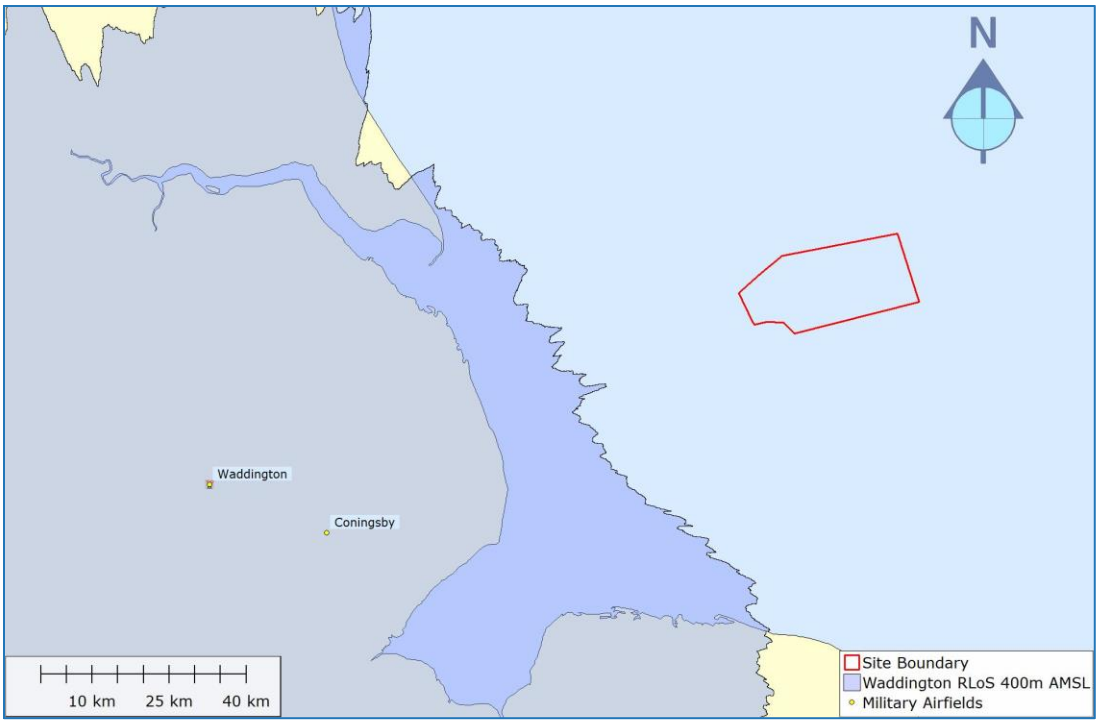

Figure 18: Waddington RLoS 400m AMSL

3.3.4.2. No WTGs within the array area, irrespective of blade tip height, would be in RLoS of Waddington PSR. It is highly unlikely that any of the WTG categories proposed to be installed within the array area would be detected by Waddington PSR.

3.4. NERL Radars

3.4.1. Closest to Array Area

3.4.1.1. The closest NERL radars to the array area are at Claxby, 89km to the west, and Cromer, 64km to the south.

3.4.2. Claxby

3.4.2.1. Claxby RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 19.

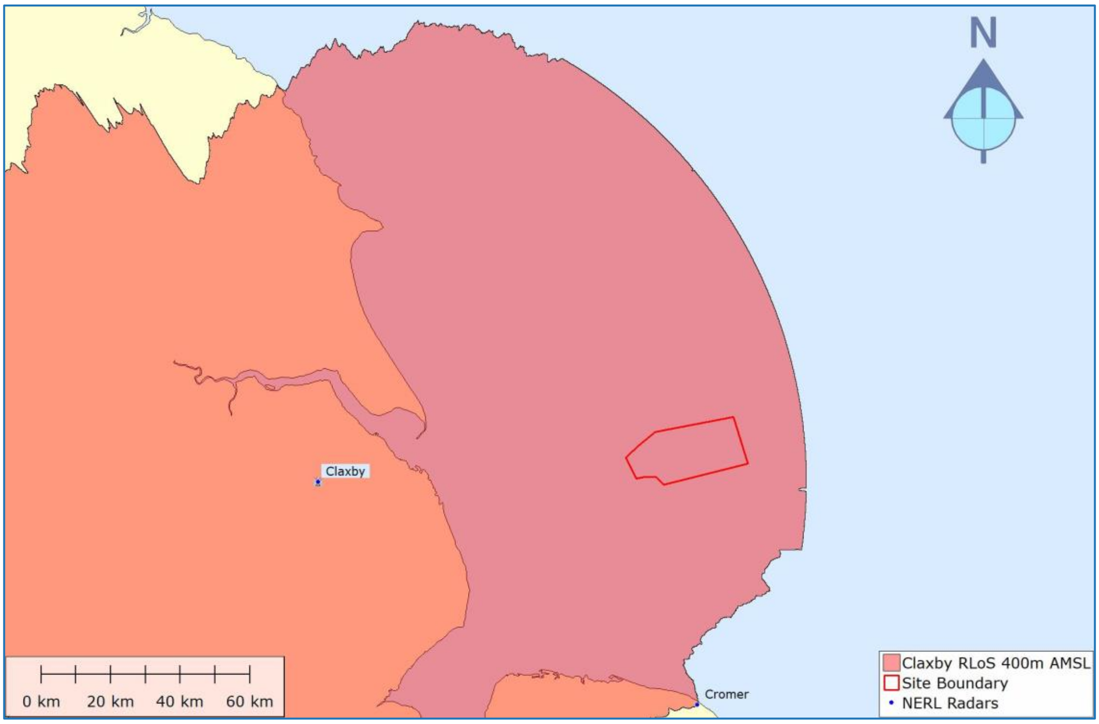

Figure 19: Claxby RLoS 400m AMSL

3.4.2.2. All WTGs within the array area with a maximum blade tip height of 400m AMSL would be in RLoS of Claxby PSR and highly likely to be detected.

3.4.2.3. Claxby RLoS coverage for the minimum proposed blade tip height of 276m AMSL is shown in Figure 20.

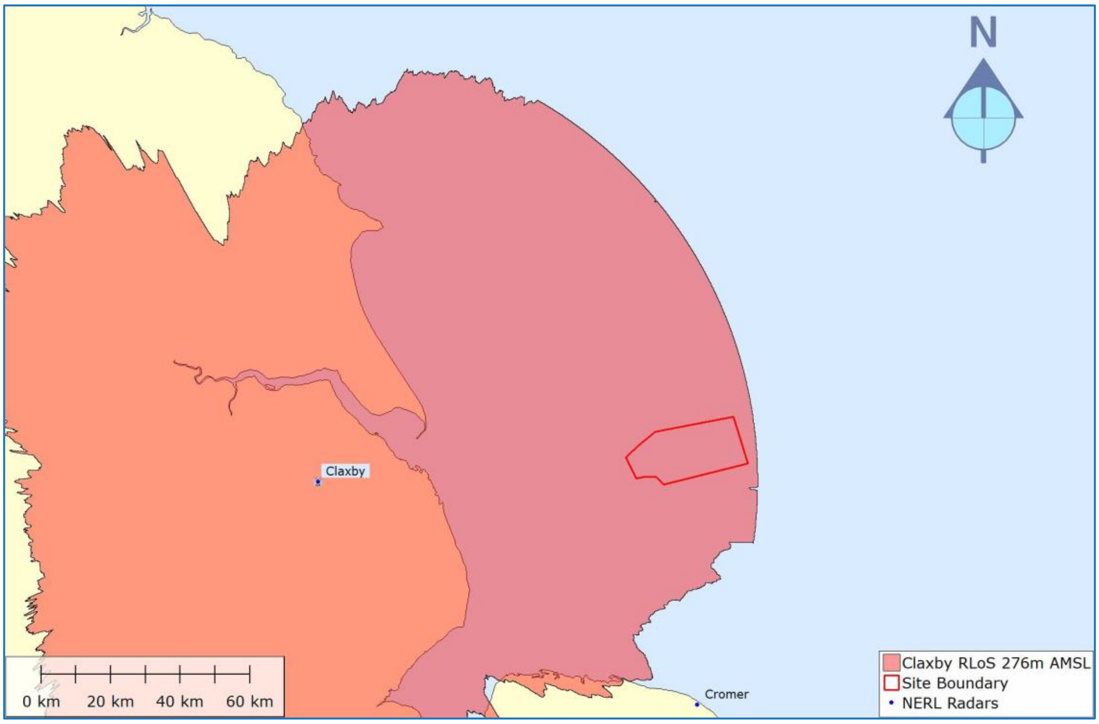

Figure 20: Claxby RLoS 276m AMSL

3.4.2.4. All WTGs within the array area with a blade tip height of 276m AMSL would be in RLoS of Claxby PSR and highly likely to be detected.

3.4.2.5. All WTGs within the array area, irrespective of blade tip height, would be in RLoS of the Claxby ASR-23SS PSR and highly likely to be detected.

3.4.3. Cromer

3.4.3.1. Cromer RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 21.

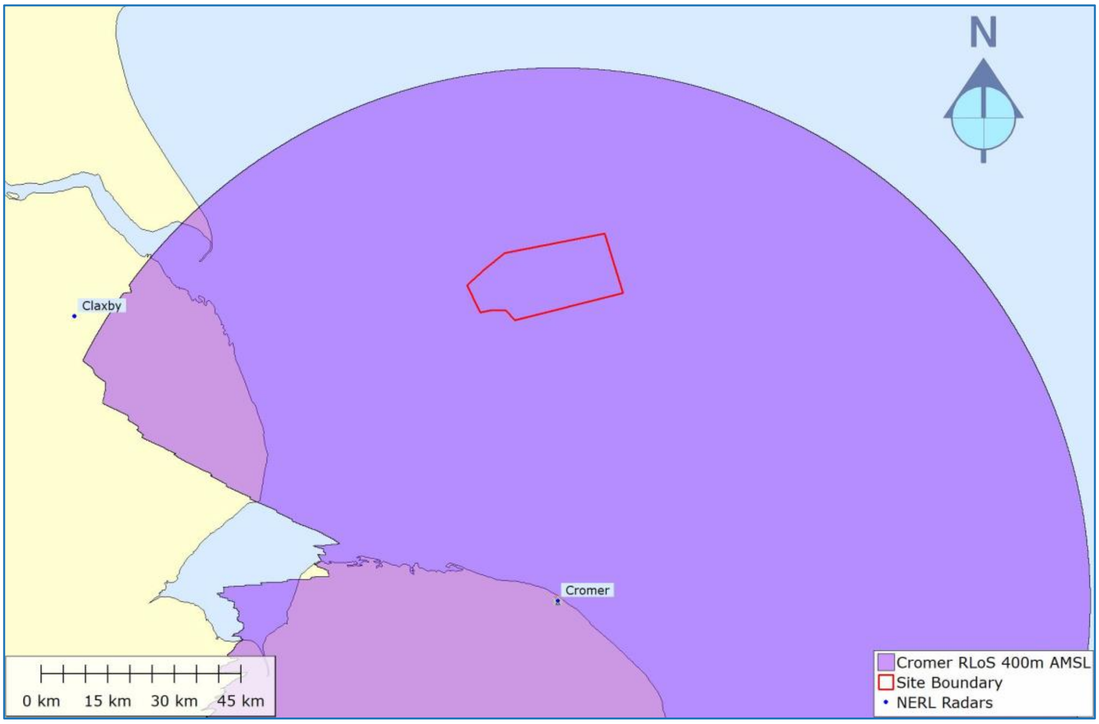

Figure 21: Cromer RLoS 400m AMSL

3.4.3.2. All WTGs within the array area with a maximum blade tip height of 400m AMSL would be in RLoS of Cromer PSR and highly likely to be detected.

3.4.3.3. Cromer RLoS coverage for the minimum proposed blade tip height of 276m AMSL is shown in Figure 22.

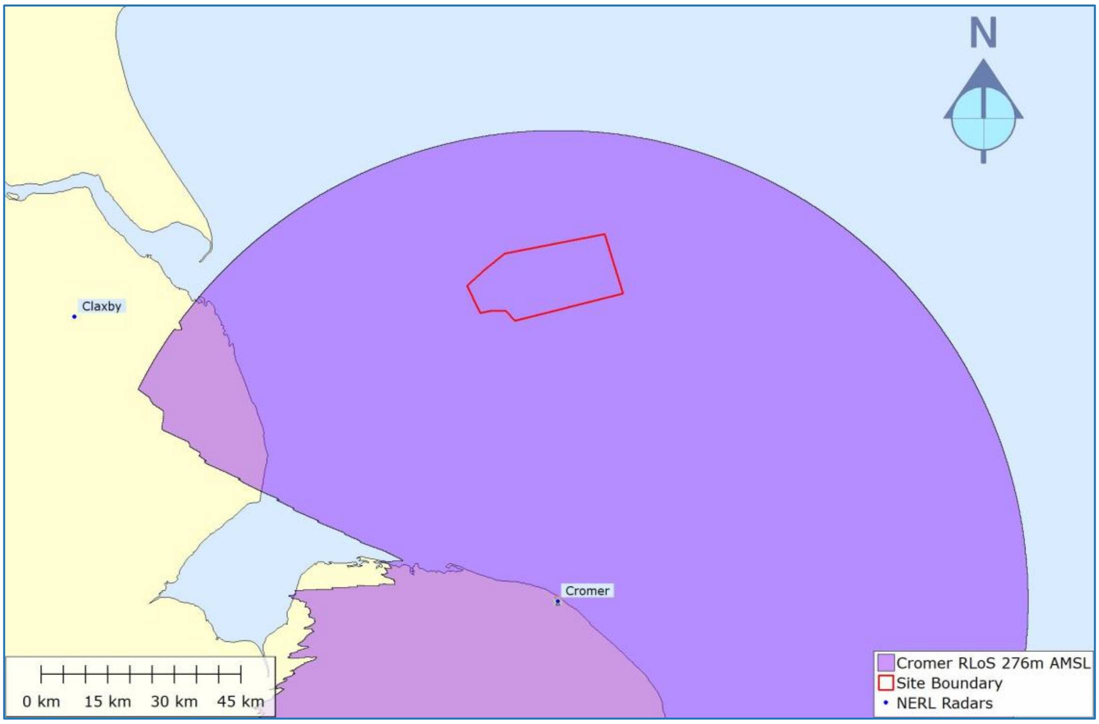

Figure 22: Cromer RLoS 276m AMSL

3.4.3.4. All WTGs within the array area with a blade tip height of 276m AMSL would be in RLoS of Cromer PSR and highly likely to be detected.

3.4.3.5. All WTGs within the array area, irrespective of blade tip height, would be in RLoS of the Cromer ASR-10SS PSR and highly likely to be detected.

3.5. MOD Air Defence Radars

3.5.1. Closest to Array Area

3.5.1.1. The closest AD radars to the array area are at Remote Radar Head (RRH) Staxton Wold, 119km to the northwest, and at RRH Neatishead, 87km to the south.

3.5.2. Staxton Wold

3.5.2.1. Staxton Wold RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 23.

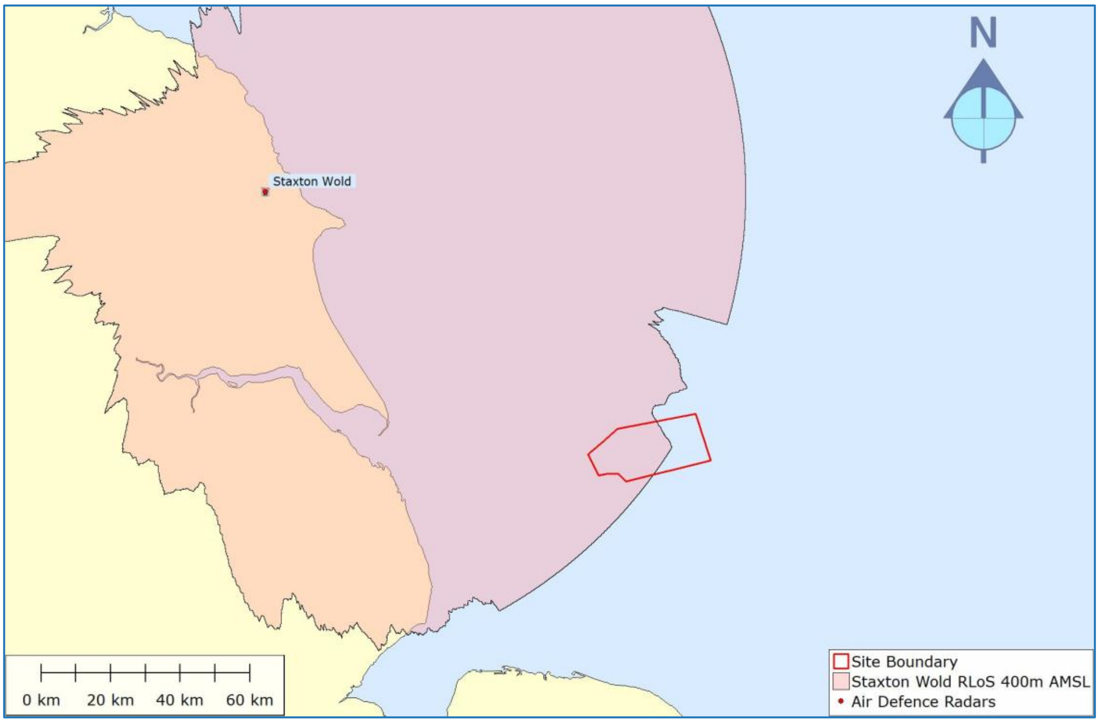

Figure 23: Staxton Wold RLoS 400m AMSL

3.5.2.2. WTGs within approximately 60% of the array area with a maximum blade tip height of 400m AMSL would be in RLoS of Staxton Wold PSR and highly likely to be detected.

3.5.2.3. Staxton Wold RLoS coverage for the minimum proposed blade tip height of 276m AMSL is shown in Figure 24.

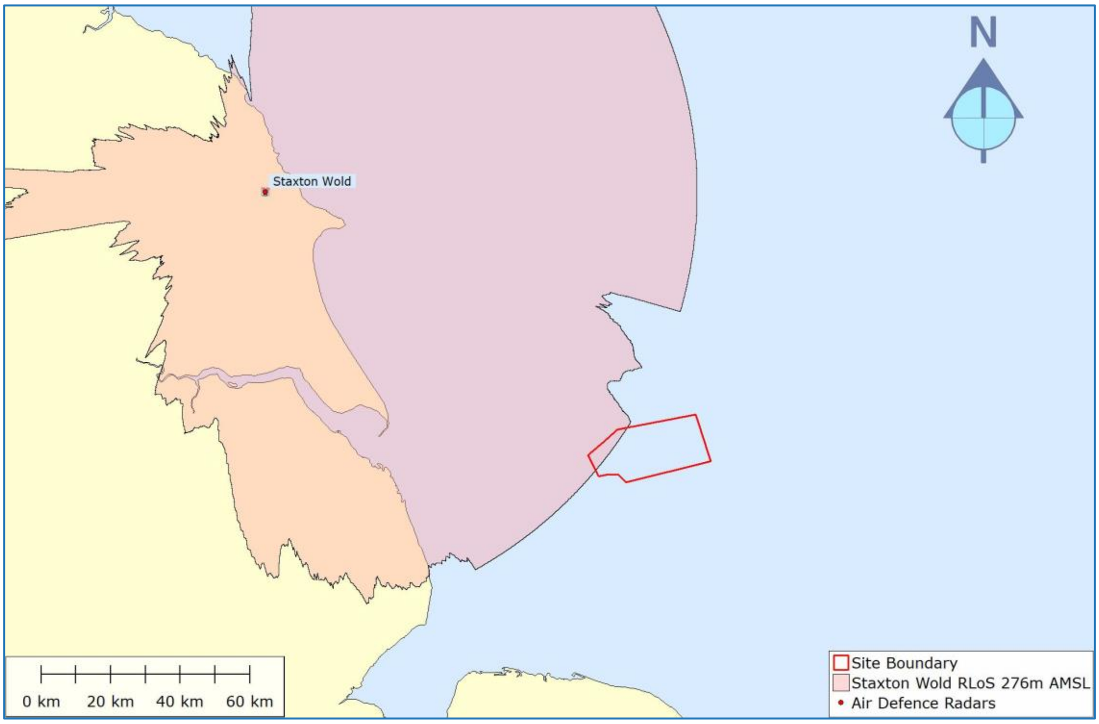

Figure 24: Staxton Wold RLoS 276m AMSL

3.5.2.4. WTGs within approximately 10% of the array area with a blade tip height of 276m AMSL would be in RLoS of Staxton Wold PSR and highly likely to be detected.

3.5.2.5. The Staxton Wold PSR has recently been upgraded to an Indra Lanza Long-Range Tactical Radar 25 (LTR-25) system. Detailed technical information for this system is not publicly available, however it can be stated that all WTGs that are in RLoS of Staxton Wold PSR would be detected and there would also be a possibility of detection for some WTGs beyond RLoS within the array area.

3.5.3. Neatishead

3.5.3.1. The MOD recently completed the relocation of the Trimingham AD radar to a new inland site at RRH Neatishead.

3.5.3.2. Neatishead RLoS coverage for the maximum blade tip height of 400m AMSL is shown in Figure 25.

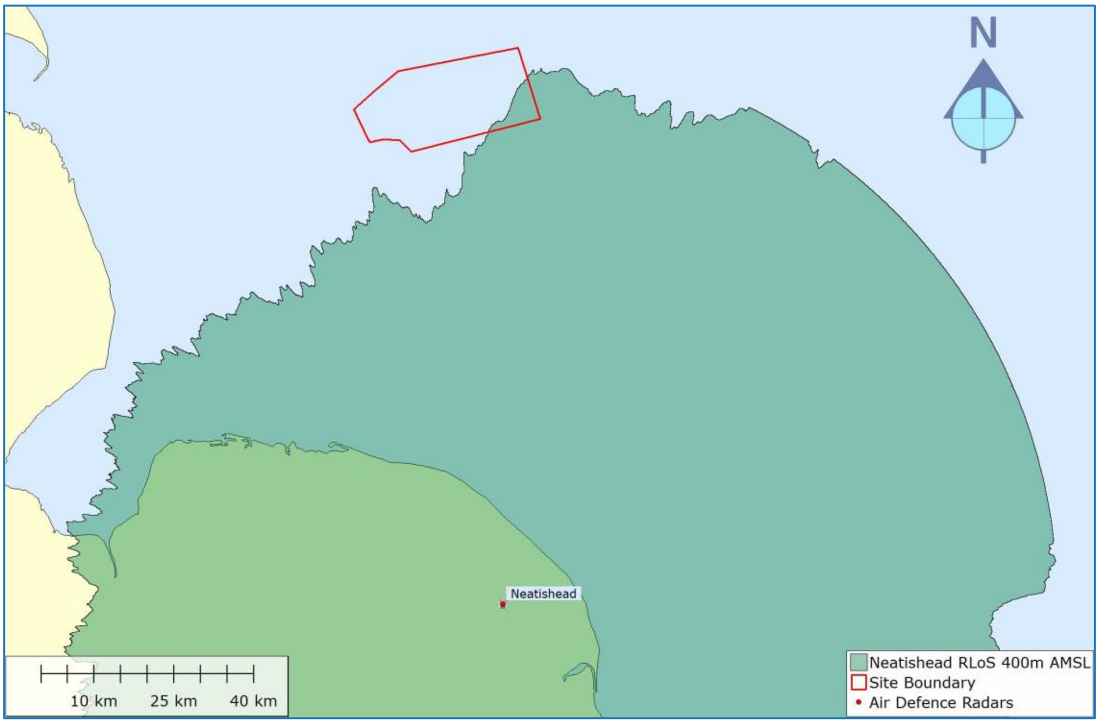

Figure 25: Neatishead RLoS 400m AMSL

3.5.3.3. WTGs within approximately 9% of the array area with a maximum blade tip height of 400m AMSL would be in RLoS of Neatishead PSR and highly likely to be detected.

3.5.3.4. Neatishead RLoS coverage for the minimum proposed blade tip height of 276m AMSL is shown in Figure 26.

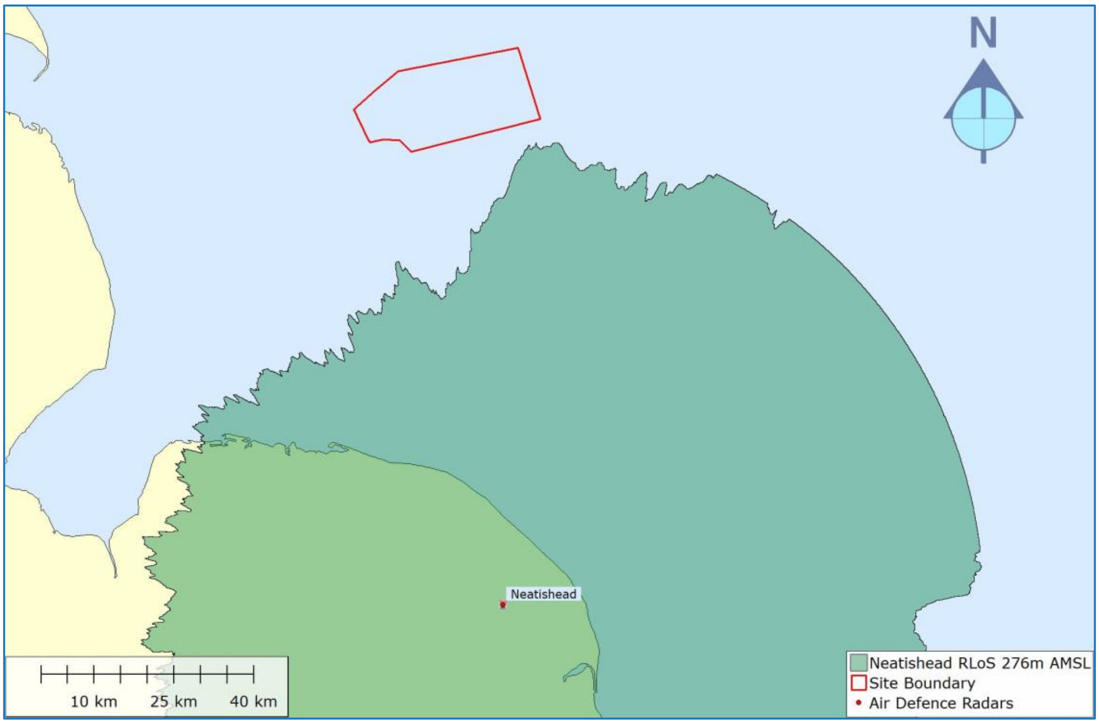

Figure 26: Neatishead RLoS 276m AMSL

3.5.3.5. No WTGs within the array area with a blade tip height of 276m AMSL would be in RLoS of Neatishead PSR. It is unlikely that 276m tip height WTGs within the array area would be detected by Neatishead PSR.

3.5.3.6. The MOD is unable to provide detailed technical information or specifications for the TPS-77 system as these are protected by the International Traffic in Arms Regulations; however, previous assessments carried out by Cyrrus using limited information from a publicly available factsheet have determined that WTGs that are in RLoS of the PSR would have a high probability of detection.

3.6. Radar Mitigation – NERL Radars

3.6.1. Possible mitigation options for WTGs that are detected by PSRs include blanking of the radar in the impacted area. This removes the unwanted WTG generated clutter from the controller's radar display, but also means that wanted aircraft returns are not displayed within the blanked area. Therefore, blanking is usually used in combination with infill data from an alternative radar feed that is not impacted by the WTGs or combined with the imposition of a TMZ.

3.6.2. A TMZ allows ATC to track an aircraft target using solely SSR within an area in which PSR clutter may otherwise have obscured the target.

3.6.3. NERL's network of radars feed their overlapping coverage data into a Multi Radar Tracking (MRT) system to produce an integrated radar picture for users at its control centres at Swanwick and Prestwick. After NERL's Claxby and Cromer radars, the next nearest en route NERL radar to the array area is at Debden, 175km to the southwest. Debden RLoS coverage in a sector encompassing the array area is depicted in Figure 27.

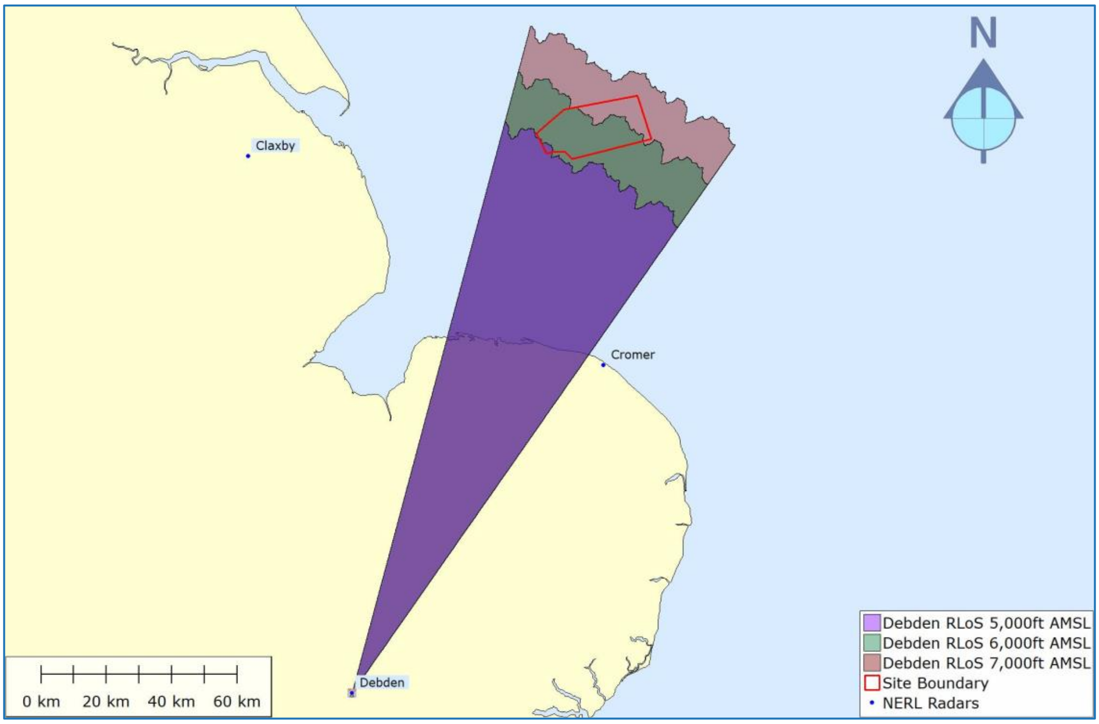

Figure 27: Debden RLoS coverage at 5,000ft, 6,000ft and 7,000ft AMSL

3.6.4. Debden PSR has RLoS coverage down to 7,000ft AMSL over the array area. The minimum RLoS coverage from Debden would not be sufficient to detect low-level helicopter traffic in the vicinity of the array area.

3.6.5. The most likely mitigation option for the impact on NERL radars would be to blank both Claxby and Cromer PSRs and establish a TMZ around the array area. This may take the form of an extension to the existing Greater Wash TMZ which lies to the south and west of the array area.

3.7. Radar Mitigation – MOD Air Defence Radars

3.7.1. In respect of the TPS-77 PSR at Neatishead, the most common WTG mitigation technique applied for previous wind farm developments was the application of a Non-Auto Initiation Zone (NAIZ) in the TPS 77's lowest beam over the footprint of any detectable WTGs. A NAIZ is a pre-defined geographical area where spurious radar returns from turbines will not initiate a track that could be interpreted as an aircraft. However, on 24 August 2018 the MOD issued a statement indicating that the TPS 77 NAIZ mitigation had not performed to expectations at flight trials over two offshore wind farms and as a result immediately paused the receipt and assessment of any technical mitigation reports or submissions relating to TPS-77 radars and multi-turbine wind farms.

3.7.2. An Air Defence and Offshore Wind (AD&OW) Windfarm Mitigation Task Force was formed as a collaborative initiative between the MOD, what was the Department for Business, Energy and Industrial Strategy (BEIS) now the Department for Energy Security and Net Zero (DESNZ), the Offshore Wind Industry Council and The Crown Estate in August 2019. The aim of the Task Force is to enable the co-existence of UK Air Defence and offshore wind by identifying potential mitigations and supporting processes, allowing offshore wind to contribute towards meeting the UK Government's Net Zero target without degrading the nation's AD surveillance capability.

3.7.3. The AD&OW Strategy and Implementation Plan (S&IP) sets the direction for this collaboration by identifying, assessing and deploying solutions that will enable the co-existence of AD&OW operations such that neither is unduly nor excessively compromised. The S&IP may lead to significant changes to current AD PSR characteristics and capabilities that in turn affect the potential impact that the Project may have.

3.7.4. In support of the S&IP, in March 2020 the MoD Defence and Security Accelerator (DASA) and BEIS launched an Innovation Challenge to reduce and remove the impact of wind farms on the UK's AD surveillance systems by seeking technological proposals in four areas:

- Alternatives to radar;
- Technologies applied to the WTG or installation;
- Technologies applied to the radar, its transmission or return; and
- Technological mitigations not covered by the above.

3.7.5. Phase 1 identified mitigations such as new radar signal processing methods or radar absorbing treatments applied to WTGs, and recommended a hybrid approach involving changes to both radar and WTG design to solve the problem in the long term.

3.7.6. Phase 2 of the competition was launched in April 2021 seeking proposals to address four main subject areas:

- Reduction of clutter or the impact of clutter;
- Ensuring efficient detection and tracking time;
- Technologies to mitigate against larger turbine blades and wider turbine spacing development; and
- Alternate methods of surveillance.

3.7.7. Of twenty submitted proposals, contracts for seven proposals were awarded in September 2021 and completed by March 2023.

3.7.8. DASA and DESNZ launched Stream 1 of Windfarm Mitigation for UK Air Defence: Phase 3 in February 2023, building upon Phases 1 and 2 to advance innovative technologies in radar signal processing, WTG materials and alternative tracking approaches.

3.7.9. In August 2023 funding was awarded for two projects: a project developing passive air defence sensors to address clutter from WTG blades, and another project developing stealth materials for next-generation WTG blades. At the same time, Phase 3 Stream 2 was launched to find solutions for the modelling and testing of different mitigation technologies.

3.7.10. The ultimate aim of the S&IP is to have mitigations in place to support offshore wind developments by Q2 2025, and therefore it is expected that such mitigation will be available before the construction of the Project.

3.8. Consultation on mitigation

3.8.1. Potential mitigation measures will be consulted upon with stakeholders throughout the DCO pre-application phase and as part of the EIA process and will also reflect appropriate measures that are being discussed at an industry level.

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