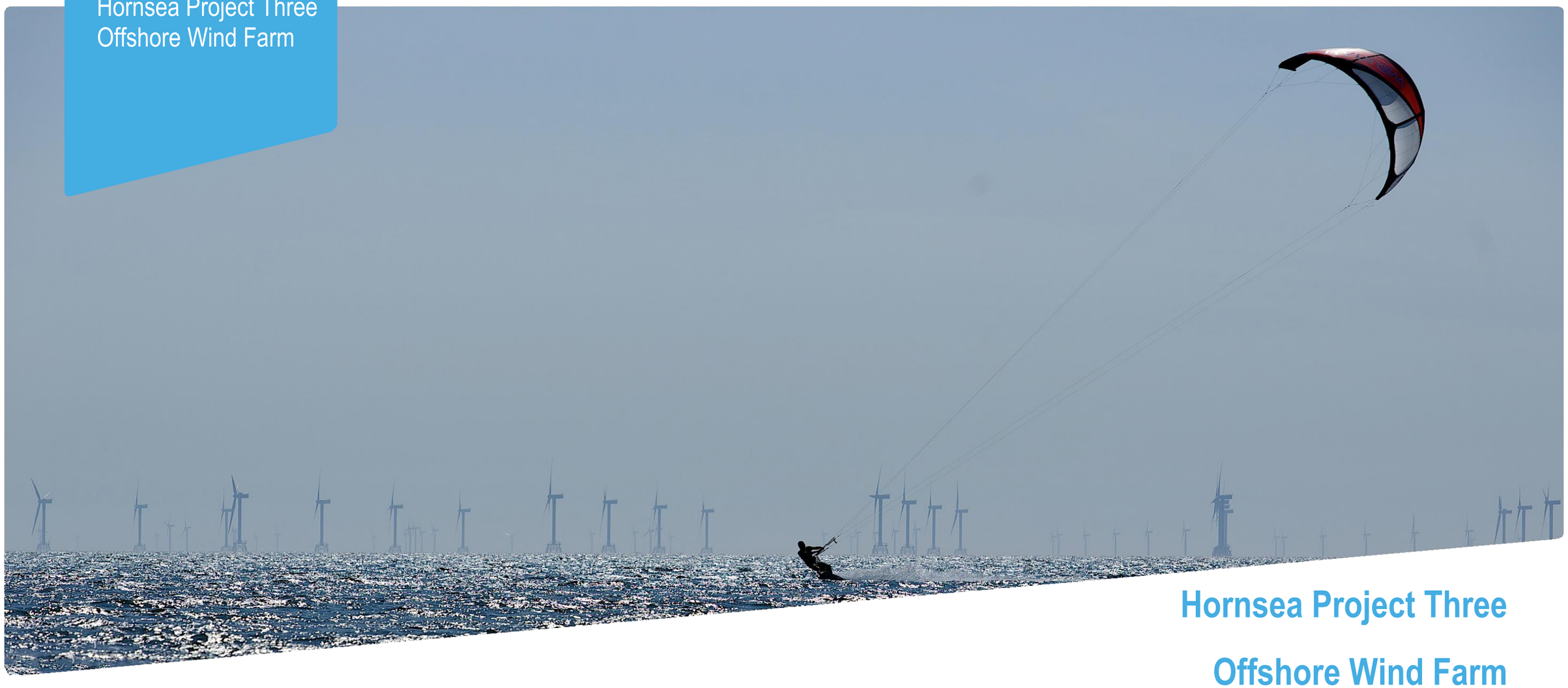
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Preliminary Environmental Information Report:
Annex 10.1 – Seascape and Visual Resources Technical Report

Date: July 2017

Hornsea 3
Offshore Wind Farm

DONG energy

Environmental Impact Assessment

Preliminary Environmental Information Report

Volume 5

Annex 10.1 – Seascape and Visual Resources Technical Report

Liability

This report has been prepared by RPS, with all reasonable skill, care and diligence within the terms of their contracts with DONG Energy Power (UK) Ltd.

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This report is also downloadable from the Hornsea Project Three offshore wind farm website at:
www.dongenergy.co.uk/hornseaproject3

DONG Energy Power (UK) Ltd.

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Front cover picture: Kite surfer near one of DONG Energy's UK offshore wind farms © DONG Energy Hornsea Project Three (UK) Ltd., 2016.

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Glossary

Term	Definition
Heritage	Historic or cultural associations.
Historic Seascape Character (HSC) type	Historic seascape types defined by a study produced by Newcastle University on behalf of English Heritage (now Historic England).
Seascape	Human perception of the sea (at or above sea level) conditioned by knowledge and identity with a place.
Seascape character	The distinct and recognisable pattern of elements that occurs consistently in a particular type of seascape and how this is perceived by people and it reflects particular combinations of current sea use and human activity. It creates the particular sense of place of different areas of the seascape.
Seascape and Visual Impact Assessment	The assessment of the impacts on seascape character and visual resources, and the evaluation of the effects of those impacts.
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual effect	Change in the appearance of the seascape as a result of development. This can be positive (i.e. beneficial or an improvement) or negative (i.e. adverse or a detraction).
Visualisation	Computer simulation, photomontage or other technique to illustrate the appearance of a development.

Acronyms

Acronym	Description
BCT	Broad Character Type
cSAC	Candidate Special Area of Conservation
EIA	Environmental Impact Assessment
GLVIA3	Guidelines for Landscape and Visual Impact Assessment: Third Edition (2013) Landscape Institute and Institute for Environmental Management and Assessment.
GSA	Guide to Best Practice in Seascape Assessment
HCS	Historic Character Subtype
HSC	Historic Seascape Characterisation
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
LAT	Lowest Astronomical Tide
LVIA	Landscape and Visual Impact Assessment
MMO	Marine Management Organisation
MoLAS	Museum of London Archaeology Service
MPS	Marine Policy Statement
MSL	Mean Sea Level
PINS	Planning Inspectorate
R&RNAV	Research and Radio Navigation Directorate of the General Lighthouse Authorities
RYA	Royal Yachting Association
SVIA	Seascape and Visual Impact Assessment
ZoC	Zone Characterisation
ZTV	Zone of Theoretical Visibility

Units

Unit	Description
GW	Gigawatt (power)
kV	Kilovolt (electrical potential)
kW	Kilowatt (power)
MW	Megawatt (power)
nm	Nautical Mile

1. Introduction

1.1 Project Overview

1.1.1.1 This Seascape and Visual Resources technical report provides the technical information relating to the Hornsea Project Three offshore wind farm, owned by 'DONG Energy Hornsea Project Three (UK) Ltd' (here after referred to as Hornsea Three) as part of the Environmental Impact Assessment (EIA) process for Hornsea Three. This technical report presents the baseline detail for the Environmental Impact Assessment (EIA) of Hornsea Three with regard to present day and historic seascape and visual resources.

1.1.1.2 Hornsea Three is located in the former Hornsea Zone in the southern North Sea. The Hornsea Three array area is 696 km^2 at a distance of 121 km from the UK coastline (at Tringham, Norfolk) and 10.1 km from the median line between UK and Dutch territorial waters. Hornsea Three will have a total generating capacity of up to 2.4 GW. There could therefore be up to 342 turbines within the array area with capacities ranging from 7 MW up to 15 MW being considered, with a maximum blade tip height of 325 m.

1.1.1.3 All references to Hornsea Three in this technical report shall, for the purposes of the report, refer to the offshore infrastructure and construction, operation and decommissioning activities only.

1.2 Purpose of this Document

1.2.1.1 This technical report presents the existing environmental baseline established from desk studies and consultation as undertaken by Hornsea Three. It characterises the present day and historic seascape and visual resources within and around the proposed Hornsea Three development (namely the Hornsea Three array area, the Hornsea Three offshore cable corridor and the offshore HVAC booster stations (Figure 2.1). Information presented in this report has been drawn from field surveys, desktop studies and computer modelling. This information has been used to support the preparation of the Seascape and Visual Resources impact assessment (see volume 2, chapter 10: Seascape and Visual Resources).

1.2.1.2 A separate onshore Landscape and Visual Impact Assessment (LVIA) has been prepared for the onshore and intertidal elements of Hornsea Three. This includes the onshore cable corridor search area and the onshore HVDC converter/HVAC substation option areas, located near the existing National Grid Substation at Norwich. This can be found within volume 3, chapter 4: Landscape and Visual Resources.

2. Seascape and Visual Impact Assessment (SVIA) Study Area

2.1.1.1 The likely effects of Hornsea Three on present day seascape character and visual resources are considered within two Seascape and Visual Impact Assessment (SVIA) study areas. The larger SVIA study area relates to the area associated with the Hornsea Three array area (hereafter referred to as 'Array SVIA study area' (50 km buffer)). The 50 km buffer is considered to be the maximum extent within which a significant effect could occur given the maximum height of the proposed wind turbines. The Array SVIA study area is not intended to provide a boundary beyond which the operational Hornsea Three cannot be seen, but rather to define the area within which Hornsea Three may have a significant present day seascape or visual effect. The recommendations for radius of study areas are set out in current best practice guidance for turbines (page 13, Table 2, Recommended distance of Zone of Theoretical Visibility (ZTV) Visual Representation of Wind Farms: Good Practice Guidance, Scottish Natural Heritage (SNH, 2017). The recommendations cover wind turbines over 150 m in height to blade tip, recommending a 45 km initial distance from the nearest turbine or outer circle of wind farm, although the guidance recognises that greater distances may need to be considered for the larger turbines used offshore. Turbines for Hornsea Three could be up to a maximum of 325 m above Lowest Astronomical Tide (LAT). Based on previous experience from Hornsea Project One and Hornsea Project Two, an Array SVIA study area of 50 km radius from the outer edges of the Hornsea Three array area has been adopted for this assessment, because it is the maximum distance at which the project would be theoretically visible, secondly, in discussions with statutory consultees on similar projects, the consultee (NE or SNH) recommended a 50 km distance for offshore wind farms with similar turbine heights to Hornsea Three.

2.1.1.2 The second SVIA study area is hereafter referred to the 'offshore HVAC booster station study area' (a 25 km buffer around the offshore HVAC booster station search area based on a maximum main structure height of 70m LAT). The two SVIA study areas are illustrated in Figure 2.1 and significant effects are considered very unlikely to occur towards the edges of the two SVIA study areas. Further detail regarding maximum design scenarios for establishing study areas is contained in volume 2, chapter 10: Seascape and Visual Resources, Table 10.9.

2.1.1.3 Following consultation with Historic England, the assessment of the effects upon Historic Seascape Character resources has concentrated on Historic Seascape Character areas where there would be a direct effect, namely those areas which contain either the turbines of Hornsea Three or the offshore cable corridor (including the offshore HVAC booster station search area to the east of Silver Pit). On this basis, although the SVIA study area is shown on those figures which address historic seascape, the study does not extend outside the characterised area.

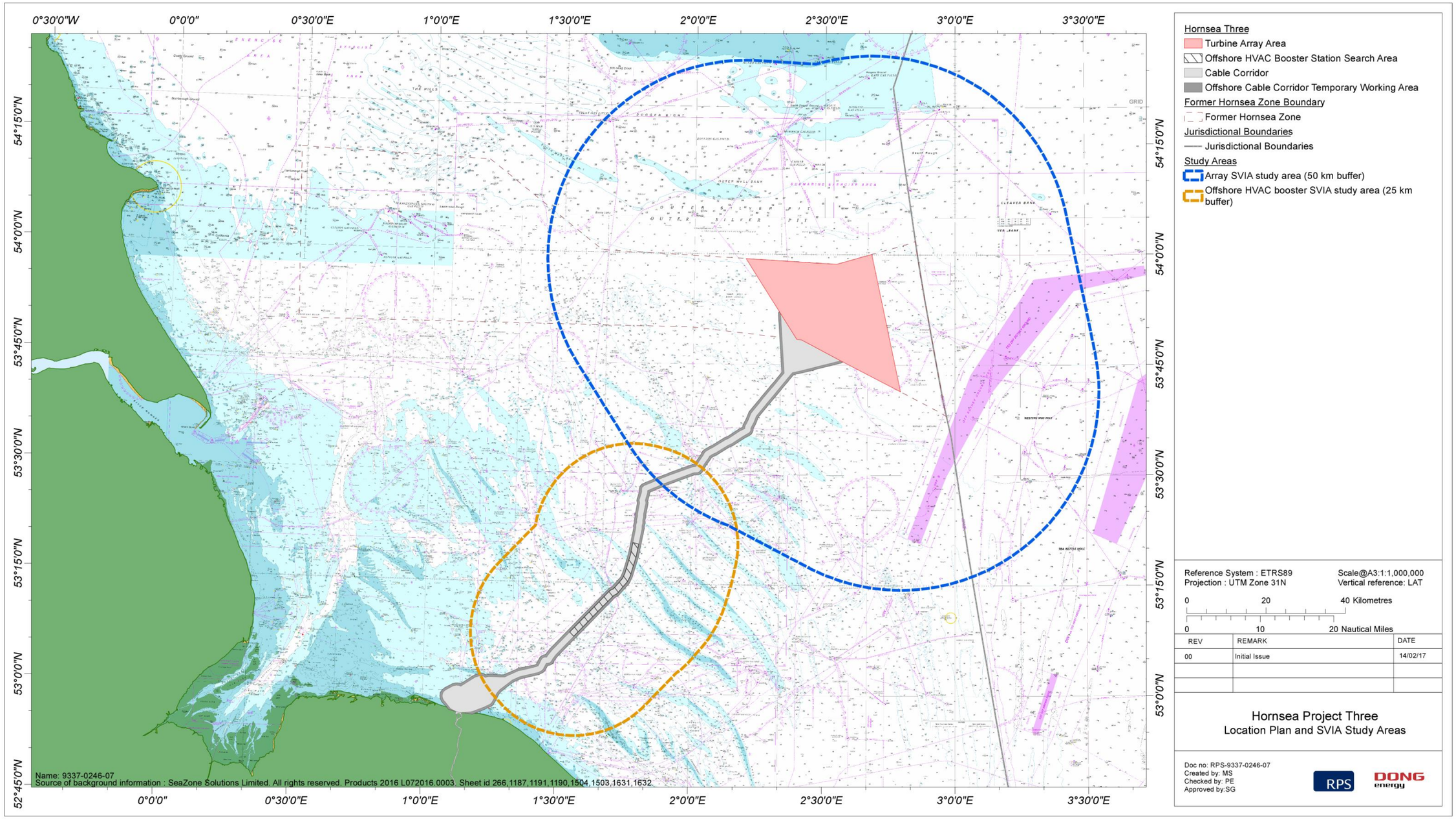

Figure 2.1: SVIA study area showing the locations of the Hornsea Three array area, the Hornsea Three offshore cable corridor and the offshore HVAC booster stations.

3. Legislation and Guidance

3.1 Planning Policy

3.1.1.1 The policy and legislation relevant to Hornsea Three is summarised in volume 1, chapter 2: Policy and Legislation. The relevant seascape and visual planning policy is detailed in volume 2, chapter 10: Seascape and Visual Resources.

3.2 Guidance

3.2.1.1 The present day seascape and visual resources elements of this EIA were designed and undertaken in accordance with the following guidance documents:

- Council of Europe, The European Landscape Convention (2000, ratified 2006) ETS No. 176;
- Countryside Agency and Scottish Natural Heritage, Landscape Character Assessment; Guidance for England and Scotland (2002);
- Countryside Agency and Scottish Natural Heritage, Topic Paper 6: Techniques and Criteria for judging Capacity and Sensitivity (2004);
- Countryside Council for Wales, Brady Shipman and Martin, University College Dublin, Guide to Best Practice in Seascape Assessment (2001) Maritime Ireland/Wales INTERREG Report No. 5;
- Department of Energy and Climate Change, UK Offshore Energy Strategic Environmental Assessment: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil and Gas and Gas Storage: Environmental Report (2009) and Appendices;
- Department of Trade and Industry, Guidance on the Assessment of the impact of offshore wind farm: Seascape and Visual Impact Report (2005), (hereafter referred to as the DTI Guidance);
- Infrastructure Planning Commission, The Infrastructure Planning (Environmental Impact Assessment) Regulations (2009);
- Landscape Institute and the Institute of Environmental Management and Assessment, Guidelines of Landscape and Visual Impact Assessment: Third Edition (2013), (hereafter referred to as GLVIA3);
- Scottish Natural Heritage, Guidance: Cumulative Effects of Wind Farms (March 2012); and
- Scottish Natural Heritage, Visual Representation of Wind farms: Good Practice Guidance (2014).

3.2.1.2 Guidance and standards relevant to historic seascape characterisation include:

- Council of Europe, The European Landscape Convention (2000, ratified 2006) ETS No. 176;
- COWRIE, Oxford Archaeology, Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (2008);
- COWRIE, Wessex Archaeology, Historic Environment Guidance for the Offshore Renewable Energy Sector (2007);
- English Heritage, The European Landscape Convention – The English Heritage Action Plan for Implementation (2009); and
- Standard and Guidance for Historic Environment Desk Based Assessment Chartered Institute for Archaeologists (2014).

4. Existing Environment

4.1 Seascape Designations

4.1.1.1 There are no national or regional seascape designations within the Array SVIA study area for this assessment.

4.2 Seascape Character

4.2.1.1 Published seascape character assessments cover the two SVIA study areas. Plans showing the present day and historic seascape character areas are set out in Figure 4.1 and Figure 4.2 below.

4.2.2 Published Present Day Seascape Character Assessment

4.2.2.1 A seascape character area assessment for the East Inshore and East Offshore Marine Plan areas assessment was published by the Marine Management Organisation (MMO) in July 2012 (MMO, 2012). The two SVIA study areas encompass marine plan areas 3 and 4 (East Inshore and East Offshore respectively) which extend as far as the median line between the UK and the Netherlands. The purpose of the MMO assessment is to provide a strategic scale seascape character assessment to inform the marine planning process.

4.2.2.2 The MMO seascape assessment is based upon an earlier pilot study seascape assessment commissioned by Natural England (Natural England, 2012).

4.2.2.3 Both the MMO and the Natural England seascape character assessments divide the East Inshore and East Offshore marine plan areas into ten National Seascape Character Areas (NSCA) ('Dogger Bank', 'Dogger Deep Water Channel', 'East Midlands Offshore Gas Fields', 'East Anglian Shipping Waters', 'Holderness Coastal Waters', 'Humber Waters', 'East Midlands Coastal Waters', 'The Wash', 'Norfolk Coastal Waters', 'Suffolk Coastal Waters') (refer to Figure 4.1 and Figure 4.2 below).

4.2.2.4 The MMO seascape character area assessment (MMO, 2012) revises the key characteristics listed for each NSCA contained within the Natural England pilot study (Natural England, 2012). These revised key characteristics are presented within this report and have been used to inform the assessment presented in volume 2, chapter 10: Seascape and Visual Resources. The more detailed Natural England pilot study is referred to for additional information on relevant seascape character areas.

4.2.2.5 Hornsea Three array area lies within the 'Dogger Deep Water Channel' NSCA and the 'East Midlands Offshore Gas Fields' NSCA. The wider Array SVIA study area also encompasses the 'Dogger Bank' NSCA and the 'East Anglian Shipping Waters' NSCA (Figure 4.1). The Hornsea Three offshore cable corridor passes from the Hornsea Three array area in the 'Dogger Deep Water Channel' NSCA, through the 'East Midlands Offshore Gas Fields' NSCA and the 'Norfolk Coastal Waters' NSCA to the 'East Midlands Coastal Waters' NSCA.

'Dogger Deep Water Channel' NSCA

4.2.2.6 The revised key characteristics of the 'Dogger Deep Water Channel' NSCA listed in the MMO assessment (MMO, 2012) are:

- *"West-to-east deep channel which cuts across the south of Dogger Bank, known as the Outer Silver Pit;*
- *Broad channel at its widest part is 125 to 175 km (75 to 105 miles) with waters deepening to between 60 and 70 metres in places;*
- *Expansive seascape with small concentrations of gas platforms;*
- *Significant fisheries area because of important fish spawning and nursery habitats;*
- *Once a lake with tributaries of melt-water supplied from glaciers to north of Dogger Bank;*
- *Designated as a military practice area;*
- *Major North Sea navigation route;*
- *Concentration of gas platforms; and*
- *Important archaeological features present."*

4.2.2.7 Section 6.7 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'Dogger Deep Water Channel' NSCA:

"Deeper waters of the North Sea are visually unified by merit of consistent horizons across extensive and unchanging tracts of open water.

"There is a much more remote and isolated quality to the seascape where sight of other marine vessels and bird life become more important within the sense of perception.

"The enormous scale of commercial vessels operating with regular frequency is a notable feature of the seascape environment. The industrial nature of commercial vessels is at odds with the wild and natural qualities of the open sea.

"Views of gas platforms create an industrial and sometimes ethereal character, though the built intervention is typically at odds with the wild and natural qualities of the open sea. Despite the focus of activity they provide, they also amplify the contrast with the isolation and sense of remoteness which otherwise typifies the area. Platforms become visually imposing features within 5 km of their location.

"Unlike the shallower coastal waters where tidal dynamics, prevailing weather conditions and land based orientating landmarks are perceptible, there is typically a sense of disorientation due to a lack of visual cues. Views of the seascape become more searching in nature as a consequence and the presence of offshore activity and wildlife add a sense of familiarity to an otherwise remote environment.

"Without sight of land the swell of waves and breakers become more dramatic, unsettling and sometimes threatening.

"With fewer visual associations and a typically monochrome and monotonous seascape character, views become more searching in nature. Climatic conditions influence the perception of seascape and sensory experiences of sounds and smells become more important."

'Dogger Bank' NSCA

4.2.2.8 Section 5.4 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'Dogger Bank' NSCA:

"Deeper waters of the North Sea are visually unified by merit of consistent horizons across extensive and unchanging tracts of open water.

"There is a much more remote and isolated quality to the seascape where sight of other marine vessels, swooping birds and other wildlife become more important within the sense of perception.

"Unlike the shallower coastal waters where tidal dynamics, prevailing weather conditions and land based orientating landmarks are perceptible, there is a sense of disorientation due to a lack of visual cues. Views of the seascape become more searching in nature as a consequence and the presence of offshore activity and wildlife add a sense of familiarity to an otherwise remote environment.

"Without sight of land the swell of waves and breakers become more dramatic, unsettling and sometimes threatening.

"With fewer visual associations views become much more panoramic in nature and the seascape becomes monochrome and monotonous in character. Climatic conditions influence the perception of seascape and sensory experiences of sounds and smells become more important."

'East Midlands Offshore Gas Fields' NSCA

4.2.2.9 The revised key characteristics of the 'East Midlands Offshore Gas Fields' NSCA listed in the MMO assessment (MMO, 2012) are:

- *"Concentrations of offshore gas extraction and aggregate extraction activities;*
- *Extensive shallow offshore waters generally below 30 metres;*
- *Represents some of the UK's most extensive stores of shallow subtidal sediments;*
- *Series of submerged long straight sand banks and tidal sand ridges which pose navigational difficulties;*
- *Widespread sand bank habitats that support large fish spawning and fish nursery grounds;*
- *Commercial offshore activities such as fishing, dredging and dumping have a localised influence on benthic and pelagic environments;*
- *Significant fisheries areas; and*
- *Important archaeological features present."*

4.2.2.10 Section 7.4 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'East Midlands Offshore Gas Fields' NSCA:

"Deeper waters of the North Sea are visually unified by merit of consistent horizons across extensive and unchanging tracts of open water."

"There is a much more remote and isolated quality to the seascape where sight of other marine vessels, swooping birds and other wildlife become more important within the sense of perception.

"Views of gas platforms create an industrial and sometimes ethereal character, though the built intervention is typically at odds with the wild and natural qualities of the open sea. Despite the focus of activity they provide, they also amplify the contrast with the isolation and sense of remoteness which otherwise typifies the area. Platforms become visually imposing features within 5 km of their location.

"Unlike the shallower coastal waters where tidal dynamics, prevailing weather conditions and land based orientating landmarks are perceptible, there is typically a sense of disorientation due to a lack of visual cues. Views of the seascape become more searching in nature as a consequence and the presence of offshore activity and wildlife add a sense of familiarity to an otherwise remote environment.

"Without sight of land the swell of waves and breakers become more dramatic, unsettling and sometimes threatening.

"Despite the increased occurrence of offshore structures views are panoramic in nature and the seascape becomes monochrome and monotonous in character. Climatic conditions influence the perception of seascape and sensory experiences of sounds and smells become more important."

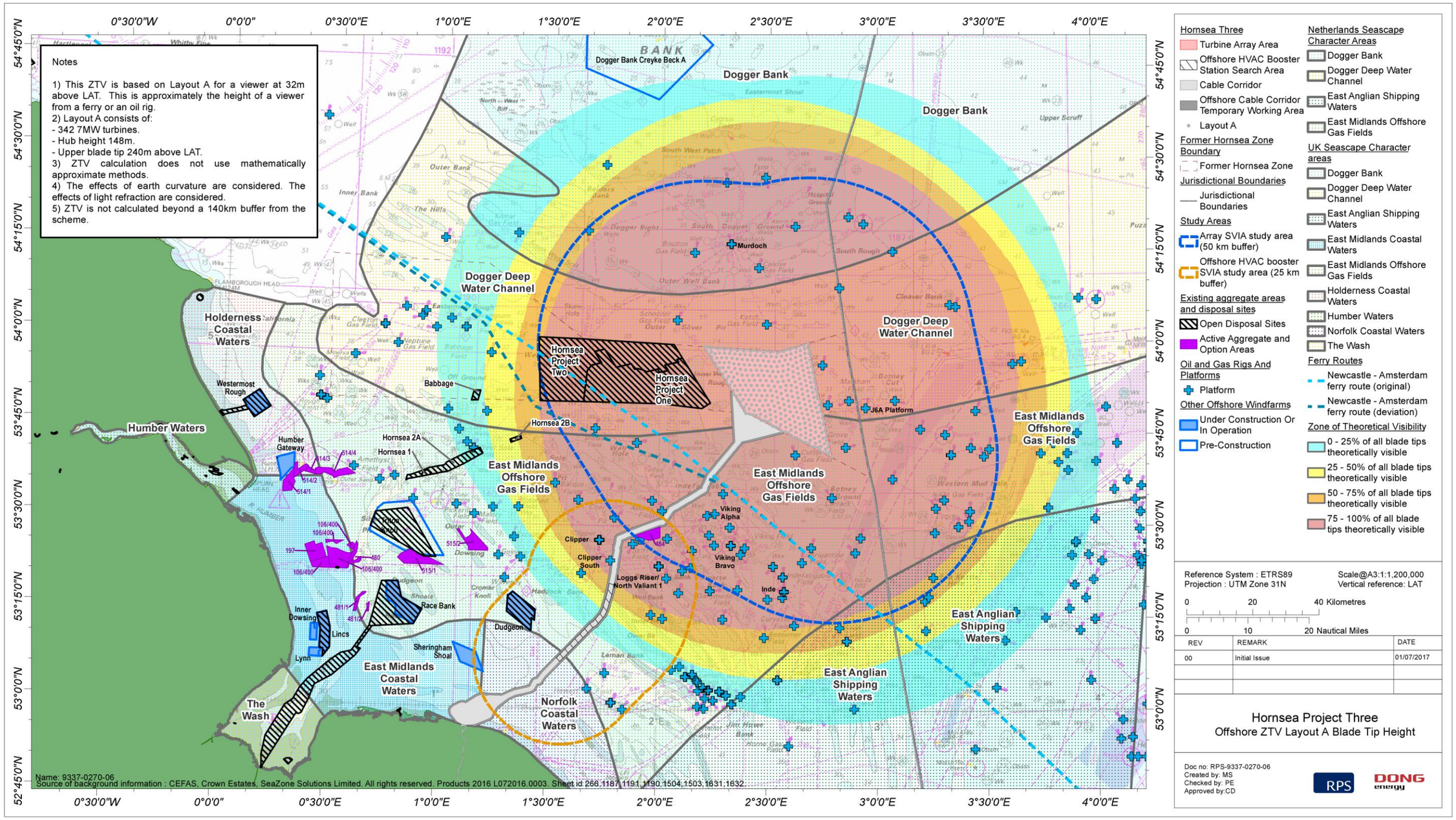

Figure 4.1: Present day seascape character areas with Layout A upper blade tip Zone of Theoretical Visibility, assumes the greatest height (240m) for the most numerous turbines (342).

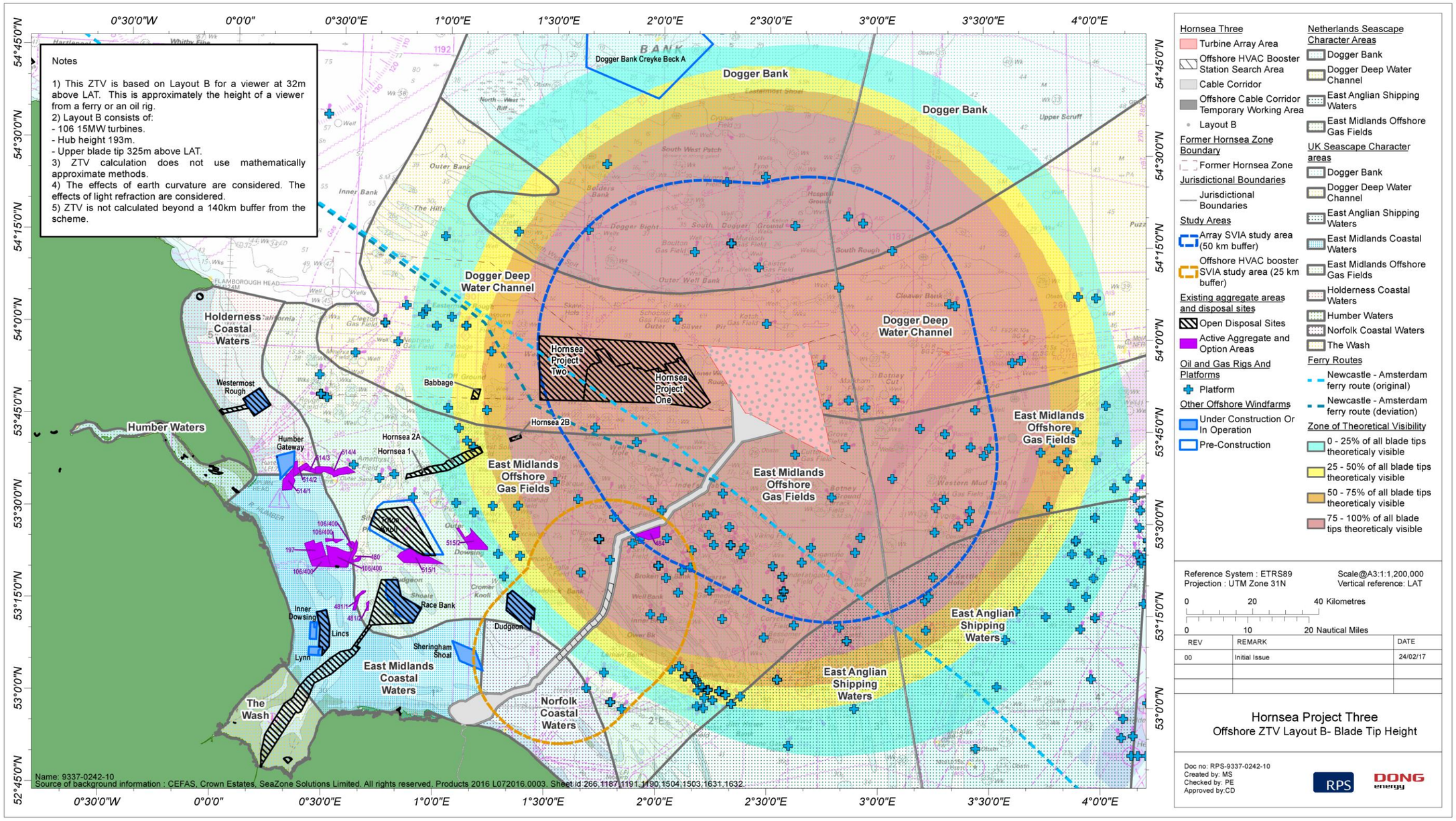

Figure 4.2: Present day seascape character areas with Layout B upper blade tip Zone of Theoretical Visibility, assumes the greatest height (325m) for 106 turbines.

'East Anglian Shipping Waters' NSCA

4.2.2.11 The revised key characteristics of the 'East Anglian Shipping Waters' NSCA listed in the MMO assessment (MMO, 2012) are:

- *Dense concentration of shipping activity;*
- *Consistently deep water between 20 and 50 metres;*
- *Designated shipping routes;*
- *Visually unified and expansive open water character with few surface features;*
- *Extensive offshore commercial activities such as fishing and dredging;*
- *Large military practice area;*
- *Windfarm developments and gas fields; and*
- *Important archaeological features present.*

4.2.2.12 Section 8.4 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'East Anglian Shipping Waters' NSCA:

Deeper waters of the North Sea are visually unified by merit of consistent horizons across extensive and unchanging tracts of open water.

There is a much more remote and isolated quality to the seascape where sight of other marine vessels, swooping birds and other wildlife become more important within the sense of perception.

The enormous scale of commercial vessels operating with regular frequency and the complex network of routes create an unsettling character where safe passage relies on awareness and adherence to shipping routes. The industrial nature of commercial vessels is at odds with the wild and natural qualities of the open sea.

Unlike the shallower coastal waters where tidal dynamics, prevailing weather conditions and land based orientating landmarks are perceptible, there is typically a sense of disorientation due to a lack of visual cues. Views of the seascape become more searching in nature as a consequence and the presence of offshore activity and wildlife add a sense of familiarity to an otherwise remote environment.

Without sight of land the swell of waves and breakers become more dramatic, unsettling and sometimes threatening.

Despite the increased occurrence of offshore structures views are panoramic in nature and the seascape becomes monochrome and monotonous in character. Climatic conditions influence the perception of seascape and sensory experiences of sounds and smells become more important.

Wind farm developments are significant features within the perceived seascape and their scale and form contrasts with the vast featureless seascape context.

'East Midlands Coastal Waters' NSCA

4.2.2.13 The revised key characteristics of the 'East Midlands Coastal Waters' NSCA listed in the MMO assessment (MMO, 2012) are:

- *"Flat, low lying coastal landscape demonstrating a complex array of dynamic natural processes;*
- *Wild and dynamic nature of the seascape with strong wave action over generally shallow waters;*
- *Shallow waters divided by a deeper water channel called The Well;*
- *Extensive submerged sand flats;*
- *Temporal seascape character heavily influenced by the tides and the exposure of vast sand flats at low tide;*
- *Extensive linear coastal geometry creating long sweeping views along the coastline and out to sea;*
- *Gently rolling dune systems and intertidal sand flats supporting a variety of coastal habitats and supporting a rich diversity of wildlife;*
- *Perception of land and sea is strongly influenced by dunes and intertidal areas which present a wild and remote character;*
- *Remote character influenced in places by concentrated urban settlements; commercial activities and both on and offshore wind farm developments;*
- *Sediment accretion influencing coastal economies;*
- *Coastal defence and beach replenishment activity;*
- *Recreational value of seascape represented by coastal resorts with much of the coastal waters recognised as RYA racing and sailing areas;*
- *Commercial offshore activities such as dredging and dumping have localised influence on benthic and pelagic environments;*
- *Important fisheries areas, particularly shellfish fisheries;*
- *Important archaeological features present;*
- *Significant for its buried peat deposits;*
- *WWII coastal defence infrastructure; and*
- *Extensive areas of salt marsh, and grazing marsh."*

4.2.2.14 Section 11.4 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'East Midlands Coastal Waters' NSCA:

"The seascape is dramatic and evocative and has a temporal and dynamic character, heavily influenced by coastal sedimentary and erosion processes and the rising and falling tides.

"Expanses of vast uninterrupted sand flats and sand dunes create a natural, wild and untamed character to the coastal edge and a largely featureless horizon evokes feelings of remoteness and loneliness.

"The exposed and open coastline together with changeable climatic conditions creates highly variable experiences and can induce a character that is tranquil and beautiful or unsettling and treacherous.

"Views from the sea are dominated by sand dunes and coastal vegetation which are often seen at great distances because of the shallow nature of the coastal waters. The uniformity of the natural coastal edge coupled with very low topography and only occasional groups of development creates a degree of disorientation and loneliness.

"In concentrated locations where human activity and development are imposing, such as where wind farms have been constructed, coastal resorts and during military training, the feeling of wilderness and remoteness is challenged and a managed and tamed quality is imposed on the seascape character."

'Norfolk Coastal Waters' NSCA

4.2.2.15 The revised key characteristics of the 'Norfolk Coastal Waters' NSCA listed in the MMO assessment (MMO, 2012) are:

- *Extensive linear coastal geometry with open and exposed sandy beaches creating long sweeping views along the coastline and out to sea.*
- *Soft glacial till cliffs that are largely wild and unmanaged – partly vegetated, prone to slippage through ground water infiltration and easily eroded at their toe.*
- *Wide variety of erosion protection measures implemented along much of the coastline.*
- *Extensive systems of mobile sandbanks aligned with the curve of the coast.*
- *Extensive chalk reef habitat.*
- *Visual influence of Cromer Ridge.*
- *Very low lying in places, particularly at the coastal interface of the Norfolk Broads where the sea is hidden inland behind sea walls.*
- *Important fisheries area, particularly for shellfish species.*
- *Presence of major shipping routes.*
- *The coastline is recognised as RYA sailing area.*
- *Submerged gas pipelines and Bacton Gas refinery associated with North Sea gas.*
- *Coastal holiday resorts.*
- *Remote character strongly influenced in places by concentrated urban settlements, commercial activities and both on and off shore wind farm developments.*
- *Important archaeological features present.*
- *Navigation restricted by shingle/sand banks.*
- *Important area for marine mammals.*

4.2.2.16 Section 13.4 of the Natural England pilot study (Natural England, 2012) includes a description of the aesthetic and perceptual qualities of the 'Norfolk Coastal Waters' NSCA:

The seascape has a powerful sense of place, largely attributable to the unique and varied coastal interfaces produced by dynamic and destructive coastal forces.

The highly dynamic and temporal nature of the marine character is evident in the erosion processes and dominating sea defences along the coastline. The natural forces impose a rugged, natural character to the seascape which is perceived as a largely fragile and vulnerable coastline.

Large slumped cliffs met by low sand dune systems create a natural, wild and untamed character to the coastal edge and a largely featureless horizon evokes feelings of remoteness and loneliness.

The exposed nature of the coastline coupled with the temperamental marine character creates an unsettling and uninviting quality.

4.2.3 Seascape Character Assessment in Dutch Waters

4.2.3.1 The Hornsea Three array area lies within approximately 10.1 km of the median line between the UK and the Netherlands, therefore a proportion of the 50 km radius Array SVIA study area lies outside of UK waters. Consultation has indicated that seascape character information is not available for Dutch Waters. To enable a consistent approach to baseline seascape mapping and in the absence of equivalent data from the Netherlands, the seascape east of the median line has been mapped by extending the corresponding seascape character units east into this area. In this way four additional sub-units have been created as follows;

- Dogger Bank: Netherlands Waters;
- Dogger Deep Water Channel: Netherlands Waters;
- East Midlands Offshore Gas Fields: Netherlands Waters; and
- East Anglian Shipping Waters: Netherlands Waters.

4.2.3.2 As the units are contiguous with UK seascape character units the features, elements and characteristics of these four areas are considered to be the same as the UK equivalent and are not described in any further detail.

4.2.4 Published Historic Seascape Character Assessment

4.2.4.1 A Historic Seascape Characterisation (HSC) of the area from the Humber to Norfolk was published in 2013 (Aldred 2013a, b and c). The Hornsea Three area lies within the Historic Seascape Characterisation (HSC) East Yorkshire to Norfolk Project Area 2.

4.2.4.2 The HSC study area extended into the open sea as far as the median line between the UK and the Netherlands (see Figure 4.3). The overall aim of the project was to carry out a GIS-based characterisation of a specified area of England's coastal and marine zones and adjacent waters to the limit of UK Controlled Waters using the national method for HSC.

4.2.4.3 The project included a case study of the character of part of the Hornsea Project One development area, located some 7km west of the Hornsea Three array area at its nearest point (Aldred, 2013b). The HSC divides the study area into a number of Broad Historic Character Types (BCT). These broad historic character types are subdivided into Historic Character Subtypes (HCS).

4.2.5 The conflated Layer

4.2.5.1 Within the Hornsea Three array area, the present-day historic character largely comprises the Fishing BCT, principally related to the Bottom Trawling HCS, involving the trawling of the lowest levels of the water column and/or the surface of the sea floor, the demersal and benthic zones respectively. These methods often result in disturbance to the sea floor itself (Aldred 2013c).

4.2.5.2 The Drift Netting HCS, areas of commercial fishing using large nets that drift in the water, moved by currents and lacking any fixtures to keep them in place, occurs in the north of the array area.

4.2.5.3 Aldred (2013b: 24) notes that:

"the North Sea fishing grounds have been exploited for many hundreds of years, and in more recent times have been an important spawning ground for herring. The Drift netting in particular has contributed to the wealth of the region, especially the fishing town of Grimsby".

4.2.5.4 The Communications BCT is represented in the form of several submarine telecommunications cables within the array area.

4.2.5.5 In addition, the Industry BCT is represented, in the form of the Hydrocarbon Installation HCS which comprises gas platforms within the array area (Aldred 2013b).

4.2.5.6 The Hornsea Three offshore cable corridor, including the offshore HVAC booster station search area, passes through a variety of HSC types, including extensive areas of the Fishing BCT. These comprise the Bottom Trawling HCS in the northeastern and southwestern parts of the Hornsea Three offshore cable corridor and the Fishing Ground HCS. In addition the Potting HCS, characterised by commercial fishing using pots and creels, extends to some 4 km from the coast.

4.2.5.7 There are also relatively large areas of the Navigation BCT, principally the Navigation Routes HCS. This character type becomes denser towards the coast. Of these Aldred (2013b: 24) notes that:

"this reflects the present-day commercial shipping activity related to the transportation of goods to and from the Humber and from Europe to the Scottish ports. There are also some known earlier Navigation routes dating to the post medieval period that constituted a part of the present-day routes, but these were located closer to the shore and not necessarily consistently evident in the offshore zone where Hornsea is largely located".

4.2.5.8 The Hornsea Three offshore cable corridor passes through several areas of the Cultural Topography BCT. In addition, the Industry BCT is represented, in the form of the Hydrocarbon Pipeline (pipelines involved in the transmission of oil or natural gas between facilities involved in their extraction, processing, storage or distribution – see Aldred 2013) and Hydrocarbon Installation HCSs which comprise gas platforms (Aldred 2013b: 24).

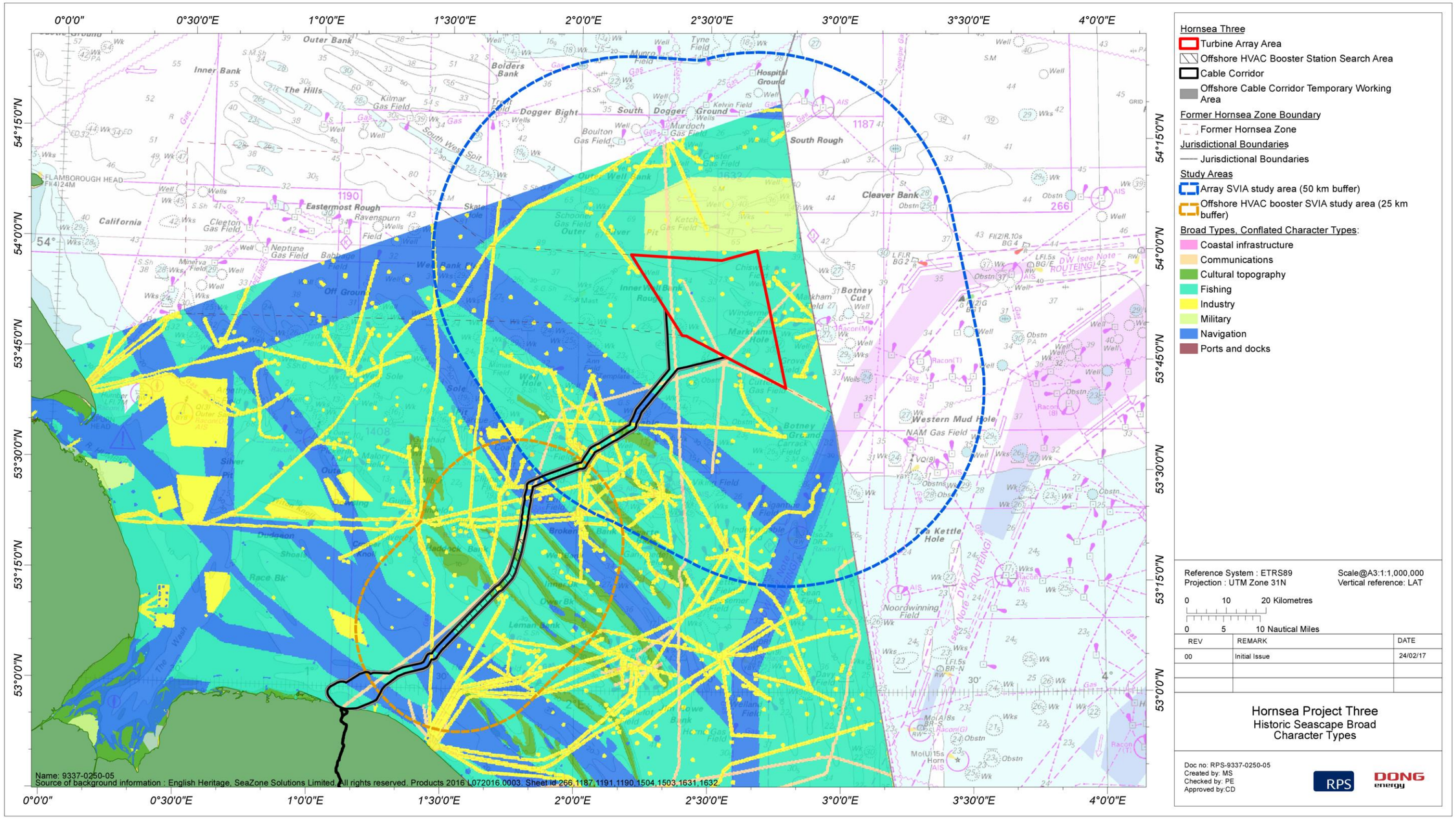

Figure 4.3: Historic Seascape Character Broad Types, Conflated, with Hornsea Three.

4.2.6 Detailed Historic Seascape Character

Sea Surface

4.2.6.1 The Hornsea Three array area contains a number of Sea Surface types (see Figure 4.4). The vast majority of the Hornsea Three array area lies within the 'Fishing' BCT. Within this, there is the Bottom Trawling HCS over much of the Hornsea Three array area. This refers to *commercial fishing involving trawling the lowest levels of the water column and/or the surface of the sea floor, the demersal and benthic zones respectively. These methods often result in disturbance to the sea floor itself. The most widely used methods are otter trawling and beam trawling (*Aldred 2013c: 48).

4.2.6.2 The Drift Netting HCS are generally used for pelagic or migratory species. Drift nets are rigged in a straight line to form a curtain in the water. Fish swim into the net and are trapped there by their gills (Aldred 2013c: 50). The Commercial Fish Technical Report (see volume 5, annex 6.1) refers to a number of different types of fishing activity within the area encompassed by the Hornsea Three array area, the offshore cable corridor and within the offshore HVAC booster station search area. It does not record drift netting within the Hornsea Three area. It is noted that the HSC characterises the historic character, while the Commercial Fisheries Technical Report describes the current position.

4.2.6.3 Under the 'Industry' BCT is the Hydrocarbon Installation HCS. This HCS refers to an installation, for example a drilling platform, directly involved in the extraction of oil and natural gas. Closely associated structures include pipelines, platforms, tanker moorings, storage containers, warning signals and lights. Unauthorised navigation is prohibited within 500 m of all such structures. In addition the Hydrocarbon Pipeline HCS refers to a pipeline involved in the transmission of oil or natural gas between facilities involved in their extraction, processing, storage or distribution (Aldred 2013c: 55-56).

4.2.6.4 The 'Communications' BCT is further characterised by areas of the Submarine Telecommunications Cables HCS. These are cables or pipes laid beneath the sea to carry telecommunications.

4.2.6.5 The Hornsea Three offshore cable corridor, including the offshore HVAC booster station search area, contains extensive areas of the 'Fishing' BCT, comprising the Bottom Trawling, Fishing Ground and Potting HCSs.

4.2.6.6 The 'Fishing Ground' HCS refers to *an area regularly exploited for commercial fish and/or shellfish extraction, but within which the locations of actual fishing activity at any given time may vary, seasonally and over other temporal cycles according to the behaviour of the target species concerned and regulations governing their exploitation. Consequently the definition of fishing grounds will depend on several factors: the distribution and behaviour of the commercial fish species, fishery regulation at regional, national and international levels, and custom and tradition within the fishery concerned* (Aldred 2013c: 50).

4.2.6.7 The 'Potting' HCS refers to areas characterised by *commercial fishing using pots and creels, traditionally made from basketry but now usually of cord mesh over a metal and wooden frame, they generally have one or more funnel-shaped entrances allowing the prey species to enter but not leave. Potting grounds are rarely more than a mile offshore and in most parts of the country occur in areas of rocky sea-floor* (Aldred 2013c: 50).

4.2.6.8 The 'Navigation Route' HCS falls under the 'Navigation' BCT and relates to routes regularly used by vessels of any description while navigating between destinations. This may be defined by usage or in some areas, formally defined by regulation. Navigation routes are distinct from 'Navigation channels' which are actively managed physical features identifying or securing a navigation route across hazardous areas of sea-floor (Aldred 2013c: 100).

4.2.6.9 In addition, the 'Industry' BCT is represented, in the form of a number of Hydrocarbon Installations, while the communications BCT is represented by Submarine Telecommunications cables.

4.2.6.10 The 'Cultural topography' BCT within the cable corridor is represented by the 'Sand Banks with Sand Waves' HCS, *areas of sand banks containing extensive wavelike structures and megaripples formed by rapidly moving currents of water on the sandbanks' surface. They may occur around the margins of sandflats and be barely submerged at various states of the tide or they may occur in deeper water. They can pose hazards to shipping and many in shallower waters appear on charts. Sand banks with sand waves also provide distinct preservation conditions for wrecks present within them. Their relationship to marine topography has implications for the potential form and survival of underlying palaeolandscape components* (Aldred 2013c: 100).

Water Column

4.2.6.11 The Hornsea Three array area includes a number of Sea Surface HCSs, including Drift Netting in the north and Bottom Trawling in the south. There are also small areas of Hydrocarbon Installation throughout the array area (see Figure 4.5).

4.2.6.12 In addition, there are two areas of the Buoyage HCS, a subtype of the 'Navigation' BCT and maritime safety character type. These are floating, fixed markers used to indicate to a navigator a sea area to approach or avoid Aldred 2013c: 94).

4.2.6.13 The Hornsea Three offshore cable corridor is almost entirely characterised by the Fishing BCT. There are large areas of the Drift Netting HCS, covering almost the entire offshore HVAC booster station search area, the Bottom Trawling and Fishing Ground HCSs, with the Potting HCS close to the shore.

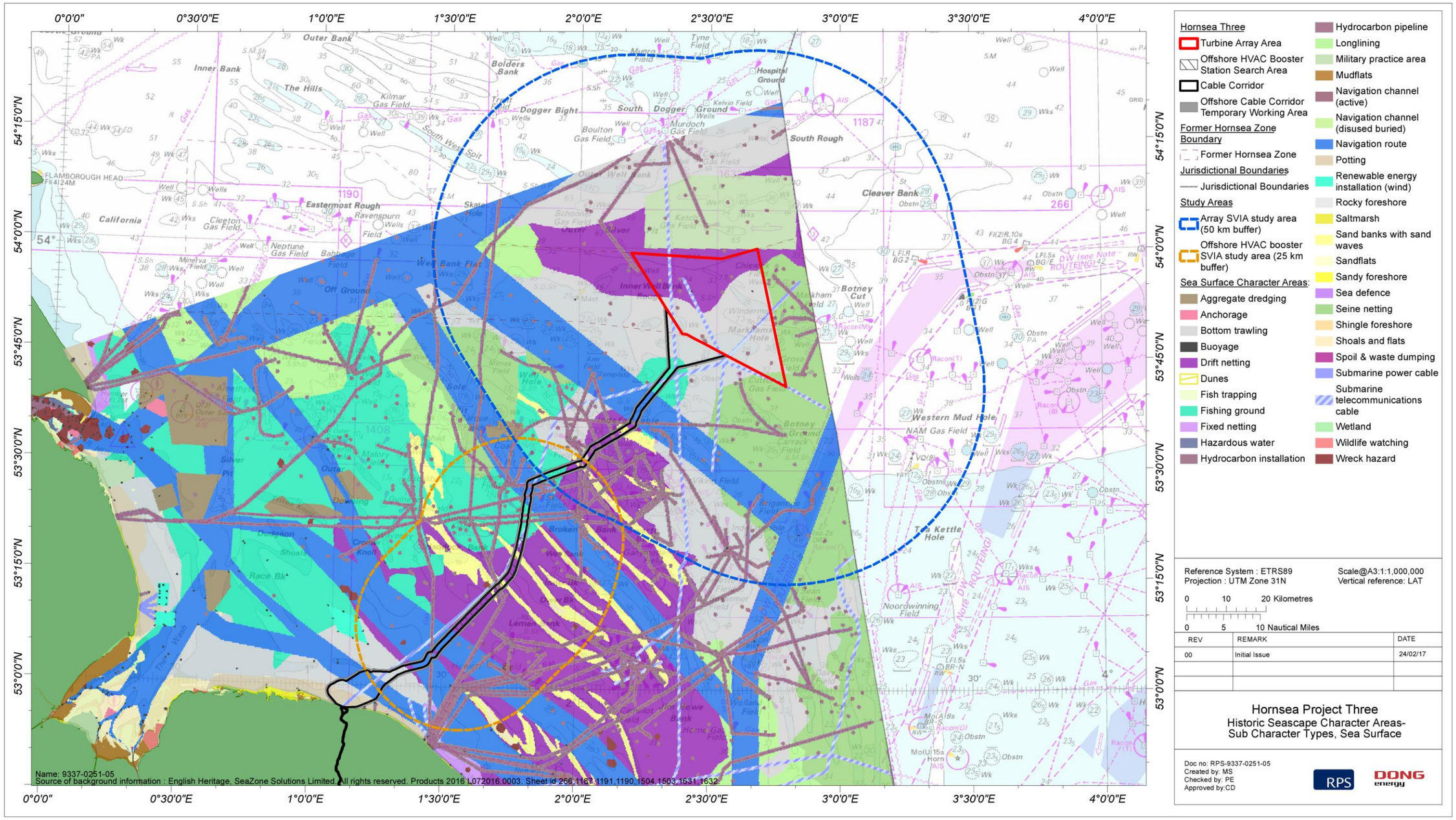

Figure 4.4: Historic Seascape Character SubTypes, Sea Surface, with Hornsea Three.

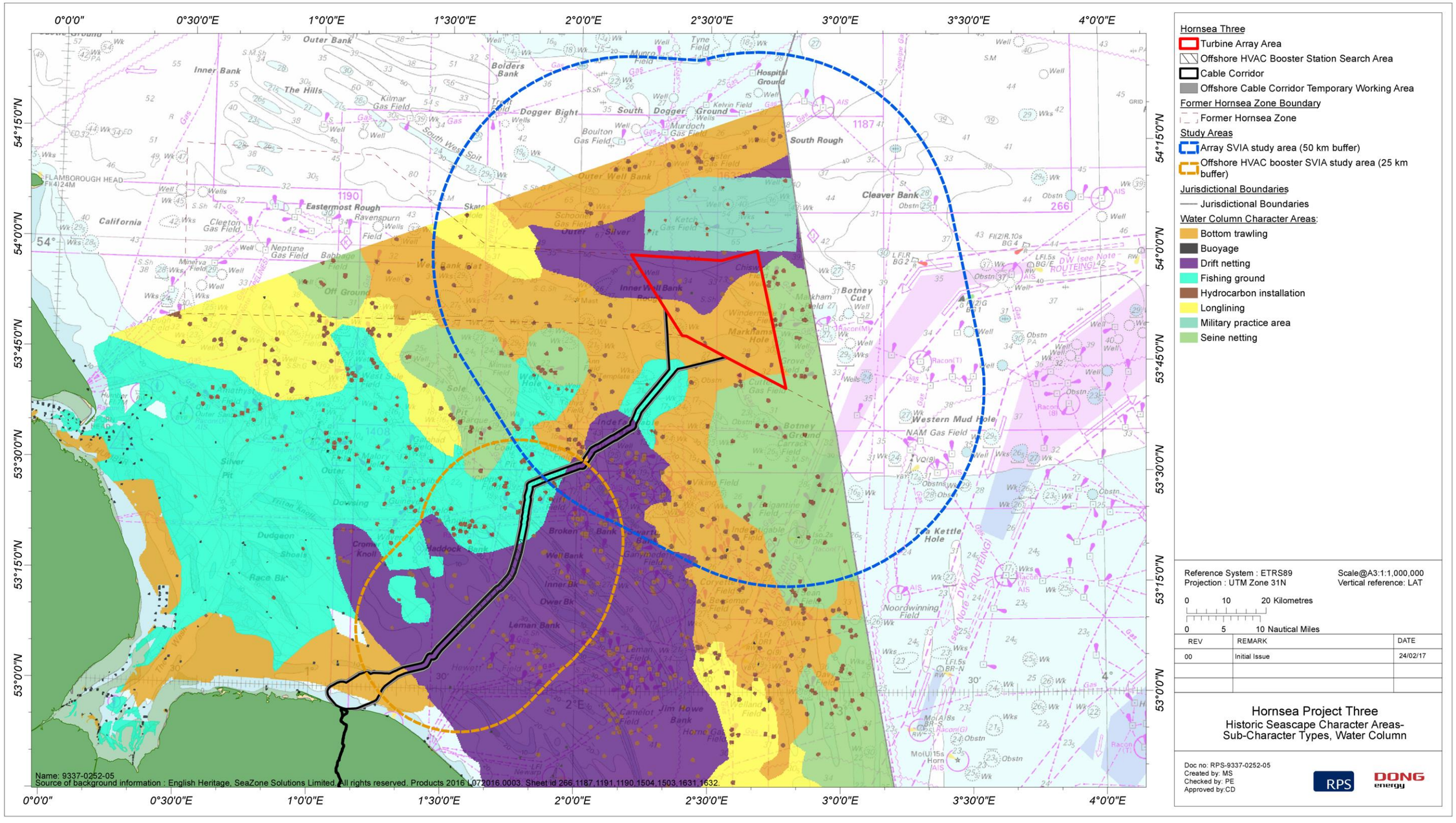

Figure 4.5: Historic Seascape Character SubTypes, Water Column, with Hornsea Three.

Sea Floor

4.2.6.14 The Hornsea Three array contains a number of Sea Floor types (see Figure 4.6). Under the Fishing BCT, the Bottom Trawling HCS dominates the southern half and much of the north-eastern part of the array area

4.2.6.15 Under the Cultural Topography BCT the Fine Sediment Plains HCS is located in the centre and north of the Hornsea Three array. This refers to large areas of seafloor whose surface sediments predominantly comprise different grades of sand and very low silt and clay content. Of cultural relevance is their role as a spawning ground and habitat for particular commercially-exploited fish species including flatfish and hence their correlation with particular fisheries and their management considerations by government, conservation bodies and fishing communities. Bottom trawling methods also have significant impacts on marine habitats and biodiversity in this HCS. Fine sediment plains also provide distinct preservation conditions for the occasional seafloor wrecks present. Their relationship to marine topography has implications for the potential form and survival of underlying palaeolandscape components. They too will also incorporate some of the 'background noise' of pollution which now affects all marine areas and tiers (Aldred 2013c: 27).

4.2.6.16 Much of the north and northeast and east of the array area is characterised by the Coarse Sediment Plains HCS. These are extensive areas of seafloor whose surface sediments predominantly comprise different grades of pebbles, rocks, boulders etc. with lower sand and very low silt and clay contents. Of cultural relevance is their role as a spawning ground and habitat for particular commercially-exploited fish species and hence their correlation with particular fisheries and their management considerations by government, conservation bodies and fishing communities. Bottom trawling methods also have significant impacts on marine habitats and biodiversity in this HCS. Coarse sediment plains also provide distinct preservation conditions for their share of the occasional seafloor wrecks present. Their relationship to marine topography has implications for the potential form and survival of underlying palaeolandscape components. They will also incorporate some of the 'background noise' of pollution, especially by littered debris, which now affects all marine areas from sea surface to sea floor (Aldred 2013c: 27).

4.2.6.17 Under the Industry BCT, there are also small areas of the Hydrocarbon Installation HCS throughout the array area

4.2.6.18 Close to the Hornsea Three array area, the Hornsea Three offshore cable corridor falls under the Fishing BCT and comprises the Bottom Trawling HCS.

4.2.6.19 There are relatively large areas of the Coarse Sediment Plains and to a lesser extent Fine Sediment Plains HCSs along the Cable route corridor, including the offshore HVAC booster station search area and several areas of the Hydrocarbon Field (Gas) HCS to the northeast of this area. This refers to a *production area for natural gas from naturally occurring reserves. Those reserves occur in organic-rich rocks such as oil shales or coal; hydrocarbons form when they are subjected to high pressure and temperature over extended periods. Mapping of these areas by HSC relates to the areas dominated by the production activity, not the full known area of the geological reserves.* (Aldred 2013c:55).

4.2.6.20 There are several areas of the Sand Banks with Sand Waves HCS falling into the 'Cultural topography' BCT. Within the same BCT, there is a small area of the Exposed Bedrock HCS. This HCS is characterised as *areas of the seafloor whose surface predominantly comprises bedrock exposures along with associated rocks and boulders but little finer sediment deposition. Variation in depth and surface irregularity of the bedrock exposures will correspond with the dangers they pose to shipping. Bedrock exposures are liable to snag fishing gear and may figure as 'rough' or 'catchy' areas in fishing ground perceptions. Their potential hazard to shipping may increase wreck debris to be found in this Sub-character Type* (Aldred 2013c: 28).

4.2.6.21 Close to the shore, falling under the Navigation BCT and Navigation type Hazard is an area of the Shoals and Flats HCS. This refers to *shallow areas of sandbanks, shoals, bars and spits as surveyed at the time the chart was produced. These areas are highly subject to change and they are generally exposed at low tide due to the mobility of sediments* Aldred 2013c: 111).

4.2.6.22 There are also areas of the Hydrocarbon Pipeline and Hydrocarbon Installation HCSs.

Sub-Sea Floor

4.2.6.23 The Array Area contains several Subsea Floor HCSs (see Figure 4.7). In the centre and north are Fine Sediment Plains (which do not lie within the same areas as those on the Sea Floor), with Coarse Sediment Plains in the east, centre and south. In addition there are two areas of Hydrocarbon Field (Gas) in the east, which are similarly located to those on the Sea Floor. There are also a number of areas of the Hydrocarbon Installation HCS.

4.2.6.24 Immediately southeast of the Hornsea Three array area, most of the Hornsea Three offshore cable corridor falls under the Coarse Sediment Plains HCS. The remainder of the Hornsea Three offshore cable corridor, including the offshore HVAC booster station search area, is dominated by the Coarse Sediment Plains and Fine Sediment Plains HCs. There are relatively large areas of the Hydrocarbon Field (gas) and Hydrocarbon Installation HCSs.

4.2.6.25 Some 5 km offshore is a large area of the Exposed Bedrock HCS. This does not lie in exactly the same area as that on the sea floor.

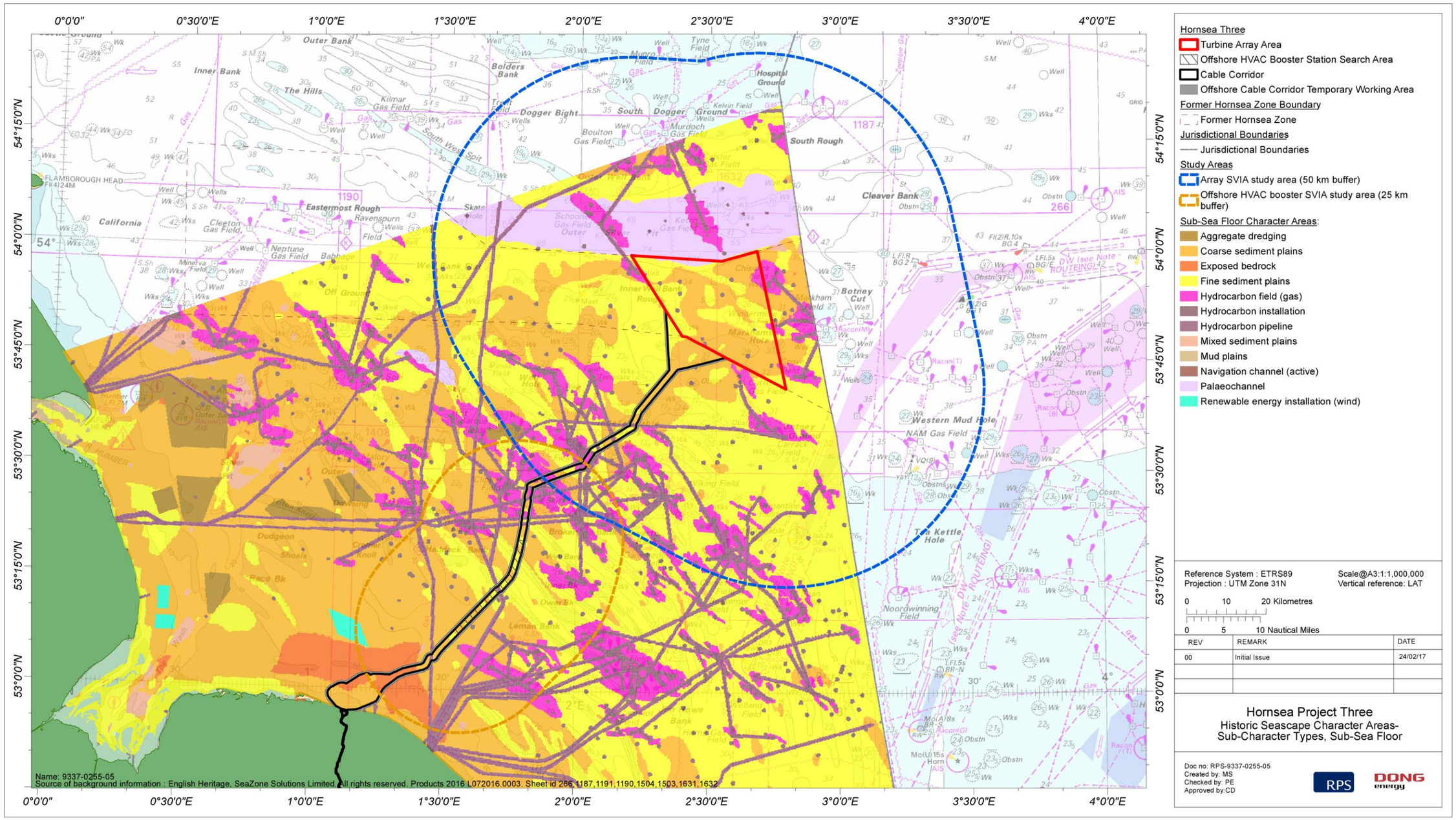

Figure 4.6: Historic Seascape Character SubTypes, Sea Floor, with Hornsea Three.

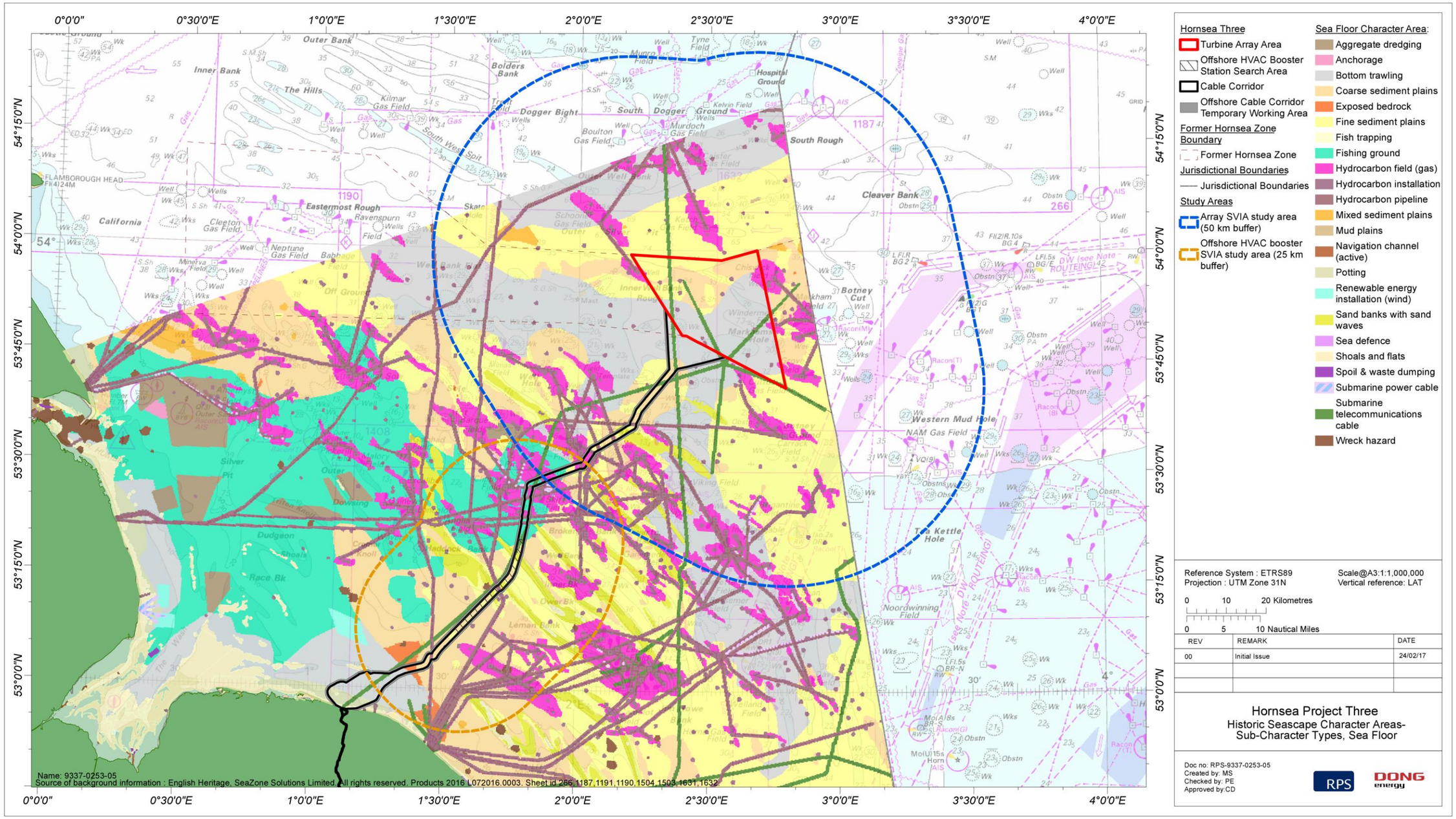

Figure 4.7: Historic Seascape Character SubTypes, Sub-Sea Floor, with Hornsea Three.

4.2.7 Factors Likely to Affect Visibility

4.2.7.1 The sea is often regarded as a flat surface, lacking in physical structures that could prevent distant views of remote objects. However, there are a variety of other factors that are likely to affect the ability to experience distant views at sea. These include the acuity of the human eye, the effects of curvature of the earth and refraction of light, as well as meteorological conditions.

4.2.8 Acuity of the Eye, the Effects of the Curvature of the Earth and Refraction of Light

4.2.8.1 There are limitations to the size of an object and its distance from the viewer that can be readily perceived by the human eye. These limitations are set out in the various seascape and wind farm guidance (onshore and offshore) used for this assessment.

4.2.8.2 The Guide to Best Practice in Seascape Assessment (GSA) (CCW *et al.*, 2001) discusses the limitations of the acuity of the human eye on an object similar to that of a turbine. The guidance states that "At a distance of 1 kilometre in conditions of good visibility a pole of 100 mm diameter will become difficult to see, and at 2 km a pole of 200 mm diameter will similarly be difficult to see. In other words there will be a point where an object whilst still theoretically visible will become too small for the human eye to resolve. Mist, haze or other atmospheric conditions may significantly exacerbate that difficulty."

4.2.8.3 In the DTI Guidance (2005), Section 7.5 discusses the limit of visual significance in relation to the curvature of the earth and wind turbine visibility. It notes that wind turbine blade tips may become theoretically visible to an observer on the beach at distances of between 45 and 53 km.

4.2.8.4 However the DTI Guidance (2005) notes that "in reality the acuity of the human eye to distinguish blade tips at this distance is highly debatable. It is more likely that as nacelles, tops of towers and full rotor blades of turbines become visible over the horizon at distances of around 30 to 35 km, that there is potential for significant effects on visual amenity to occur. This is considered to be the outer limit of potentially significant effects."

4.2.8.5 The Visual Representation of Wind farms: Good Practice Guidance (Technical Appendix F1 paragraphs F1, F2 and F5) (SNH, 2014) explains "OS co-ordinates are not fully 3-Dimensional. The northing and easting define a point on a plane corresponding to the transverse Mercator map projection and the altitude above OS datum is measured above an equipotential surface passing through the OS datum point at Newlyn. In reality, the earth is of course round, so a correction has to be made in order to position geographical features correctly in three dimensions for ZTV calculation and for visualisation" and "If it wasn't for the presence of the Earth's atmosphere, a simple allowance for curvature would be sufficient… In the practice, rays of light representing sightlines over long distances are also curved downwards as a result of refraction of light, allowing one to see slightly beyond the expected horizon."

4.2.9 The Influence of Weather

4.2.9.1 As highlighted in the extract from the GSA above, the length of available views may be limited by meteorological conditions.

4.2.9.2 Changing weather patterns and local climatic conditions will influence the visibility of Hornsea Three in terms of the extent of view, the colour and contrast of the wind turbines and the number of wind turbines visible and thus the perceived visual impact. There will be periods of low visibility (e.g. sea mist, fog, low cloud and warm conditions that are accompanied by the haze of temperature inversions) as well as periods of high visibility in clear weather.

4.2.9.3 Differing weather conditions would have an effect on how Hornsea Three may be seen. In some instances the turbines may be 'back-lit' (appearing darker in colour during sunset/sunrise and periods of pale or white blanket cloud) and 'up-lit' during stormy periods that combine dark clouds and bright sunshine.

4.2.9.4 Volume 2, chapter 7: Shipping and Navigation chapter refers to information given in the Admiralty Sailing Directions (2003). The chapter reports that *"Fog occasionally affects the east coast of the UK, particularly in the north. In open sea fog is relatively infrequent, with most sea fog occurring in the north during the summer and most often in the south during winter."*

4.2.9.5 Recorded visibility data for an area of the North Sea around Hornsea Three have been provided by the Met Office (refer to Appendix A). These data cover the period between January 2007 and December 2016.

4.2.9.6 It is noted that the method of recording offshore visibility data is less comprehensive than that used for onshore data. Further information relating to the methodology of data collection from The Marine Observer's Handbook (HMSO, 1995) is set out in Appendix B.

4.2.9.7 Onshore data are recorded from fixed positions at regular intervals, which give an extensive data set over a known period. The determination of the most distant object which is visible on any given occasion constitutes the observation of visibility.

4.2.9.8 Offshore data is recorded by passing vessels whose positions and time of recording vary across the area of study. These vessels estimate the extent of visibility by observing when other sea based objects (e.g. ships, gas platforms) become visible, compared to their known location from radar observations. The extent of available visibility is recorded against a range of distance bands (e.g. 1,001 m to 2,500 m).

4.2.9.9 The method of estimating the distance over which there is clear visibility is also less accurate than that used for onshore data, as there are fewer objects of known distance from the vessel to observe.

4.2.9.10 Observation data for the area around Hornsea Three is illustrated in Figure 4.8 and Figure 4.9 below.

4.2.9.11 The percentage of observations in each distance band per month is illustrated at Figure 4.8 below. The highest number of observations in each month across the study period was in the 1,001 to 2,500 m distance band.

4.2.9.12 The recorded visibility based from the Monthly Met Office data between January 2007 and December 2016 shows that particular months have varying levels of visibility at sea. The highest number of observations in each month across the study period was in the 1,001 to 2,500 m distance band. The cumulative percentage of visibility observations throughout the Met Office study period per distance band is shown in Figure 4.9. Visibility of up to 5,000 m was available for up to 95% of the study period. Visibility of up to 10,000 m dropped to 85% of the time. Visibility of up to 25,000 m was available for 68% of the study period. The results show that 33% of the readings taken in July had visibilities between 25,001 to 50,000 m. This was the highest percentage recorded at the greatest range of visibility. On average May, August and November had the best months of visibility between 10,001 and 25,00 m. May had the highest percentage in that range of visibility. The combined average percentages of all observed visibility ranges between 10,000 to 50,000 m shows that 81% of all readings in July were in this distance range, followed by August (80%), October (79%) and November (77%). December had the highest percentages of visibilities ranging from 5,001 to 10,000 m. February and August had the highest percentages of low visibility below 5,000 m ranging from 19 to 21%, making them the poorest months to observe visibility distance.

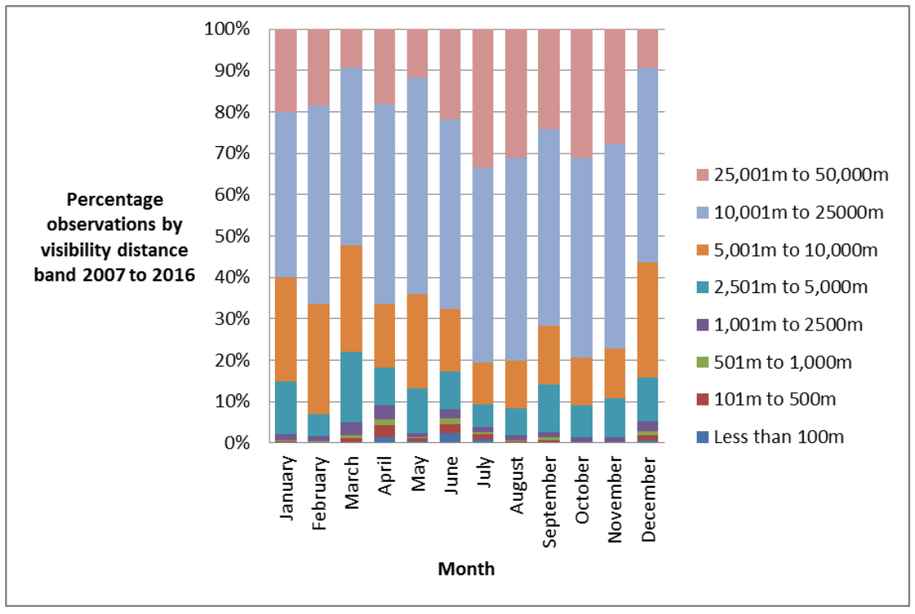

Figure 4.8: Monthly Met Office visibility data for the period 2007 to 2016.

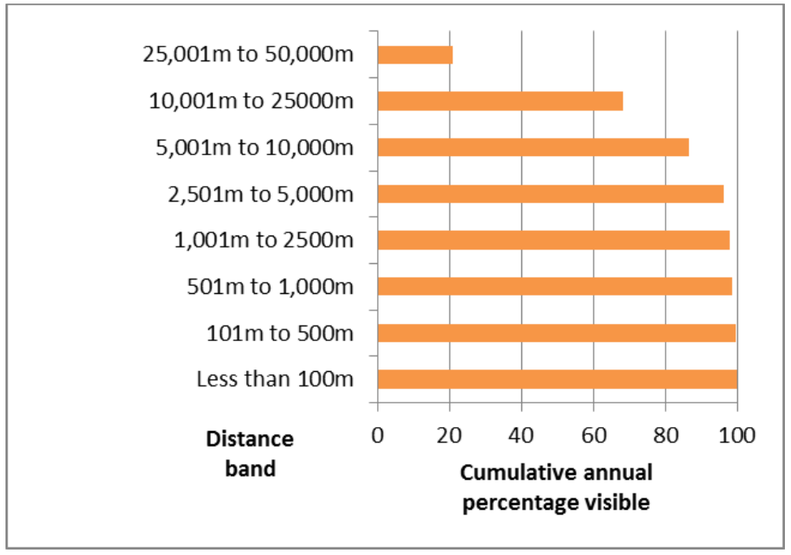

Figure 4.9: Cumulative percentage of visibility observations by distance band.

4.2.10 Potential for Views from Coastal Locations

4.2.10.1 Given that the wind turbines of Hornsea Three will be located approximately 120 km from the nearest location on the north Norfolk coast the effects of the curvature of the earth and refraction of light over the distances involved will prevent any views of Hornsea Three turbines from onshore locations.

4.2.10.2 Assuming a viewer eye level height of 1.5 m, the upper blade tips of 325 m above LAT (the maximum size proposed for Hornsea Three) would cease to be visible from shoreline locations beyond 91 km out to sea, as shown in Figure 4.10. The hub of the wind turbines at 193 m above LAT ceases to be visible at approximately 75 km from shore.

4.2.10.3 Computer generated ZTVs for both the upper blade tip height and hub height for Layouts A and B (see volume 1, chapter 3: Project Description) have been prepared for the assessment of visual effects (see volume 2, chapter 10: Seascape and Visual Resources). These take into consideration the effects of curvature of the earth and the refraction of light and confirm that the wind turbines would not be visible from coastal locations.

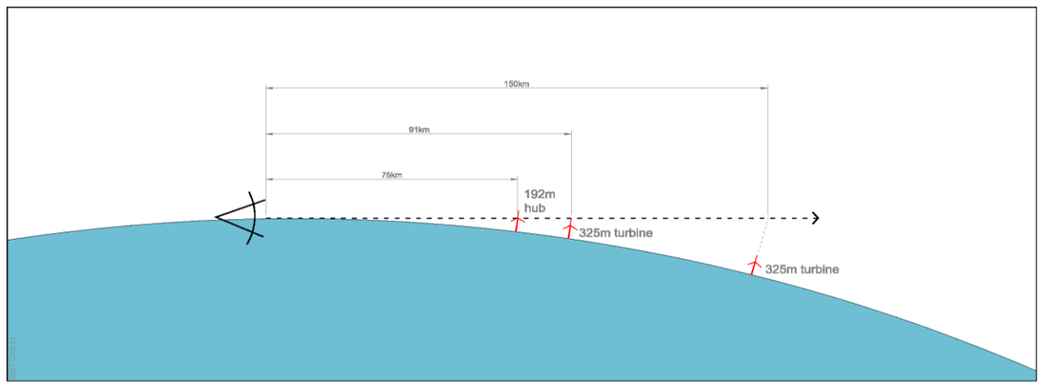

Figure 4.10: Illustration of the effects of curvature of the earth on visibility (not to scale).

4.2.10.4 The offshore HVAC booster stations would be located approximately 27 to 56 km from the shore of the north Norfolk coast. At this distance, the ZTVs have shown that there would be some views from low-lying coastal locations (see volume 2, chapter 10: Seascape and Visual resources, Figure 10.9).

4.2.10.5 Areas of higher land on the Norfolk coastline, largely within the Norfolk Coast Area of Outstanding Natural Beauty (AONB), would enable receptors to gain views of the offshore HVAC booster stations. Assuming a viewer eye level height of 1.5 m and an object 70 m high, areas of land would provide opportunities for views of the structure (see volume 2, chapter 10: Seascape and Visual Resources). These onshore viewpoint locations are therefore considered further in volume 3, chapter 4: Landscape and Visual Resources.

4.2.10.6 The potential for coastal views of the onshore elements associated with Hornsea Three including onshore and near shore views of the cable laying activities in the intertidal area during the construction phase are also considered in volume 3, chapter 4: Landscape and Visual Resources.

4.2.11 Principal Visual Receptors and Representative Viewpoints

4.2.11.1 Listed below are the types of visual receptor known to be present within the SVIA study areas:

- People following the cruising routes identified by the Royal Yachting Association (RYA);
- Passengers and workers on board commercial ferries or cruise liners;
- People at their place of work on passing cargo, tanker or other commercial vessels;
- People at their place of work on static gas platforms or travelling to the platforms;
- People at their place of work on commercial fishing vessels;
- People at their place of work on aggregate dredging vessels;
- Military personnel using identified Military Practice Areas; and
- Other marine users (for example, ecologists carrying out survey work).

4.2.11.2 With the exception of views from gas platforms, other available views would be typically dynamic, experienced from moving vessels or other craft. Many of the people who would experience these views would be in the SVIA study areas due to their work activities or are passing through the area to get to another destination. The RYA cruising routes, the cruise ferry routes and the locations of oil and gas platforms in relation to the ZTV of Layout B are illustrated on Figure 4.11 below.

4.2.11.3 At a coarse scale, most views from these locations are of the open sea with occasional glimpses of gas platforms or associated infrastructure and other vessels. As noted above, the extent of any available view may be limited by meteorological conditions.

People following the cruising routes identified by the RYA

4.2.11.4 The Version 2.0 of the RYA's UK Coastal Atlas of Recreational Boating - Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast (RYA, 2016) provides an update of the previous 2012 data. The new approach to data gathering is based on tangible passages and accurately portrays the behaviour of recreational vessels regardless of differing weather conditions, providing a robust picture of UK cruising activity. The new format uses a 'heat map' approach based on an Automatic Identification System (AIS). This identifies a light to heavy vessel activity within a limit of 12 nm. Route identification points are used to show the approximate expected direction of routes beyond 12 nm. These compliment the AIS data without losing information from the previous 2012 datasets further offshore. The data sets out details of the general boating areas, offshore routes, RYA affiliated training clubs, RYA affiliated training centres and marinas used by recreational craft around the UK coast. Section 5 of the RYA's UK Coastal Atlas of Recreational Boating - Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast identifies these uses in the North Norfolk, Greater Wash and Humber Area, including the majority of the SVIA study areas used in this assessment. General boating areas and racing areas associated with RYA affiliated training centres and marinas are confined to areas close to the coastline, and thus beyond the scope of this assessment.

4.2.11.5 Figure 4.11 illustrates the locations of offshore routes in relation to the SVIA study areas for this assessment. Two cruising routes, referred to as RYA North East Region Route and RYA North Eastern Region Route which are identified as attracting Medium Recreational Use, cross the south-west sector of the SVIA study areas. The RYA document defines Medium Recreational Use as "Popular routes on which some recreational craft will be seen at most times during summer daylight hours".

4.2.11.6 A representative viewpoint for assessment has been selected along the RYA North East Region Route which forms the closest of the two RYA cruising routes to the south-west of Hornsea Three. Its location is illustrated on Figure 4.11. An indicative view point height of 4.0 m above sea level (including eye height of viewer) has been used for the purposes of this SVIA.

Passengers and workers on board commercial ferries or cruise liners

4.2.11.7 Only commercial passenger ferries from Newcastle to Amsterdam are known to use the main routes through the Array SVIA study area. The routes used by the Hull to Zeebrugge and Rotterdam ferries pass through the HVAC booster station and cable route corridor study area. However, due to the relatively small scale of the HVAC booster stations, effects on views from the ferries have not been considered further in this annex as any change in view at night when the ferries sail, is unlikely to be significant.

4.2.11.8 Volume 2, chapter 7: Shipping and Navigation chapter sets out the main traffic routes in the vicinity of Hornsea Three and sets out a description of the principal users of each route and the average number of ships per day using each route.

4.2.11.9 Of the main shipping routes identified within the SVIA study areas, all except the Newcastle to Amsterdam ferry route are used by a combination of tankers and/or cargo vessels for the majority of the time. The Newcastle to Amsterdam ferry route is principally used on a one journey per day basis, throughout the year by the DFDS Seaways ferry from Newcastle to Amsterdam. The main vessels to operate on this route are the large commodore class 'cruise ferries' the King Seaways and the Queen Seaways. The average number of vessels using this route each day is two.

4.2.11.10 The King Seaways has 13 decks and accommodates over 1,500 passengers and 600 cars. The main external observation deck is Deck 10 and is estimated to be approximately 25 m above the water line. The ferry has a cruising speed of 21 knots. It departs Newcastle daily at 17:00 and the return journey arrives back at Newcastle at 09:00. The Sunday service arrives back to Newcastle at 09:30.

4.2.11.11 Based on their published departure times, their typical cruising speed and the distance from the array SVIA study area, the shortest time taken for the ferries to reach and pass through the array SVIA study area can be estimated.

4.2.11.12 The cruise ferry from Newcastle is calculated to reach the edge of the 50 km radius array study area approximately 6 hours after departure. It then takes approximately 3 hours to traverse the array SVIA study area, reaching its southern edge 12 hours after leaving Newcastle. Note: these figures are calculated using average cruising speeds and do not take into account time to manoeuvre within the port or the time taken to reach cruising speed. As such they represent the shortest travel times from leaving the port. The actual time to travel from port to the edge of the array SVIA study area is therefore likely to be longer than these figures which are calculated on average cruising speeds only.

4.2.11.13 Given the 17:00 scheduled daily departure time of the ferry from Newcastle, this indicates that the cruise ferry would pass through the 50 km radius array SVIA study area around Hornsea Three during the hours of darkness for the majority of the year i.e. arriving at the northern edge of the array SVIA study area at 23.00 and leaving the southern edge at 02.00.

4.2.11.14 On the return journey leaving Amsterdam at 17:30, the cruise ferry arrives at the southern edge of the 50 km radius study area 3 hours and 30 minutes after departure and leaves at the northern edge of the array SVIA study area a further 3 hours later. Again, for the majority of the year, the cruise ferry will pass through the array SVIA study area during the hours of darkness i.e. arriving at the southern edge of the SVIA study area at 20:30 and leaving the northern edge at 23:30.

4.2.11.15 Three representative locations along the Newcastle to Amsterdam cruise ferry route have been selected for use in this assessment. Their locations (Viewpoints 1, 2 and 3) are illustrated on Figure 4.11. The existing ferry route cuts through the south-west corner of Hornsea Project Two, so a proposed deviated route has been used in this assessment.

4.2.11.16 The first viewpoint is from a location along the diverted route and relates to the view from the west of the array near the outer limits of the 50 km radius study zone for Hornsea Three. The second view is from approximately midway along the ferry route within the array SVIA study area. The third view is from the out limits of the 50 km radius study zone to the south of the array. An indicative view point height of 26.5 m above sea level (including eye height of viewer) has been used for the purposes of this SVIA.

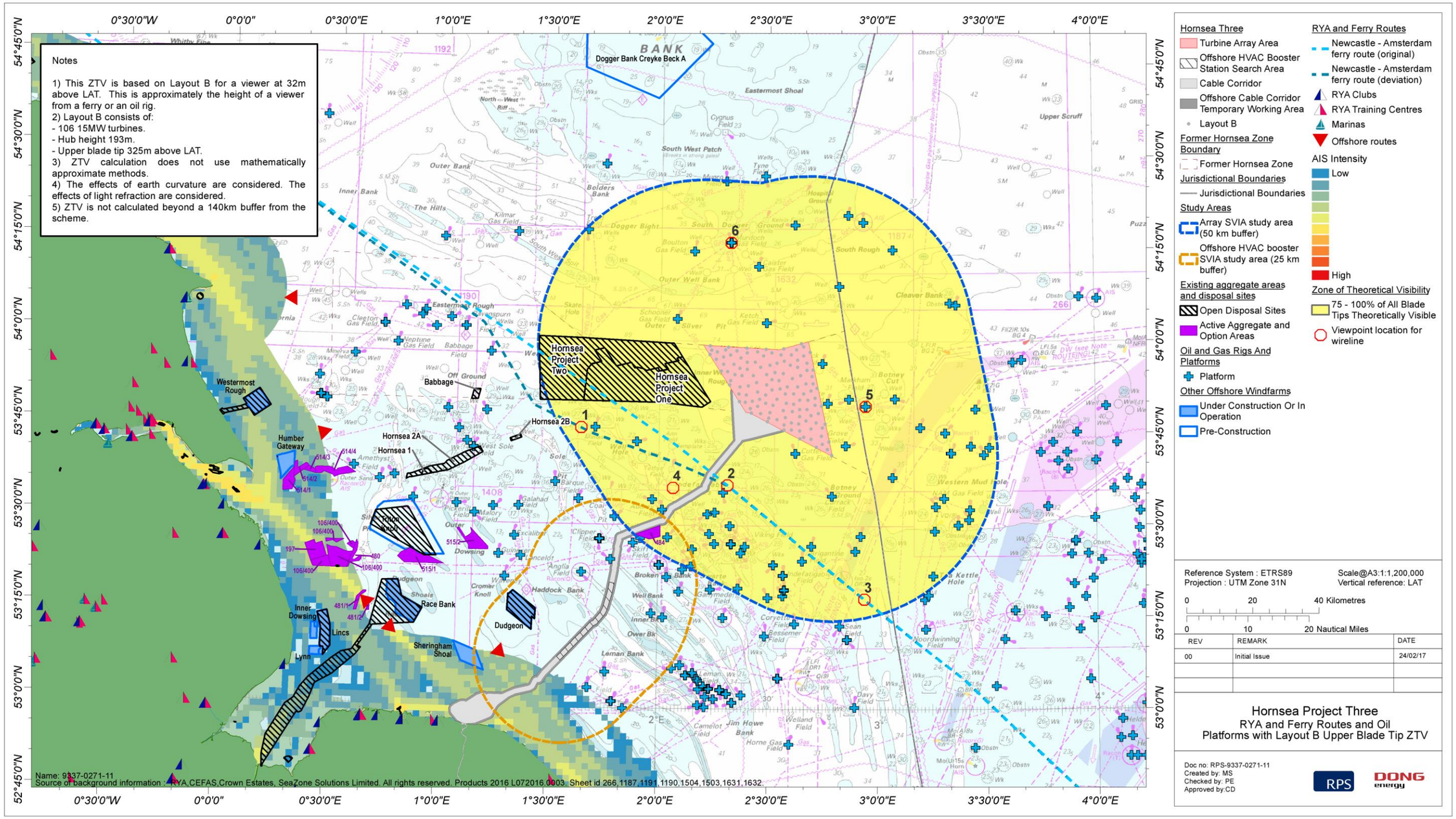

Figure 4.11: RYA and ferry routes and oil platforms with Layout B upper blade tip ZTV.

People at their place of work on passing cargo, tanker or other commercial vessels

4.2.11.17 As noted above, with the exception of the cruise ferry route, all of the main shipping routes identified within the study areas are used by a combination of tankers and/or cargo vessels for the majority of the time.

4.2.11.18 Volume 2, chapter 7: Shipping and Navigation chapter sets out the main traffic routes in the vicinity of Hornsea Three and details the average number of ships per day using each route.

People at their place of work on static oil and gas platforms or travelling to the platforms

4.2.11.19 Figure 4.11 illustrates the location of the 81 static gas platforms which lie within the SVIA study areas. 54 platforms lie within the 50 km radius study area for the Hornsea Three array area, 14 of which are manned. 30 platforms lie within the 25 km radius HVAC booster station study area, of which 10 are manned. Three platforms lie within an area of sea which coincides with both SVIA study areas.

4.2.11.20 The manned platforms within the 50 km radius study area include J6A to the east in Netherlands' waters; Murdoch Accommodation and Compression to the north; Viking Alpha Riser, Viking Bravo Drilling, Accommodation, Compression and Production and INDE AC, AP, AQ, AT, CD and CP to the south.

4.2.11.21 The manned platforms within the 25 km radius study area include Clipper PM, PC, PW, PT and South, Loggs Compression, Production, Riser and Accommodation and North Valiant One lie within the northern part of the study area.

4.2.11.22 Travel to and between the oil platforms may be by support helicopter or by vessel.

4.2.11.23 Two gas platforms (J6A in Netherland's waters and Murdoch) have been selected to provide representative viewpoint locations for the SVIA. The height of platforms above LAT varies between them. Indicative view point heights (height above LAT including eye height of viewer) based on a location on the main deck have been used for the purposes of this SVIA.

4.2.11.24 It is noted that people working on oil platforms are based there for several weeks at a time, rotating periods at home (onshore) with periods at work (offshore). However, despite the extended periods that people are based on the oil platforms, the platform is considered to remain primarily a place of work.

People at their place of work on commercial fishing vessels

4.2.11.25 Various forms of commercial fishing take place within the SVIA study areas, see volume 2, chapter 6: Commercial Fisheries. Commercial fishing activity in the vicinity of Hornsea Three is dominated by Dutch and UK beam trawlers targeting plaice and sole, amongst other species. Danish industrial trawlers also target sand eels and sprat. Catches are typically landed at ports along the north-east coast of England, as well as destinations in Holland and Denmark.

People at their place of work on aggregate dredging vessels

4.2.11.26 Volume 2, chapter 11: Infrastructure and Other Users, provides details of aggregate dredging activities in the area around Hornsea Three. No dredging activities occur within the zone itself. Aggregate dredging activity within the 50 km array SVIA study area is concentrated to the south-west of Hornsea Three.

Military personnel using identified Military Practice Areas

4.2.11.27 The MOD uses all uncontrolled UK airspace and waters for Air Force, Navy and Army training.

4.2.11.28 Part of the former Hornsea Zone falls within two Practice and Exercise Areas (PEXAs) which can be used by the Army, Air Force or Navy for firing practice and exercises. In addition, a submarine exercise area is located within the Outer Silver Pit (refer to volume 2, chapter 8: Aviation, Military and Communications). Typical activities in these areas include live firing and bombing, air combat and training exercises, small arms firing and, surface and subsurface submarine exercises.

Other marine users

4.2.11.29 Other marine users may include people monitoring or observing marine species/habitats for ecological purposes, particularly in relation to the candidate Special Areas of Conservation (cSACs) at Dogger Bank and North Norfolk Sandbanks and Saturn Reef.

4.2.11.30 Volume 2, chapter 11: Infrastructure and Other Users notes that it is highly unlikely that recreational anglers would be present within Hornsea Three, as it is outside of the range of recreational fishing fleets. Transit times and fuel costs to get to locations further from the shore make them less desirable for recreational fishing.

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Appendix A – Visibility Data Provided by the Met Office

A.1.1.1 Visibility analysis with cumulative frequency and percentages

A.1.1.2 Location: 54.5N to 53.5N, 002.1 to 002.9E

A.1.1.3 Period of Data: January 2007 to December 2016

Frequency													
Visibility (decametres)	**Months**												
	January	***February***	***March***	***April***	***May***	***June***	***July***	***August***	***September***	***October***	***November***	***December***	***Annual***
0	0	0	0	2	0	8	0	0	0	0	0	0	10
1 to 50	7	4	37	123	34	97	53	7	17	1	6	56	442
51 to 100	3	8	20	47	5	30	10	7	13	6	2	29	180
101 to 250	26	25	99	97	31	51	28	33	29	35	39	77	570
251 to 500	234	132	532	274	316	211	139	156	266	249	291	327	3,127
501 to 1,000	456	659	808	454	663	353	251	287	330	366	386	876	5,889
1,001 to 2,500	723	1,182	1,344	1,436	1,524	1,061	1,173	1,205	1,103	1,534	1,571	1,462	15,318
2,501 to 5,000	368	452	289	544	345	503	836	764	560	993	880	295	6,829
Total	1,817	2,462	3,129	2,977	2,918	2,314	2,490	2,459	2,318	3,184	3,175	3,122	32,365

Cumulative frequency													
Visibility (decametres)	*Months*												
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Annual*
0 or more	1,817	2,462	3,129	2,977	2,918	2,314	2,490	2,459	2,318	3,184	3,175	3,122	32,365
1 or more	1,817	2,462	3,129	2,975	2,918	2,306	2,490	2,459	2,318	3,184	3,175	3,122	32,355
51 or more	1,810	2,458	3,092	2,852	2,884	2,209	2,437	2,452	2,301	3,183	3,169	3,066	31,913
101 or more	1,807	2,450	3,072	2,805	2,879	2,179	2,427	2,445	2,288	3,177	3,167	3,037	31,733
251 or more	1,781	2,425	2,973	2,708	2,848	2,128	2,399	2,412	2,259	3,142	3,128	2,960	31,163
501 or more	1,547	2,293	2,441	2,434	2,531	1,917	2,260	2,256	1,993	2,893	2,837	2,633	28,036
1,001 or more	1,091	1,634	1,633	1,980	1,869	1,564	2,009	1,969	1,663	2,572	2,451	1,757	22,147
2,501 or more	368	452	289	544	345	503	836	764	560	993	880	295	6,829

Cumulative percentages													
Visibility (decametres)	*Months*												
	January	*February*	*March*	*April*	*May*	*June*	*July*	*August*	*September*	*October*	*November*	*December*	*Annual*
0 or more	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1 or more	100.0	100.0	100.0	99.9	100.0	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0
51 or more	99.6	99.8	98.8	95.8	98.8	95.5	97.9	99.7	99.3	100.0	99.8	98.2	98.6
101 or more	99.4	99.5	98.2	94.2	98.7	94.2	97.5	99.4	98.7	99.8	99.7	97.3	98.0
251 or more	98.0	98.5	95.0	91.0	97.6	92.0	96.3	98.1	97.5	98.7	98.5	94.8	96.3
501 or more	85.1	93.1	78.0	81.8	86.8	82.8	90.8	91.7	86.0	90.9	89.4	84.3	86.6
1,001 or more	60.0	66.4	52.2	66.5	64.1	67.6	80.7	80.1	71.7	79.4	77.2	56.3	68.4
2,501 or more	20.3	18.4	9.2	18.3	11.8	21.7	33.6	31.1	24.2	31.2	27.7	9.4	21.1

Appendix B Criteria for the Assessment of Significance

B.1 Extract from Marine Observers Handbook

B.1.1.1 Visibility (extracts from Marine Observer's Handbook_HMSO_1995).

B.1.1.2 On land the determination of the most distant object which is visible on any given occasion constitutes the observation of visibility.

B.1.1.3 At sea such a detailed determination of visibility is not usually possible, but in making estimates, a coarse scale is used, see Figure B.1.

Figure B.1

Code	Visibility (metres)
90	<50
91	50
92	200
93	500
94	1,000
95	2,000
96	4,000
97	1,000
98	2,000
99	50

B.1.1.4 If the distance of visibility is between the distances given in the table, the code figure for the shorter distance is reported. In a long vessel, the determination of the lowest number offers no such difficulty as objects at known distances may be used. Visibility numbers in the middle of the range indicate conditions of obscurity such that visibility is greater than the length of the ship but it is not sufficient to allow full speed to be maintained. In the open sea, when other ships are sighted, visibility may be estimated by noting the radar range when the vessel is first sighted visually and again when it disappears from view. It is customary to use the horizon to estimate visibility numbers in the higher range although they cannot be relied upon.

Appendix C Photography and Visualisation Methodology

C.1 Methodology for the Production of Computer Models (Visualisation)

C.1.1.1 Wirelines of the proposed development are generated using ReSoft WindFarm:

- Base mapping and height data of the relevant area are set up to real-world co-ordinates;
- The proposed development is located according to the scheme design;
- Turbines are modelled to the correct hub and blade diameter specifications;
- The viewpoints are set up at the chosen locations and heights using sourced data;
- Surrounding existing structures such as other wind farms and oil platforms are also modelled for context;
- For cumulative wirelines surrounding wind farms within the planning process are also modelled;
- Curvature of the earth is calculated using standard settings within the software; and
- Cylindrical projection wireline views are generated at the desired field of view.

C.2 Presentation

C.2.1.1 Wirelines are used as a series of figures in this Environmental Statement. The general format of this document is A3 landscape.

- Each viewpoint is presented on an A3 sheet showing the proposed view with distance to the proposed scheme. The A3 format allows for a 75° field of view, which should be viewed at approximately 300 mm from the image. If the print is curved around the viewer to give a constant 300 mm viewing distance it produces an accurate reproduction of how the viewer would perceive things on site;
- Where the scheme covers more than a 75° field of view a 180° field of view has been included;
- Cumulative wirelines show a sequence of four 90° fields of view to give a full 360° coverage for context; and
- Views are annotated to aid interpretation.

Appendix D Zone of Theoretical Visibility Methodology

D.1 Method for Calculating a Zone of Theoretical Visibility (ZTV)

D.1.1.1 ZTV calculation is performed in ArcGIS 10.1 using the Viewshed Analysis tool (part of the 3d Analyst extension). A ZTV is a line of site indication between an object (e.g. wind turbine) and an observer location over a digital terrain model (DTM). If the object is visible a value of one is returned, otherwise the value is zero. If there is more than one object, the results are added together to give an indication of how many objects are visible from that single observer location.

D.1.1.2 The ZTVs will be calculated with raster height data (the DTM) interpolated to a 50 m grid. That is to say the land form is split into individual cells (pixels/squares) of 50 by 50 m. Each cell has a single height value representing the average height for the whole cell. When making the calculation the following variables are used:

- Offset A = the height of the object; and
- Offset B = the height of the observer. Assumed to be the eye level of a standing adult and set at 1.5 m. Where the viewer is expected to be on an oil rig or ferry the observer height is increased by a further 30 to 31.5 m.

D.2 Zone of Theoretical Visibility Methodology

D.2.1.1 Panorama height data is measured relative to the Newlyn Datum. Where heights are defined relative to another vertical datum, the resulting offset was transformed to the Newlyn Datum. The assumptions and parameters used are shown as notes on the ZTV figures.

D.2.1.2 Panorama height data is supplied in the British National Grid (BNG) coordinate system. As this is not suitable for use offshore the DTM was transformed to UTM 31N using the ESRI petroleum transformation.

D.2.1.3 Where an object is expected to have visibility from both land and sea based receptors a ZTV was produced for both 1.5 and 31.5 m offsets. The ZTV's where then merged into a single output showing 31.5 m viewer offshore, and 1.5 m viewer onshore.

D.2.1.4 The curvature of the earth is also incorporated.

D.2.1.5 It should be noted the accuracy of this methodology is entirely dependent on the accuracy and resolution of the underlying DTM. This provides height data at 50 m point intervals to an accuracy that is one half the vertical interval of the source data (OS Landranger 1:50,000 contour 10 m contour lines), typically ±5 m RMSE. The process of transformation ton UTM31N may have increased the error further.

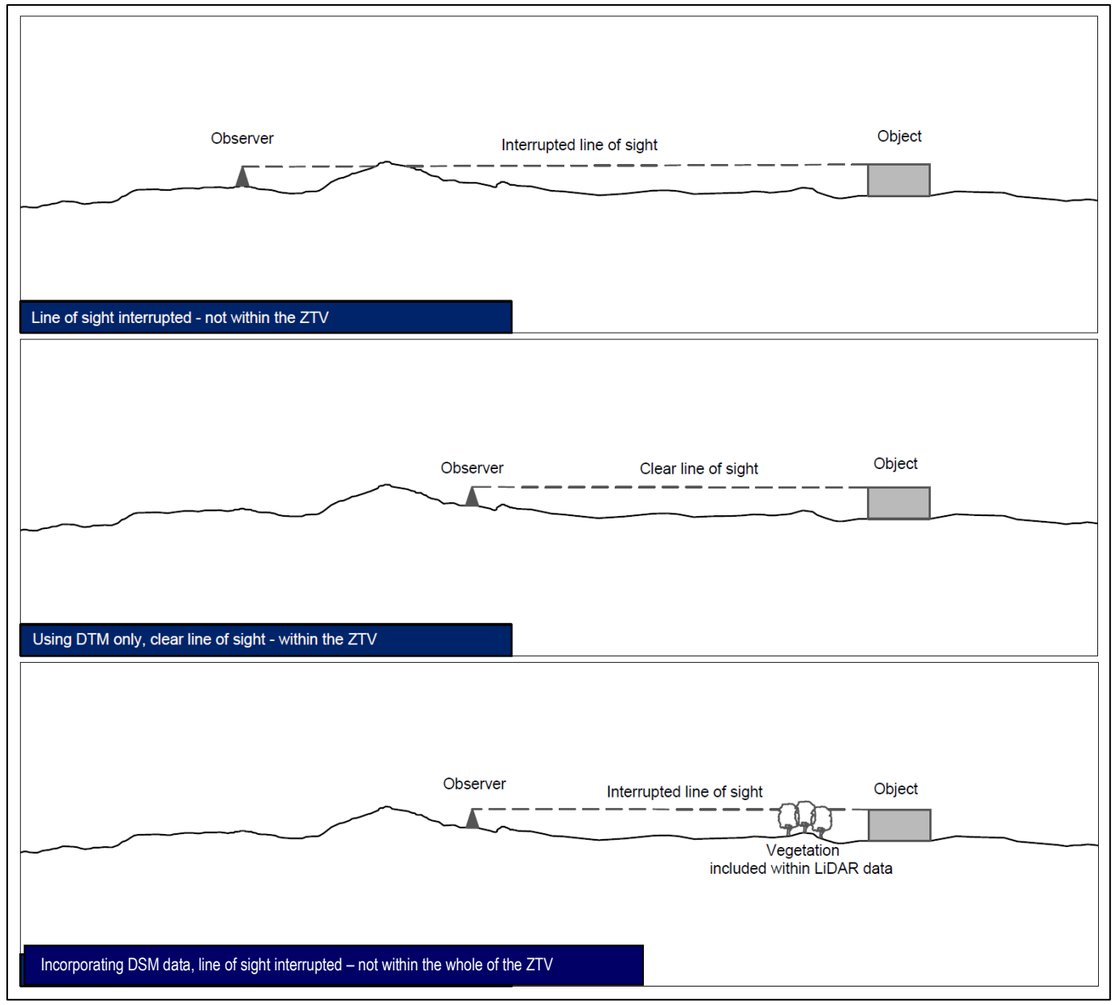

Figure D.1 Zone of Theoretical Visibility – Methodology and Assumptions.

D.2.1.6 A further caveat is the nature of a DTM, which only includes topography. Those landscape features such as infrastructure further are not included. Therefore the ZTV will tend to provide a worst-case scenario as if there were no built features or other obstructions within the landscape to act as visual barriers above the existing relief.