GA Pet Food Wind Turbine

Warton Aerodrome CNS Safeguarding Assessment Report

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Executive Summary

Introduction

Warton Aerodrome ("the Aerodrome") is responsible for the technical safeguarding of their Communications Navigation and Surveillance (CNS) systems in accordance with the Civil Aviation Authority (CAA) requirements.

GA Pet Food Partners ("the Client") has commissioned Osprey to conduct technical safeguarding assessments to determine potential aviation impacts against the CNS systems at the Aerodrome, that could be impacted by the Client's proposed Wind Turbine Generator (WTG) ("the Development").

This report details the approach and presents the results of the technical safeguarding assessments commissioned and identifies any potential impacts on the CNS systems at the Aerodrome.

Scope

In-Scope CNS

For the purposes of this report and the scope of work undertaken, the In-Scope CNS systems being considered are defined as the Aerodromes:

- Primary Surveillance Radar (PSR)
- Very High Frequency (VHF) Communications (Comms) Transmitter (TX)/ Receiver (RX) Site
- Non-Directional Beacon (NDB)

The Development

For the purposes of this report and the scope of work undertaken in the assessments contained within, the Development is defined as the proposed single WTG with a maximum tip height of 199.76 meters (m) Above Ground Level (AGL), located approximately 5.2 Nautical Miles (NM) from the Aerodromes, Aerodrome Reference Point (ARP).

The Requirement

Three specific technical safeguarding assessments has been conducted as follows:

- **Radar Line of Site Assessment**
  Radar Line of Sight (LOS) assessment using industry standard Radio Frequency (RF) Planning tools, of the WTG of the Development against the Aerodromes following In-Scope CNS:
  - PSR
- **CNS Coverage Assessment**
  Intervisibility assessment using industry standard RF Planning tools, of the Development as a single obstruction against the Aerodromes following In-Scope CNS:
  - PSR
  - VHF Comms TX/ RX Site
  - NDB

- **CAP 670 Carrier Interference (C/I) Ratio Prediction Assessment**
  C/I Ratio prediction assessment of the Project array area following the CAA Publication (CAP) 670 methodology against the Aerodromes following In-Scope CNS:
  - VHF Comms TX/ RX Site.

Purpose

This report details the approach and presents the results of the technical safeguarding assessments commissioned and identifies any potential impacts on the In-Scope CNS systems at the Aerodrome.

The results and conclusions of each of the assessments conducted are summarised below:

Radar LOS Assessment

- **Conclusions**
  The Radar LOS assessment conducted concludes that the Developments WTG is expected to have direct optical visibility to the Aerodromes PSR, and therefore without suitable mitigations could cause an impact to the Air Traffic Service (ATS) provided by the Aerodrome.
- **Recommendations**
  Osprey recommends the Aerodrome review the results of this assessment against their operational coverage areas and identify suitable and appropriate mitigations that could reduce the operational impacts to a satisfactory level.

CNS Coverage Assessment

- **Conclusions**
  PSR: The assessment concludes that the Development will be visible to the Aerodromes PSR and might cause shadowing of the signal in space at coverage altitudes of 5,000ft ASL and below.

  VHF Comms TX/ RX Site: The assessment concludes that the Development will be visible to the Aerodromes VHF Comms TX/ RX Site and might cause shadowing of the signal in space at coverage altitudes of 5,000ft ASL and below.

  NDB: The assessment concludes that the Development will be visible to the Aerodromes NDB and might cause shadowing of the signal in space at the coverage altitude of 1,000ft ASL.
- **Recommendations**
  Osprey recommends that the Aerodrome review the results of this assessment against the ATS provided in their operational coverage areas, specifically taking consideration that the impacted Sector which might have RF shadowing is likely to be less than 1 º in azimuth, and that the nature of the indicated areas where degradation could occur will be intermittent and changeable as the WTG has been modelled in the worst-case profile. In real world operations, the profile of the WTG being presented to the CNS will vary in relation to its orientation at any point in time. For this Assessment the WTG is oriented against the In-Scope CNS presenting a low probability 'worst-case scenario' as the WTG could never be presenting the largest RCS to the In-Scope CNS at all times, as that would require the wind direction to be north-southeast at all times and the prevailing wind in the UK is from the southwest.

CAP 670 C/I Ratio Prediction Assessment

- **Conclusions**

  The Assessment concludes that the Development will generate C/I ratio below the CAP 670 threshold of <14dB at 1,000ft AGL in a very small region localised to the Development. C/I Ratio below this threshold might cause the audio quality of radio communications as perceived by either an Air Traffic Control (ATC) Controller or Pilot to be lower than the optimal reading of 5 on the ‘readability scale’.

  The CAP 413 - Radiotelephony Manual provides a simple ‘readability scale’ of 1 to 5 (1 being unreadable and 5 being perfectible readable) for ATC Controllers/ Pilots to categorise the quality of communications when conducting radio checks.

  C/I Ratio does not fall below the CAP670 threshold at the other altitudes assessed.

- **Recommendations**

  The Aerodrome should consider that the nature of the indicated areas where degradation could occur will be intermittent and changeable as the WTG has been modelled in the worst-case profile. In real world operations, the profile of the WTG being presented to the CNS will vary in relation to its orientation at any point in time. For this Assessment the WTG is oriented against the In-Scope CNS presenting a low probability ’worst-case scenario’ as the WTG could never be presenting the largest RCS to the In-Scope CNS at all times, as that would require the wind direction to be north-southeast at all times and the prevailing wind in the UK is from the southwest.

  The CAP670 GEN 02 states that:

  > ‘Technical impact (interference levels) and operational impacts are assessed separately. The type of operational usage and the geographic location and volume of affected airspace (Volume of Interest) will affect the level of operational impact and hence sensitivity to a particular development proposal’

  This document presents the Technical Impact, Osprey recommends that the Aerodrome conducts an Operational Assessment of the results of this Assessment against the Air Traffic Services (ATS) they provide in the affected area, specifically considering that C/I is might only be intermittently present at a coverage height 1,000ft AGL and lower where they may not necessarily provide ATS.

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1 Introduction

1.1 Introduction

Warton Aerodrome ("the Aerodrome") is responsible for the technical safeguarding of their Communications Navigation and Surveillance (CNS) systems in accordance with the Civil Aviation Authority (CAA) requirements.

GA Pet Food Partners ("the Client") has commissioned Osprey to conduct technical safeguarding assessments to determine potential aviation impacts against the CNS systems at the Aerodrome, that could be impacted by the Client's proposed Wind Turbine Generator (WTG) ("the Development").

1.2 Purpose

This report details the approach and presents the results of the technical safeguarding assessments commissioned and identifies any potential impacts on the CNS systems at the Aerodrome.

1.3 Scope

1.3.1 The Development

For the purposes of this report and the scope of work undertaken in the assessments contained within, the Development is defined as the proposed WTG located approximately 5.2 Nautical Miles (NM) from the Aerodromes, Aerodrome Reference Point (ARP). Figure 1 depicts the localisation of the WTG to the Aerodrome.

Figure 1 - Localisation

The Development consists of a single WTG with a maximum tip height of 199.76 meters (m) Above Ground Level (AGL). Specific WTG parameters and geolocations used in the assessments are detailed in Table 1 below.

	Coordinates (4NGR[1])		Tip Height (m AGL)	Blade Length (m)	Blade Chord (m)	Tower Height (m AGL)	Tower Width (m)	Label
		North/ South						
		2°48'54.71"W	199.76	67.79	3.93	125.9		PFPT1

Table 1 - Development Parameters

1.3.2 Requirements

The Client has commissioned the following specific technical assessments, each are detailed in respective sections of this document, with summary conclusions and recommendations also being provided:

- **Section 2** - Radar Line of Sight (LOS) assessment
- **Section 3** - CNS Coverage (Intervisibility) assessment
- **Section 4** - CAA Publication (CAP) 670 Compliant Carrier Interference (C/I) assessment

1.3.3 In-Scope CNS

For the purposes of this report and the scope of work contained within, the Aerodrome CNS being considered, and the respective technical assessments conducted, are defined in Table 2 below. Table 3 includes the CNS parameters used for the assessments.

Warton CNS	Section 2 Radar LOS Assessment	Section 3 CNS Coverage Assessment	Section 4 C/I Assessment
Primary Surveillance Radar (PSR)	✓	✓	
		✓	✓
Non-Directional Beacon (NDB)		✓	

Table 2 - CNS Assessment Scope

Warton CNS		Antenna Electrical Centre Height (m AGL)	Peak Power (kW)	Frequency (MHz)	Antenna Gain (dBi)	DOC[2] (NM)
PSR	54°44'20.04"N 2°53'37.22"W	23	24	1300	36	40
VHF Comms TX/RX Site	53°44'44.30"N 002°53'20.11"W	26.2	0.005	127.2	2.1	40

[1] National Grid Reference.
[2] As published in the UK Aeronautical Information Publication (AIP) AD 2.EGNO-1 dated 3rd Oct 2024).

Warton CNS		Antenna Electrical Centre Height (m AGL)	Peak Power (kW)	Frequency (MHz)	Antenna Gain (dBi)	DOC[2] (NM)
Non-Directional Beacon (NDB)	53°45'5.93"N 2°51'8.36"W	15	N/A	N/A	N/A	15

Table 3 - CNS Parameters

1.4 Abbreviations

The following abbreviations are used within this document:

	Meaning
	feet
G	Gain
	Range
RCS	Radar Cross Section

	Meaning
	Wind Turbine Generator

Table 4 - Abbreviations

2 Radar LOS Assessment

2.1 Introduction

This section presents the Radar LOS Assessment. Using composite optical line of site functions, coupled with RF propagation and Fresnel zone calculations in ATDI HTZ Communications (HTZ Comms) which is an industry standard RF network planning toolset with extensive RF Propagation analysis and modelling capabilities. Analysis has been conducted of point-to-point (optical) and RF (Fresnel) visibility between the In-Scope CNS and the WTG of the Development.

2.2 Overview

LOS in its most simplistic form is a calculation to determine whether one object can see another in a direct path. A WTG presents reflecting surfaces on which a radar transmitting Radio Frequency (RF) energy can be returned and processed from. If a radar can see a WTG, then it will most likely be processed and cause an impact to the radar's ability to determine valid targets.

Radars operate by transmitting pulses of RF energy. RF does not just propagate in straight 'optical' lines, but rather it spreads after it leaves the antenna. This spread is known as the Fresnel zones. Objects which appear in a Fresnel zone can cause in phase or out of phase reflections of the RF wave.

Additionally, to better understand whether a reflecting object will be seen by a radar, consideration must also be made of interlaying terrain and the curvature of the earth.

Osprey has extensive experience of modelling Radar LOS using HTZ Comms. Our assessment considers optical line of site, the upper Fresnel zone, the Earth's curvature and terrain.

2.3 Scope

As detailed in Section 1.3.3, the Aerodromes In-Scope CNS considered in the LOS Assessment is as follows:

- PSR

2.4 Methodology

2.4.1 CNS Modelling

The In-Scope CNS was modelled as an RF emitter with specific parameters as detailed in Table 3.

2.4.2 Development Model

A model of the WTG was created in HTZ Comms using the data detailed in Table 1; specifically:

- The WTG was created as a target point in space by using x, y and z as location and the max tip height parameters.

2.4.3 LOS Assessment

The WTG was assessed for visibility against the In-Scope CNS. An example of a resultant profile path is depicted in Figure 2 below:

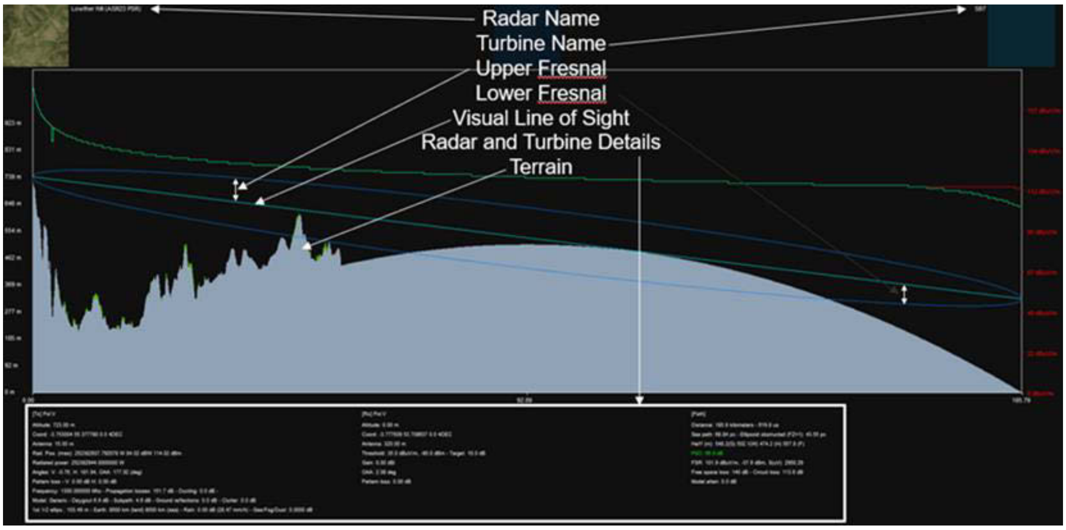

Figure 2 - Example LOS Profile Path

The profile path was evaluated by a Subject Matter Expert (SME) who determined whether the WTG visibility is:

- Yes (Red) - Visible to the In-Scope CNS System (the WTG has direct optical LOS)
- Likely (Amber) - Likely to be visible to the In-Scope CNS System (the WTG does not have direct optical LOS, but the interlaying terrain intersects less than or equal to 60% of the upper Fresnel zone)
- Unlikely (Yellow) - Unlikely to be visible to the In-Scope CNS System (the wind turbine does not have direct optical LOS, but the interlaying terrain intersects more than 60% but less 100% of the upper Fresnel zone)
- No (Green) - Not visible to the In-Scope CNS System (the wind turbine generator does not have direct optical LOS as the interlaying terrain intersects more than 100% of the upper Fresnel zone).

2.5 Results

Summary results of the LOS assessment conducted against the Development are presented in Table 5 below:

	Tip Height (m AGL)	Visibility Result	Description	Appendix 1 Reference
PFPT1	199.76	**YES**	Visible to the In-Scope CNS System (the WTG has direct optical LOS)	Figure 8

Table 5 - Warton PSR LOS Results

2.6 Conclusion

The LOS assessment conducted, concludes that the Development is expected to have direct optical visibility to the In-Scope CNS, and therefore without suitable mitigations might cause an impact.

2.7 Recommendations

Osprey recommends that the Aerodrome review the results of this assessment against their operational coverage areas and identify suitable and appropriate mitigations that could reduce the operational impacts to a satisfactory level.

3 CNS Coverage Assessment

3.1 Introduction

This section presents the CNS Coverage Assessment, using composite optical line of site (Intervisibility) functions in HTZ Comms to create coverage maps highlighting potential impacts on the CNS coverage (shadowing) caused by physical obstruction from the Development.

HTZ Comms is an industry standard RF network planning toolset with extensive RF Propagation analysis and modelling capabilities.

3.2 Overview

An intervisibility calculation fundamentally ascertains whether a point in space can be directly seen from a source point, or whether the path to the point in space is blocked by an obstruction. The results are presented as a 360° coverage map.

HTZ Comms incorporates extensive Digital Terrain Models (DTM) which feature not only terrain elevation at high resolution, but also includes clutter layers (building and vegetation height). The Development is also added to the model as a 'building' object which might act as a signal blocker.

Where the results of a Intervisibility Assessment display loss of coverage to an In-Scope CNS system, we can determine that there is direct optical line of site, and that the Development will be visible to the system in question and might cause shadowing of its respective RF signal in space.

Unlike a Radar LOS assessment, Intervisibility only considers direct optical path and not RF propagation characteristics.

3.3 Scope

As detailed in Section 1.3.3 the Aerodromes In-Scope CNS considered in the CNS Coverage Assessment is as follows:

- PSR
- VHF TX/ RX Site
- NDB

3.4 Methodology

3.4.1 CNS Modelling

Each In-Scope CNS was modelled as an individual source points by using x, y, z data from Table 3 as location and height (of the antenna) parameters.

3.4.2 Development Model

The Development (WTG) was modelled as a single building, with its height and footprint derived from Client provided data. Figure 3 below depicts the WTG modelled as a building on HTZ Comms:

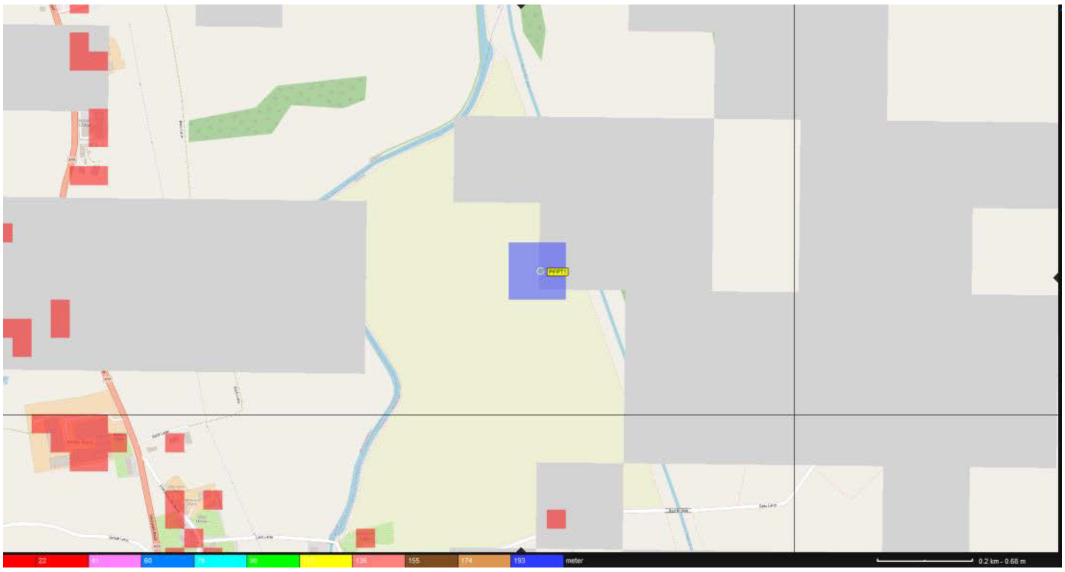

Figure 3 - WTG Modelled as a Building in HTZ Comms

3.4.3 Assessment Process

Test points along an azimuth are tested at the same altitude path, either until the direct visibility is blocked by terrain, clutter, or the Development; or until the maximum test range as been reached. This process is repeated for every azimuth step from the source point with a full 360° intervisibility coverage chart being produced.

Readers of this report should note: Each individual CNS system has its own Declared Operational Coverage (DOC) which varies from system to system. For the purposes of this report the DOC's as detailed in Table 3 were applied for the respective In-Scope CNS systems.

Figure 24 below depicts this process for a single azimuth step on a defined azimuth/ altitude path.

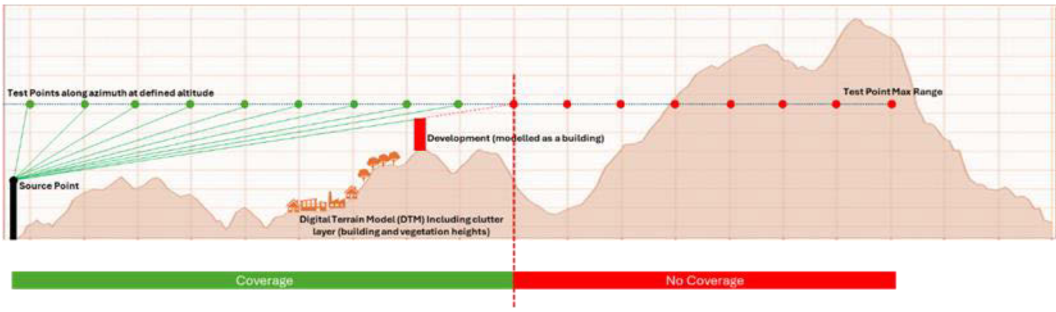

Figure 4 - CNS Coverage Assessment along Azimuth/ Altitude Path

Important Note: Modelling the Development as a single building presents the 'worst case' profile to the In-Scope CNS; in real-world operation the profile will be variable dependent on the position, size and orientation of the actual WTG with respect to the CNS being considered. Additionally, RF waves do not propagate only in direct 'straight lines', as such the actual impact upon coverage is likely to be less than depicted by the Coverage Assessment maps in this report.

Intervisibility coverage maps were produced for the In-Scope CNS for the following three use cases:

- **Baseline Intervisibility Coverage Map**
  Baseline intervisibility coverage map without the Development. This displays the potential coverage of the CNS without any impacts from the Development. Figure 5 below depicts an example of a Baseline Intervisibility Coverage Map.

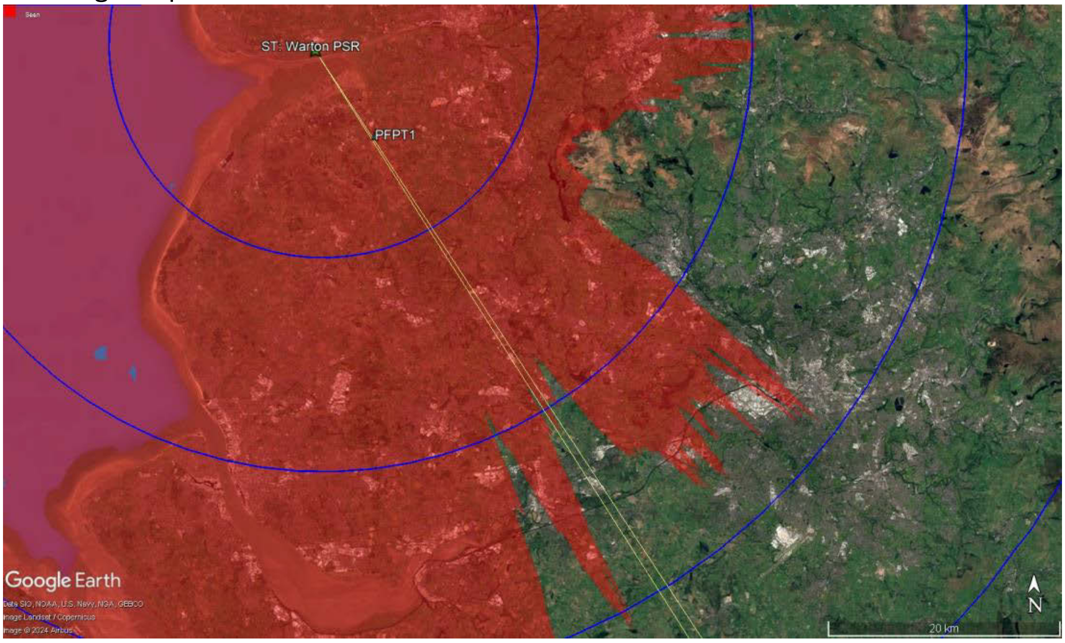

Figure 5 - Example Baseline Intervisibility Coverage Map

- **Development Intervisibility Coverage Map**
  An Intervisibility coverage map with the Development modelled as a building. This displays the potential coverage of the In-Scope CNS after the Development is in place. Figure 6 below depicts an example of a Development Intervisibility Coverage Map.

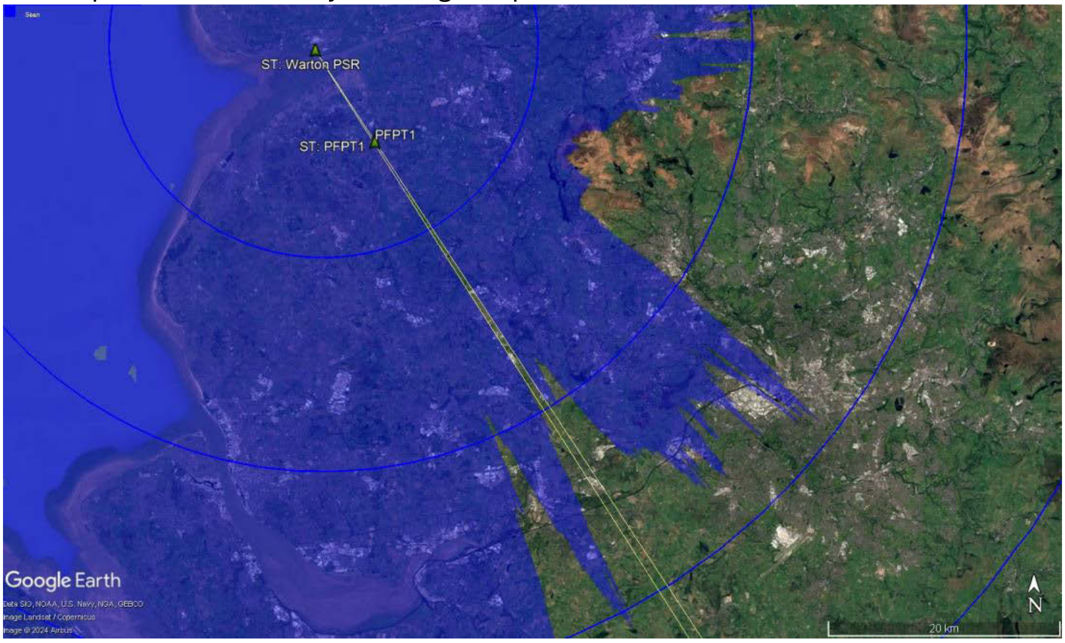

Figure 6 - Example Development Intervisibility Coverage Map

- **Composite Intervisibility Coverage Map**
  Composite intervisibility coverage map where the Development Intervisibility Coverage Map (Blue) is overlaid on a Baseline Intervisibility Coverage Map (Red). Red areas on this type of map illustrate the extent of potential CNS coverage loss where Red areas is coverage before the Development and Blue areas is the coverage after the Development is in place. Figure 7 below depicts an example of a Composite Intervisibility Coverage Map.

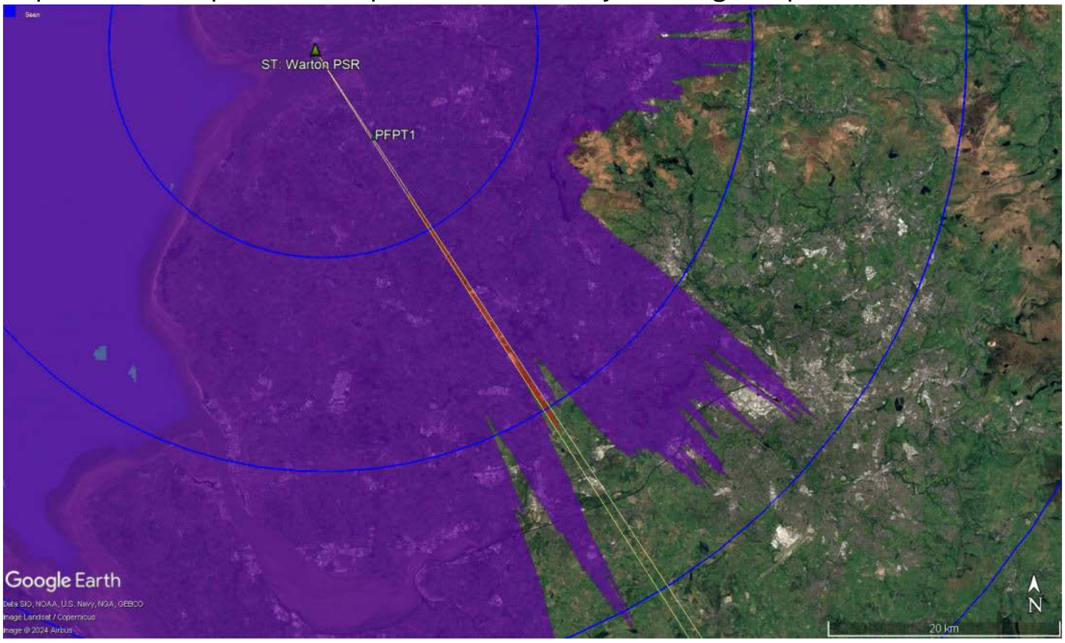

Figure 7 - Example Composite Intervisibility Coverage Map

Azimuth bearings from the respective CNS under consideration to the Development site are included in the Composite Intervisibility Coverage Map to show the areas where coverage shadows are possible.

To assess potential impacts at key altitudes, Intervisibility coverage maps for each CNS and each use-case stated above were produced at the following heights:

- 1,000 feet (ft) Above Sea Level (ASL).
- 2,000ft ASL.
- 3,000ft ASL.
- 5,000ft ASL.
- 7,500ft ASL.
- 10,000ft ASL.

3.5 Results

Composite Intervisibility Coverage maps (Appendix 2) have been produced and assessed for the In-Scope CNS; impact summaries are detailed in the paragraphs following:

3.5.1 PSR

Potential issues on the Aerodromes PSR coverage caused by physical obstruction from the Development is presented in Table 6 below:

- **Composite Intervisibility Coverage Map**
  Composite intervisibility coverage map where the Development Intervisibility Coverage Map (Blue) is overlaid on a Baseline Intervisibility Coverage Map (Red). Red areas on this type of map illustrate the extent of potential CNS coverage loss where Red areas is coverage before the Development and Blue areas is the coverage after the Development is in place. Figure 7 below depicts an example of a Composite Intervisibility Coverage Map.

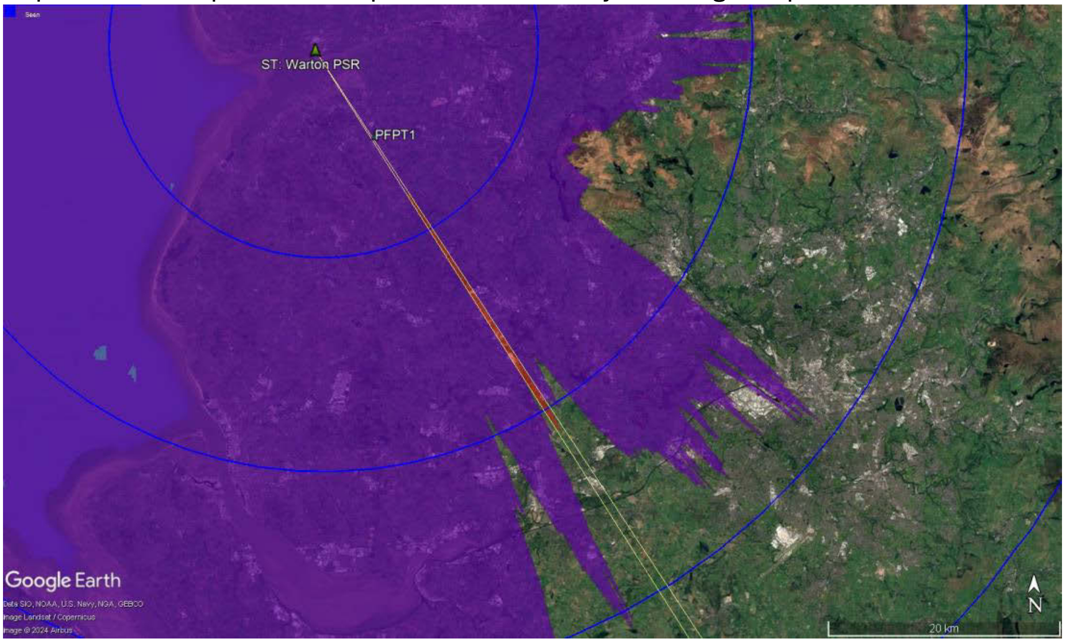

Figure 7 - Example Composite Intervisibility Coverage Map

Azimuth bearings from the respective CNS under consideration to the Development site are included in the Composite Intervisibility Coverage Map to show the areas where coverage shadows are possible.

To assess potential impacts at key altitudes, Intervisibility coverage maps for each CNS and each use-case stated above were produced at the following heights:

- 1,000 feet (ft) Above Sea Level (ASL).
- 2,000ft ASL.
- 3,000ft ASL.
- 5,000ft ASL.
- 7,500ft ASL.
- 10,000ft ASL.

3.5 Results

Composite Intervisibility Coverage maps (Appendix 2) have been produced and assessed for the In-Scope CNS; impact summaries are detailed in the paragraphs following:

3.5.1 PSR

Potential issues on the Aerodromes PSR coverage caused by physical obstruction from the Development is presented in Table 6 below:

Altitude	Sector	Impacted Range Window (circa NM)	Appendix 2 Reference
10,000ft ASL	164° to 165°	Nil	Figure 26

Table 8 - NDB CNS Coverage Impact Summary

3.6 Conclusions

3.6.1 PSR

The assessment concludes that the Development will be visible to the Aerodromes PSR and might cause shadowing of the signal in space at coverage altitudes of 5,000ft ASL and below.

3.6.2 VHF Comms TX/ RX Site

The assessment concludes that the Development will be visible to the Aerodromes VHF Comms Site and might cause shadowing of the signal in space at coverage altitudes of 5,000ft ASL and below.

3.6.3 NDB

The assessment concludes that the Development will be visible to the Aerodromes NDB and might cause shadowing of the signal in space at the coverage altitude of 1,000ft ASL and below.

3.7 Recommendations

Osprey recommends that the Aerodrome review the results of this assessment against the ATS provided in their operational coverage areas, specifically taking consideration that the impacted Sector which might have RF shadowing is likely to be less than 1 ° in azimuth, and that the nature of the indicated areas where degradation could occur will be intermittent and changeable as the WTG has been modelled in the worst-case profile. In real world operations, the profile of the WTG being presented to the CNS will vary in relation to its orientation at any point in time. For this Assessment the WTG is oriented against the In-Scope CNS presenting a low probability 'worst-case scenario' as the WTG could never be presenting the largest Radar Cross Section (RCS) to the In-Scope CNS at all times, as that would require the wind direction to be north-southeast at all times and the prevailing wind in the UK is from the southwest.

4 CAP670 C/I Ratio Prediction Assessment

4.1 Introduction

This section presents the CAP 670 C/I Ratio Prediction Assessment using the Network Interference functions in HTZ Comms to create C/I Sum maps following the methodology prescribed in the CAP 670 GEN 02[3].

HTZ Comms is an industry standard RF network planning toolset with extensive RF Propagation analysis and modelling capabilities.

4.2 C/I Overview

C/I refers to the phenomenon where an unwanted RF signal can cause degradation to a wanted RF signal in the same (or adjacent sub carrier) frequency band. This can reduce the quality of ATC radio communications in areas where C/I occurs.

In the case of Wind Farms, WTGs can reflect the CNS RF signal such that it appears to have originated from an unwanted source. C/I ratio is the assessment of the level of that unwanted signal against the field strength of the wanted signal.

C/I can also occur in areas where the signal strength of the wanted RF signal is weak or heavily attenuated through terrain etc. and where other unwanted signals overwhelm the much weaker field strength of the wanted signal. In such areas where the original field strength is weak in the first place, it is likely that the CNS signal quality will be unreliable even without the presence of Wind Farms.

4.3 Scope

As detailed in Section 1.3.3 the Aerodromes In-Scope CNS considered in the CAP670 C/I Ratio Prediction Assessment is as follows:

- VHF Comms TX/ RX Site

4.4 Methodology

4.4.1 CNS Models

Parametric models were created of the In-Scope CNS; specifically:

- A parametric model of the CNS was created using both data detailed in Table 3 and data derived from the CAP670 GEN02.
- FS coverage of the Radiation Pattern Envelope (RPE) of the CNS was calculated in HTZ Comms using the parameters provided.

4.4.2 Development Model

- A Parametric model for the WTG was created with mast height and blade size taken from data provided by the Client as detailed in Table 1; a reference frequency was set at 127MHz in accordance with the CAP670.

[3] Part B, Section 4: Appendix A to GEN 02: Methodology for the Prediction of Wind Turbine Interference Impact on Aeronautical Radio Station Infrastructure.

- WTG Blade and Tower RCS were calculated using HTZ Comms functions in relation to the data provided by the Client as detailed in Table 1 where:
  - Blade RCS is calculated by the length of the blade and chord (diameter).
  - Tower RCS was calculated using the Tower Height and diameter.
- The WTG was modelled as a VHF TX emitter with a nominal power output calculated using conventional Radar Theory[4] and appropriate RCS Value.
- FS coverage of the RPE was calculated in HTZ Comms using the ITU-R-805 function. The WTG was oriented against the In-Scope CNS on the respective true bearing this presents a low probability 'worst-case scenario' as the WTG could never be orientated directly towards the In-Scope CNS at all times as that would require the wind direction to be north-southeast at all times and the prevailing wind in the United Kingdom (UK) is from the southwest.

4.4.3 C/I Ratio Maps

Using the HTZ Comms Sum Interference function, C/I ratio maps were created at specific altitudes. These maps detail the ratio of the signal reflected by the WTG surface that interferes with the wanted signal from the CNS, whereby:

- C = Power of the wanted signal received from the selected CNS.
- I = Highest interfering signal found from the power sum of all interfering signals emanating from the WTG.
- The calculations were made for receiving points located inside the coverage area and within a 16.19NM radius from the WTG.
- As per the CAP670 GEN02 requirements, a threshold of 26 dBμV was applied to the coverage where interference calculations were performed.

The altitudes[5] assessed for the In-Scope CNS were:

- 1,000ft AGL.
- 2,000ft AGL.
- 3,000ft AGL.
- 5,000ft ASL.

The C/I maps present:

- C/I Impact: areas where C/I Ratio falls below the CAP670 threshold of 14dB in the volume of interest; and
- No C/I Impact: areas where C/I Ratio is equal to or above the CAP670 threshold of 14dB in the volume of interest.

[4] Pr (W)=(Ps/(4π*R12))*G*RCS

[5] The CAP670 stipulates altitudes of 1000ft AGL, 2000ft AGL, 5000ft ASL, 10000ft ASL and 20000ft ASL to be assessed. Experience of previous assessments conducted by Osprey has shown that a sufficient set of results can be achieved by assessing the altitudes of 1000ft AGL, 2000ft AGL, 3000ft AGL and 5000ft ASL.

4.5 Results

A summary of the results of the CAP670 C/I Ratio predication assessment is presented in Table 9 below:

Altitude	CNS	CI Impact (below <14dB Threshold[6])	Appendix 2 Reference
1,000ft AGL	VHF Comms TX/ RX Site	Yes	Figure 27
2,000ft AGL	VHF Comms TX/ RX Site	No	Figure 28
3,000ft AGL	VHF Comms TX/ RX Site	No	Figure 29
5,000ft ASL	VHF Comms TX/ RX Site	No	Figure 30

Table 9 - CAP670 C/I Ratio Prediction Summary

4.6 Conclusions

4.6.1 VHF Comms TX/ RX Site:

The Assessment concludes that C/I ratio below the CAP670 criteria of <14dB which is generated from the Development might be present at 1,000ft AGL. The affected region is very small and localised to the Development itself (extending approx. 0.4 NM behind) as indicated as the white region on Figure 27.

C/I Ratio does not fall below the CAP670 threshold at the other altitudes assessed.

4.6.2 Summary

The CAP 670 threshold value has been determined from laboratory-based susceptibility testing of a wide range of ground based and airborne radio receiver types. It includes a modest safety margin to allow for signal fading, effects of weather, multipath reflection etc., which will all potentially degrade the C/I ratio further.

This C/I threshold value of ≥ 14dB ensures that audio quality as perceived by either ATC Controller or Pilot is not significantly impaired.

Areas where C/I ratio <14dB is predicted, indicate that that audio quality of radio communications as perceived by either ATC Controller or Pilot might be impaired.

The actual level of degradation caused to a CNS signal by C/I alone is impossible to quantify accurately as there are many other factors and variables, including (but not limited to); atmospheric conditions/ weather, equipment serviceability and calibration, frequency, TX power, RX sensitivity, and aircraft antenna position relative to the ground stations; all of which can also influence the overall quality of the signal at any point in time.

In terms of ATS provision, the CAP 413 - Radiotelephony Manual provides guidance for ATC controllers/ Pilots to categorise the quality of communication (when conducting radio checks) with a simple readability scale (reproduced in Table 10 below):

[6] 'YES' indicates C/I that has been generated by the Development.

	Meaning
1	Unreadable
2	Readable now and then
3	Readable but with difficulty
4	Readable
5	Perfectly readable

Table 10 - CAP 413 Readability Scale

Where areas have been identified to have C/I below the CAP 670 threshold of 14dB, it is anticipated that the quality of radio communications will be lower than the optimal reading of 5 on the ‘readability scale’.

The Assessment results indicate that the Development could cause a very small area of approximately 0.4 NM localised to the Development where VHF communications at 1,000ft AGL might be sub optimal.

4.7 Recommendations

The Aerodrome should consider that the nature of the indicated areas where degradation could occur will be intermittent and changeable as the WTG has been modelled in the worst-case profile. In real world operations, the profile of the WTG being presented to the CNS will vary in relation to its orientation at any point in time. For this Assessment the WTG is oriented against the In-Scope CNS presenting a low probability ’worst-case scenario’ as the WTG could never be presenting the largest RCS to the In-Scope CNS at all times, as that would require the wind direction to be north-southeast at all times and the prevailing wind in the UK is from the southwest

The CAP 670 GEN 02 states that:

> ‘*Technical impact (interference levels) and operational impacts are assessed separately. The type of operational usage and the geographic location and volume of affected airspace (Volume of Interest) will affect the level of operational impact and hence sensitivity to a particular development proposal*’

This document presents the Technical Impact, Osprey recommends that the Aerodrome conducts an Operational Assessment of the results of this Assessment against the Air Traffic Services (ATS) they provide in the affected area, specifically considering that C/I is might only be present at a coverage height 1,000ft AGL and lower where they may not necessarily provide ATS.

	Meaning
1	Unreadable
2	Readable now and then
3	Readable but with difficulty
4	Readable
5	Perfectly readable

Table 10 - CAP 413 Readability Scale

Where areas have been identified to have C/I below the CAP 670 threshold of 14dB, it is anticipated that the quality of radio communications will be lower than the optimal reading of 5 on the ‘readability scale’.

The Assessment results indicate that the Development could cause a very small area of approximately 0.4 NM localised to the Development where VHF communications at 1,000ft AGL might be sub optimal.

4.7 Recommendations

The Aerodrome should consider that the nature of the indicated areas where degradation could occur will be intermittent and changeable as the WTG has been modelled in the worst-case profile. In real world operations, the profile of the WTG being presented to the CNS will vary in relation to its orientation at any point in time. For this Assessment the WTG is oriented against the In-Scope CNS presenting a low probability ’worst-case scenario’ as the WTG could never be presenting the largest RCS to the In-Scope CNS at all times, as that would require the wind direction to be north-southeast at all times and the prevailing wind in the UK is from the southwest

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This document presents the Technical Impact, Osprey recommends that the Aerodrome conducts an Operational Assessment of the results of this Assessment against the Air Traffic Services (ATS) they provide in the affected area, specifically considering that C/I is might only be present at a coverage height 1,000ft AGL and lower where they may not necessarily provide ATS.

Appendix 2 Composite Intervisibility Coverage Maps

A2.1 Introduction

In conducting the Intervisibility Coverage Assessment, many technical artifacts are generated. Map images are produced for three different use cases at every altitude being assessed for each CNS being considered.

To improve readability of this document, only the key Composite Intervisibility Coverage Maps have been included for reference in this Appendix.

The Baseline Invisibility Coverage Maps and Development Invisibility Coverage Maps are available for audit/ inspection by the client.

A2.2 Contents

The contents of this Appendix are as follows:

- A2.3 - PSR
- A2.4 - VHF Comms TX/RX Site
- A2.5 - NDB

Note: [Images are displayed from the next page onwards]

A2.3 PSR - Composite Intervisibility Coverage Maps

A2.3.1 1,000ft ASL

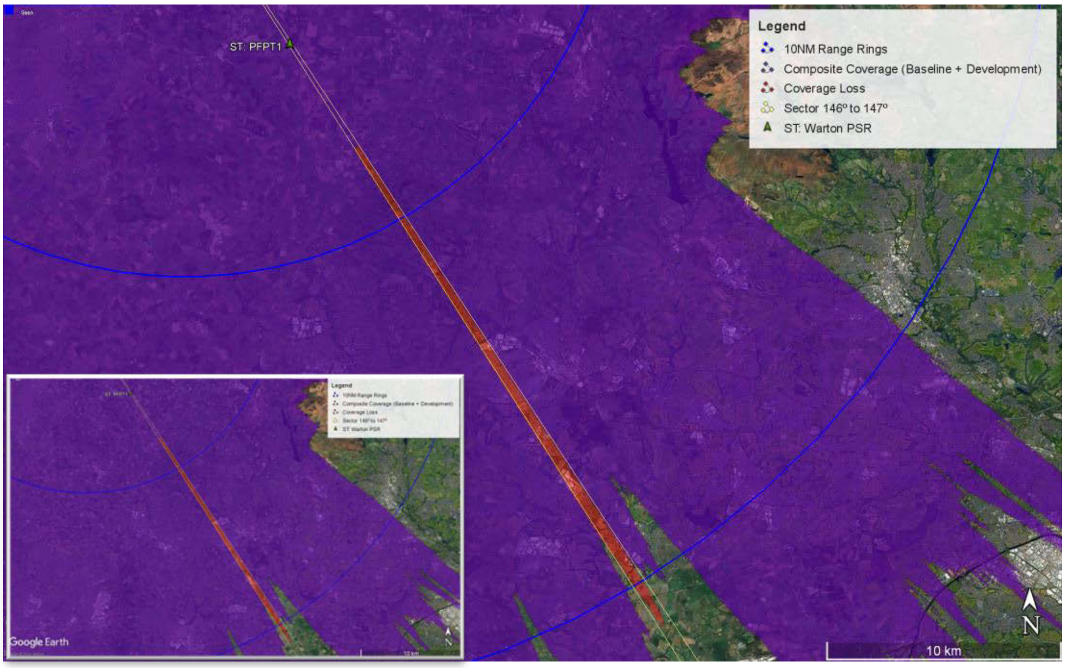

Figure 9 - PSR 1,000ft ASL Composite Intervisibility Coverage Map

A2.3.2 2,000ft ASL

Figure 10 - PSR 2,000ft ASL Composite Intervisibility Coverage Map

A2.3.3 3,000ft ASL

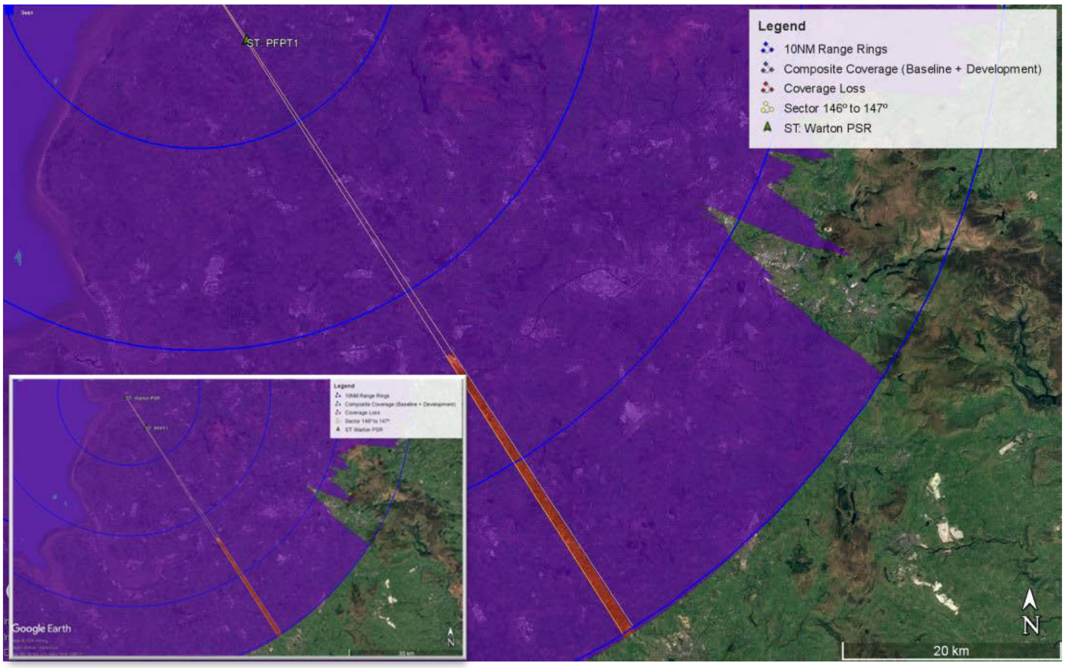

Figure 11 - PSR 3,000ft ASL Composite Intervisibility Coverage Map

A2.3.4 5,000ft ASL

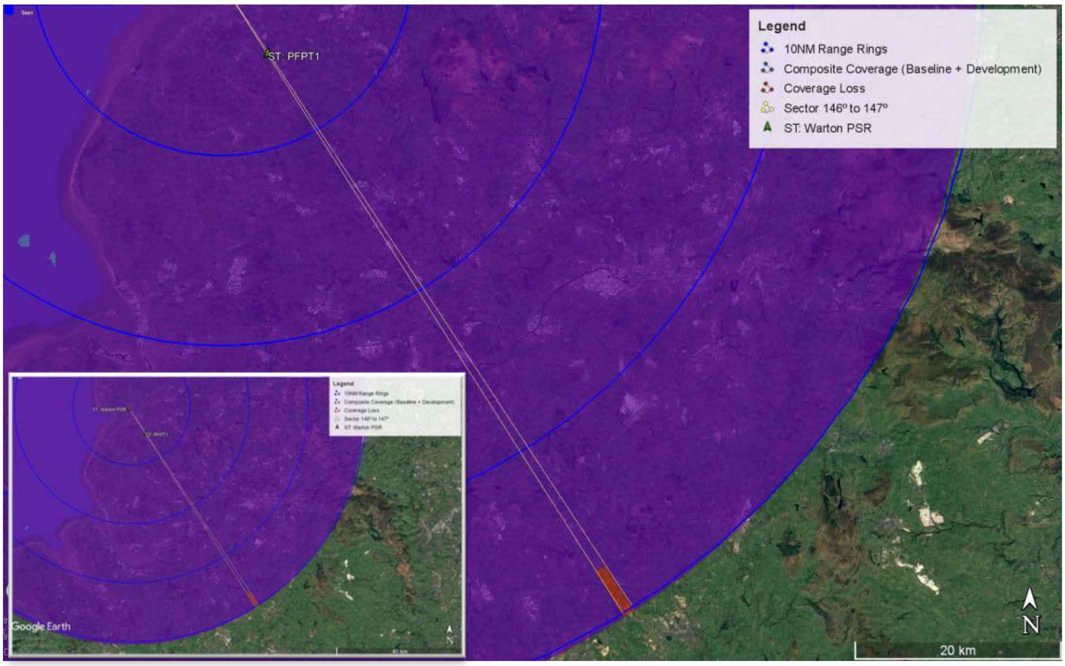

Figure 12 - PSR 5,000ft ASL Composite Intervisibility Coverage Map

A2.3.3 3,000ft ASL

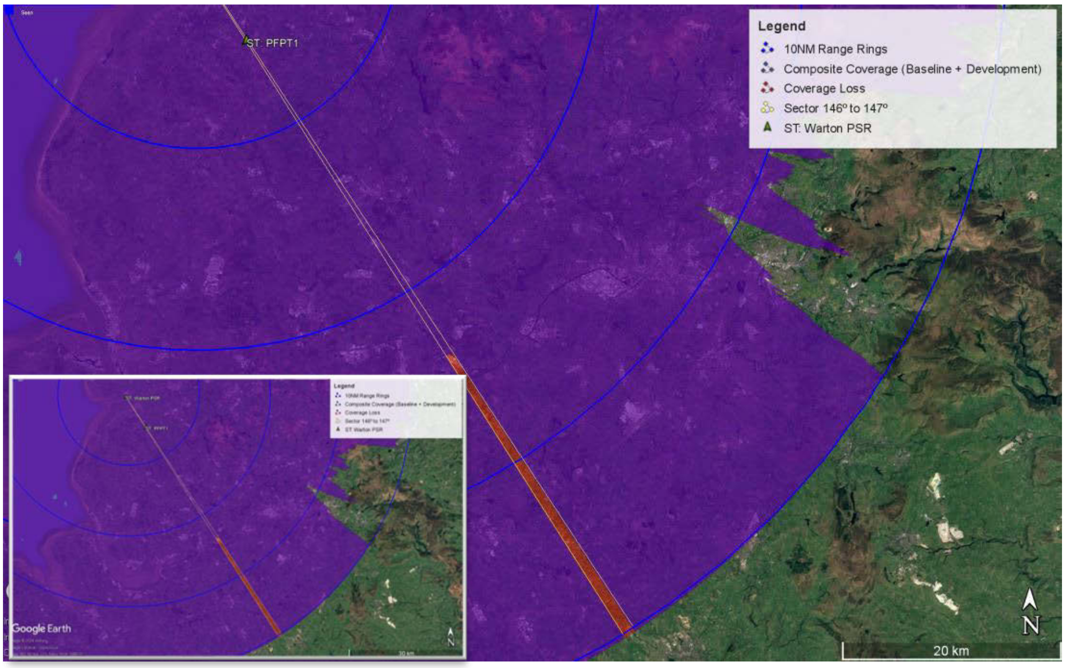

Figure 11 - PSR 3,000ft ASL Composite Intervisibility Coverage Map

A2.3.4 5,000ft ASL

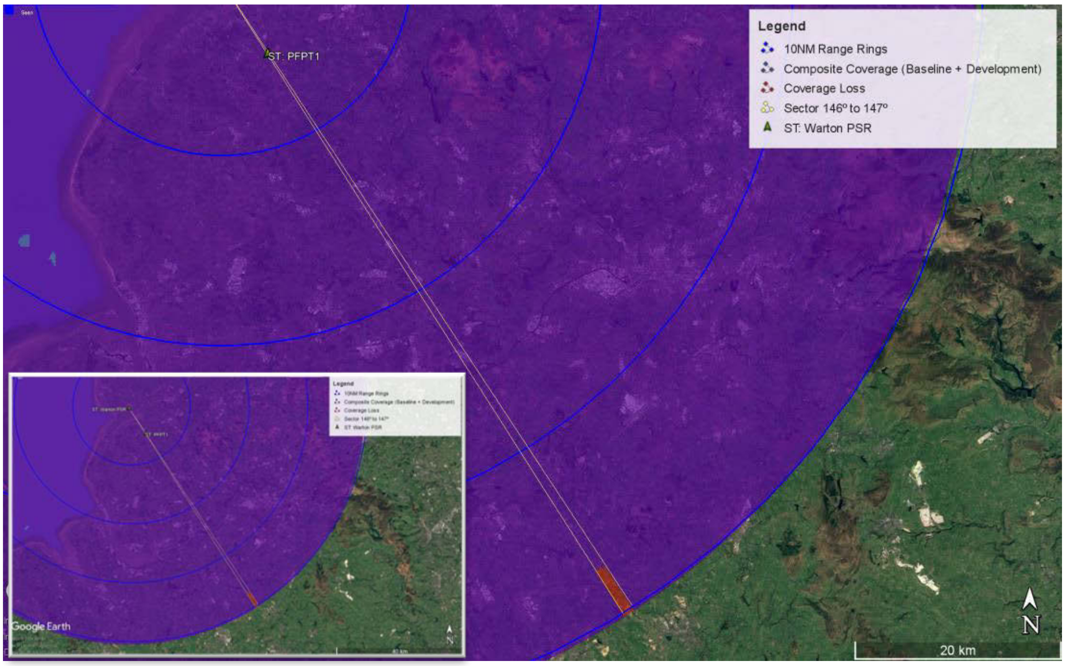

Figure 12 - PSR 5,000ft ASL Composite Intervisibility Coverage Map

A2.4 VHF Comms TX/RX Site - Composite Intervisibility Coverage Maps

A2.4.1 1,000ft ASL

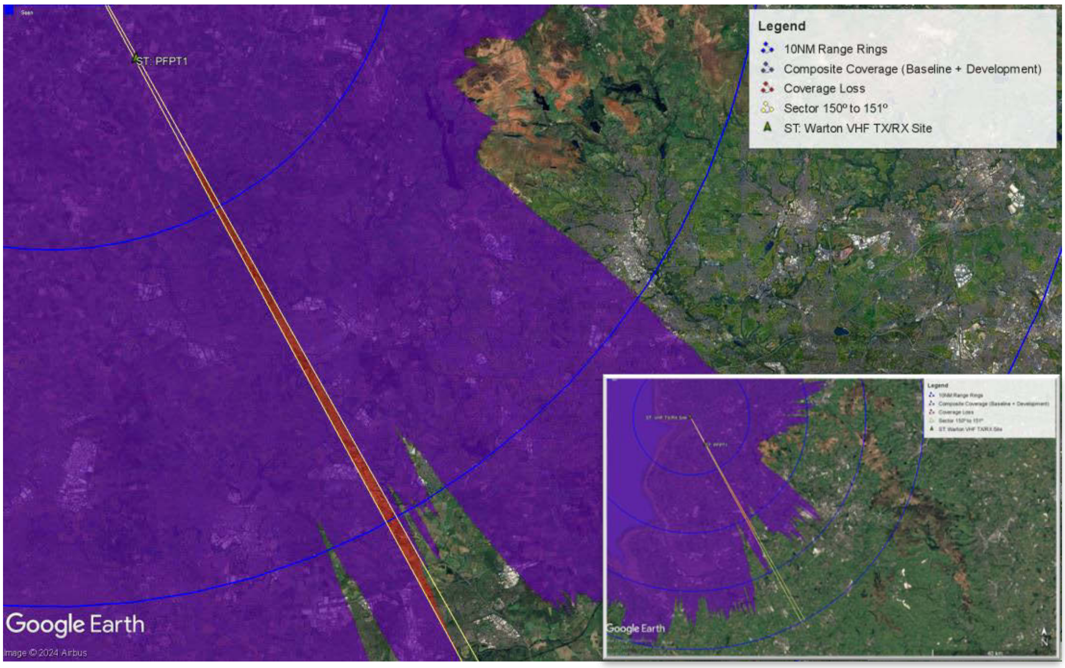

Figure 15 - VHF Comms TX/RX Site 1,000ft ASL Composite Intervisibility Coverage Map

A2.4.2 2,000ft ASL

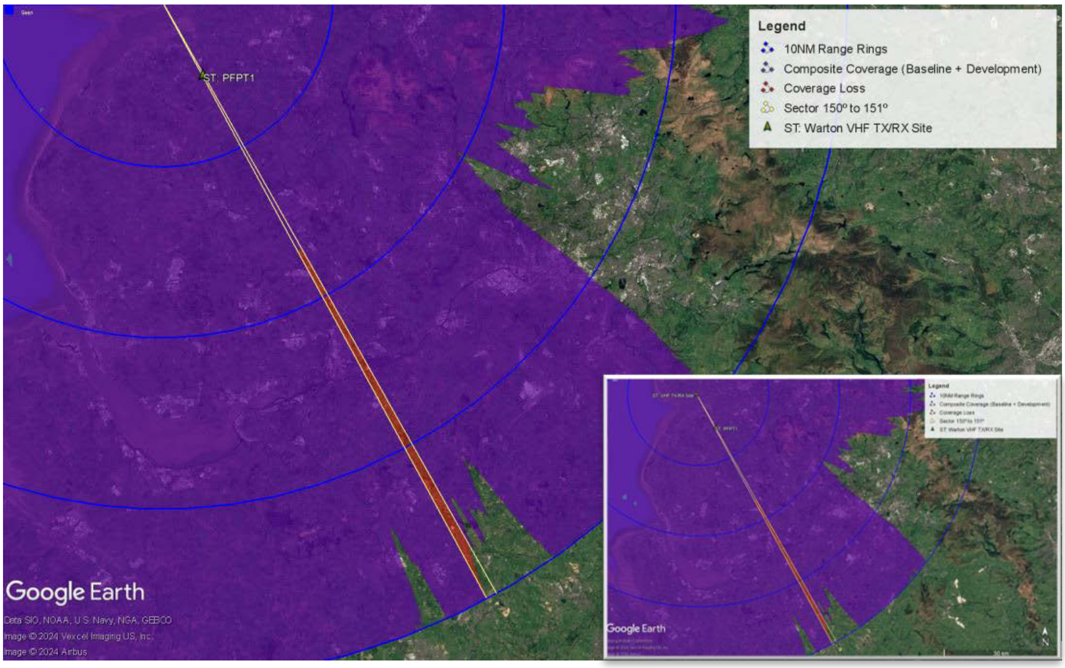

Figure 16 - VHF Comms TX/RX Site 2,000ft ASL Composite Intervisibility Coverage Map

A2.4 VHF Comms TX/RX Site - Composite Intervisibility Coverage Maps

A2.4.1 1,000ft ASL

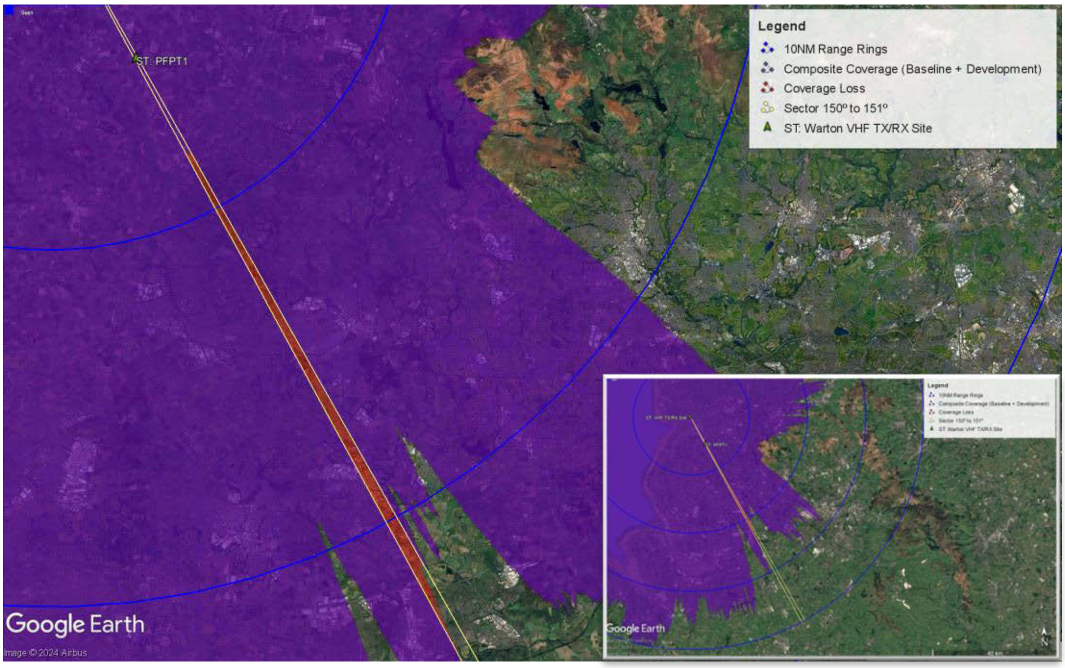

Figure 15 - VHF Comms TX/RX Site 1,000ft ASL Composite Intervisibility Coverage Map

A2.4.2 2,000ft ASL

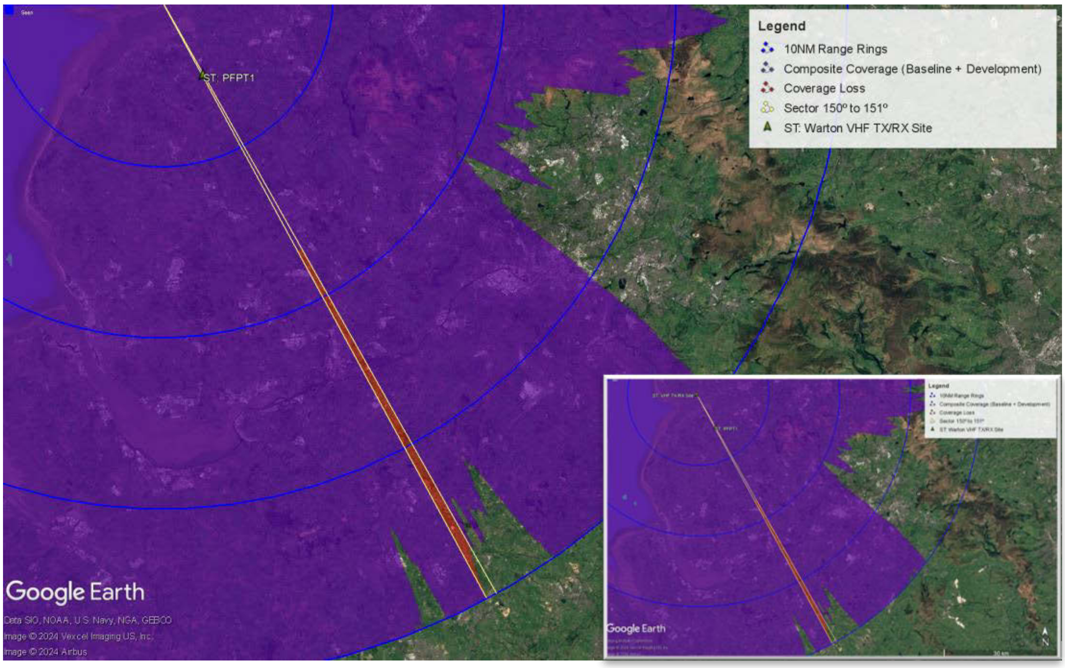

Figure 16 - VHF Comms TX/RX Site 2,000ft ASL Composite Intervisibility Coverage Map

A2.4.3 3,000ft ASL

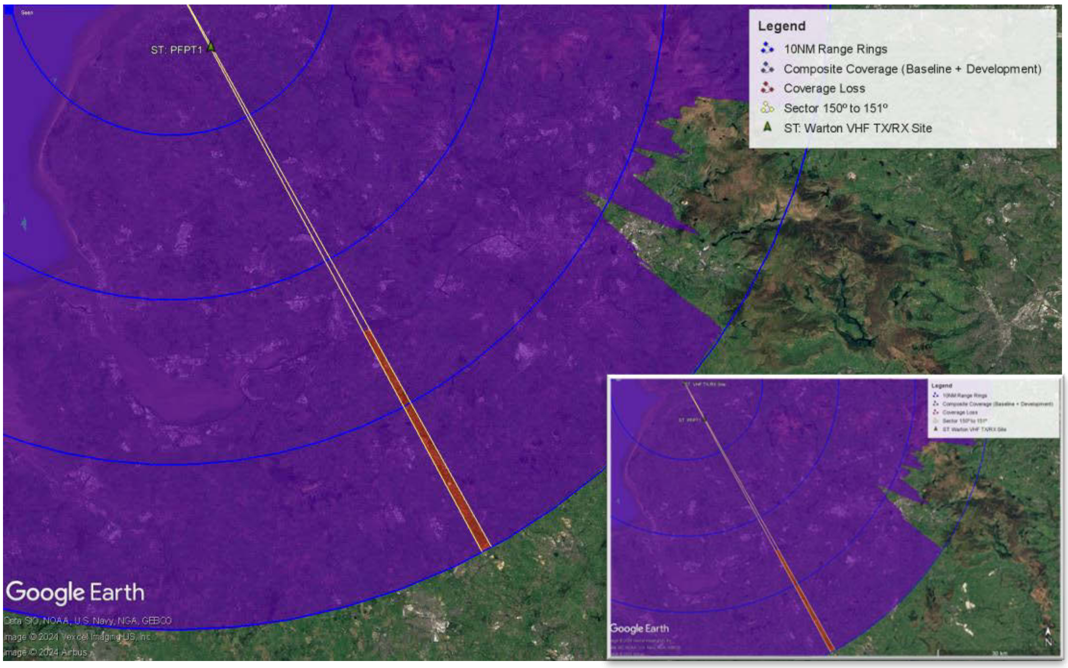

Figure 17 - VHF Comms TX/RX Site 3,000ft ASL Composite Intervisibility Coverage Map

A2.4.4 5,000ft ASL

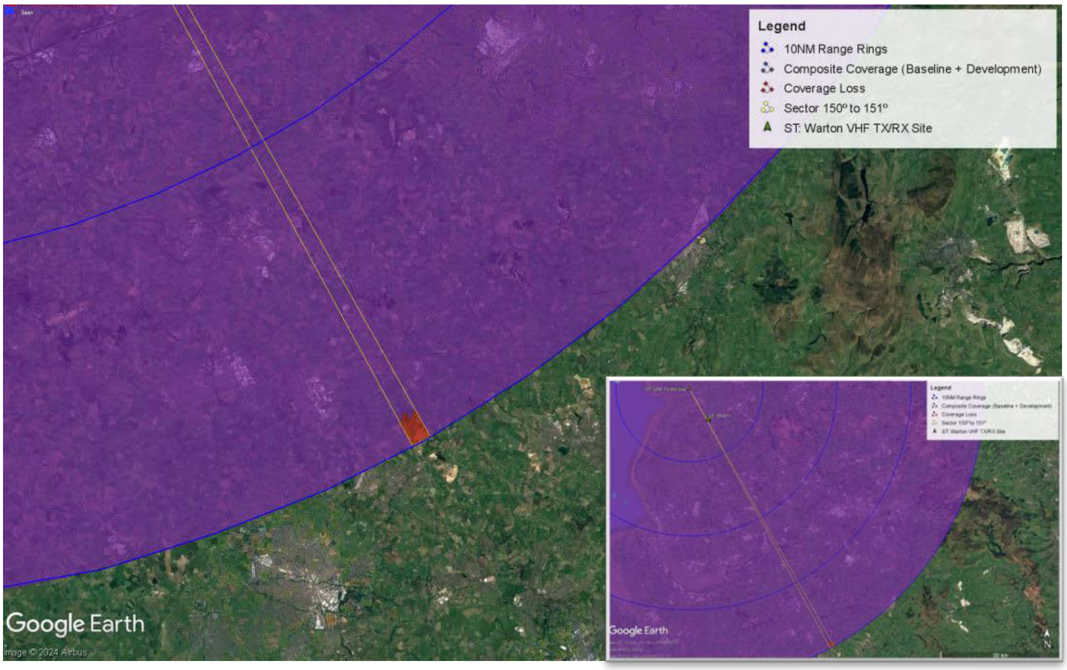

Figure 18 - VHF Comms TX/RX Site 5,000ft ASL Composite Intervisibility Coverage Map

A2.5 NDB - Composite Intervisibility Coverage Maps

A2.5.1 1,000ft ASL

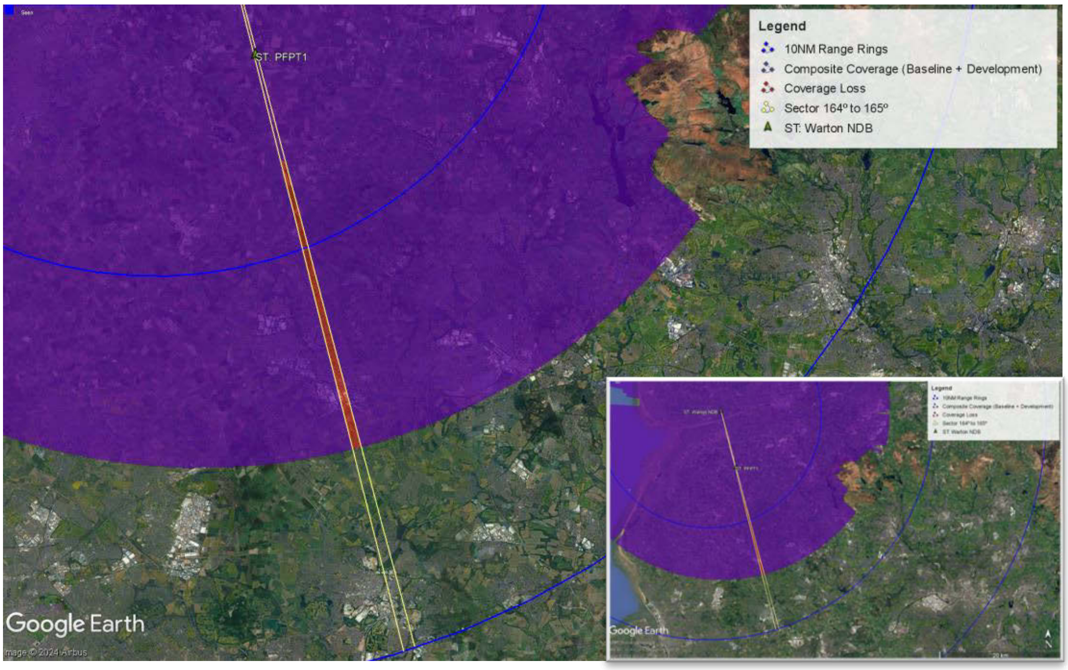

Figure 21 - NDB 1,000ft ASL Composite Intervisibility Coverage Map

A2.5.2 2,000ft ASL

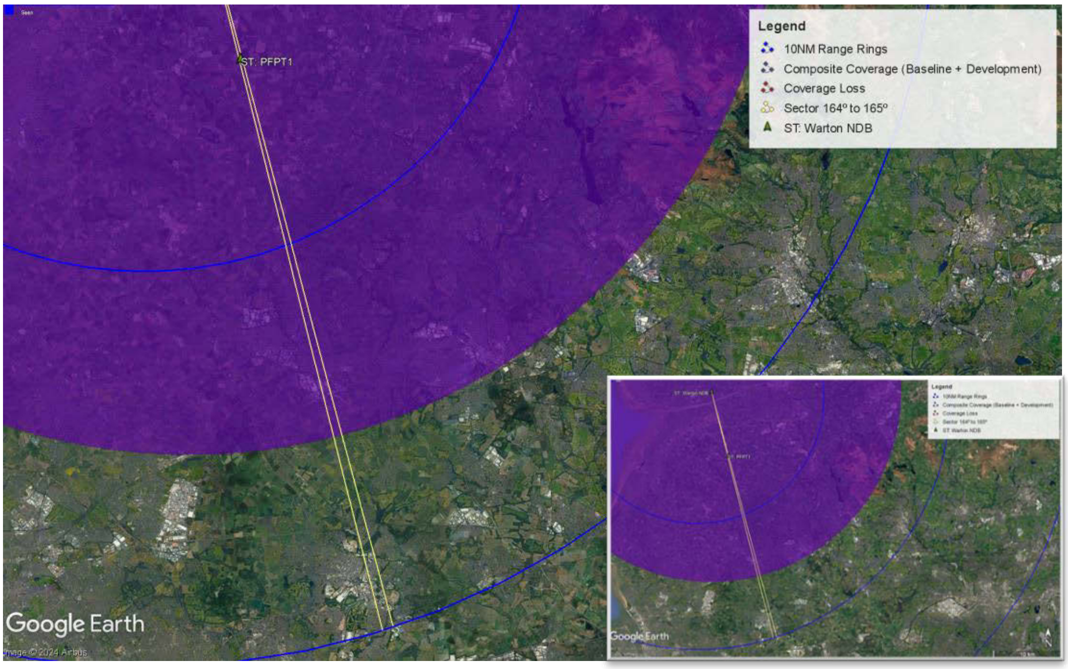

Figure 22 - NDB 2,000ft ASL Composite Intervisibility Coverage Map

A2.5.3 3,000ft ASL

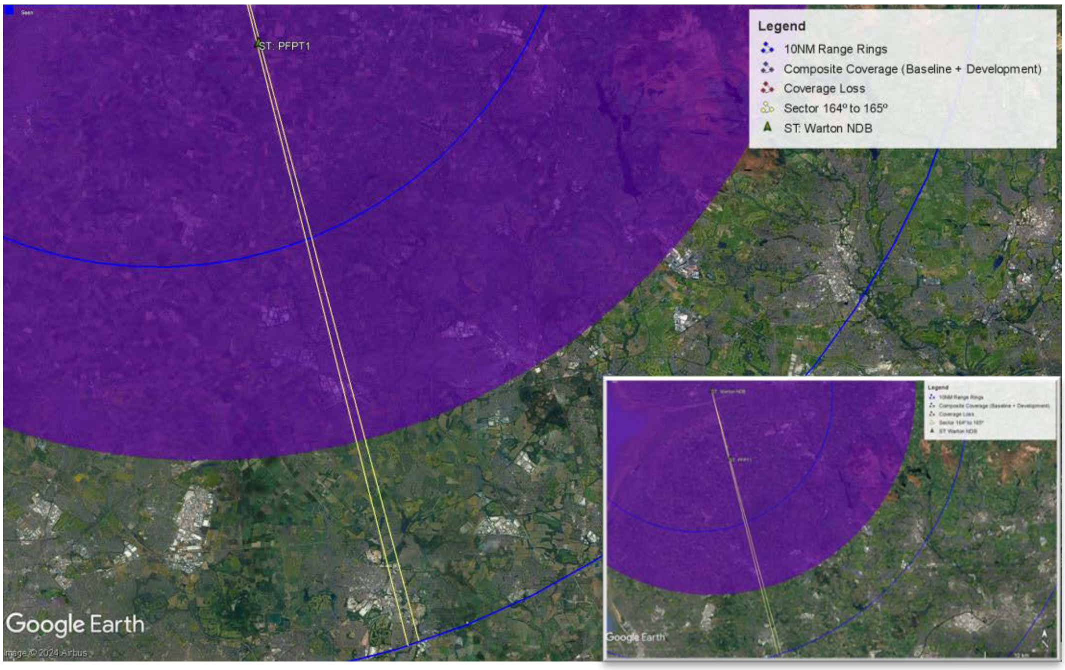

Figure 23 - NDB 3,000ft ASL Composite Intervisibility Coverage Map

A2.5.4 5,000ft ASL

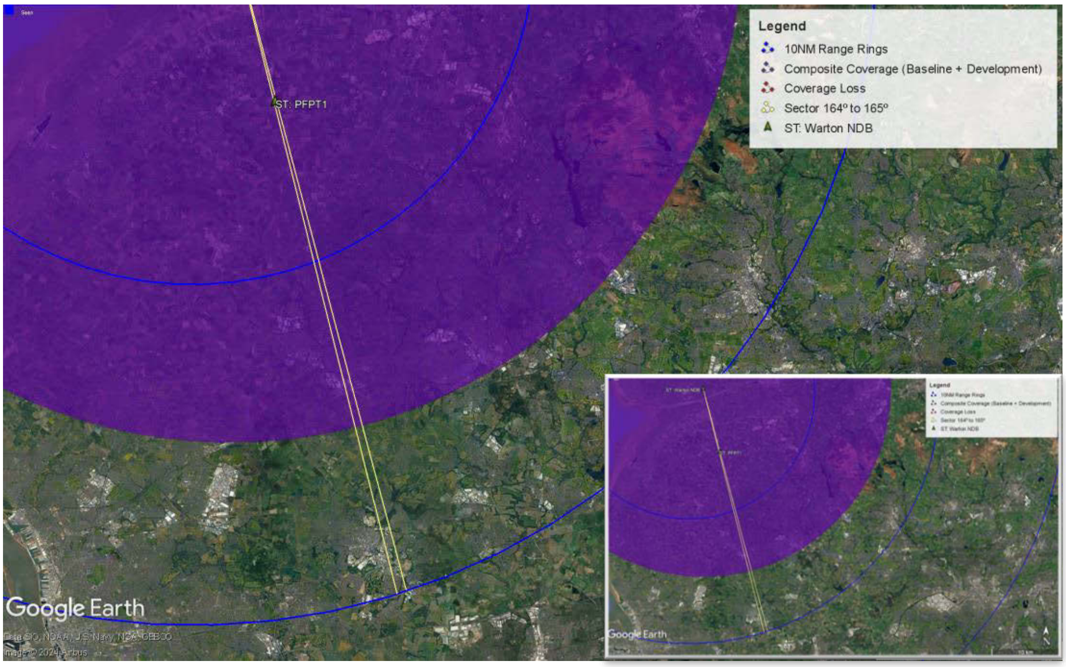

Figure 24 - NDB 5,000ft ASL Composite Intervisibility Coverage Map

A2.5.5 7,500ft ASL

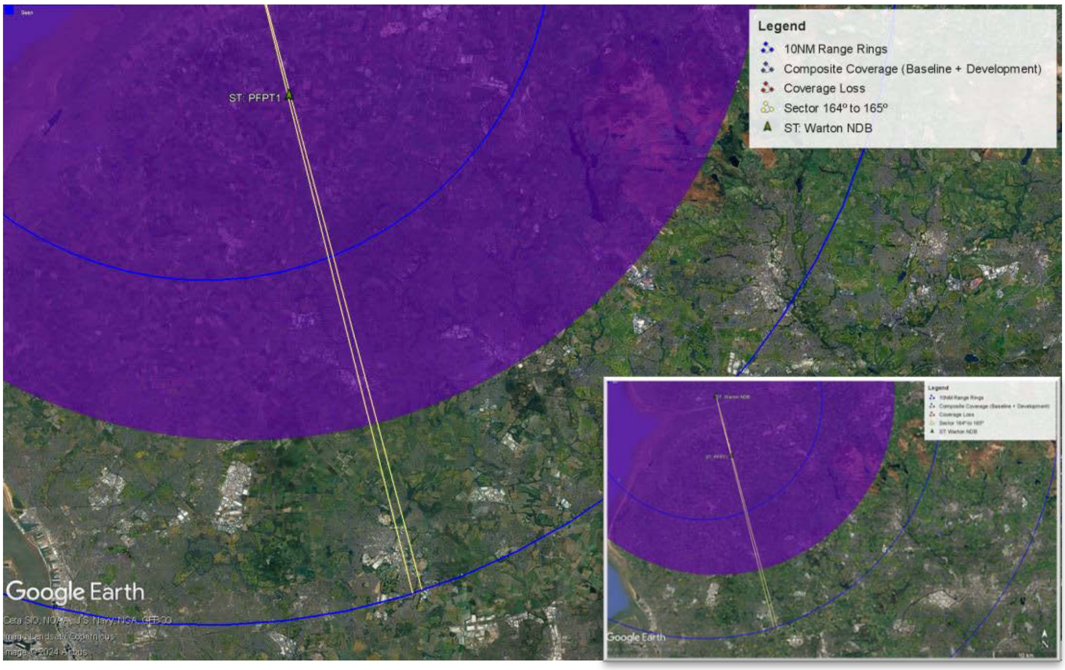

Figure 25 - NDB 7,500ft ASL Composite Intervisibility Coverage Map

A2.5.6 10,000ft ASL

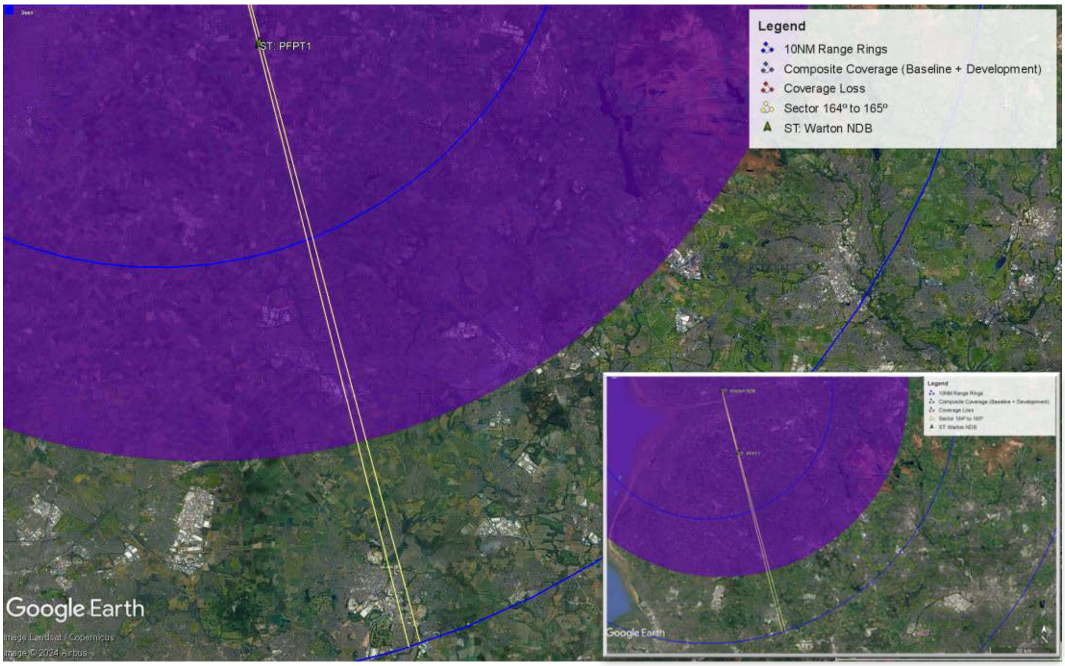

Figure 26 - NDB 10,000ft ASL Composite Intervisibility Coverage Map

Appendix 3 CAP670 C/I Ratio Maps

A3.1 Introduction

In conducting the CAP 670 C/I Ratio Prediction Assessment, many technical artifacts are generated. Map images are produced for Post Development at every altitude being assessed for each CNS system being considered. For ease of readability of the main report, these images are contained within this Appendix.

A3.2 Contents

The contents of this Appendix are as follows:

Note: [Images are displayed from the next page onwards]

A3.3 VHF Comms TX/RX Site - CAP670 C/I Ratio Maps

A3.3.1 1,000ft AGL C/I Ratio Map

Figure 27 - VHF Comms TX/RX Site 1,000ft AGL Post Development C/I Map

A3.3.2 2,000ft AGL C/I Ratio Map

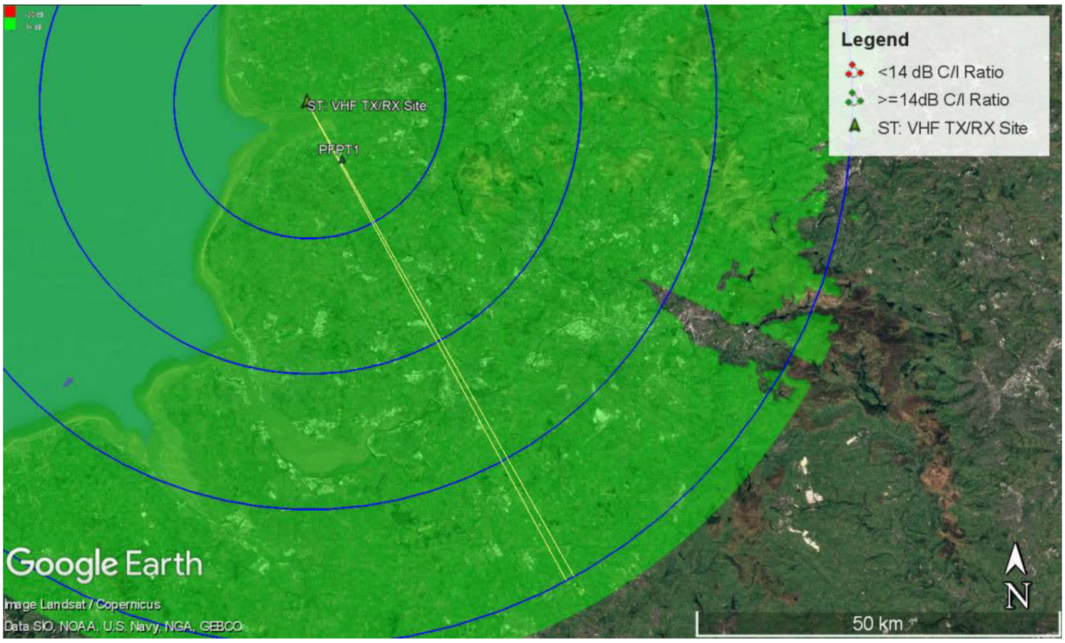

Figure 28 - VHF Comms TX/RX Site 2,000ft AGL Post Development C/I Map

A3.3.3 3,000ft AGL C/I Ratio Map

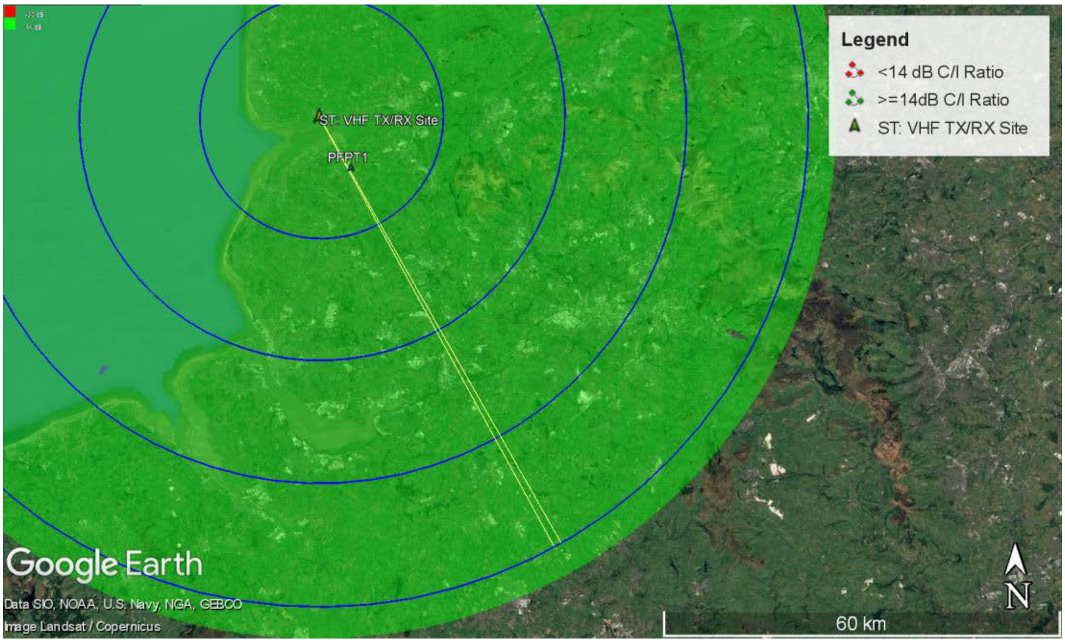

Figure 29 - VHF Comms TX/RX Site 3,000ft AGL Post Development C/I Map

A3.3.4 5,000ft ASL C/I Ratio Map

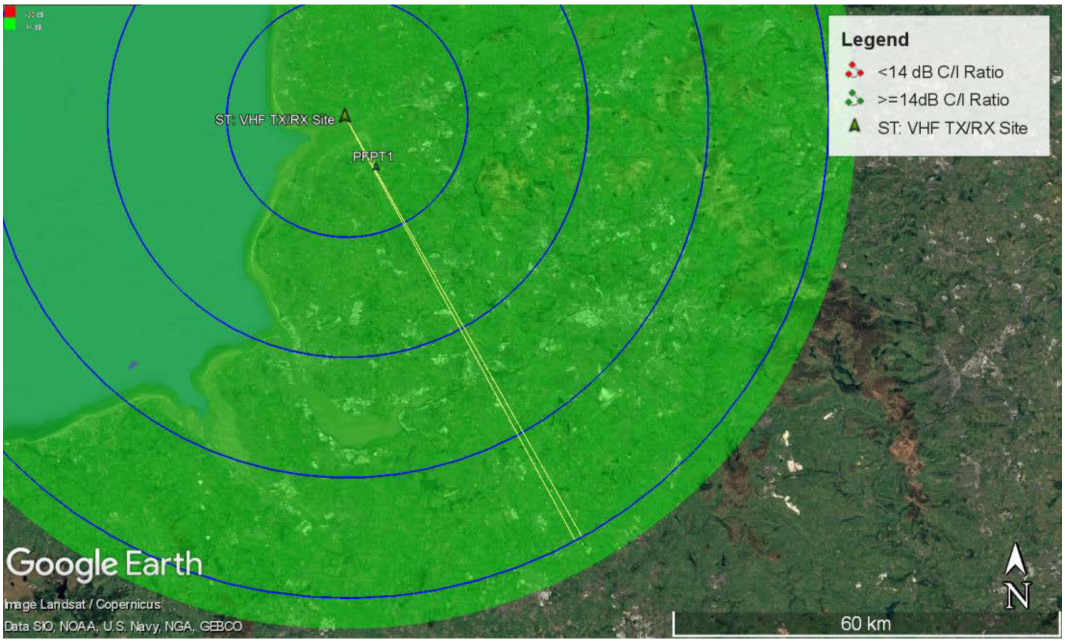

Figure 30 - VHF Comms TX/RX Site 5,000ft ASL Post Development C/I Map