Appendix 14.1: Aviation, Military and Communications Technical Report

Array EIA Report

2024

Revision	Comments	Author	Checker	Approver
FINAL	Final	Osprey/RPS	RPS	RPS

Approval for Issue		
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1. INTRODUCTION

1. This Aviation, Military and Communications Technical Report provides a detailed description of aviation and military activity within the area of the Ossian Array (hereafter referred to as 'the Array') and the northern North Sea region. This Technical Report considers wind turbines once they are fully installed with regard to civil aviation and military aviation activity.

2. This information has been used to inform the Array Environmental Impact Assessment (EIA) Report (volume 2, chapter 14) being undertaken as part of the consenting process for the Array.

2. STUDY AREA

3. To identify and characterise aviation, military and communications receptors, a broad study area has been defined and based on recommendations provided by the Civil Aviation Authority (CAA) Civil Aviation Publication (CAP) 764 Policy and Guidelines on Wind Turbines (CAA, 2016a). Whilst not definitive, CAP 764 (CAA, 2016a) provides criteria for assessing whether any wind turbine development might have an impact on aerodrome and radar related operations. Consideration of the Array's potential to impact on aviation receptors has been undertaken in accordance with the recommended consultation distance for aviation of within 30 km of an aerodrome with a surveillance radar facility, as stated in CAP 764 (CAA, 2016a). However, CAP 764 (CAA, 2016a) states that the operational range of a radar system is dependent on the type of radar used and its operational requirement.

4. Although CAP 764 (CAA, 2016a) provides a guide of 30 km for assessment of radar impact, impact to aviation radar is dependent on radar detectability of operational wind turbines, the radar's operational range and the use of airspace in which the development sits. The identification of the aviation, military and communications study area and assessment of potential operational impact has considered physical safeguarding of flight, airspace characteristics and procedures as published in the CAA CAP 032, United Kingdom (UK) Integrated Aeronautical Information Package (IAIP) (CAA, 2023) and the Ministry of Defence (MOD) Military Aeronautical Information Publication (Mil AIP) (MOD, 2023a).

5. The aviation, military and communications study area covers the aviation radar systems that potentially detect the maximum (highest) wind turbine blade tip height of 399 m above Lowest Astronomical Tide (LAT) (Figure 2.1). The aviation, military and communications study area encapsulates the Array, and applicable airspace between the Array and the UK mainland from the location of the NATS En-route Limited (NERL) operated Allanshill Primary Surveillance Radar (PSR) to the north and the Brizlee Wood Remote Radar Head (RRH) Air Defence Radar (ADR) to the south.

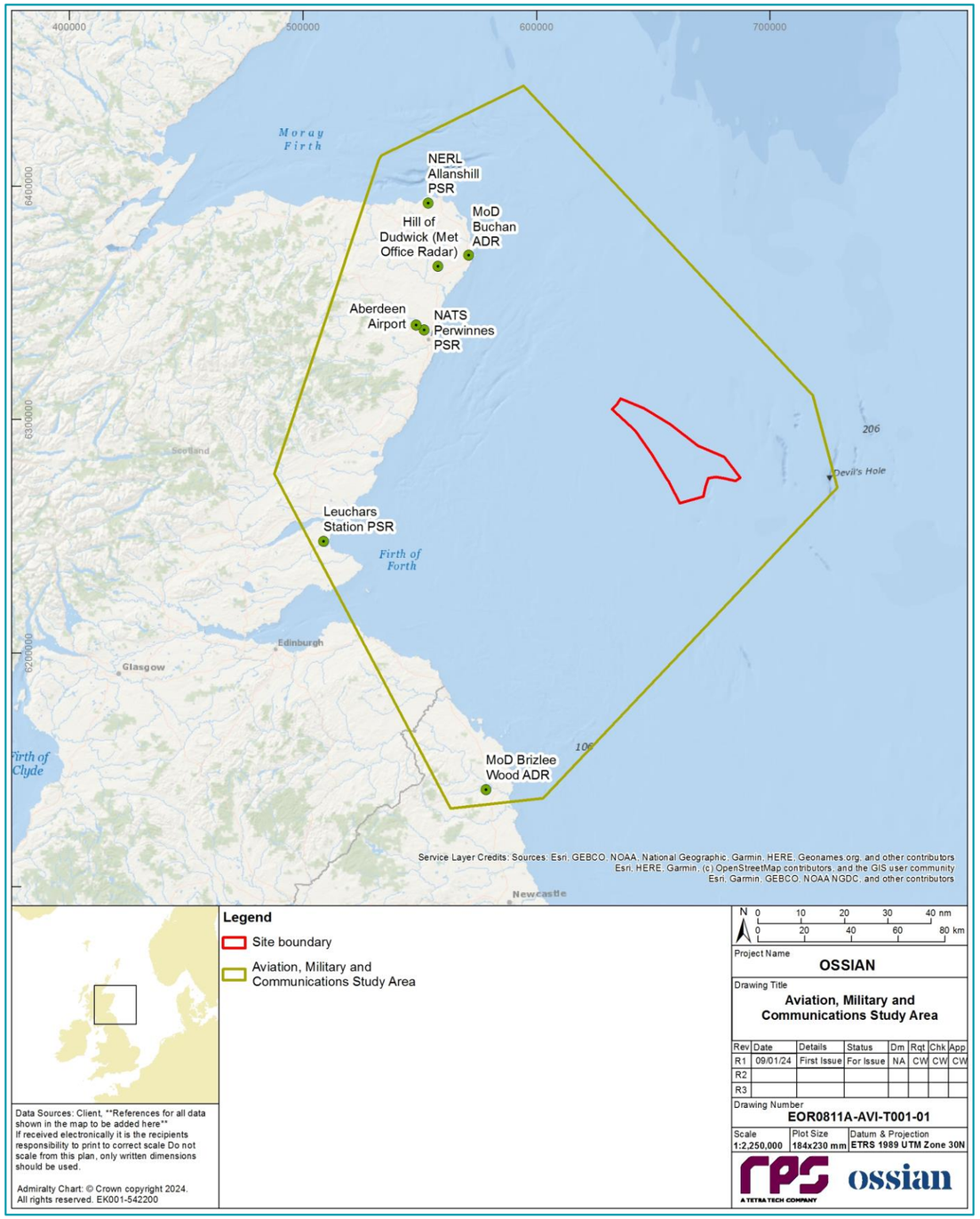

Figure 2.1: Aviation, Military and Communications Study Area

3. BASELINE

3.1. METHODOLOGY

6. Through the desktop study the identification of all aviation, military and communications receptors potentially affected by the Array was established in accordance with regulatory guidelines on safeguarding distances from CAP 764 (CAA, 2016a). A variety of national and international aviation publications contain information and guidance relating to the potential effects of an offshore wind development on aviation receptors; all relevant documents were considered in establishing the aviation, military and communications baseline. The primary source of aviation related data used during desktop studies in support of this report is the UK IAIP (CAA, 2023) and the Mil AIP (MOD, 2023a). Both documents contain details on airspace and en-route procedures as well as charts and other air navigation information. The aviation industry and the provision of Air Navigation Services (ANSs) (including radar services) are regulated through extensive legislation; however, the main mechanism for regulating the relationship between aviation and offshore wind is through the consenting system. The contents and guidance within the documents in Table 3.1, as a minimum, have been considered within this report.

3.2. DESKTOP STUDY

7. A detailed desktop review of existing studies and datasets was undertaken to gather information on aviation (civil and military) and radar within the aviation, military and communications study area. Table 3.1 summarises the data sources and guidance documents considered as part of the desktop review in the establishment of the aviation, military and communications baseline for the Array.

Table 3.1: Summary of Key Desktop Reports

Title	Source	Year	Reference
Policy and Guidelines on Wind Turbines (CAP 764)	CAA	2016	CAA, 2016a
Air Navigation Order (ANO) (CAP 393)	CAA	2016 (as amended 2022)	CAA, 2016b
Air Traffic Services Safety Requirements (CAP 670)	CAA	2019	CAA, 2019
Safeguarding of Aerodromes (CAP 738)	CAA	2020	CAA, 2020
Licensing of Aerodromes (CAP 168)	CAA	2022	CAA, 2022a
UK Visual Flight Rules (VFR) Charts - Sheet 2150ABCD Scotland Edition 35	NATS/CAA	2022	CAA, 2022b
Implementation and Safeguarding of Instrument Flight Procedures (IFP) in the UK (CAP 785B)	CAA	2022	CAA, 2022c
UK IAIP (CAP 032)	CAA	2023	CAA, 2023
Mil AIP	MOD	2023	MOD, 2023a
UK En Route Low Altitude North Sea West Offshore Installations Chart - UK (Low) 5 OIL	MOD	2023b	MOD, 2023b
Marine Guidance Note (MGN) Safety of Navigation Offshore Renewable Energy Installations (OREI)	MCA	2021	MCA, 2021
International Civil Aviation Organisation (ICAO) Document 8168 Ops/611 Procedures for Air Navigation Services - Aircraft Operations (PANS-Ops)	ICAO	2018	ICAO, 2018
ICAO Annex 14 Aerodromes Design and Operations contains Standards and Recommended Procedures (SARPs)	ICAO	2022	ICAO, 2022
Statement of the Operational Programme for the Exchange of Weather Radar (OPERA) group on the cohabitation between weather radars and wind turbines	OPERA	2009	OPERA, 2009

3.2.1. SITE-SPECIFIC SURVEYS

8. No site-specific surveys were undertaken during the desktop study.

3.2.2. BASELINE CHARACTERISATION

9. The airspace above and around the Array is used by both civil and military aircraft, which are tracked by radar systems operated by both NATS and the MOD. The Array is located within the Scottish Flight Information Region (FIR) in an area of Class G uncontrolled airspace, which is established from surface up to Flight Level (FL) 195 (approximately 19,500 ft). Above this Class G uncontrolled airspace is established Class C Controlled Airspace (CAS).

10. Within Class G uncontrolled airspace an Air Traffic Service[1] (ATS) is not mandatory. In Class G airspace, any aircraft may fly when and where they like, subject to a set of simple rules. Although there is no legal requirement to do so, many pilots notify ATC of their presence and intentions, and pilots take full responsibility for their own safety. Pilots may request an ATS which may be provided by NATS or military controllers located at an Area Control Centre (ACC) or Air Defence (AD) controllers, subject to suitable radar and radio coverage being available to them. Aircraft operating in this area may be in receipt of an ATS; however, within this classification of airspace, pilots are ultimately responsible for their own terrain and obstacle clearance. This is achieved through prudent planning (using published aviation charts, the UK IAIP and local aerodrome instructions) and diligent ‘lookout’ throughout the flight.

11. All aircraft operating within CAS must be in receipt of an ATS from NATS, military air traffic controllers located at a NATS ACC or under the control of military AD controllers. Within Class C CAS all flights are subject to mandatory air traffic control instructions with standard separation maintained between aircraft dependent on whether they are flying under Instrument Flight Rules (IFR) or VFR. When flying under IFR aircrews are referring to aircraft cockpit instruments for situation awareness and navigation and may not be able to operate the aircraft with visual reference to maintain visual separation from obstacles, terrain

[1] Air Traffic Service. An Air Traffic Service is provided to expedite and maintain an orderly flow of air traffic, and provide advice and information useful for the safe and efficient conduct of flights. ATC are able to notify appropriate organisations regarding aircraft in need of search and rescue aid and assist such organisations as required.

and other aircraft. When flying under VFR, aircrews are referring to a set of regulations under which a pilot operates the aircraft in weather conditions which generally allow the pilot to maintain visual separation from obstacles, terrain and other aircraft.

Civilian aviation

12. The UK civil airport nearest to the Array is Aberdeen Airport, which is located on a bearing of approximately 292°/50 nm north-west of the Array. Due to the location of the Array, Aberdeen Airport is the only airport which may be impacted.

13. Figure 2.1 provides the location of the two NATS PSR which may be affected by the development of the Array; the following approximate distances are taken from the closest boundary of the Array to each NATS PSR potentially affected:

- Perwinnes PSR located on a bearing of 296°/47.4 nm; and
- Allanshill PSR located on a bearing of 314°/63.5 nm.

14. A PSR is a conventional radar sensor that illuminates a large portion of space with an electromagnetic wave and receives back the reflected waves from targets within that space. The term thus refers to a radar system used to detect and localise potentially non-cooperative targets. Typically, PSR systems employ a 'cosec2 antenna' which produces two beams (low and high). The two beams give a capability to reduce fixed ground clutter in the immediate area of the radar. These systems provide target detection in range and azimuth only and are generally known as two dimensional (2D) radars. A wind turbine that is detectable by a PSR system can be a significant cause of radar false plots, or unwanted returns (clutter), as the rotating blades can trigger the Doppler threshold (e.g. minimum shift in signal frequency) of the Radar Data Processor (RDP) and therefore might be interpreted as aircraft targets. Additionally, the rotation of the wind turbine blades provides an indication to the radar system that the target acquired is moving and thus defeating Doppler processing techniques. This issue can be further compounded by a large number of wind turbines located together (such as a wind farm) which leads to a cumulative effect over a greater volume of airspace with higher densities of radar clutter produced. It is opposed to the secondary radar which receives additional information from the target's transponder.

15. Secondary Surveillance Radar (SSR) is a collaborative radar system which means that the radar will 'interrogate' a transponder on the aircraft for useful information such as altitude and heading, which is then passed to the ATC display console. All military aircraft (and most civilian aircraft) carry transponders which respond to secondary radar interrogation.

16. The CAA advises that effects on Secondary Surveillance Radar (SSR) are only relevant to consider when wind turbines are located less than 10 km from the SSR CAP 764 (CAA, 2016a). The closest aviation SSR systems to the Array is co-located at the Perwinnes and Allanshill PSR locations which lie outside the area of interaction with any aviation related SSR systems and is not considered further.

17. Commercial offshore helicopter operations in this region encompass support to offshore oil and gas exploitation and Search and Rescue (SAR) operations. Mitigation (if required) will adhere to guidance set out in MGN 654.

18. Helicopters supporting offshore oil and gas in the northern North Sea use Helicopter Main Route Indicators (HMRIs), radiating from Aberdeen Airport (the main support base) on a hub/spoke radial pattern as illustrated in Figure 3.1. These HMRIs lie to the north of the Array; the closest being 4 nm to the north of the Array's north-eastern boundary. The CAA recommend within CAP 764 (CAA, 2016a) that there should be no obstacles within 2 nm either side of the centreline of a HMRI.

19. The Met Office safeguards its weather radar and provides site-specific (radar) pre-planning advice for proposals sited in Met Office consultation zones. The Array is located outside of the consultation zone for the nearest Met Office radar at Hill of Dudwick, Aberdeenshire which is located on a bearing of 307°/52.1 nm (96.5 km) from the closest boundary of the Array (Figure 2.1); however, the draft National Policy Statement (NPS) for Energy (EN-1) indicates that some energy structures, such as wind turbines, have the potential to adversely impact weather radar signals, even beyond 100 km from the radar (Department for Energy Security and Net Zero (DESNZ), 2023). The Met Office has responded to engagement providing confirmation that there is no potential for the Hill of Dudwick weather radar operation or data and products derived from it to be impacted by the Array and it is, therefore, not considered further.

Military aviation

20. The MOD through the Air Surveillance and Control System (ASACS) is responsible for compiling a Recognised Air Picture (RAP) to monitor the airspace in and around the UK to launch a response to any potential airborne threat. This is achieved through the utilisation of a network of long range ADR systems, some of which are located along the east coast of the UK. ADR systems typically employ complex rotating phased array antennas. The antennas produce many smaller 'pencil' beams which are stacked in elevation, this allows the system to process the received targets signal strength in each of the pencil beams, which in turn gives the radar the ability to provide an indication of the coarse height of a target as well as its range and azimuth. These types of radar are generally referred to as three dimensional (3D) systems. ADRs are similarly impacted by the detection of operational wind turbines as listed in paragraph 32. Any identified effect of wind turbines on the ASACS radar systems that serve the airspace above and beyond the Array may potentially reduce the capability of the ASACS Force to effectively monitor airspace in locating a potential airborne threat.

21. Figure 2.1 provides the location of radar systems with the potential to be impacted by the Array. The nearest ADR to the Array is the TPS-77 (Type 92) ADR located at RRH Buchan, Aberdeenshire which is located on a bearing of approximately 316°/48 nm from the closest boundary of the Array. A TPS-77 ADR is one of Lockheed Martin's radars which provides multi-mission ground-based radar solutions for medium to long range air surveillance. RRH Brizlee Wood in Northumberland operates a TPS-77 type ADR and is located on a bearing of approximately 215°/80 nm from the closest boundary point on the south-west of the Array. Leuchars Station PSR is located on a bearing of approximately 245°/73 nm from the closest boundary of the Array. Although there is potential for this PSR to detect the operational wind turbines, the Array is outside of Leuchars Station PSR ATS Area of Responsibility (AoR), which extends to approximately 40 nm radius from the Leuchars Station PSR position, therefore, Leuchars Station PSR is not considered further.

22. The Array straddles the lateral boundaries of a number of military Practice and Exercise Areas (PEXAs) known as D613 A/B/C/D, and abbreviated as the '613s'. These Managed Danger Areas (MDAs) are created to provide segregated airspace for military flying training, bookings for which are managed by the Military Airspace Management Cell (MAMC). MDAs are only activated on request. The vertical extent of the '613s' are from a base level of FL 100 (approximately 10,000 ft) to FL 660 (approximately 66,000 ft). As the lower base height of aerial activity in the '613s' is well above the maximum height of the Array wind turbines, no impact is predicted to the '613s' operation.

23. The UK Low Flying system (UKLFS) used for military low flying activity covers the airspace over the entire UK land mass and surrounding sea (excluding restricted, PEXA and built-up areas) generally out to 2 nm from the coastline, from the surface to 2,000 ft above ground level (agl) or above mean sea level (amsl), however, military low flying activities can take place further from the coastline out to sea. The Array has the potential to impact low flying operations due to the construction of multiple obstacles above sea level. Military low flying activities take place in uncontrolled airspace below 2,000 ft, offshore, above mean sea level (amsl) within defined Low Flying Areas (LFAs). The UK is divided into twenty separate LFA where military low flying is permitted. With the introduction of radar-guided surface-to-air missile and gun systems, low level tactics are vital to enable aircraft to fly below radar coverage to evade or delay engagement, whether for offensive action, or to transport troops and equipment both in fixed and rotary-wing aircraft. The Array is adjacent to LFA 14 which covers mainland Scotland, north of the central region, the Western Isles, Orkney and Shetland. Military low flying is likely to take place above and around the Array. It is common practice for the Defence Infrastructure Organisation (DIO), who safeguard MOD operations and infrastructure, to request aviation obstruction lighting to be fitted to wind turbines in accordance with CAP 393 (CAA, 2016b (as amended)).

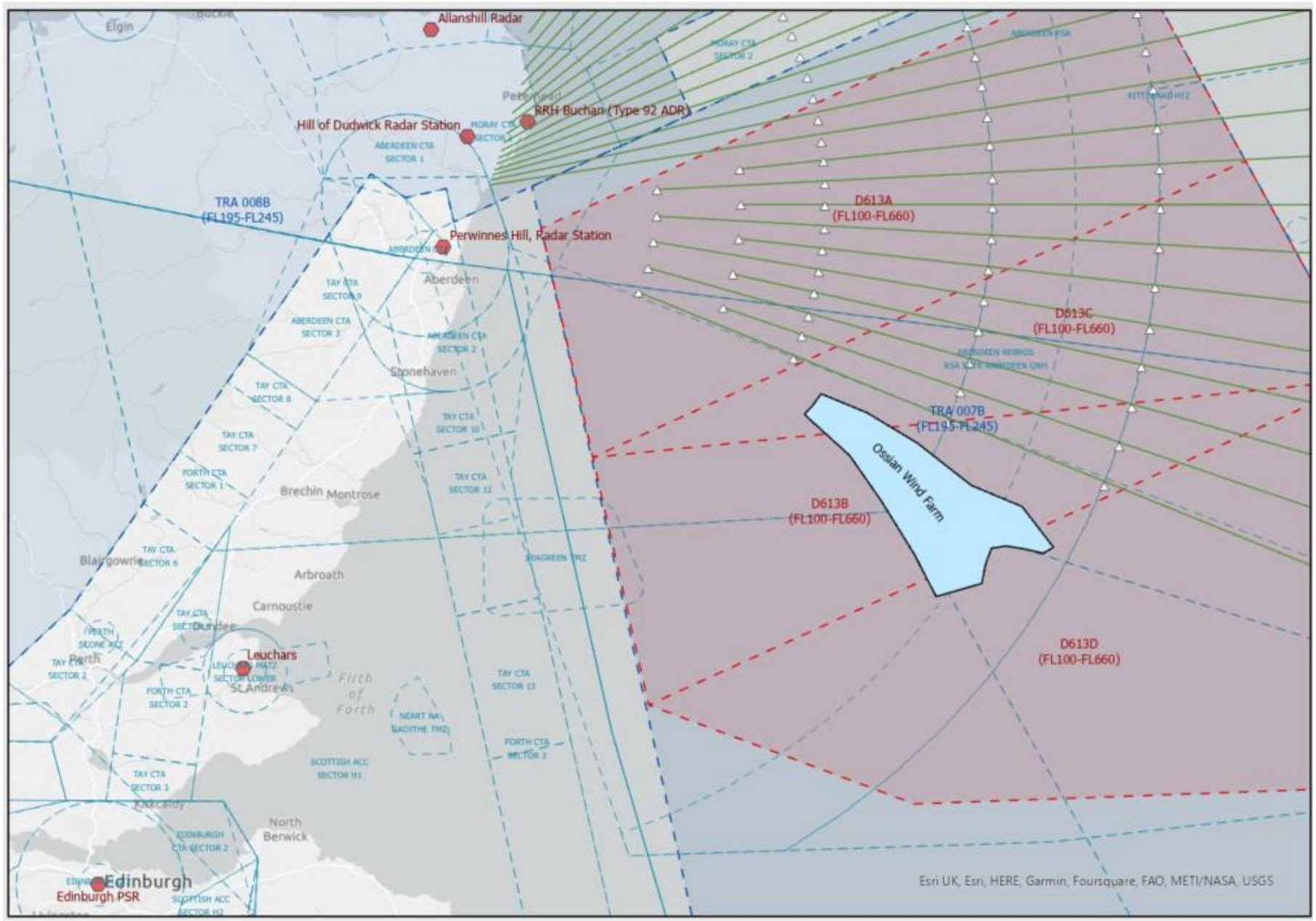

Figure 3.1: Airspace Construction in the Vicinity of the Array

Radar line of sight modelling

24. Radar line of sight (LoS) modelling is an industry standard method in providing potential of the detectability by aviation radar systems of operational wind turbines. The radar LoS analysis between the blade tip height and potentially affected civil and military aviation radar systems was completed to establish the theoretical detectability of the wind turbines to those regional radar systems which have the potential to be affected by their operation.

25. The Advanced Topographic Development and Imaging (ATDI) ICS LT (Version 22.4.7 x64) tool was utilised to model the terrain elevation profile between the identified PSR systems and the Array. Otherwise known as a point-to-point radar LoS analysis, the result is a graphical representation of the intervening terrain and the direct signal LoS, taking into account earth curvature and radar signal properties.

26. It should be noted that this is a limited and theoretical desk-based study; in reality there are unpredictable levels of signal diffraction and attenuation within a given radar environment that can influence the probability of a wind turbine being detected. The analysis is designed to give an indication of the likelihood of the wind turbine being detected such that the operational significance of the Array relative to the radar systems can be assessed.

27. The aim of the LoS analysis is to determine which radar systems have the potential to detect operational wind turbines at the maximum blade tip height placed within a projected area; the layout of wind turbines does not have a material effect on establishing theoretical radar LoS. Therefore, to enable the analysis, points of reference in the form of a regular grid pattern were established across the projected Array with wind turbines on all Array vertices at the maximum blade tip height of 399 m above LAT, which is considered to be the Maximum Design Scenario (MDS) for aviation. The model does not use precise planned/proposed wind turbine positions as these would be confirmed at detailed design stage, but representative locations within the projected Array area, on a 4 km grid pattern of 78 wind turbines, ensuring an even distribution. The result for a particular location provides an indication of detectability of a wind turbine, based on a maximum upper blade tip height, within a 2 km radius of that location; providing a result that covers the whole of the projected Array.

28. The qualitative definitions utilised in the LoS assessment are defined in Table 3.2.

Table 3.2: Radar LoS Qualitative Definitions

Result	Definition
Yes	The wind turbine is highly likely to be detected by the radar; direct LoS exists between the radar and the wind turbine.
Likely	The wind turbine is likely to be detected by the radar at least intermittently.
Unlikely	The wind turbine is unlikely to be detected by the radar but cannot rule out occasional detection.
No	The wind turbine is unlikely to be detected by the radar as significant intervening terrain exists.

29. A radar LoS analysis across the Array has been completed in order to establish theoretical radar detectability of the wind turbines, placed within the Array to selected PSR systems based on a maximum upper blade tip height of 399 m LAT. Radar operates by alternately transmitting a stream of high power radio frequency pulses and 'listening' to echoes received back from targets within its radar LoS. Generally, air surveillance (aviation) radars employ a rotating antenna that provides 360° coverage in azimuth; the typical scan rate is 15 rpm thus illuminating a given target every four seconds.

30. PSR can distinguish between moving and static targets; for targets that are moving towards or away from the radar, the frequency of the reflected signal from a moving target changes between each pulse (transmit and receive) which is known as the Doppler shift. This can be most practically explained by considering the change in frequency of the engine sound heard by a pedestrian when a car passes by on the road, the sound as the car approaches is higher than the sound heard by the pedestrian as it travels away. The Doppler shift has the effect of making the sound waves appear to bunch up in front of the vehicle (giving a higher frequency) and spread out behind it (lower frequency). The true frequency of the engine is only heard when the car is immediately next to the pedestrian. The aviation radar receiver is 'listening' to the radio waves reflected from the moving object and working out whether the returned signal is of a higher or lower frequency (moving object) or if the returned frequency is the same as the transmitted signal (a stationary object).

31. Wind turbines are a significant cause of PSR false plots or clutter, as the rotating blades can trigger the Doppler threshold (minimum shift in signal frequency) of the Radar Data Processor (RDP) and therefore may be interpreted as aircraft movements (CAA, 2016a). Significant effects have been observed on radar sensitivity caused by the substantial Radar Cross Section[2] (RCS) of the wind turbine structural components (blades, tower and nacelle) which can exceed that of a large aircraft; the effect 'blinds' the radar (or the operator) to wanted targets in the immediate vicinity of the wind turbine. False plots and reduced radar sensitivity may reduce the effectiveness of the radar system itself to an unacceptable level and compromise the provision of a safe radar service to participating aircraft.

32. The generalised effects wind turbines have on PSR and ADR systems through radar detection of operational wind turbines are as follows:

- Twinkling appearance/blade flash effect can distract the air traffic controller from their primary task.
- Masking of real aircraft targets caused by increased clutter being displayed on the radar data display screen.
- Increase in unwanted targets or false aircraft tracks.
- Receiver saturation: if a large clutter signal sends a radar system into saturation, the result is a modification to the spectrum of the signal. This change in spectral content reduces the ability of the signal processor to carry out Doppler processing and degrades the detection of aircraft.
- Target desensitisation where real aircraft targets may not be displayed to the air traffic controller.
- Shadowing behind the wind turbines caused by physical obstruction (blocking of radar transmitted signal).
- Degradation of target processing capability and processing overload which will lead to the loss of genuine aircraft targets.
- Degradation of tracking capabilities including track seduction: wind turbines can have a significant effect on air surveillance radars as the spinning blades reflect a large amount of radar energy. Wind turbines can appear on a radar screen as false air targets or lead to track seduction of legitimate radar tracks. The interfering radar echoes generated by the wind turbines can desensitise a radar in the vicinity of the wind turbines, causing legitimate radar tracks to disappear from the radar screen.

Radar line of sight modelling summary

33. Due to the location of the Array and the maximum blade tip height elevation, possible effects are likely to impact the operations associated with the following PSR/ADR due to detectability of the operational wind turbines. The Perwinnes PSR and Allanshill PSR systems are referred to in the following figures as Airport Surveillance Radar (ASR) systems. An ASR is a radar system used at airports to detect and display the presence and position of aircraft in the airspace around airports.

[2] Radar Cross Section is a measure of how detectable an object is by radar. A larger RCS indicates that an object is more easily detectable than a lower RCS. While important in detecting targets, strength of emitter and distance are not factors that affect the calculation of an RCS because RCS is a property of the target's reflectivity.

34. Two-thirds of the Array (the areas closest to the radar location) are theoretically highly likely to be detected by the Perwinnes PSR and Buchan ADR systems. Intermittent radar detection of the operational wind turbines in the south-east area (the remaining third) of the Array cannot be ruled out.

35. The Allanshill PSR is theoretically likely to intermittently detect operational wind turbines in the north-west corner of the Array, the remaining Array will not theoretically be detectable by this PSR.

36. The Brizlee Wood ADR will theoretically detect wind turbines at the maximum blade tip height across the western edge of the Array (the closest area to the ADR location). The remaining area of the Array will not theoretically be detectable although occasional detection cannot be ruled out across the central area of the Array.

37. Figure 3.2 to Figure 3.5 provide an illustration of the radar LoS results for each radar system assessed. Radar detectability of operational wind turbines may lead to the effects as listed in paragraph 32.

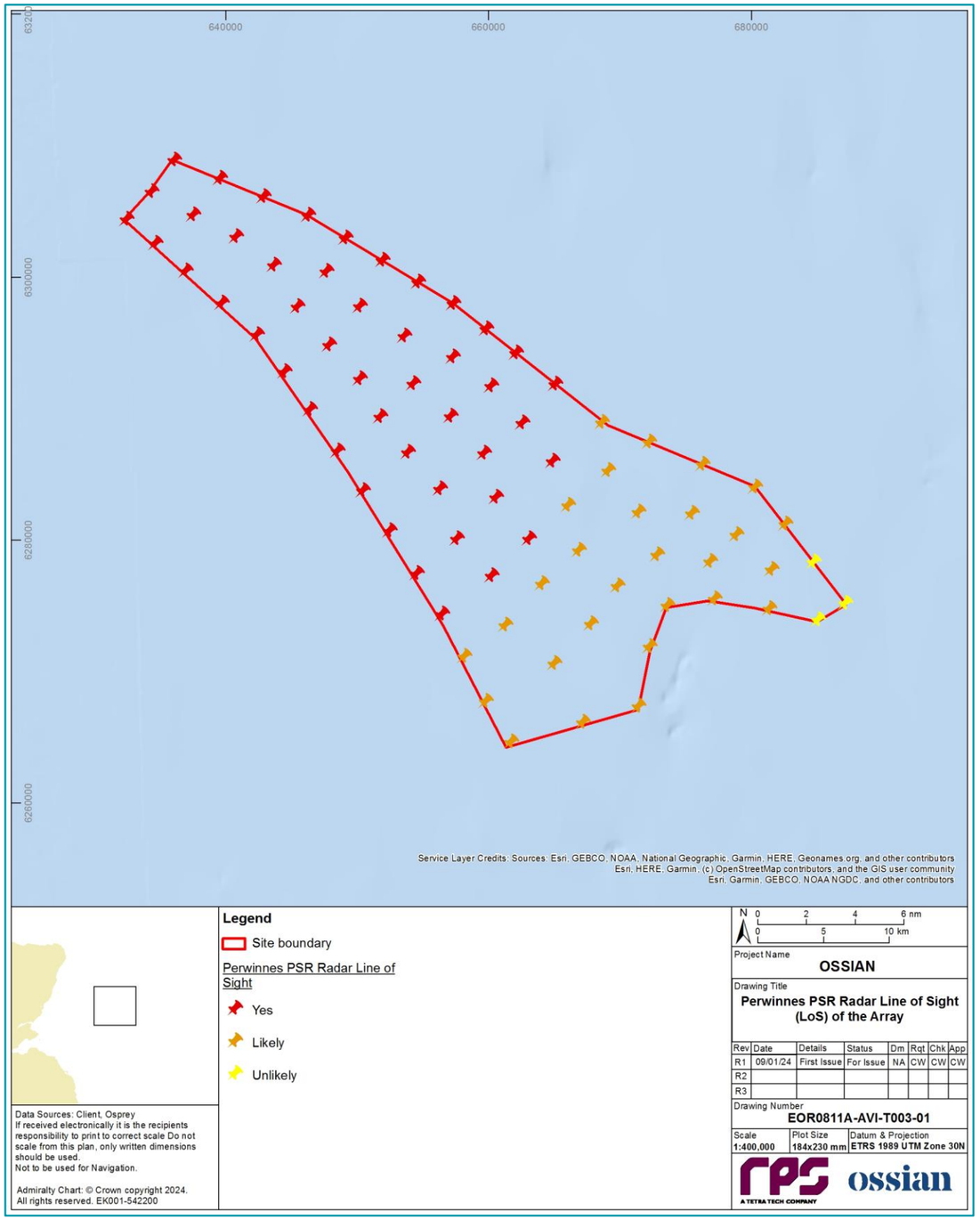

Figure 3.2: Perwinnes (ASR) PSR Radar LoS of the Array (Not to Scale)

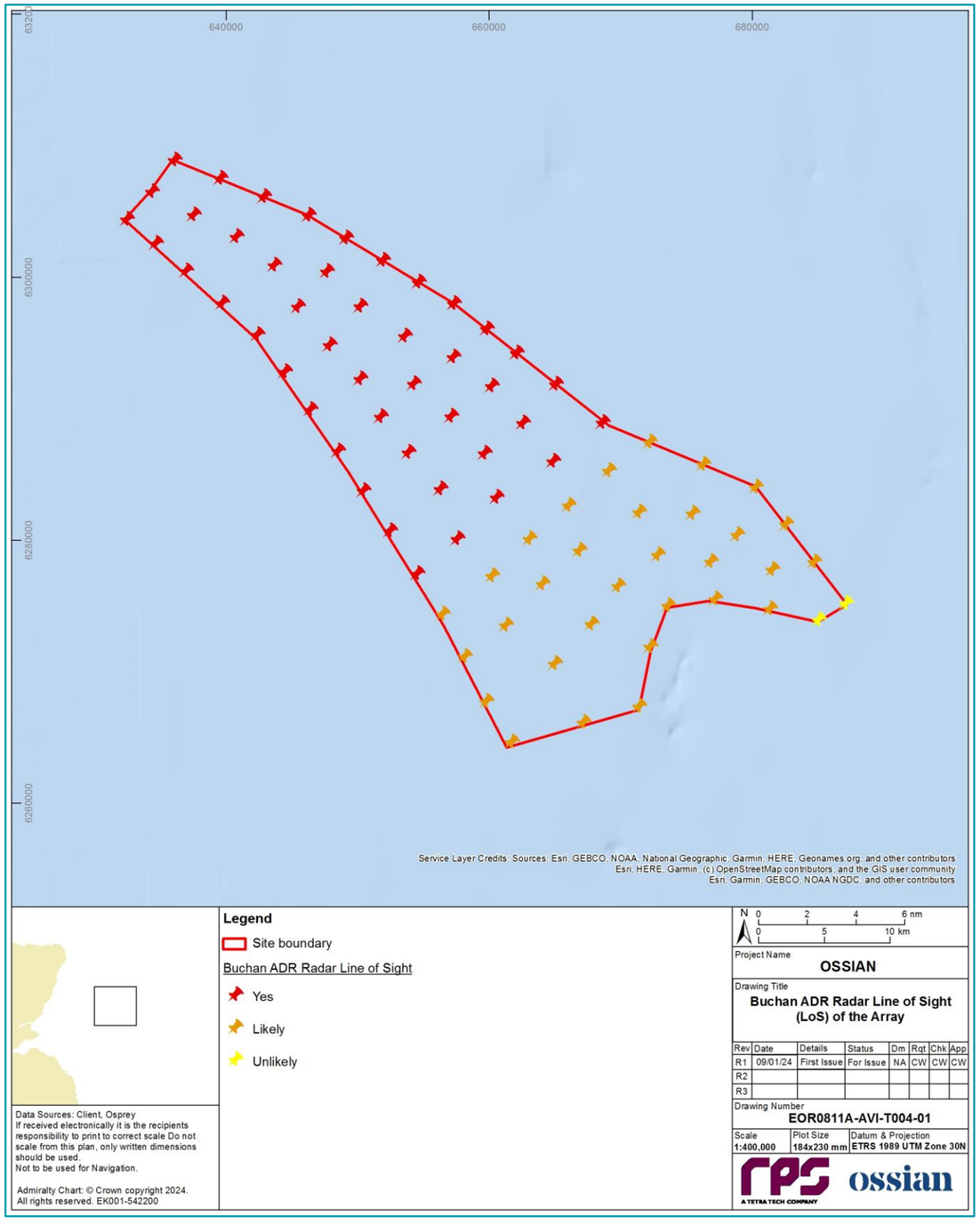

Figure 3.3: Buchan ADR Radar LoS of the Array (Not to Scale)

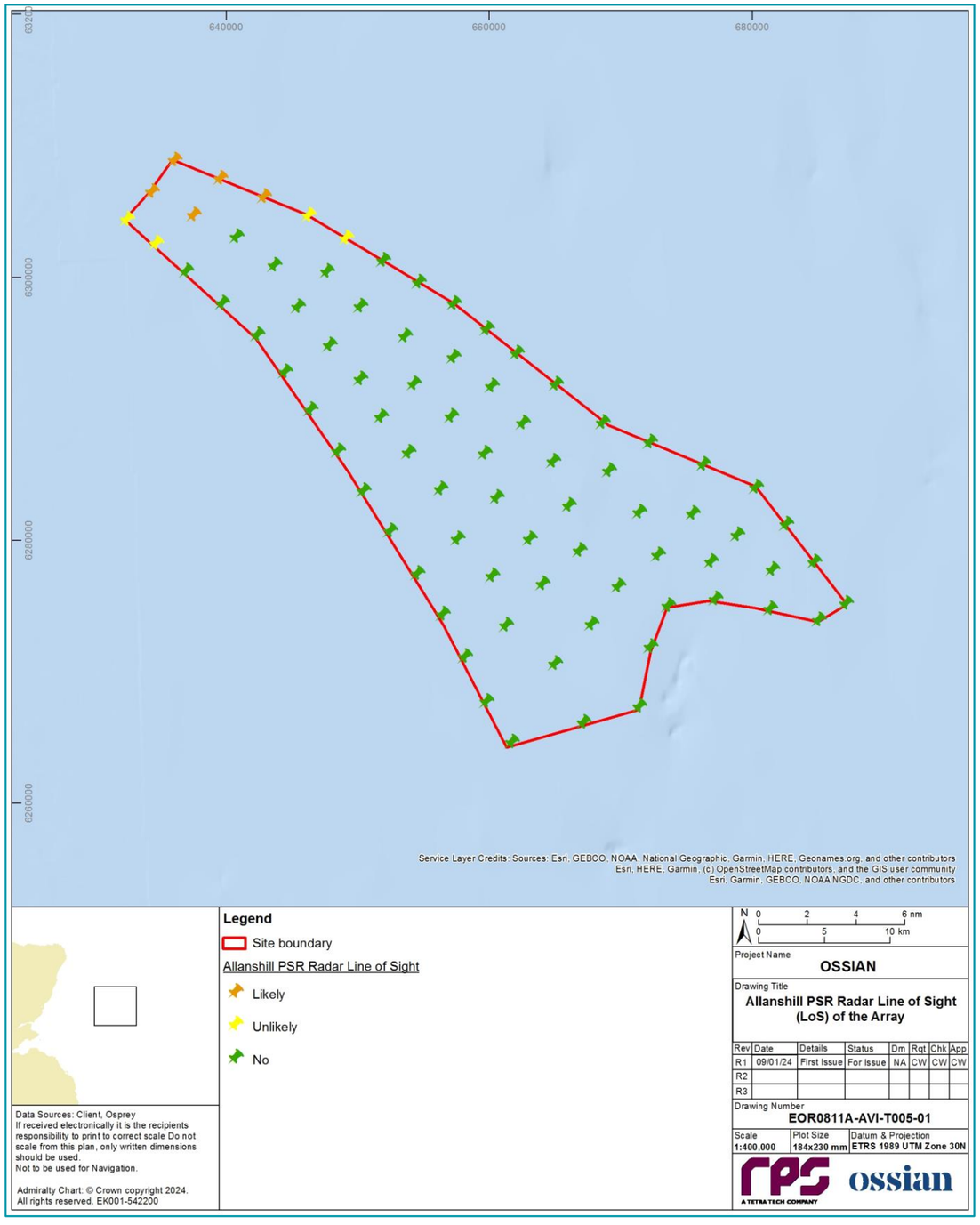

Figure 3.4: Allanshill (ASR) PSR Radar LoS of the Array (Not to Scale)

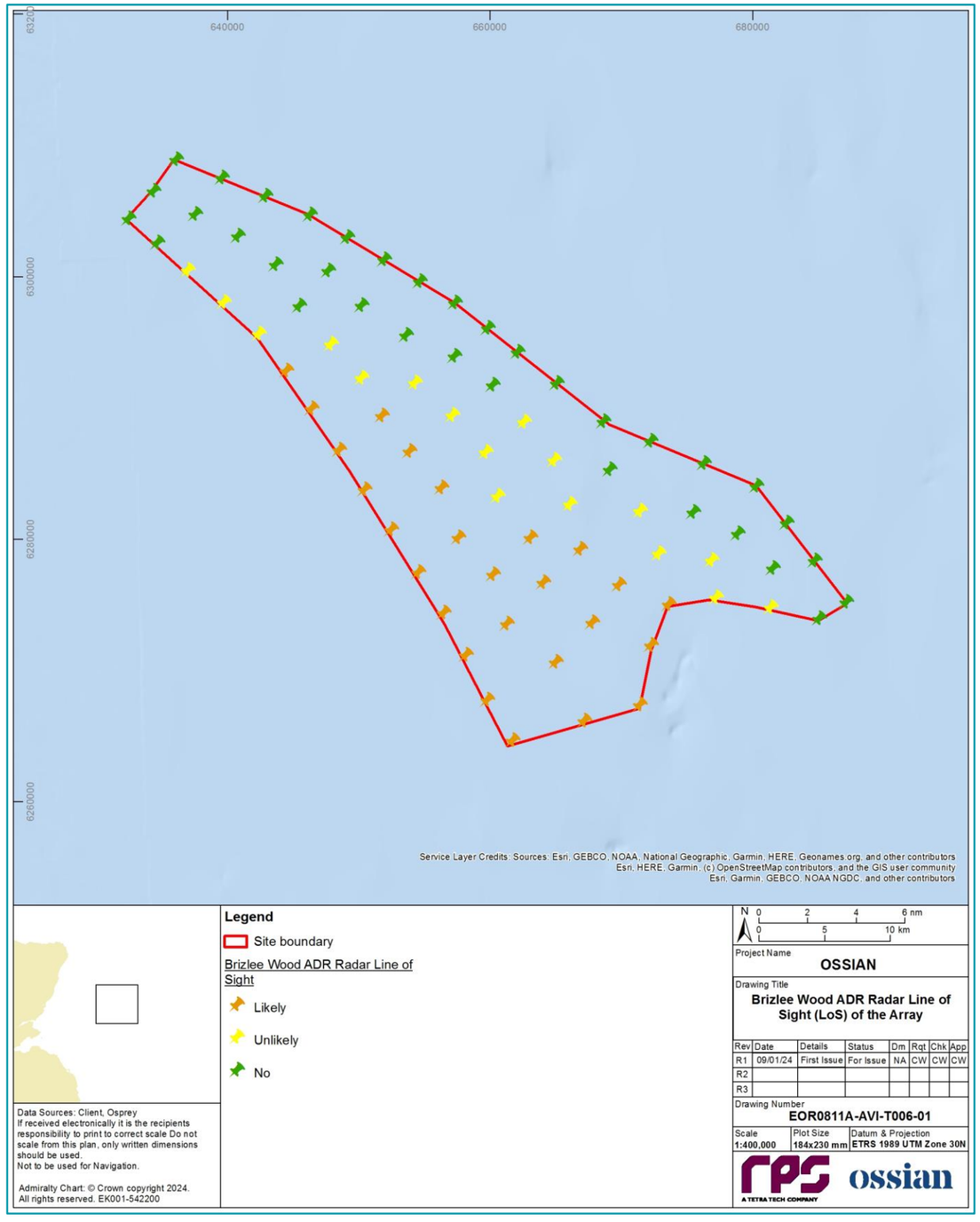

Figure 3.5: Brizlee Wood ADR Radar LoS of the Array (Not to Scale)

4. SUMMARY

38. This Aviation, Military and Communications Technical Report provides a detailed description of aviation, military and communications activity in the vicinity of the Array.

39. To identify and characterise aviation, military and communications receptors, a broad study area has been defined and covers the aviation radar systems that potentially detect the maximum (highest) wind turbine blade tip height of 399 m above LAT. The aviation, military and communications study area is presented in Figure 2.1.

40. Consideration of the Array's potential to impact on aviation receptors has been undertaken in accordance with the recommended consultation distance of within 30 km of an aerodrome with a surveillance radar facility, stated in CAP 764 (CAA, 2016a). However, CAP 764 (CAA, 2016a) states that the operational range of a radar system is dependent on the type of radar used and its operational requirement. Radar impact is dependent on radar detectability of operational wind turbines, the radar's operational range and the use of airspace in which the development sits.

41. Radar LoS analysis indicates that the Perwinnes PSR will theoretically detect operational wind turbines at a maximum height of 399 m LAT. The Allanshill PSR will theoretically detect intermittently, operational wind turbines within the northern quarter of the Array (the closest to the radar location).

42. Radar LoS analysis predicts that the operation of the Buchan ADR may be theoretically impacted by the detection of operational wind turbines within the Array, at a maximum height of 399 m LAT. The results for the Brizlee Wood ADR are mixed. Intermittent detection cannot be ruled out in the southernmost part of the Array (the closest to the radar location).

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