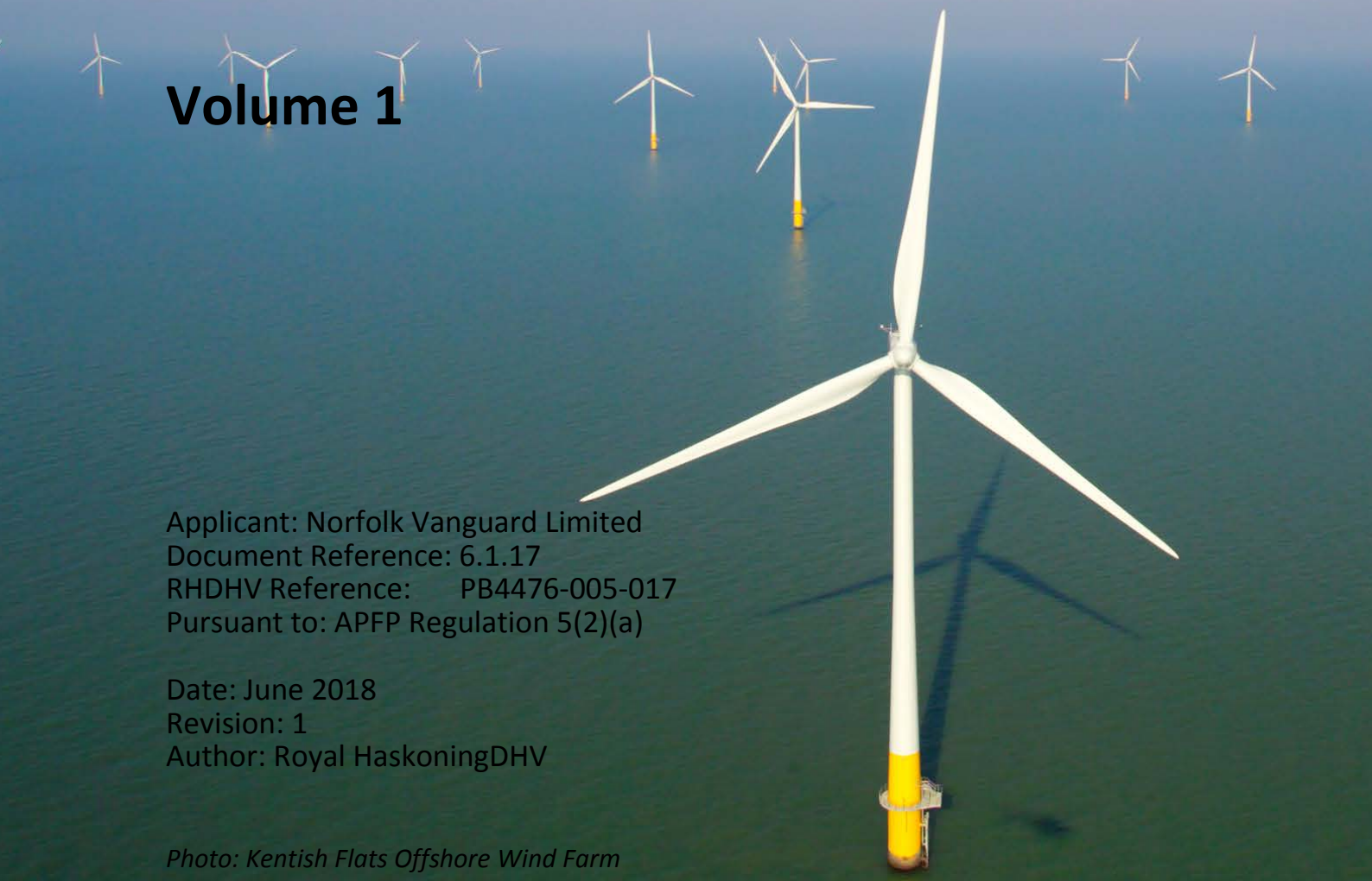
Norfolk Vanguard Offshore Wind Farm

Chapter 17

Offshore and Intertidal Archaeology and Cultural Heritage

Environmental Statement

Volume 1



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Environmental Impact Assessment
Environmental Statement

Document Reference: PB4476-005-017

June 2018

For and on behalf of Norfolk Vanguard Limited

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Date: 8th June 2018

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Glossary

AEZ	Archaeological Exclusion Zones
AHOB	Ancient Human Occupation of Britain
DCO	Development Consent Order
DEFRA	Department for Environment, Food and Rural Affairs
DML	Deemed Marine Licence
EMU	EMU Limited (geophysical survey contractor)
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
Fugro	Fugro Survey B. V. (geophysical and geotechnical survey contractor)
HDD	Horizontal Directional Drilling
HSC	Historic Seascape Characterisation
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMO	Marine Management Organisation
NHER	Norfolk Historic Environment Record
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NRHE	National Record of the Historic Environment
NSIPs	Nationally Significant Infrastructure Project
nT	nanoTesla
OWF	Offshore Wind Farm
PAB	Pathways to Ancient Britain
PEIR	Preliminary Environmental Information Report
ROV	Remote Operated Vehicle
UKHO	United Kingdom Hydrographic Office
WSI	Written Scheme of Investigation

Terminology

Array cables	Cables which link the wind turbine generators and the offshore electrical platform.
Interconnector cables	Buried offshore cables which link the offshore electrical platforms
Landfall	Where the offshore cables come ashore at Happisburgh South
Offshore accommodation platform	A fixed structure (if required) providing accommodation for offshore personnel. An accommodation vessel may be used instead
Offshore cable corridor	The corridor of seabed from the Norfolk Vanguard OWF sites to the landfall site within which the offshore export cables would be located.
Offshore electrical platform	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which bring electricity from the offshore electrical platform to the landfall.

Offshore project area	The overall area of Norfolk Vanguard East, Norfolk Vanguard West and the offshore cable corridor
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
The Applicant	Norfolk Vanguard Limited
The OWF sites	The two distinct offshore wind farm areas, Norfolk Vanguard East and Norfolk Vanguard West

17 OFFSHORE AND INTERTIDAL ARCHAEOLOGY AND CULTURAL HERITAGE

17.1 Introduction

1. This chapter of the Environmental Statement (ES) sets out existing baseline conditions for offshore and intertidal archaeology and cultural heritage within the Norfolk Vanguard OWF sites, the offshore cable corridor and at the landfall below Mean High Water Springs (MHWS). This chapter also assesses the potential impacts to offshore and intertidal archaeological receptors from the proposed project, and details the embedded mitigation which will be applied for the project.

2. The approach to assessment taken in this chapter takes account of industry standards and guidance (see section 17.2) with specific reference to the National Planning Policy Framework (NPPF), the Marine Policy Statement and to the relevant National Policy Statements (NPS):

   - Overarching NPS for Energy (EN-1) (July 2011); and
   - NPS for Renewable Energy Infrastructure (EN-3) (July 2011).

3. The methodology has also been informed by consultation with Historic England and Norfolk County Council's Historic Environment Service (see section 17.2).

4. A summary of the known and potential offshore and intertidal archaeological resource within the boundary of the project is presented in section 17.6 with respect to:

   - Seabed prehistory (i.e. archaeological remains on the seabed corresponding to the activities of prehistoric populations that may have inhabited what is now the seabed when sea levels were lower);
   - Maritime archaeology (i.e. the remains of boats and ships and archaeological material associated with prehistoric and historic maritime activities);
   - Aviation archaeology (i.e. the remains of crashed aircraft and archaeological material associated with historic aviation activities);
   - Historic seascape character (i.e. the attributes that contribute to the formation of the historic character of the seascape); and
   - Buried archaeology (including palaeoenvironmental deposits) within the intertidal zone below MHWS.

5. Baseline conditions have been established through a desk-based assessment and a review of geophysical and geotechnical data undertaken by Wessex Archaeology. The technical report authored by Wessex Archaeology, which presents the full results of this work, is provided in Appendix 17.1. Further technical reports detailing the results of subsequent geoarchaeological assessment of the geotechnical data, also undertaken for the project by Wessex Archaeology, are presented in Appendix 17.2, Appendix 17.2 and Appendix 17.4.

6. The approach to impact assessment adopted for this chapter (as detailed in section 17.4) differs slightly from the standard Environmental Impact Assessment (EIA) approach adopted more generally for other technical disciplines. While the standardised and tailored EIA matrices provide a useful framework for the identification and appropriate responses to identified impacts, when analysing impacts upon heritage assets and their settings, the outcomes of the matrix-based approach must also be qualified through expert judgement and additional descriptive comment. The results of the impact assessment are presented in sections 17.7.6 to 17.7.8.

17.2 Legislation, Guidance and Policy

7. A detailed summary of the legislation, policy and guidance applicable to the assessment of offshore and intertidal archaeology is presented in section 2 of Appendix 17.1.

8. In demonstrating adherence to industry good practice, this chapter has been compiled with respect to available archaeological guidance for offshore development including:

- The Setting of Heritage Assets: Historic Environment Good Practice Advice in Planning Note 3 (Second Edition) (Historic England, 2017);
- Chartered Institute for Archaeologists' Standard and Guidance for Historic Environment Desk-Based Assessments (2014a) and Code of Conduct (2014b);
- Marine Geophysical Data Acquisition, Processing and Interpretation – guidance notes. (Historic England, 2013);
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector (Gribble and Leather, 2011);
- Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy (Oxford Archaeology, 2008);
- Historic Environment Guidance for the Offshore Renewable Energy Sector. Guidance (Wessex Archaeology, 2007); and
- Code for Practice for Seabed Development (Joint Nautical Archaeology Policy Committee (JNAPC), 2006).

9. In the absence of an industry standard methodology for heritage impact assessment within the framework of EIA, the assessment methodology adopted takes account of overarching principles presented in policy and guidance:

- NPPF (Department for Communities and Local Government, 2012);
- Marine Policy Statement (HM Government, 2011);
- Overarching NPS for Energy (EN-1) and NPS for Renewable Energy Infrastructure (EN-3) (DEFRA, 2011); and

- Conservation Principles: Policy and Guidance for Sustainable Management of the Historic Environment (Historic England, 2008).

10. The NPSs are the principal decision-making documents for Nationally Significant Infrastructure Projects (NSIPs). Table 17.1 sets out how specific policies relevant to the historic environment are addressed within this chapter.

Table 17.1 NPS Guidance for the Historic Environment

NPS Requirement	NPS Reference	ES Reference
EN-1 Overarching NPS for Energy		
"As part of the ES the applicant should provide a description of the significance of the heritage assets affected by the proposed development and the contribution of their setting to that significance. The level of detail should be proportionate to the importance of the heritage assets and no more than is sufficient to understand the potential impact of the proposal on the significance of the heritage asset."	Paragraph 5.8.8	The significance and value of the archaeological receptors considered in this chapter of the ES have been detailed in Appendix 17.1 and summarised in section 17.7.5. The contribution of setting to significance is addressed in section 17.6.4. Issues relating to the setting of onshore heritage assets have been considered as part of Chapter 28 Onshore Archaeological and Cultural Heritage.
"Where a development site includes, or the available evidence suggests it has the potential to include, heritage assets with an archaeological interest, the applicant should carry out appropriate desk-based assessment and, where such desk-based research is insufficient to properly assess the interest, a field evaluation. Where proposed development will affect the setting of a heritage asset, representative visualisations may be necessary to explain the impact."	Paragraph 5.8.9	This chapter of the ES has been informed by a desk-based assessment (see Appendix 17.1) which identified the presence of archaeological receptors within the offshore study area.
"The applicant should ensure that the extent of the impact of the proposed development on the significance of any heritage assets affected can be adequately understood from the application and supporting documents."	Paragraph 5.8.10	This chapter of the ES provides an account of the potential impacts of Norfolk Vanguard upon heritage assets and their significance (section 17.7).
EN-3 NPS for Renewable Energy Infrastructure		
"Consultation with the relevant statutory consultees (including English Heritage or Cadw) should be undertaken by the applicants at an early stage of the development."	Paragraph 2.6.140	Consultation has been undertaken with relevant statutory consultees, as outlined in section 17.4. Consultation will be on going throughout the development process.
"Assessment should be undertaken as set out in section 5.8 of EN-1. Desk-based studies should take into account any geotechnical or geophysical surveys that	Paragraph 2.6.141	The assessment has been undertaken in accordance with section 5.8 of EN-1, as detailed above. Geophysical and geotechnical studies have underpinned the

NPS Requirement	NPS Reference	ES Reference
have been undertaken to aid the windfarm design."		assessment (section 17.7 and Appendix 17.1).
"The assessment should also include the identification of any beneficial effects on the historic marine environment, for example through improved access or the contribution to new knowledge that arises from investigation."	Paragraph 2.6.142	Any beneficial effects to the offshore archaeology and cultural heritage resource resulting from the proposed Norfolk Vanguard project have been identified and incorporated as part of section 17.7.
"Where elements of an application (whether offshore or onshore) interact with features of historic maritime significance that are located onshore, the effects should be assessed in accordance with the policy at section 5.8 of EN-1."	Paragraph 2.6.143	Potential impacts of the proposed Norfolk Vanguard project upon onshore heritage assets have been considered in Chapter 28 Onshore Archaeology and Cultural Heritage.

11. This assessment has also been prepared in accordance with the East Inshore and East Offshore Marine Plans (DEFRA 2014), which outlines the objective 'to conserve heritage assets, nationally protected landscapes and ensure the decisions consider the seascape of the local area'. This objective recognises the need to consider whether developments are appropriate to the area they will be located in and have an influence upon, and seeks to ensure that, as far as possible, the value of such assets and characteristics are not compromised. Policies specific to heritage assets are outlined in Table 17.2.

Table 17.2 Summary of East Inshore and East Offshore Marine Plans

Plan policies specific to heritage assets	Norfolk Vanguard Assessment
Policy SOC2: Proposals that may affect heritage assets should demonstrate, in order of preference: That they will not compromise or harm elements which contribute to the significance of the heritage asset How, if there is compromise or harm to a heritage asset, this will be minimised How, where compromise or harm to a heritage asset cannot be minimised it will be mitigated against or The public benefits for proceeding with the proposal if it is not possible to minimise or mitigate compromise or harm to the heritage asset	The primary method of mitigation when dealing with the archaeological resource as set out in this chapter is the precautionary principle, based on the prevention of damage to receptors by putting in place protective measures rather than attempting to repair damage. Avoidance by means of Archaeological Exclusion Zones (AEZ) will serve to ensure that such assets will not be compromised. Potential archaeological receptors are safeguarded or the effects upon them minimised by means of mitigation measures outlined in section 17.7.2.

17.3 Consultation

12. Consultation is a key part of the Development Consent Order (DCO) application process. Consultation to inform the Preliminary Environmental Information Report (PEIR) regarding offshore archaeology and cultural heritage was conducted through

Expert Topic Group (ETG) meetings held throughout 2017 and the Scoping Report (Royal HaskoningDHV, 2016). Further consultation to address Section 42 comments received on the PEIR and to inform the ES has been conducted comprising an Evidence Plan Process (EPP) ETG meeting held in March 2018. Full details of the project consultation process are presented within Chapter 7 Technical Consultation. Meeting minutes of the ETG meetings are provided in Appendix 9.23 and 25.4 of the Norfolk Vanguard Consultation Report (document reference 5.1).

13. Table 17.3 presents consultee responses (within the Planning Inspectorate (2016) Scoping Opinion) to the Norfolk Vanguard Scoping Report, (Royal HaskoningDHV, 2016), the Offshore Archaeology Method Statement and subsequent ETG meetings (1st February and 6th July 2017). The table also outlines the main items discussed and actions from a separate meeting held with the Ancient Human Occupation of Britain (AHOB) and Pathways to Ancient Britain (PAB) in respect to the landfall at Happisburgh South. The table also details the Historic England response to the PEIR chapter and notes how specific comments have been addressed by the project, and summarises the key issues discussed at the March 2018 ETG meeting held to inform this ES chapter.

14. Feedback received during the consultation process to date has been incorporated into the ES wherever possible.

15. Consultation responses and discussion points are paraphrased as necessary and not produced verbatim.

Table 17.3 Consultation Responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	The ES should set out the procedures that would be put in place for unknown assets discovered during pre-construction or construction activity. Such procedures should be agreed with Historic England and the Marine Management Organisation (MMO) and secured, for example through a Written Scheme of Investigation (WSI). The Secretary of State recommends that a draft WSI is provided with the DCO application and draws the Applicant's attention to the comments from Historic England in this regard.	A formal protocol for archaeological discoveries will be established by the project (see section 17.7.2). Procedures have been outlined in an Outline WWSISI submitted with the DCO application (Document reference 8.6).
The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	Paragraph 691 of the Scoping Report proposes to scope out impacts to the setting of onshore heritage assets from construction of the offshore works because of the existing context of a busy shipping channel and gas rigs and service vessels. Having had regard to the response	Setting is discussed in section 17.6.4 and the potential impact during construction is discussed in 17.7.6.4

Consultee	Date /Document	Comment	Response / where addressed in the ES
		received by Historic England the Secretary of State considers that this element of the assessment should not be scoped out at this stage.	
The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	Similarly operational impacts upon setting are proposed to be scoped out in paragraph 692 of the Scoping Report due to the distance of the array from the coast which is more than the 35km limit identified in DTI guidance. The Secretary of State agrees with Historic England that this should not be scoped out at this stage and that the ES should consider changes to historic character within the Historic Seascape assessment.	Setting is discussed in section 17.6.4 and the potential impact during operation is discussed in 17.7.7.4
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Marine Historic Environment)	A crucial matter is the commissioning of geophysical and geotechnical surveys to be carried out before works commence, in order to inform turbine array layout (in both proposed offshore development areas) and electricity export route selection. The Applicant would need to discuss with Historic England the survey strategy to be employed so that data generated are sufficiently robust to enable professional archaeological interpretation and analysis.	The assessment of geophysical and geotechnical data forms part of the embedded mitigation (section 17.7.2) and Historic England will be consulted on the scope of all surveys undertaken for the project.
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Marine Historic Environment)	A fundamental principle must be that survey commissioning, interpretation and reporting are programmed, so that the eventual engineering design selected for delivery of this project, should consent be obtained, is fully informed and guided by archaeological advice.	Ongoing consultation with Historic England at all stages of the project will ensure that the design of the project is fully informed by archaeological advice.
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Terrestrial Historic Environment)	It is crucial that the project affords sufficient time and resources to undertake a full assessment of the historic environment within this area, including the physical footprint of the works, as well as areas outside which could be indirectly impacted by changes in coastal or marine processes within the intertidal zone.	A full assessment of the Historic Environment was undertaken by Wessex Archaeology (Appendix 17.1) with impacts assessed as part of this ES chapter (section 17.7).
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Terrestrial Historic	The assessment must also consider any potential impact upon the setting of nearby designated (and non-designated) heritage assets both within, and without, the onshore cable corridor. This work should include detailed consultation with Historic England, The Norfolk Historic	Setting of offshore and intertidal heritage assets is discussed in section 17.6.4 and the potential impact discussed in 17.7.6.4, 17.7.7.4 and 17.7.8.4.

Consultee	Date /Document	Comment	Response / where addressed in the ES
	Environment)	Environment Service and the relevant local planning authorities' Conservation and Landscape Officers and should be undertaken at the earliest stage possible in order to inform the need for and scope of any mitigation which might be required.	A full settings assessment of heritage assets onshore is provided in the onshore assessment of archaeology and cultural heritage (see Chapter 28).
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Terrestrial Historic Environment)	Of particular note is the proposed landfall between Bacton Green and Eccles-on- Sea which is internationally recognised for the earliest evidence of human existence in the UK as well as other archaeology – dating back 700,000 years to the Pleistocene-for example the famous hand axes and footprints of Homo antecessor found in the area around Happisburgh in 2014.	Considered as part of the intertidal baseline section 17.6.3 and within onshore assessment of archaeology and cultural heritage (Chapter 28)
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion (Offshore / The Terrestrial Historic Environment)	The landfall area also contains evidence of a more recent and complex historic landscape with a large number of non-designated archaeological sites, areas of archaeological potential and designated heritage assets.	Considered as part of the intertidal baseline section 17.6.3 and within onshore assessment of archaeology and cultural heritage (Chapter 28)
SUGGESTED QUESTIONS FOR CONSIDERATION: INTRODUCTION			
Q1. Please tell us about any information you can share regarding any or each of the sectors which will help VWPL understand constraints and opportunities associated with identifying the most suitable landfall location within this search area?			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	Historic England requested to be officially invited by the Applicant to participate in the EPP as a priority action.	Historic England have participated, and will continue to participate, in the EPP.
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	With regards to the international importance of Happisburgh, the work of the AHOB project (Ancient Humans of Britain) would be of interest as a starting point to understand the presence of the Cromer Forrest Bed deposits within the area of the landfall.	An initial meeting was held with representatives from the AHOB and PAB research teams in May 2017. A specific independent academic steering group has been established, including members of the AHOB and PAB research teams, with respect to coastal, intertidal and nearshore archaeological considerations at the

Consultee	Date /Document	Comment	Response / where addressed in the ES
			landfall options – focusing on Happisburgh.
SUGGESTED QUESTIONS FOR CONSIDERATION: OFFSHORE			
Q1. Please tell us about further data sources that could be reviewed as part of the site characterisation for each topic?			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	For the purposes of effectively completing an EIA it will be necessary to commission and interpret survey data to an appropriate professional standard and to obtain geo-spatial data records from the National Record of the Historic Environment and other information as held by Historic England (archive@historicengland.org.uk).	Geophysical survey data was acquired for the project and assessed by Wessex Archaeology alongside geo-spatial data from the Historic England archive (NRHE) and other relevant information (e.g. UKHO wrecks and obstructions). This data forms the basis for the PEIR and ES and informed the assessment of the historic environment undertaken by Wessex Archaeology (Appendix 17.1).
Q2. Tell us about any other relevant potential impacts for each topic?			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	It is essential that early engagement, as already initiated, is maintained and ideally coordinated through the EPP. Information provided on potential impacts during construction is useful and we await further discussion based on suitable evidence of how and where AEZs should be employed.	Historic England has participated, and will continue to participate, in the EPP. Recommendations for AEZs are detailed in section 17.7.6.1.
Q3. Do you agree with the potential impacts that have been scoped out for each topic? If not, please provide details.			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	The scoping report proposes that the impact upon the setting of offshore heritage is unlikely to be considered significant and has therefore scoped out from the EIA. It is the opinion of Historic England that the setting within the offshore element of this particular topic of Offshore Archaeology and Cultural Heritage is progressed to EIA for additional consideration.	Setting of offshore and intertidal heritage assets is discussed in section 17.6.4and the potential impact discussed in 17.7.6.4, 17.7.7.4 and 17.7.8.4.
Q4. Have the relevant potential cumulative impacts been identified? If not, please provide details			
Historic England via The Planning	November 2016 /	Rigid criteria such as visual limits cannot necessarily be applied when assessing the	The assessment of setting is presented as

Consultee	Date /Document	Comment	Response / where addressed in the ES
Inspectorate (Secretary of State)	Scoping Opinion	significance of heritage assets and the contribution made by their setting (e.g. the contribution that views looking out from the assets make to their overall significance). Such an assessment of significance should instead by a matter of expert judgment of 'what matters and why', framed within a concise narrative description.	a narrative description in section 17.6.4.
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	It might be appropriate for the Applicant to instead consider assessment regarding the maximum size possible for 15MW turbines and the extent of visibility from selected heritage assets on the adjacent coast during both daylight and any impression of night time illumination, plus cumulative factors with other similar developments.	A full settings assessment of heritage assets onshore is provided in the onshore assessment of archaeology and cultural heritage (see Chapter 28).
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	Within this assessment of setting the Applicant would need to consider Historic Seascape. We would encourage the focus to be on determining any change to the historic character and the capacity of the presently perceived historic character to accommodate that change.	Historic seascape character is discussed in section 17.6.4 and the capacity of the presently perceived historic character to accommodate change discussed in 17.7.6.4, 17.7.7.4 and 17.7.8.4.
Q5. Have the relevant potential transboundary impacts been identified? If not, please provide details			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	The specific reference to cultural heritage associated with wrecks (vessel or aircraft) of non-British, European nationality provides a very limited consideration of this factor which must be developed with a sound methodological approach to determine the nature and substance of any transboundary impacts as relevant to this proposed project.	Transboundary impacts are discussed in section 17.9.
Q6. Do you agree with that the proposed approach to assessing each impact is appropriate? If not, please provide details.			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	It is an essential matter that through our involvement in the EPP that every opportunity is taken by the Applicant to develop the outline or draft WSI that will eventually accompany the submission for examination by the Planning Inspectorate.	An Outline WSI (DCO Document 8.6) has been prepared for consultation with Historic England and submitted alongside the DCO application (see section 17.7.2). The draft Outline WSI would be finalised by

Consultee	Date /Document	Comment	Response / where addressed in the ES
			the project post-consent and in consultation with Historic England.
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	Whilst standardised EIA matrices are useful tools, we consider the analysis of setting, seascape, significance and the impact upon heritage assets as a matter of qualitative and expert judgement which cannot be achieved solely by use of systematic matrices, ridged criteria or scoring systems.	The outcomes of the matrix-based approach are qualified through expert judgement in section 17.7 in accordance with the NPPF principles of harm and loss.
Q7. Is there any further guidance relating to each topic that we should be aware of? If so, please provide details.			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	The "Offshore Renewables Protocol for Archaeological Discoveries" (published by The Crown Estate, revised edition 2014) should be included as a clearly identified and separate matter to be addressed and included within the ES.	Reference is made to the Offshore Renewables Protocol for Archaeological Discoveries in section 17.7.2.
ADDITIONAL HISTORIC ENGLAND COMMENTS: OFFSHORE SECTION			
Historic England via The Planning Inspectorate (Secretary of State)	November 2016 / Scoping Opinion	While we acknowledge that engagement has been initiated with us regarding the survey programme, we request that such matters are incorporated into the Expert Topic Group meetings for the EEP and the role of Historic England is formalised in the Terms of Reference for the EEP Project Steering Group.	The approach to geophysical and geotechnical survey forms part of the EPP and the role of Historic England in providing archaeological advice on survey requirements formalised through the Terms of Reference.
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Landfall option at Happisburgh** Importance of liaising with British Museum (AHOB project) to understand extent of the deposit – any SI works to be undertaken could highlight benefit of mapping inshore extent of deposit which is largely misunderstood. Vattenfall to engage with British Museum.	An initial meeting was held with AHOB and PAB Team in May 2017 and a steering group with respect to the landfall at Happisburgh has been established.
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Geophysical Survey** HE needs to understand difference between surveying campaigns in Norfolk Vanguard East and Norfolk Vanguard West (from East Anglia FOUR previous geophysical surveys). German WWI U boat (U31) has clear sensitivities. Acquisition of additional geophysical data over the site during	Geophysical data was acquired for the project and assessed an interpreted by Wessex Archaeology. The details are presented in Appendix 17.1. The potential for

Consultee	Date /Document	Comment	Response / where addressed in the ES
		future survey campaigns will be considered. Draft Outline WSI will be provided alongside the DCO application. To be prepared in conjunction with application, and should be tailored for techniques looking to apply post consent.	future high resolution survey of U31 has been noted as a consideration for future survey. An Outline WSI has been prepared for consultation with Historic England and submitted alongside the DCO application (see section 17.7.2).
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Geotechnical Survey** Produce a deposit model (as a method of mitigation). Sub sea bed palaeogeology mapping proportionate to the complexity of a site – can be just a narrative or explanation.	Geoarchaeological assessment has been undertaken by Wessex Archaeology. The details of the assessment and deposit model are presented in Appendices 17.2, 17.3 and 17.4 and summarised in section 17.6.1.
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Archaeological Assessment** Agreement that as all works will be undertaken within the project red line boundaries there is no need to add a buffer for the study area for the assessment. • Data Sources • Previous archaeological work • UKHO, HER and NRHE data searches • Further relevant projects such as East Coast War Channels (WWI and WWII) Ensure passed on to Wessex for the desk-based assessment.	The desk-based assessment undertaken by Wessex Archaeology was undertaken with consideration of these sources and presented in Appendix 17.1
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Approach to Impact Assessment** Inshore and offshore Marine Plan is available in this area – looks at language for heritage policies to translate into the assessment. UK Marine Policy Statement to make sure when you are talking about the impacts (potential impacts) framed for that Plan area. Policy SOC2.	See impact assessment methodology section 17.4. Consideration of East Inshore and East Offshore Marine Plans summarised in Table 17.2.
Historic England / Norfolk County Council Historic	February 2017 / EPP ETG Offshore	**Setting** Setting assessment (for offshore) is	Setting and historic seascape character is discussed in sections

Consultee	Date /Document	Comment	Response / where addressed in the ES
Environment Service	Archaeology Meeting Log	focussed more on the physical setting, historic associations and character (i.e. rather than visual, noise, dust etc.), measured by reference to the capacity of that setting/character to accommodate change. The extent of change will be described within the assessment although this will not be assessed as an impact (i.e. Sensitivity/magnitude).	17.6.4, 17.7.6.4, 17.7.7.4 and 17.7.8.4.
Historic England / Norfolk County Council Historic Environment Service	February 2017 / EPP ETG Offshore Archaeology Meeting Log	**Cumulative** Cumulative nature of development is considered and explained in reference to context of other development which has occurred – in order to understand what the impacts are and viability of mitigation. Cumulative knowledge of understanding and positive gains. 'What matters and why' – a narrative around clarification of approach.	Cumulative impact assessment presented in section 17.8.
Historic England / Norfolk County Council Historic Environment Service	February 2017, EPP ETG Offshore Archaeology Meeting Log	**Transboundary impact scenarios to consider:** • International wrecks and aircraft consideration. • Transboundary sensitivities in conjunction with local community groups and interests. • Cumulative effects of changes to physical processes have the potential to impact archaeology across extended sea areas. • - Potential to affect larger-scale archaeological features such as palaeolandscapes/ historic seascapes across boundaries. Represents a valid way to proceed and sound methodological approach.	Transboundary impacts are discussed in section 17.9.
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Do you have any comments on the project description?** We support your intention to commission further data analysis to understand existing archaeological interest as might be present in the vicinity of any of the possible landfall locations.	Onshore geotechnical survey has been carried out with accompanying geoarchaeological watching brief as advised by the AHOB and PAB steering group. A programme of geoarchaeological assessment has been undertaken by Wessex Archaeology (Chapter 28) and the specific archaeological interest

Consultee	Date /Document	Comment	Response / where addressed in the ES
			of Happisburgh will form part of future survey campaigns as required.
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Do you agree with the indicative worst case scenario identified for this topic?** The recognition that constraints on final selection of turbine locations will be informed by offshore archaeology assessments is welcomed, but we must make it clear that in the first instance the programme to conduct these archaeological assessments must be informed by a draft or outline archaeological WSI, which we see you will produce as part of the pre-application process. We also note the geophysical and geotechnical survey programmes and we look forward to seeing archaeological interpretation of these data in accordance with agreed method statements derived from the outline WSI.	Worst case scenarios are presented in detail in section 17.7.4. The necessary programme for archaeological assessment is detailed in the Outline WSI (Document reference 8.6).
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Are there any further data sources that could be reviewed for this topic?** It's directly relevant that full attention is given to the legacy of archaeological project work directed at the Happisburgh coastal area.	Considered as part of the intertidal baseline section 17.6.3 and within onshore assessment of archaeology and cultural heritage (Chapter 28).
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Do you have any comments on the approach to characterising the existing environment for this topic?** We must direct you to equally consider the entire nearshore seabed area and the possibility of encountering palaeo-environment sedimentary sequences of archaeological interest or even buried artefacts.	Considered as part of the existing environment presented in section 17.6.
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Are there any other relevant potential impacts to be considered for this topic?** We require full (archaeological) assessment of possible impacts to consider the entire associated working area necessary to deliver the proposed project (e.g. operation of plant on the foreshore).	A full archaeological assessment of impacts has been undertaken including the potential direct impacts to intertidal archaeology in section 17.7.6.2.
Historic England	February	**Have the relevant potential cumulative**	Cumulative impact

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	2017, Response to Offshore Archaeology Method Statement	**impacts been identified? If not, please provide details** We note that Vattenfall is also developing the Norfolk Boreas offshore wind farm (OWF) and that at this stage Norfolk Boreas will use the same offshore cable corridor and landfall location as both Norfolk Vanguard turbine array areas. We also welcome the statement regarding other OWF developments off East Anglia and we look forward to receiving from you how the Cumulative Impact Assessment (CIA) and how any identifiable transboundary impacts will be assessed as relevant to the historic environment and landscape/seascape factors.	assessment presented in section 17.8. Transboundary impacts are discussed in section 17.9.
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Is there any further guidance relating to each topic that we should be aware of? If so, please provide details** Historic Seascape Characterisation (HSC) must be considered as relevant separately. Should specifically include the adopted East Inshore and Offshore Marine Plans (2014). Reference should be given to research frameworks (e.g. The North Sea Prehistory Research and Management Framework published 2009). Reference should be made to East Coast War Channels in the First and Second World War by Antony Firth, March 2014 We also direct you to the COWRIE guidance Historic Environment Guidance for the Offshore Renewable Energy Sector and Offshore Geotechnical Investigations and Historic Environment Analysis.	Reference is made to the HSC report in section 17.6.4. Reference is made to the East Inshore and Offshore Marine plans in Table 17.2. Reference is made to the East Coast War Channels in section 17.6.4. Reference is made to the COWRIE guidance in section 17.2.
Historic England	February 2017, Response to Offshore Archaeology Method Statement	**Additional comments:** Any such phased programme of geoarchaeological assessment should produce an agreed Deposit Model. We particularly encourage you to talk with us directly regarding how any Deposit Model might be produced given that any such deliverable might also comprise mitigation and therefore a material aspect in preparation of any application for consent. We recommend that this project gives full	Geoarchaeological assessment has been undertaken by Wessex Archaeology. The details of the assessment and deposit model are presented in Appendices 17.2, 17.3 and 17.4 and summarised in section 17.6.1.

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		attention to convening an independent expert panel of established experts in palaeoenvironmental research. The independent panel should have a specific purpose to advise the Applicant regarding how geoarchaeological works are undertaken in the preparation of the EIA and if new information is produced as a result of these activities that consideration is given to publication through project newsletters as well as any technical publications as agreed.	Onshore geotechnical survey has been carried out with accompanying geoarchaeological watching brief as advised by the AHOB and PAB steering group. A programme of geoarchaeological assessment has been undertaken by Wessex Archaeology (Chapter 28) and the specific archaeological interest of Happisburgh will form part of future survey campaigns as required. The Outline WSI (document reference 8.6) includes provision for the publication of the results of archaeological works undertaken for this project.
AHOB and PAB Representatives, Norfolk County Council Historic Environment Service / North Norfolk District Council	May 2017 / Meeting	Discussion of coastal, intertidal and nearshore archaeological considerations at the landfall options – focusing on Happisburgh.	All parties agreed to undertake regular engagement from 2019 onwards.
Historic England	July 2017 / EPP ETG Offshore Archaeology Meeting	Key points of agreement were as follows: • Formalisation of coordination and commitment to data acquisition and a programme of survey works post-consent within the DML / WSI • Identification of interested parties re: Happisburgh and the formalisation of their involvement within the DML / WSI • To inform CP of any consultation with the Happisburgh landfall steering group • Consultation with HE regarding what is taken forward for further analysis re: the offshore geoarchaeological assessment • Consultation with regulators relevant to onshore archaeology and cultural	Noted and all taken forward through this chapter, the draft DCO and Outline WSI as specified in this Table.

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		heritage • The WSI to reflect the potential for a borehole campaign • Project community engagement with respect to archaeology to be considered • To provide anomaly data to Vattenfall for constraints mapping purposes • To identify inter-tidal anomalies in assessment • To highlight areas which haven't been surveyed in assessment • WSI to include measures ensuring vigilance for prehistoric discoveries in the inter-tidal area • CIA should include reference to 20th century military seascapes and clarification between prehistoric and historic elements of seascape may be required • To feed results of the physical processes chapter into the PEIR chapter when available • The direct use of UXO survey data for archaeological objectives should be formalised • Prepare WSI in a manner consistent with The Crown Estate guidance documents for WSIs and in consultation with HE and also James Albone (NCC) due to the foreshore elements.	
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	In 5.3 (paragraph 20) of the PEIR it is stated that the landfall location of the cable route will be at Happisburgh. It is important to note that internationally significant archaeology has been found in this area dating to c.800,000yrs -1 million years ago, representing the earliest evidence for hominids in the UK. There is the potential for deposits/remains associated with the Cromer Forest Bed Formation (CF-bF) to be disturbed and/or damaged by the process of bringing the cables onshore. If significant features/remains are identified then we would expect to see a suitable mitigation strategy established in the WSI.	Due to the presence of deep deposits of glacial origin at the landfall the potential for significant features to be present is anticipated to be low. The Outline WSI (document reference 8.6) includes provision for further geoarchaeological assessment and deposit modelling to clarify any requirement for further mitigation.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site	It is stated (paragraph 21 of the PEIR) that the development is considering the use of either HVDC or HVAC cables. The impacts of both options on the historic	Following PEIR, only the HVDC option is now being taken forward in the final

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	Description)	environment will need to be discussed.	design for the project.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	It is stated that under cliff drilling will be carried out using HDD drilling. It should be noted that there is the potential for the bentonite slurry used in the HDD process to breakout and spread into/coat archaeological deposits, features and materials. Information would need to be provided regarding the chemistry, pH and composition of the drilling fluid used. The impact that these approaches would have on the archaeology would also need to be considered, particularly where the drill will pass under significant and in-situ archaeological remains.	The potential impact of drilling fluid breakout associated with Horizontal Directional Drilling (HDD) is discussed in section 17.7.6.5.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	The impact that the various foundation types that are being considered may have on the buried or near-surface archaeology needs to be considered and mitigated against. Likewise scour protection may be required for the different foundation options, which would also have the potential to affect, through erosion or construction, any sea bed deposits in the adjacent areas. This in turn may result in archaeological deposits or features becoming exposed or buried.	The potential impacts of the foundation types and associated scour protection are assessed through the worst case scenarios and discussed in sections 17.7.6, 17.7.6.5 and 17.7.8. The Outline WSI (document reference 8.6) includes details of potential mitigation options if significant impacts are identified.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	The foundation type and construction method of the offshore electrical platforms has not yet been finalised, and so a number of options are presented (see Section 5.4.4.1.1 of the PEIR). Information is therefore required regarding the potential impact that any anchorage of vessels or foundations would have on any buried or near-surface archaeology.	The potential impact from the anchorage of vessels or foundations are discussed in sections 17.7.6, 17.7.6.5 and 17.7.8.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	The heat lost per meter of HVAC cable is an important aspect to consider in terms of the historic environment, as heat may have a damaging effect on any waterlogged archaeological remains that may be present, such as palaeoenvironmental remains and waterlogged wood. Similar comments apply for HVDC cables	The potential for heat loss to impact any waterlogged archaeological remains is discussed in section 17.7.7.5.
Historic England	11/12/2017 PEIR Response (Chapter 5. Site Description)	We note the discussion of the export cable installation, array cable installation and burial, the pre-lay grapnel run, dredging of sand waves prior to installation, ploughing, trenching/cutting or jetting to bury cables	The potential impact from cable installation and seabed preparation is discussed in section

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		at target depths of between 1m and 3m. All these methods will need to be discussed in terms of their impact on any buried or near-surface archaeology, and suitable mitigation strategies developed. Similar analysis and strategies will be needed for the areas where it is not possible to bury the cables, and where cable protection is needed.	17.7.6. The Outline WSI (document reference 8.6) includes details of potential mitigation options if significant impacts are identified.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	If significant features/remains are identified then we would expect to see a suitable mitigation strategy established in the WSI. The scientific dating of these deposits needs to be considered carefully as the techniques that can be applied to deposits of this age often require specific collection, storage and processing approaches to be used, such as OSL, Amino Acid Racemisation, and biostratigraphy, and therefore would require the involvement of specialists.	Geoarchaeological assessment, including dating, has been undertaken by Wessex Archaeology. The details are presented in Appendix 17.2, 17.3 and 17.4 and summarised in section 17.6.1. The Outline WSI (document reference 8.6) includes provision for further geoarchaeological assessment, including the involvement of specialists, to be undertaken post-consent.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Under paragraph 17.1 in the PEIR it would be useful to include the Coastal and Intertidal Zone Archaeology Network (CITiZAN) project database of archaeological find spots created as part of this project. The database/GIS layer is updated regularly by project members and volunteers, providing an opportunity to take advantage of recently collected information.	Data from the CITiZAN project has been added as a data source in section 17.5.2 and reviewed to inform the updated baseline for Intertidal Archaeology in section 17.6.3.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	The automatic assumptions made in the PEIR are to focus on negative impacts, when we suggest that attention could also be given to highlighting the magnitude of any positive effects. For example, the commissioning of geophysical and geotechnical surveys before any works commence, should consent be obtained, to discuss with us the survey strategy to be employed, so that data generated are sufficiently robust to enable professional archaeological interpretation and analysis.	Additional detail on potential positive impacts of the project have been added to the impact assessment methodology and detailed in section 17.4.1.

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		In doing so it should be possible to demonstrate a positive effect and public benefit through actively contributing new data and information about our shared historic environment.	
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Table 17.6 of the PEIR requires more explanation regarding "beneficial magnitude" especially in reference to the explanation provided by Table 17.7 which appears to be focussed on negative effects.	Additional detail on positive impacts added to the impact assessment methodology in section 17.4.1.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	17.6.2 (paragraph 68) of the PEIR summarises the geophysical techniques that have been utilised to identify a number of archaeological features (Side Scan Sonar, Magnetometry, and Multibeam Bathymetry), but the percentage coverage and resolution of the surveys are not stated here. It would have been useful to present a summary of the data quality here so it is clear how much weight can be placed on the conclusions drawn from the data.	This detail has been summarised from Appendix 17.1 in Table 17.8.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	A fundamental principle must be that survey commissioning, interpretation and report are programmed, so that the eventual engineering design selected for delivery of this project, should consent be obtained, is fully informed and guided by archaeological advice.	The necessary programme for archaeological assessment, fully informed and guided by archaeological advice, is detailed in the Outline WSI (document reference 8.6).
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Section 17.6.3 (Intertidal archaeology) of the PEIR; we note the acknowledgement in paragraph 87 regarding the potential to encounter prehistoric material within the intertidal zone and paragraph 89 states that there is high potential for further Palaeolithic remains to found where the CF-bF is found in situ. We would support this statement and encourage that this formation is thoroughly investigated in order to mitigate any loss or damage to any potentially significant remains that may be present. The mitigation strategy would need to be integrated into the geotechnical specification and archaeology programme, as well as being specified in a WSI. The results of the ground investigations conducted with archaeological supervision would need to	The results of a programme of geoarchaeological assessment undertaken by Wessex Archaeology (Chapter 28) and the specific archaeological interest of Happisburgh is summarised in section 17.6.3. This indicates reduced potential compared to that considered in the PEIR.

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		be included within the Environmental Statement (ES).	
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Section 17.6.4 (Historic Seascape Character) of the PEIR paragraph 95, mentions that within the NV East and NV West project areas that "…all wrecks and anomalies are currently unidentified and, as such, there is no further information which can be used to ascertain the contribution that setting makes to their significance." There is however more identification of charted wrecks within the electricity export cable route such that consideration of setting is possible. It is therefore for the EIA exercise to determine how the proposed development(s) may change perceptions of character and the capacity of presently perceived character to accommodate such change.	This is discussed in detail in sections 17.7.6.4, 17.7.7.4, 17.7.8.4, and in particular in terms of cumulative impact in section 17.8.2.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Section 17.7.2 (embedded mitigation) of the PEIR summarises the embedded mitigation that will be employed to minimise the risk to the historic environment, including the implementation of Archaeological Exclusion Zones (AEZs), the further investigation of A2 anomalies, geo-archaeological coring of features, watching briefs etc. (paragraph 104). In general, we agree with the matters outlined in this section and the measures to be identified within any Deemed Marine Licence. Additional detail will be required in terms of how each of the strategies will be carried out and this should be compiled into a WSI in support of these mitigation strategies.	The Outline WSI (document reference 8.6) captures the detail of the proposed embedded mitigation.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Section 17.7.3 (worst case) of the PEIR, we require clarification regarding the statement made in paragraph 110 and whether or not the EIA exercise will assess how sediment accumulation might provide in-situ protection.	The positive impact of sediment accumulation upon archaeological remains is discussed in sections 17.7.6.3, 17.7.7.3 and 17.7.8.3.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	It is stated in Section 17.7.5.1 of the PEIR that AEZs will not be implemented for A2 or A3 anomalies, but will be largely avoided by micro-siting. It is further stated that high resolution geophysics will be carried out pre-construction, mainly for UXO identification, which will further clarify and refine the nature and extent of	The Outline WSI (document reference 8.6) includes provision for specialist input from a marine geophysicist with archaeological experience in planning

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		some of the anomalies. This working team should include a marine geophysicist with archaeological experience so that the collected data is of use for both UXO identification and archaeology. We also note that many UXO have archaeological interest.	pre-construction surveys.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Under Section 17.7.5 (potential impacts during construction) of the PEIR, the recommendations for Archaeological Exclusion Zones (AEZs) stated in paragraph 119 are welcomed and it is important that the WSI includes all these AEZs. However, the proposed action is confusion with specific reference to what are described as "…magnetic only A1 anomalies": 70058; 70615; 71297; 71299; 71314; 71323; 71325; and 71479, which have not been afforded AEZs for the stated reason that "…it is not possible to say with certainty that they are of archaeological interest." We must take issue with this statement as the entire purpose of an AEZ is precautionary and the fact that these anomalies have been afforded A1 status therefore leads to the conclusion that they should be afforded spatially defined AEZs. We add also that through adopting such defined AEZs it should be possible to determine an appropriate strategy for any micro-siting. Furthermore, the detail in Table 17.17 (Recommended AEZs) provides clarity regarding proposed spatial extents for AEZs (e.g. 50 metre) and we recommend that the same principles should be applied to all A1 anomalies.	AEZs have been added to the embedded mitigation for magnetic only A1 anomalies (section 17.7.6.1)
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Paragraphs 121 and 122 in the PEIR outline proposals for anomalies classed as A2 and A3 and we acknowledge the proposed approach for handling these anomalies and we add that specific reference should be made to the role the archaeological WSI provides in setting out methodological approaches to subsequent investigations either employing geophysical, direct visual inspection techniques including intertidal walkover survey. We also hereby welcome the statement made in paragraph 130 regarding the preparation of Protocol for Archaeological Discoveries: Offshore Renewables Projects, in line with guidance published by The Crown Estate and we hope a draft version will accompany the	The proposed methodological approaches for handling A2 and A3 anomalies and a draft Protocol for Archaeological Discoveries are set out in the Outline WSI (document reference 8.6) and will be confirmed through the final Offshore WSI (required under condition [14(1)(j)] of the DMLs).

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		ES.	
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	However, we take issue with the statements made in paragraph 132 such as "…potential to recover from the effect of this removal", we consider it more a matter where effective completion of long-term conservation measures should allow archaeological materials to be stabilised. Therefore, it is not immediately apparent that impact significance can be considered as "minor".	Noted and taken into account in updated impact assessment presented in section 17.7.6.2.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	We also do not agree with the claim made in paragraph 135 that if HDD exits below the low water mark that impact within the intertidal zone will have "negligible magnitude of effect" given that depth of HDD may still impact in-situ sedimentary sequences contained within the intertidal zone. The matters addressed in paragraph 136 are of major importance as relevant to the appropriate action to be taken by all parties identified with this proposed project. We appreciate that mitigation measures are identifiable that could address the significance of any likely impact, but we reserve any further comment until effective mitigation measures are produced in consultation with us and local curators as required should consent be obtained. We also offer the observation that liaison with other interested parties should be updated as we understand that the successor to the AHOB project is PAB.	Noted and taken into account in updated impact assessment presented in section 17.7.6.2.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	In Section 17.7.5.3 (indirect impacts to heritage assets) of the PEIR we note that paragraph 140 mentions "…localised and short-term disturbance to the beach and nearshore zone, but there would be no long-term effect on sediment transport processes." The conclusion therefore "no impact upon archaeological receptors from changes in…coastal morphology at the landfall" is not an issue that we can agree on as we are minded to direct your attention to the statements made in section 17.6.3, paragraph 89 regarding the identification on footprints which by their very nature will be immediately vulnerable to loss on exposure. The issue here therefore is to recognise that short-term disturbance and alteration, by the proposed project of "coastal morphology" could have considerable impact on	Noted and taken into account in updated impact assessment presented in section 17.7.6.3. The selection of the long HDD option means that there will be no effect upon the beach and nearshore zone.

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		presently unknown archaeological receptors.	
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	It is important to acknowledge that that there are different perceptions of historic character and this element of the analysis should pay more attention to such matters in order to produce any determination of capacity to accommodate change. Similarly, the statements made in section 17.7.6.4 (paragraph 150) of the PEIR do not acknowledge the duration of this development and that it will introduce a clear change to present perception of historic character and thereby influence future perception of character. We therefore request that this matter is re-assessed within the ES.	Noted and taken into account in updated impact assessment presented in section 17.7.7.4.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	The remarks made in paragraph 168 of the PEIR must be substantiated in the draft Development Consent Order to demonstrate commitment to deliver mitigation in a timely manner to professional standards	A commitment to complete studies to professional archaeological standards and make the results publicly available has been included in this chapter.
Historic England	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	We welcome the attention given in Section 17.9 (Transboundary Impacts) of the PEIR to cultural heritage associated with wrecks (vessel or aircraft) of non-British, European or international identity as well as the attention given to research directed at submerged prehistoric landscapes and how recent projects have promoted pan-European collaboration. In particular we see that attention is given to possible positive effects associated with expanding knowledge and understanding. Furthermore, paragraph 177 references other European maritime policy measures and it would therefore seem appropriate to add reference to published Marine Plan policy effective in the UK that may support gain in knowledge and understanding for effective decision making.	Noted, reference is made to the East Inshore and Offshore Marine plans in Table 17.2.
MMO	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Main mitigation of a Working Scheme of Investigation and archaeological exclusion zones will require consultation with Historic England and captured in the DCO and Deemed Marine Licence.	Noted and taken forward to draft DCO through [condition 14(1)(h) (DCO Schedules 9 and 10) and 9.(1) (h) (DCO Schedules 11 and 12)] of the Deemed Marine Licences (DMLs).

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MMO	11/12/2017 PEIR Response (Chapter 17. Offshore and Intertidal Archaeology and Cultural Heritage)	Chapter 14 of the PEIR– Offshore and intertidal archaeology has a referencing error in Page 14.	Amended

17.4 Assessment Methodology

17.4.1 Impact Assessment Methodology

17.4.1.1 Defining impact significance

16. The scoping response provided by Historic England advised that a full assessment of the historic environment should determine the impact of the proposed development upon designated and non-designated heritage assets (and their settings), and assess the level of any resulting benefit, harm or loss to their significance.

17. The impact assessment methodology adopted for archaeology and cultural heritage defines those assets likely to be impacted by the proposed scheme. The assessment is not limited to direct physical impacts, but also assesses possible indirect impacts upon the setting of heritage assets, whether visually, or in the form of noise, dust and vibration, spatial associations and a consideration of historic relationships between places and the historic seascape character.

18. More specifically the impact assessment presents:

- The heritage significance (importance) of any heritage assets identified being affected;
- The anticipated magnitude of effect (change) upon those assets and their settings;
- The significance of any identified impacts upon those assets and their settings; and
- The level of any harm (or benefit) and loss of heritage significance (importance).

19. The assessment of the significance of any identified impact is largely a product of the heritage significance (importance) of an asset and the perceived magnitude of the effect on it, assessed and qualified by expert judgement.

20. An assessment of effects on an asset involves an understanding of the heritage significance of the asset and in the case of an effect on the setting of that asset, the contribution that the setting makes to the heritage significance of the asset. Policy

sets out that the level of detail should be proportionate to the significance of the heritage asset and no more than is sufficient to understand the potential impact of the proposed development (NPPF paragraph 128, 2012).

21. The standardised EIA matrices provide a useful framework for the identification and appropriate responses to identified impacts, however, when analysing impacts upon heritage setting and heritage significance, the outcomes of the matrix-based approach need to be qualified through expert judgement and further comments / arguments based upon the heritage specific legislation, policy and guidance documents available, and using the fundamental concepts from the NPPF of benefit, harm and loss.

17.4.1.2 Sensitivity

22. The sensitivity of a receptor is a function of its capacity to accommodate change and reflects its ability to recover if it is affected. However, while impacts to a heritage asset's setting or character can be temporary, impacts which result in damage or destruction of the assets themselves, or their relationship with their wider environment and context, are permanent. Once destroyed an asset cannot recover. For this reason, the sensitivity of heritage assets is defined solely by their heritage significance (archaeological importance). The heritage significance of an asset, the determination of which is outlined below, can therefore be regarded as equating to its sensitivity.

23. The importance of a heritage asset is a function of a range of factors. The Marine Policy Statement (2011) states that the value of heritage assets to this and future generations lies in their heritage interest, which may be archaeological, architectural, artistic or historic.

24. In accordance with this definition, the importance of heritage assets are assessed by examining the asset's age, type, rarity, survival and condition, fragility and vulnerability, group value, documentation, associations, scientific potential and outreach potential. These factors help to characterise a heritage asset and to assess how representative it is in comparison to other similar archaeological, architectural, artistic or historic heritage assets. In the majority of cases, statutory protection is only provided to a site or feature judged to be an above average example in regard to these factors. The criteria used for assessing the importance of intertidal and offshore archaeology are specified in Table 17.4.

Table 17.4 Indicative (outline) criteria for determining heritage significance (importance)

Heritage Significance (Importance)	Definitions / Example Assets
High (perceived International / National Importance)	Assets of acknowledged international / national importance (e.g. World Heritage Sites, Scheduled Monuments, Protected Wreck Sites and undesignated assets of the quality and importance to be designated under national and international legislation). Assets that can contribute significantly to acknowledged international / national research objectives.
Medium (perceived Regional Importance)	Assets that contribute to regional research objectives. Assets with regional importance, educational interest or cultural appreciation.
Low (perceived Local Importance)	Assets that contribute to local research objectives. Assets with local importance, educational interest or cultural appreciation. Assets that may be heavily compromised by poor preservation and/or poor contextual associations.
Negligible	Assets with no significant importance or archaeological / historical interest.
Unknown	The importance / existence / level of survival of the asset has not been ascertained (or fully ascertained/understood) from available evidence.

25. The criteria in Table 17.4 provide a provisional guide to the assessment of perceived heritage significance, which is to be based upon professional judgement. However, due to the nature of the archaeological record, it is often the case that information regarding individual assets may, at times, be limited. As such, the categories and definitions of heritage significance do not necessarily reflect a definitive level of importance of an asset. Instead they should be regarded as providing a preliminary or likely heritage significance based on information available to date. The heritage significance of an asset can therefore be amended or revised as more information comes to light. Archaeological assessments that may alter the perceived heritage significance of an asset may be undertaken pre- and post-consent and can include the archaeological assessment of further geophysical and geotechnical data, ground truthing using Remote Operated Vehicles (ROVs) or divers or further desk-based research (e.g. on individual historic wrecks).

26. Where uncertainty occurs, the precautionary approach is to assign high importance (and hence high sensitivity). This precautionary approach represents good practice in archaeological impact assessment and reduces the potential for impacts to be under-estimated.

27. It is crucial that for each asset there is a narrative accompanying the assessment which clearly sets out the reasoning (in accordance with the above factors) and the

measure of professional judgment employed in assessing the importance of that asset.

17.4.1.3 Magnitude

28. The classification of the magnitude of effect on heritage assets takes account of such factors as:

- The physical scale and nature of the anticipated disturbance; and
- Whether specific features or evidence would be lost that are fundamental to the historic character and integrity of a given asset, and its understanding and appreciation.

29. Both direct physical and indirect non-physical (e.g. visual, setting) impacts on heritage assets are considered relevant. Impacts may be adverse or beneficial. Depending on the nature of the impact and the duration of development, impacts can also be temporary and / or reversible or permanent and / or irreversible.

30. The finite nature of archaeological remains means that physical impacts are almost always adverse, permanent and irreversible; the 'fabric' of the asset and, hence, its potential to inform our historical understanding, will be removed. By contrast, effects upon the setting of heritage assets will depend upon the scale and longevity of the development and the sensitivity with which the landscape is re-instated subsequent to decommissioning / demolition, if applicable.

31. The indicative criteria used for assessing the magnitude of adverse effect with regard to archaeology and cultural heritage are presented in Table 17.5 below.

Table 17.5 Indicative criteria for assessing adverse magnitude of effect

Magnitude	Definition
High	Total loss of or substantial harm to an asset. Complete and permanent loss of, or change to, those characteristics of an asset's setting which contribute to its significance, such as could be caused by its disassociation with its historical setting.
Medium	Partial loss of, harm to or alteration of an asset which will substantially affect its significance. Substantial change to the key characteristics of an asset's setting, which falls short of being a total disassociation with the historical context, or a more total loss which is temporary and/or reversible.
Low	Minor loss of or alteration to an asset which leave its current significance largely intact. Minor and/or short term changes to setting which do not affect the key characteristics and in which the historical context remains substantially intact.
Negligible	Minor alteration of an asset which does not affect its significance in any notable way. Minor and short term, or very minor and reversible, changes to its setting which do not affect the key characteristics of the asset's significance.

32. The magnitude of beneficial effect with regard to archaeology and cultural heritage directly relates to the level of public value associated with an individual effect. Benefits may correspond directly to the project itself where a project will enhance the historic environment (e.g. through measures which will improve the setting of a heritage asset or public access to it, or through indirect impacts which provide additional protection to an exposed site on the seabed through increased sediment cover) or will enhance public understanding by adding to the archaeological record (e.g. through the accumulation of publicly available data). The measure of beneficial effect (high/medium/low) is therefore necessarily situational and specific to a given site, area or subject. For this reason, magnitude of beneficial impact is discussed within the narrative of the assessment according to criteria defined on a case by case basis, and not defined by overarching criteria as for adverse magnitude of effect in Table 17.5 above.

17.4.1.4 Impact significance

33. An initial indication of impact significance is gained by combining the predicted magnitude of effect and heritage significance (importance) in accordance with the impact assessment matrix provided in Table 17.6 below.

Table 17.6 Impact Significance Matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*	*Moderate*	*Major*	*Major*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Minor*	*Minor*	*Moderate*	*Major*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*	*Minor*	*Minor*	*Moderate*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Minor*

34. As with the definitions of magnitude and sensitivity, the matrix used is clearly defined by the expert assessor within the context of that assessment. The impact significance categories are divided as shown in Table 17.7.

Table 17.7 Adverse Impact Significance Definitions

Impact Significance	Definition
Major (Substantial)	May equate to substantial harm or total loss of the value of a designated heritage asset (or asset potentially worthy of designation) such that development may not be consented unless substantial public benefit is delivered by the project. Effective / acceptable mitigation options are still likely to be possible, to offset and / or reduce residual impacts to satisfactory levels.

Impact Significance	Definition
Moderate (Less than Substantial)	Less than substantial harm to the significance of a designated heritage asset (or asset potentially worthy of designation) such that the harm should be weighed against the public benefit delivered by the development to determine consent. Effective / acceptable mitigation options are likely to be possible, to offset and / or reduce residual impacts to satisfactory levels.
Minor (Slight)	Harm to a designated or non-designated heritage asset that can be adequately compensated through the implementation of a programme of industry standard mitigation measures.
Negligible	Impact that is nil, imperceptible and not significant.
No Impact	No change, therefore no impact in receptor condition.

35. Note that for the purposes of this chapter of the ES, 'major' and 'moderate' impacts are generally deemed to be significant (in EIA terms). In addition, whilst minor impacts are not significant in their own right, it is important to distinguish these from other non-significant (negligible) impacts as they may contribute to significant impacts cumulatively or through interactions between heritage assets or elements of the historic environment (historic landscape).

36. Embedded mitigation (for example where potential impacts to known heritage assets are avoided through AEZs and micrositing through design) is referred to and included prior to initial assessment of impacts. If the impact does not require mitigation (or no mitigation is possible) the residual impact will remain the same. If however, specific mitigation is required then there an assessment of the post-mitigation residual impact is provided.

37. With regard to beneficial impact, as outlined for magnitude in section 17.4.1.3 above, definitions are dependent upon the level of public value relevant to a given area, site or subject and are discussed within the narrative on a case by case basis.

17.4.2 Cumulative Impact Assessment

38. Cumulative impacts may occur where archaeological receptors also have the potential to be impacted by other existing, consented and/or proposed developments or activities. This includes consideration of the extent of influence of changes to marine physical processes (see Chapter 8) arising from the proposed project alone and those arising from the proposed project cumulatively or in combination with other OWF developments (particularly East Anglia THREE, East Anglia ONE and Norfolk Boreas due to their proximity to the project).

39. The cumulative impact assessment has been carried out in accordance with the document Guidance for Assessment of Cumulative Impacts on the Historic

Environment from Offshore Renewable Energy issued by COWRIE (Oxford Archaeology 2008).

40. Cumulative impacts are considered in section 17.8.

17.4.3 Transboundary Impact Assessment

41. Transboundary impacts may be relevant to offshore archaeology and cultural heritage where wrecks of non-British, European nationality are subject to impact from development and may therefore fall within the jurisdiction of another country. Transboundary impacts may also occur if the cumulative effects of changes to physical processes have the potential to impact archaeology across extended sea areas. In addition, there is potential for developments, individually and cumulatively, to affect larger-scale archaeological features such as palaeolandscapes and to affect the setting of heritage assets and historic landscapes/seascapes which may also extend across these boundaries. This may also include sensitivities in conjunction with local community groups and interests.

42. Transboundary impacts are considered in section 17.9.

17.5 Scope

17.5.1 Study Area

43. The study area comprises the red line boundaries of Norfolk Vanguard OWF sites (Norfolk Vanguard West (NV West) and Norfolk Vanguard East (NV East)), the offshore cable corridor and the landfall up to MHWS (Figure 17.1).

44. In order to ensure that all known and potential heritage assets within the originally proposed project boundaries would be captured as part of the assessment, the study area assessed by Wessex Archaeology (Appendix 17.1) comprised the extents of NV West and NV East and the provisional offshore cable corridor extending from a landfall search area between Bacton Green and Happisburgh South. The proposed landfall has since been confirmed at Happisburgh South (Figure 17.1) and the baseline presented in this chapter (section 17.6) has been refined to reflect this reduced study area (corresponding to the currently proposed red line boundary).

17.5.2 Data Sources

45. The technical report authored by Wessex Archaeology (Appendix 17.1) has been informed by the following data sources:

- Geophysical survey and geotechnical data acquired for the project by Fugro Survey B. V. (Fugro) between September and November 2016 over NV West and the offshore cable corridor;

- Geophysical survey data previously acquired over NV East by EMU Limited (EMU) and over the eastern end of the offshore cable corridor by Coastline Surveys Ltd in 2012;
- The United Kingdom Hydrographic Office (UKHO) data for charted wrecks and obstructions;
- The National Record of the Historic Environment (NRHE) maintained by Historic England, comprising data for terrestrial and marine archaeological sites, find spots and archaeological events;
- The National Heritage List for England maintained by Historic England, comprising data of designated heritage assets including sites protected under the Protection of Military Remains Act 1986 and the Protection of Wrecks Act 1973;
- The Norfolk Historic Environment Record (NHER), comprising a database of all recorded terrestrial and marine archaeological sites, find spots and archaeological events within the county and offshore;
- The HSC report for East Yorkshire to Norfolk (Newcastle University, 2014);
- The Coastal and Intertidal Zone Archaeology Network (CITiZAN) project database of archaeological find spots;
- Relevant mapping including Admiralty Charts, historic maps and Ordnance Survey; and
- Relevant documentary sources and grey literature held by Wessex Archaeology, and those available through the Archaeological Data Service and other websites.

46. Full details of the technical specifications of the acquired geophysical data can be found in section 3.3 of Appendix 17.1 and are summarised in Table 17.8 below.

Table 17.8 Summary of Acquired Geophysical Data

Survey campaign		Line spacing	Data type and resolution	Data quality*	Suitability
NV West and offshore cable corridor, Fugro 2016	*Fugro Pioneer* (NV West and offshore section of offshore cable corridor)	Main line spacing of 100m, with cross lines run every 1,000m	Sidescan sonar (typically 125m horizontal range)	Variable	Overall suitable quality to support a robust archaeological assessment
			Multibeam bathymetry (1m resolution)	Good	Good standard for archaeological assessment
			Magnetometer	Average	Affected by noise and some background variation
			Sub-bottom profiler (hull-mounted pinger)	Good	Good standard for archaeological assessment

Survey campaign		Line spacing	Data type and resolution	Data quality*	Suitability
	RV *Discovery* (mid-section of offshore cable corridor)	Line spacing ranging from 50m to 100m, depending on the area.	Sidescan sonar (typically 75m horizontal range)	Variable	Overall suitable quality to support a robust archaeological assessment
			Multibeam bathymetry (1m resolution)	Good	Good standard for archaeological assessment
			Magnetometer	Average	Affected by noise and some background variation
			Sub-bottom profiler (hull-mounted pinger)	Variable	Cannot be guaranteed that all palaeogeographic features of archaeological potential have been identified
	Valkyrie (inshore section of offshore cable corridor)	Line spacings ranging from 15m to 75m, depending on the area	Sidescan sonar (25m horizontal range)	Variable	Overall suitable quality to support a robust archaeological assessment
			Multibeam bathymetry (1m resolution)	Good	Good standard for archaeological assessment
			Magnetometer	Average	Affected by noise and some background variation
			Sub-bottom profiler (hull-mounted pinger)	Variable	Cannot be guaranteed that all palaeogeographic features of archaeological potential have been identified
NV East, Emu 2012	MV *Aurelia*	Main line spacing of 100m, with cross lines acquired every 2,000m	Sidescan sonar (75m horizontal range)	Good	Some weather noise; on the whole suitable for archaeological assessment
			Multibeam bathymetry (1m resolution)	Good	Good standard for archaeological assessment
			Magnetometer	Variable	Affected by the geological composition of the site

Survey campaign		Line spacing	Data type and resolution	Data quality*	Suitability
			Sub-bottom profiler (pinger and sparker)	Average	High degree of swell on some lines; still deemed suitable for archaeological interpretation.
Eastern end of offshore cable corridor, Coastline Surveys Ltd 2012	MV *Flatholm*	Main line spacing of 100m, with cross lines acquired every 2,000m	Sidescan sonar (75m horizontal range)	Good (small number of lines Variable)	On the whole suitable for archaeological assessment
			Multibeam bathymetry (1m resolution)	Good	Good standard for archaeological assessment
			Magnetometer	Variable	Affected by the geological composition of the site
			Sub-bottom profiler (pinger and boomer)	Poor or very poor, with very few lines rated as 'Average' or 'Good'	Data affected by high degrees of swell and penetration and resolution of features is generally very low

*Wessex Archaeology criteria for assigning geophysical data quality rating (Appendix 17.1, Table 1)	
Good	Data which are clear and unaffected by weather conditions or sea state. The dataset is suitable for the interpretation of standing and partially buried metal wrecks and their character and associated debris field. These data also provide the highest chance of identifying wooden wrecks and debris.
Average	Data which are affected by weather conditions and sea state to a slight or moderate degree. The dataset is suitable for the identification and partial interpretation of standing and partially buried metal wrecks, and the larger elements of their debris fields. Wooden wrecks may be visible in the data, but their identification as such is likely to be difficult.
Variable	This category contains datasets with the quality of individual lines ranging from good to average to below average. The dataset is suitable for the identification of standing and some partially buried metal wrecks. Detailed interpretation of the wrecks and debris field is likely to be problematic. Wooden wrecks are unlikely to be identified.

17.5.3 Assumptions and Limitations

47. Data used to compile this report consists of primary geophysical and geotechnical survey data and secondary information derived from a variety of sources relevant to this assessment. The assumption is made that the secondary data, as well as that derived from other secondary sources, is reasonably accurate.

48. The records held by the UKHO, NRHE, NHER and the other sources used in this assessment are not a record of all surviving cultural heritage assets, rather a record

of the discovery of a wide range of archaeological and historical components of the marine historic environment. The information held within these datasets is not complete and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown. In particular, this relates to buried archaeological features.

17.6 Existing Environment

17.6.1 Seabed Prehistory

49. There are no known seabed prehistory sites within the study area. Prehistoric archaeology at the landfall at Happisburgh South is discussed in section 17.6.3.

50. The potential for prehistoric sites to be present within the study area, either exposed on or buried within the seabed, is primarily associated with surviving terrestrial features and deposits corresponding to times when sea levels were lower and hence prehistoric hominin populations may have inhabited what is now the seabed. Archaeological material may also be present within secondary contexts, as isolated finds within deposits comprising material from terrestrial phases that may have been reworked by marine or glacial processes, for example.

51. Wessex Archaeology has identified a broad pattern of eight geological units within the study area. These units, and the archaeological potential associated with each unit, are detailed in Table 17.9. Not all eight units are identified in any one area and the precise stratigraphy varies according to location. The sequence presented in Table 17.9 represents an updated interpretation since that presented in Appendix 17.1. This revised interpretation takes account of the geoarchaeological assessment undertaken since the drafting of the (Appendix 17.2, Appendix 17.3 and Appendix 17.4). The identified units have also been correlated with those identified by Fugro (2016; 2017) for Norfolk Vanguard to ensure consistency across the project.

Table 17.9 Shallow geological units identified within the study areas by Wessex Archaeology (Appendix 17.3 Table 2)

WA Unit	Fugro Unit	Geological Unit	Geoarchaeological and Archaeological Potential
8	A1	Holocene seabed sediments Post-transgression (MIS 1)	Gravelly sand with shell fragments, sand waves and ripples indicate sediment is mobile. Low potential in areas of mobile sediment: basal contact may cover old land surfaces.
7	A2	Holocene sediments Pre-transgression (MIS 2–1)	Fluvial, estuarine and terrestrial (including peat) deposits. Shallow infilled depressions or channels with potential for preserved organic material of palaeoenvironmental significance.
6	B	Twente Formation Upper Devensian (MIS 2)	Thin layer of aeolian periglacial sand. Potential to contain *in-situ* and derived archaeological and palaeoenvironmental material.
5	C	Upper Brown Bank Formation Early/Mid Devensian (MIS 5d–3)	Clayey silty sand infilling channels or hollows and deposited in an intertidal/lagoon environment. Potential for *in-situ* Lower Palaeolithic artefacts. Middle Palaeolithic artefacts may be associated with channel edges dependent on age of infill. Basal contact may cover old land surface.
4	C/D	Lower Brown Bank Formation / Eem Formation Ipswichian or Lower Devensian (MIS 5e–5d)	Silty sand and sandy silt. Possible intertidal or shallow marine deposit. *In-situ* Lower Palaeolithic artefacts may be protected. Middle Palaeolithic artefacts may be associated with channel edges dependent on age of infill. Basal contact may cover old land surface.
3	E	Swarte Bank Formation Anglian (MIS 12)	Silty sandy clays associated with the Anglian glaciation. Unlikely to contain archaeological material.
2	F	Yarmouth Formation Lower to Middle Pleistocene (MIS >13)	Silty sand with occasional shell fragments, deposited as part of marine delta complex. Low potential, unlikely to contain archaeology or deposits of palaeoenvironmental significance.
1	I	Westkapelle Ground Formation Pliocene – Lower Pleistocene (MIS 103-63)	Deltaic silty clays and sands. Pre-date earliest occupation; of no archaeological interest

52. Unit 1 (Westkapelle Ground Formation) is of no archaeological interest as this pre dates the earliest occupation of the UK by hominins.

53. Unit 2 (Yarmouth Roads Formation) is an extensive delta top deposit covering a large section of the Southern North sea and deposited during the Cromerian (interglacial) prior to the Anglian Glaciation. This upper layers of this Unit is believed to be

contemporaneous with the Cromer Forest Bed Formation onshore, within which the earliest evidence for prehistoric hominin activity in the UK has been discovered at Happisburgh and Pakefield (Parfitt *et al*., 2010; Parfitt *et al*., 2005). However, this marine deposit offshore is considered unlikely to contain archaeology or deposits of palaeoenvironmental significance.

54. Unit 3 (Swarte Bank Formation) is associated with the Anglian glaciation, a period when hominin presence was precluded by the subglacial environment, and is not considered to be of archaeological interest.

55. Unit 4 (Lower Brown Bank / Eem Formation) is of uncertain age comprising either the shallow marine/intertidal Eem Formation laid down during the Ipswichian interglacial or lower deposits of the Brown Bank Formation, a lagoon deposit of Lower Devesnian age. The marine Eem formation is of limited archaeological potential, although the unit may cover earlier land surfaces. The Lower Brown Bank deposits may contain derived artefacts and intact organic material of palaeoenvironmental interest.

56. Unit 5 (Upper Brown Bank Formation) has been seen infilling channels or hollows and was deposited in an intertidal/lagoon environment during the Early or Mid Devensian. There is potential for Lower Palaeolithic artefacts to be preserved *in situ* and for underlying landsurfaces to be protected beneath the unit. There is further potential for Middle Palaeolithic artefacts associated with the channel edges (dependent on the age of the infill).

57. Unit 6 (Twente Formation) is a thin layer of wind-blown sand which formed following the Last Glacial (Devensian) maximum and the retreat of the ice sheet. Elsewhere in East Anglia and on continental Europe these wind-blown deposits are associated with relatively high archaeological potential as even small sand ridged became foci for human habitation within low-lying wetlands. There is potential for *in situ* archaeological material, palaeoenvironmental material associated with the Twente Formation which may also protect underlying surfaces.

58. Unit 7 comprises pre-transgression fluvial, estuarine and terrestrial (including peat) deposits laid down in the Holocene and with high potential to contain *in situ* and derived archaeological material, and palaeoenvironmental material.

59. Unit 8 comprises post-transgression marine sediments laid down during the Holocene and not considered to be of archaeological potential in themselves, although they could periodically bury and expose sites such as shipwrecks in areas of mobile sediment, and thicker sand deposits could protect earlier land surfaces.

60. The sub-bottom profiler data interpreted by Wessex Archaeology has also demonstrated the presence of a number of palaeogeographic features indicative of

former terrestrial environments. These are summarised below and listed in full in the gazetteers in Appendix III, IV and V of Appendix 17.1. The technical specifications for the acquired data are detailed in section 3.3 of Appendix 17.1 and are summarised in Table 17.8 above.

61. A total of 171 features of palaeogeographic potential (18 in Norfolk Vanguard East, 110 in Norfolk Vanguard West, and 43 in the provisional offshore cable corridor) have been identified within the study area.

62. Features identified within NV East are shown on Figure 17.2. In NV East, Unit 2 (Yarmouth Roads Formation) is observed across the area, in some areas associated with complex cross cutting channels, interpreted as a complex delta-top deposit rather than a single river channel. One feature (75014) has been identified as potentially associated with preserved organic material which may suggest a buried terrestrial environment. Directly above Unit 2 are a number of infilled depressions associated with Unit 4 (Lower Brown Bank / Eem Formation) which are overlain by a blanket deposit of Unit 5 (Upper Brown Bank Formation). No features have been observed in this area associated with Unit 5 although large areas of seismic blanking, potentially indicative of preserved organic material have been seen within Unit 5.

63. Features associated within NV West are shown on Figure 17.3. Unit 2 was observed across the area, again with distinct, cross cutting channels as seen in NV East. A number of deep subglacial valleys are also present associated with Unit 3. Unit 4 has only been sporadically identified in NV West and likely remains as scattered remnants at the base of Unit 5, which again survives as a blanket deposit across the area. In NV West, however, there are a number of internal features within Unit 5 including:

- A possible bank or transgression feature (75127) potentially indicative of a coastal bank or past coastline;
- A number of v-shaped fluid escape features;
- A number of possible internal erosion surfaces, potentially indicative of buried land surfaces created during periodic drying of lagoons;
- Possible relict dune features (75055, 75081, 75099 and 75115) up to 2 to 3m in height, which would have developed on an erosion surface and suggests exposure as a terrestrial landscape for a significant period of time. The elongate nature of the dunes and their alignment may suggest a possible buried coastline; and
- Small areas of acoustic blanking potentially indicating the presence of preserved organic material.

64. In NV West, Unit 5 is overlain by Unit 6 (Twente Formation) which is in turn overlain by pre-transgression Holocene deposits (Unit 7) comprising a number of features

and including a peat horizon in the northern half of NV West. This is indicative of an extensive terrestrial landscape in this area potentially forming preferentially on top of the aeolian sand deposits. A total of 12 pre-transgression fluvial features and 38 isolated cut and fill features, possibly the remnants of eroded palaeochannel systems, have also been identified associated with Unit 7

65. Features identified within the offshore cable corridor are shown on Figures 17.4 to 17.7. Unit 2 is present along most of the corridor with Unit 3 potentially present at the landfall location. Unit 4 is tentatively identified in association with palaeogeographic features and Unit 5 overlies Unit 4, where present, and Unit 2, becoming more intermittent closer to shore and completely absent by c. 30km from landfall. As in NV West some possible internal erosion surfaces have been identified within Unit 5 and five areas of dune features (75156, 75157, 75158, 75161 and 75162) are located within the westernmost outcrop of the unit, general smaller and less well developed than those in NV West. Small areas of acoustic blanking have also been identified within Unit 5. Unit 6 is mapped by the BGS but was not identified by Wessex Archaeology in the data.

66. Within the offshore cable corridor there are a number of pre-transgression Holocene features (Unit 7) potentially representing peat deposits (mainly 75140, 75142 and 75143), fluvial features (75131, 75144, 75150 and 75153), cut and fill features potentially the remnants of an eroded palaeochannel system (features (75135, 75148 to 75149, 75151, 75155, 75159 and 75163 to 75169) and complex cut and fill features with more than one phase of fill (75167 and 75168).

67. The archaeological potential associated with the above geological sequence and palaeogeographic features is described in detail in sections 4.2 and 4.3 of Appendix 17.1. In summary, the key areas of potential for seabed prehistory within the study area comprise:

- Potential for Lower Palaeolithic artefacts and landsurfaces protected by overlying Brown Bank Formation;
- Potential for Middle Palaeolithic artefacts associated with Unit 4 (Lower Brown Bank) where present in NV East, identified tentatively within the offshore cable corridor and sporadically in NV West as scattered remnants at the base of Unit 5;
- Potential for Middle Palaeolithic derived and *in situ* artefacts and intact organic material of palaeoenvironmental interest associated with Unit 5 (Brown Bank Formation) identified as a blanket deposit across the study area, particularly in association with channel features as seen in NV West and the offshore cable corridor;

- Potential for post-glacial Upper Palaeolithic *in situ* archaeological material and palaeoenvironmental material associated with Unit 6 in NV West and possibly in two small areas within the offshore cable corridor to the south of NV West;
- Potential for Mesolithic *in situ* archaeological material and palaeoenvironmental material associated with Unit 7. In particular:
    - The peat layer identified in NV West and the offshore cable corridor may represent a buried land surface and is considered of high archaeological and palaeoenvironmental potential, as it could contain *in situ* archaeological artefacts and preserved organic material;
    - The pre-transgression fluvial features identified in NV West and the offshore cable corridor are deemed to be of high archaeological interest as they may provide evidence of a former terrestrial environment and could contain both *in situ* or derived anthropogenic artefacts and preserved palaeoenvironmental material; and
    - The isolated cut and fill features identified in NV West and the offshore cable corridor may be the remnants of eroded palaeochannel systems although, as their nature is less certain, they are considered of lower archaeological potential.

17.6.2 Maritime and Aviation Archaeology

68. There are several previously recorded wrecks and obstructions charted by the UKHO (described below) although there are no known aircraft crash sites within the study area. Furthermore, there are no sites within the study area that are subject to statutory protection from the Protection of Wrecks Act 1973, the Protection of Military Remains Act 1986 or the Ancient Monuments and Archaeological Areas Act 1979.

69. Sidescan sonar, multibeam bathymetry and magnetometer data interpreted by Wessex Archaeology has demonstrated the presence of a number of seabed features which have been identified as being of archaeological interest (A1) or potentially of archaeological interest (A2 and A3). The technical specifications for the acquired data are detailed in section 3.3 of Appendix 17.1 and are summarised in Table 17.8 above.

70. Seabed features of archaeological interest are discriminated by Wessex Archaeology in accordance with the definitions set out in Table 17.10.

Table 17.10 Wessex Archaeology's criteria discriminating relevance of seabed features to proposed scheme (Appendix 17.1 Table 2)

Archaeological Discrimination		Description
Non-Archaeological	U1	Not of anthropogenic origin
	U2	Known non-archaeological feature
	U3	Position of a recorded loss at which no physical wreck remains have ever been identified
Archaeological	A1	Anthropogenic origin of archaeological interest
	A2	Uncertain origin of possible archaeological interest
	A3	Historic record of possible archaeological interest – UKHO reference to feature that shows no trace on seabed

71. In total 1475 features of archaeological interest or potential archaeological interest have been identified by Wessex Archaeology. Following revision of the offshore cable corridor, 1234 of these are now located within (or immediately adjacent to) the study area. These are summarised in Table 17.11 below and discussed in detail in Appendix 17.1.

Table 17.11 Features of archaeological potential within the study area

Archaeological Discrimination	Number of seabed features			Total
	NV East	NV West	Offshore Cable Corridor	
A1	5	11	26	**42**
A2	312	172	706	**1190**
A3	1	1	0	**2**
Total	**318**	**184**	**732**	**1234**
Gazetteer Reference (Appendix 17.1)	Appendix VI of Appendix 17.1	Appendix VII of Appendix 17.1	Appendix VIII of Appendix 17.1	
Figure Reference	Figure 17.8	Figure 17.9	Figures 17.10 to 17.17	

72. Within NV East there are four A1 anomalies and a further wreck of a submarine which is lying just outside the study area:

- 70021 is an unidentified, partially buried wreck with an associated magnetic anomaly indicating the presence of ferrous material. The wreck has not previously been charted by the UKHO (Appendix 17.1 Wreck Sheet 1);
- 70255 is an unidentified, badly damaged and partially buried wreck with associated debris (possibly up to 125m away i.e. 70248, 70253 and 70250) and a

strong magnetic anomaly indicating a significant amount of ferrous material. The wreck is located c. 35m from the recorded position of UKHO charted wreck ID 11213 (Appendix 17.1 Wreck Sheet 2);

- 70262 is an unidentified, intact wreck, lying on its side and partially buried with associated debris (70263 and 70265) and an associated magnetic anomaly indicating the presence of ferrous material. The wreck is charted by the UKHO ID 11214 (Appendix 17.1 Wreck Sheet 3);
- 70058 is an extremely strong magnetic anomaly (6587nT) without a corresponding sidescan sonar or bathymetry anomaly suggestive of a buried wreck with a significant amount of ferrous material in its construction. The wreck has not previously been charted by the UKHO;
- 71480 lies just outside NV East and is the wreck of a submarine (UKHO ID 79542) discovered in 2014.

73. There is a single A3 record within NV East (70079) which is an unidentified obstruction described by the UKHO (ID 11216) as very small contact first detected in 1994. No geophysical anomaly was identified at this location and it is possible that the object has since become buried.

74. Within NV West there are 11 A1 anomalies:

- 71334 is a large spread of debris indicating a very broken up wreck and associated with a large magnetic anomaly indicating a substantial quantity of ferrous material. The wreck is charted by the UKHO ID 11190 (Appendix 17.1 Wreck Sheet 4). Three further pieces of debris possibly associated with this wreck have also been discriminated as A1 (71332, 71333 and 71336) and it is considered likely that there is further buried debris in the vicinity of the wreck;
- 71301 is a debris field possibly indicative of a partially buried and previously uncharted wreck with a very large magnetic anomaly indicating a substantial quantity of ferrous material; and
- Six magnetic anomalies (71297, 71299, 71314, 71479, 71323 and 71325) with no associated surface expression which have the potential to be substantial buried ferrous debris. Two of the anomalies (71323 and 71325) are possibly associated with wreck 71334.

75. There is a single A3 record within NV West (71377) which is an area of foul ground (an area charted by the UKHO over which it is safe to navigate but which should be avoided for anchoring) described by the UKHO (ID 11236). Nothing anthropogenic was identified here in the geophysical data.

76. Within the offshore cable corridor there are 26 A1 anomalies. Sixteen of these are wrecks which have previously been charted by the UKHO:

- Anomaly 70342 *Golden Oriole* (possibly) (UKHO ID 11091) (Appendix 17.1 Wreck Sheet 5);
- Anomaly 70360 HMS *Dunoon* (possibly) (UKHO ID 11093) (Appendix 17.1 Wreck Sheet 6);
- Anomaly 70459 *Phillipp M* (UKHO ID 11092) (Appendix 17.1 Wreck Sheet 7);
- Anomaly 70565 unknown wreck (UKHO ID 10722) (Appendix 17.1 Wreck Sheet 8);
- Anomaly 70617 *Rye* (UKHO ID 10544) (Appendix 17.1 Wreck Sheet 9);
- Anomaly 70639 *Trevethoe* (UKHO ID 10546) (Appendix 17.1 Wreck Sheet 10);
- Anomaly 70645 unknown wreck (UKHO ID 82114) (Appendix 17.1 Wreck Sheet 11);
- Anomaly 70659 unknown wreck (UKHO ID 10849) (Appendix 17.1 Wreck Sheet 12);
- Anomaly 70704 unknown wreck (UKHO ID 10545) (Appendix 17.1 Wreck Sheet 13);
- Anomaly 70709 *Montferland* (UKHO ID 10549) (Appendix 17.1 Wreck Sheet 14);
- Anomaly 70744 unknown wreck (UKHO ID 10548) (Appendix 17.1 Wreck Sheet 15);
- Anomaly 70809 *Seagull* (UKHO ID 10550) (Appendix 17.1 Wreck Sheet 16);
- Anomaly 70834 *Xanthe* (UKHO ID 10660) (Appendix 17.1 Wreck Sheet 17);
- Anomaly 70934 *Sheaf Water* (UKHO ID 10554) (Appendix 17.1 Wreck Sheet 18);
- Anomaly 70954 unknown wreck (UKHO ID 10680) (Appendix 17.1 Wreck Sheet 19). Associated with A2 rope or chain feature 70960; and
- Anomaly 70962 *Fulgens* (UKHO ID 10556) (Appendix 17.1 Wreck Sheet 20). Associated with A2 debris field 70958 and four A2 anomalies interpreted as a likely rope or chain 70952, 70955, 70956 and 70959.

77. In addition to these wrecks there are 10 further A1 anomalies comprising six pieces of debris (70460, 70618, 70640, 70784, 70832 and 70833), three debris fields (70785, 70810 and 70958) and a very large magnetic anomaly (70615).

78. A total of 1190 anomalies have been interpreted as A2 (uncertain origin of possible archaeological interest). The types of features identified are summarised in Table 17.12 and described in detail in Appendix 17.1.

Table 17.12 Types of A2 features within the study area

Type of feature	NV East	NV West	Offshore Cable Corridor	Total
Debris	16	18	45	**79**
Debris Field	6	13	25	**44**
Seafloor Disturbance	17	13	4	**34**

Type of feature	NV East	NV West	Offshore Cable Corridor	Total
Bright Reflector	4	15	19	**38**
Dark Reflector	116	79	114	**309**
Rope/Chain	11	2	30	**43**
Magnetic	142	31	463	**636**
Mound	0	1	6	**7**
Total	**312**	**172**	**706**	**1190**

79. Seabed features interpreted as A2 have been identified as being of possible anthropogenic origin and have the potential to represent archaeological material on the seabed of maritime or aviation origin. Magnetic only anomalies (without visible surface expression) have the possibility to be buried objects with ferrous content that are of archaeological potential.

80. There is also potential for the presence of further maritime archaeological material to be present, dating from the Mesolithic period up to the present day, which has not previously been identified. A deposit of post-transgression Holocene marine sediment (Unit 8) is present across the study area which varies in thickness from a thin veneer to sand banks up to 15m thick. This sediment could periodically bury and expose archaeological material in areas of mobile sediment. An overview of maritime archaeological potential, summarised by Wessex Archaeology, is presented in Table 17.13.

Table 17.13 Summary of key areas of maritime potential (Appendix 17.1 Table 14)

Period	Summary
Pre-1508 AD	Low potential for material associated with prehistoric maritime activities. Prehistoric maritime activities include coastal travel, fishing and the exploitation of other marine and coastal resources. Vessels of this period include rafts, hide covered watercraft and log boats.
	Low potential for material associated with later prehistoric maritime activities, including seaworthy watercraft suitable for overseas voyages to facilitate trade and the exploitation of deep water resources. Such remains are likely to comprise larger boat types, including those representing new technologies such as the Bronze Age sewn plank boats which are associated with a growing scale of seafaring activities.
	Low potential for material of Romano-British date, associated with the expansion and diversification of trade with the Continent. Watercraft of this period, where present, may be representative of a distinct shipbuilding tradition known as 'Romano-Celtic' shipbuilding, often considered to represent a fusion of Roman and northern European methods.
	Low potential for material associated with coastal and seafaring activity in the 'Dark Ages', associated with the renewed expansion of trade routes and Germanic and Norse invasion and migration. Vessels of this period may be representative of new shipbuilding traditions such as the technique.

Period	Summary
	Low potential for material associated with medieval maritime activity, including that associated with increasing trade between the UK and Europe, the development of established ports around the southern North Sea and the expansion of fishing fleets and the herring industry. Vessels of this period are representative of a shipbuilding industry which encompassed a wide range of vessel types (comprising both larger ships and vernacular boats). Such wrecks may also be representative of new technologies (e.g. the use of flush-laid strakes in construction), developments in propulsion, development of reliable navigation techniques and the use of ordnance.
1509 to 1815	Medium potential for post-medieval shipwrecks representative of continuing technological advances in the construction, fitting and arming of ships, and in navigation, sailing and steering techniques. Vessels of this period continued to variously represent both the clinker techniques and construction utilising the flush-laid strakes technique.
	Medium potential for post-medieval shipwrecks associated with the expansion of transoceanic communications and the opening up of the New World.
	Medium potential for post-medieval shipwrecks associated with the establishment of the Royal Navy during the Tudor period and the increasing scale of battles at sea.
	Medium potential for post-medieval shipwrecks associated with continuing local trade and marine exploitation including the transport of goods associated with the agricultural revolution.
1816 to 1913	Higher potential for the discovery of shipwrecks associated with the introduction of iron and later steel in shipbuilding techniques. Such vessels may also be representative of other fundamental changes associated with the industrial revolution, particularly with regards to propulsion and the emergence of steam propulsion and the increasing use of paddle and screw propelled vessels.
	Higher potential for the discovery of shipwrecks demonstrating a diverse array of vernacular boat types evolved for use in specific environments.
	Higher potential for wrecks associated with large scale worldwide trade, the fishing industry or coastal maritime activity including marine exploitation.
1914 to 1945	Higher potential for the discovery of shipwrecks associated with the two world wars including both naval vessels and merchant ships. Wrecks of this period may also be associated with the increased shipping responding to the demand to fulfil military requirements. A large number of vessels dating to this period were lost as a result of enemy action.
Post- 1946	Potential for wrecks associated with a wide range of maritime activities, including military, commerce, fishing and leisure. Although ships and boats of this period are more numerous, loses decline due to increased safety coupled with the absence of any major hostilities. Vessels dating to this period are predominantly lost as a result of any number of isolated or interrelated factors including human error, adverse weather conditions, collision with other vessels or navigational hazards or mechanical faults.

81. Similarly, although there are no known aircraft crash sites within the study area, there is potential for the discovery of previously unknown aircraft material, also associated with Unit 8. An overview of maritime archaeological potential, summarised by Wessex Archaeology, is presented in Table 17.14.

Table 17.14 Summary of key areas of aviation potential (Appendix 17.1 Table 14)

Period	Summary
Pre- 1939	Minimum potential for material associated with the early development of aircraft. Aircraft of this period may represent early construction techniques (e.g. those constructed of canvas covered wooden frames) or may be associated with the mass-production of fixed wing aircraft in large numbers during WWI.
	Minimum potential for material associated with the development of civil aviation during the 1920s and 1930s, associated with the expansion of civilian flight from the UK to a number of European and worldwide destinations.
1939 to 1945	Very high potential for WWII aviation remains, particularly as the east coast acted as a hub for hostile activity. Aircraft of this period are likely to be representative of technological innovations propelled by the necessities of war which extended the reliability and range of aircraft.
Post- 1945	Potential for aviation remains associated with military activities dominated by the Cold War, the evolution of commercial travel and recreational flying and the intensification of offshore industry (including helicopter remains). Aircraft of this period may be representative of advances in aerospace engineering and the development of the jet engine

17.6.3 Intertidal Archaeology

82. Although long HDD will pass beneath the beach, the archaeological potential of the intertidal zone is included for completeness.

83. There are 17 previously recorded heritage assets within the intertidal zone (up to MHWS) at the landfall at Happisburgh South. These are described in detail in Appendix 17.1.

84. Thirteen of the records relate to findspots of prehistoric material on the beach (positions at which finds have previously been discovered and recorded but at which material is no longer present):

- 1001 to 1008, 1018 and 1025 are chance finds of prehistoric flint artefacts;
- 1010 relates to the Lower Palaeolithic lithic working and butchery site known as Happisburgh Site 1; and
- 1034 and 1035 are chance finds of Bronze Age artefacts on Happisburgh beach.

85. One of the records is a multi-period findspot (1033) with artefacts ranging in date from the prehistoric to post-medieval period.

86. Two of the records relate to medieval findspots: 1037, an early Saxon silver pyramid mount; and 1038, a late 12th or 13th century gold ring.

87. The final record, 1045, is the site of Happisburgh Low Lighthouse, one of two lighthouses erected in Happisburgh in 1791. By 1886 it is recorded that the lighthouse had fallen into the sea although a survey in 1980 noted that remains of

part of the foundations still survived *in situ* exposed in the cliff, although the majority of the remains lay on the beach or had been covered over by sand.

88. An intertidal walkover was carried out by Royal HaskoningDHV in November 2017 in order to ground truth the recorded locations of these intertidal assets. At the site of the Happisburgh low lighthouse (1045), scattered red brick was observed, dispersed in the broad location of the recorded position located behind the former, now ruined, breakwaters (Plate 17.1).

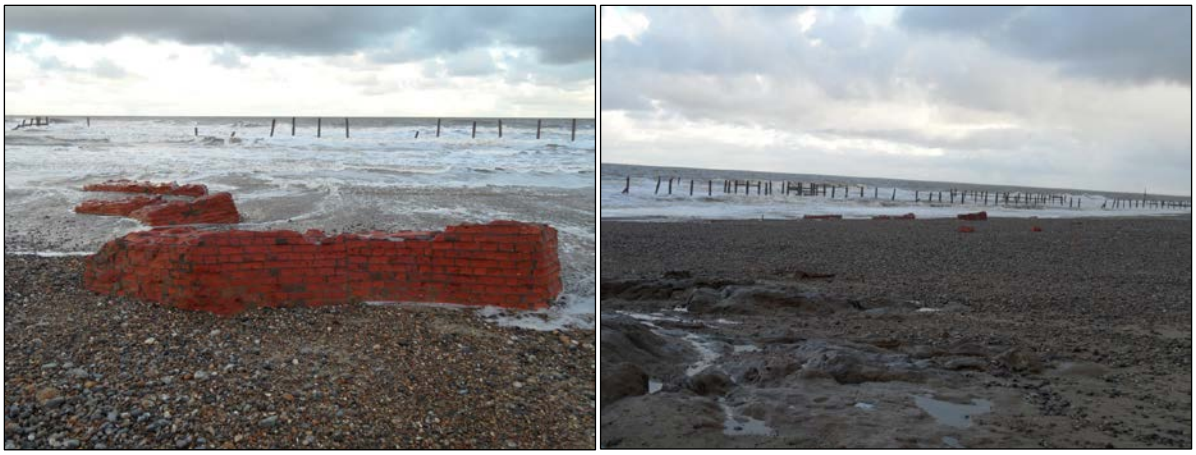

Plate 17.1 Potential remains of Happisburgh Low Lighthouse observed during site visit

89. No further remains were observed which could be formally correlated to a previously recorded heritage asset although scattered, brick, stone, breeze blocks and large flints were observed further along the beach just to the north west of the landfall (Plate 17.2).

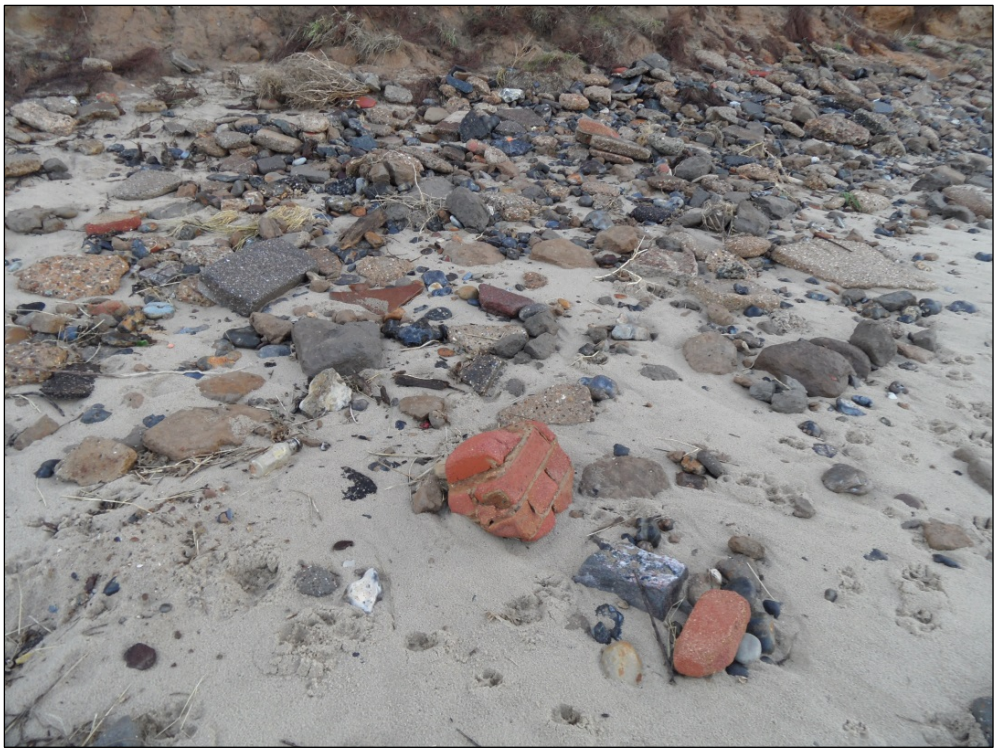

Plate 17.2 Scattered debris relating to previously extant structures observed during site visit

90. Similarly, a borehole (BH17-L1A-05) drilled on the beach and monitored by Wessex Archaeology (Appendix 28.6) comprised 1.8m of coarse beach sand containing fragments of brick, interpreted as having resulted from a former or denuded brick built structure (e.g. a pillbox). Military features are prevalent along this stretch of coastline and the former locations of (now demolished) features such as pillboxes, Second World War coastal defences, a coastal battery and a machine gun post are recorded in the vicinity of the landfall however, these features are now outside the study area (see Appendix XIII and Figure 17 of Appendix 17.1).

91. In order to confirm if any further, more recent finds are known from the intertidal area, the CITiZAN baseline dataset of coastal and intertidal sites and features was also accessed. As the database is updated regularly by project members and volunteers this provides an opportunity to take advantage of recently collected information. However, no further finds are recorded from within the intertidal zone at the landfall, with the only record being that of a Palaeolithic flint implement, 'found in the parish of Happisburgh' and already captured in the HER data (1025).

92. In addition to the 17 previously recorded assets there is further potential for archaeological material to be present buried within the intertidal zone. Of particular significance is the potential for prehistoric material.

93. Lower Palaeolithic sites excavated at Happisburgh and at Pakefield on the Suffolk coast represent the earliest known evidence for Hominin activity in the UK dating

from *c.* 800,000 and 700,000 BP respectively. Both sites pre-date the earliest known glaciation of the UK and the finds and palaeoenvironmental evidence discovered within the Cromer Forest Bed Formation at these locations are of international importance for studies of the Palaeolithic. Approximately 800m further north along the coast from the landfall, severe wave erosion in May 2013 exposed a series of elongated hollows identified as Hominin footprints within an extensive area of laminated sediments on the foreshore. This exposed surface was formed between 1 million and 0.78 million years ago, making the Happisburgh features the oldest known hominin footprints found outside of Africa.

94. The exposed footprints (1017 in Appendix 17.1) and other early hominin sites at Happisburgh were investigated between 2005 and 2013 by the AHOB project. These sites have pushed back the known record of human occupation of northern Europe by at least 350,000 years and continuing erosion of the coastline is expected to reveal further evidence which will contribute to our understanding of the earliest human occupation of northern latitudes. The potential for further Palaeolithic material of international importance to be present within the study area at the landfall is, therefore, considered to be high where Cromer Forest Bed Formation survives *in situ*.

95. However, no deposits resembling the Cromer Forest-Bed Formation were encountered at the landfall during onshore ground investigations for the Norfolk Vanguard Project (Appendix 28.6). Sands clays and gravels recorded beneath surface deposits (topsoil and beach sand) are understood to be glacial in origin with a likely origin correlating to suggestions from the AHOB team that a large doline-type geological feature (sinkhole or solution feature) is present, infilled with glacial deposits. The geoarchaeological assessment of the onshore cores concludes that if Cromer-Forest-Beds do survive, they are likely to be found at significant depth (> 20mbgl). The potential for *in situ* Palaeolithic archaeological material to be encountered at the landfall is, therefore, anticipated to be low given the depths of glacial till seen in the boreholes. This is discussed further with respect to potential impact of HDD at the landfall in section 17.7.6.2 below.

17.6.4 Historic Seascape Character and Setting

96. The Historic Seascape Character (HSC) of coastal and marine areas around England has been mapped through a series of projects funded by Historic England. The programme uses GIS to map data that can be queried to identify the key cultural processes that have shaped the historic seascape within a given area. The study area is located within the East Yorkshire to Norfolk HSC, undertaken by the projects team of the School of History, Classics and Archaeology at Newcastle University (2014).

97. The primary cultural processes which have shaped the historic seascape of the study area, and the primary values and perceptions for each character type as defined by Newcastle University (2014), are set out in Table 17.15 below.

Table 17.15 HSC – primary cultural processes in the study area (Appendix 17.1 Table 17)

Present Broad Character Types	Present Character Sub-Types	Present Perceptions (Newcastle University, 2014)
Cultural Topography	Landward mobile cliffs	The cliffs are important from a much longer view into the past. These act as repositories for fossils including evidence of the earliest occupation of northern Europe.
	Marine sand banks with sand waves	The marine cultural topography has high archaeological potential, and can contribute to our understanding of past landscape use.
	Palaeolandscapes	Value is becoming more positive on these remains and resource due to growing interest in submerged landscapes fuelled by the media and popular culture. Developing interest within certain sectors of society who come into contact with the resource (e.g. fishermen and aggregate dredgers). Submerged landscapes are becoming ever more recognised and valued within the archaeological community.
Coastal Infrastructure	Flood and erosion defences	Flood and erosion defences are considered by many coastal communities to be essential. Groynes and breakwaters are a common sight along the East Anglian beaches today, and not only have a role in reducing long-shore drift, but are also perceived as part of the recreational landscape.
Communications	Submarine telecommunication cables	Submarine telecommunications cables are mostly undetected in the marine environment. However, they are a highly reliable form of transferring information and are critical to our present-day life. They can be perceived as obstacles to certain sea users such as fishermen and dredgers.
Fishing	Aquaculture – cultivated shellfish	Modern aquaculture is increasingly coming to the attention to the wider general public because of its concern as a sustainable practice. Therefore, modern perceptions of aquaculture are often related to the destruction of the fish resource and the seabed.
	Inshore fisheries	Commercial fishing has long been important to this region and the industry remains a distinctive element of the East Anglian coastal character. Generally fishing fleets today have distinct fishing grounds, predominantly within 10 km of their home port. As such the local fishermen from each area know their particular area intimately. From a recreational point of view the traditional fishing industry has now taken on an almost 'quaint' character, a memory of better days.
	Offshore fishing grounds – trawling, netting, longline, potting	

Present Broad Character Types	Present Character Sub-Types	Present Perceptions (Newcastle University, 2014)
Industry	Energy industry – gas supply pipeline	The North Sea as a whole has always been important to the energy industry, most notably for its natural oil and gas resources which have been heavily exploited since the 1960s. More recently nuclear power and renewable energy sources have become viewed as more important as a result of increasing concerns about CO_2 emissions from energy generation using fossil fuels. The North Sea and in particular the East Anglian coast has remained crucial to these newer energy industries
	Extractive industry – marine aggregates dredging	Aggregate extraction has a strong economic value to the area, employing large numbers of people both offshore, landward and at wharves and docks. Many people believe that the extensive dredging off the East Anglian coast is contributing to increasingly severe coastal erosion. In terms of the historic environment, aggregate dredging has been perceived as destructive of past landscapes and features.
Military	Military defence and fortification	Overall the defence heritage along the coastline in this area is perceived by most as being an important aspect of the landscape. This applies to both what is represented by the fortifications and more practically to the value of structures such as Orford castle as navigation aids.
Navigation	Maritime safety – lighthouse	Overall maritime safety features are considered both invaluable and locally characteristic of this area, although those located wholly offshore will only be known to small sectors of the community. The coastal landscape is dotted with daymarks and lighthouses which are now seen as particularly iconic.
	Navigation route	Navigation activity has always been important to the East Anglian region economy and coastal character. For centuries communities have made their living from their proximity to the North Sea and its connecting routes, linking East Anglia to other parts of Britain and to the continent. Navigation activities are deeply ingrained in the psyche of the local communities.

98. The setting of a heritage asset is described as the surroundings in which a heritage asset is experienced (Historic England, 2017). Elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to appreciate that significance or may be neutral.

99. The assessment of setting for offshore heritage assets for this project is focused on the physical setting (i.e. historic associations and character) rather than the ways in which views, for example, contribute to the significance of an asset. Historic England's guidance on setting (2017) notes how the setting of buried heritage assets

may not be readily appreciated by a casual observer, but retains a presence in the landscape. In the case of submerged heritage assets, although some wreck sites have a setting which can be experienced and appreciated within their seascape, by divers or visitors on boat trips for example (e.g. wreck sites at the Needles on the Isle of Wight) most submerged archaeological sites are not 'readily appreciated by a casual observer'.

100. Within NV East and NV West, all wrecks and anomalies are currently unidentified and as such there is no further information which can be used to ascertain the contribution the setting makes to their significance. Similarly, six of the wrecks and all the anomalies within the offshore cable corridor are unidentified and without additional information.

101. The wrecks *Seagull* (70809) and *Xanthe* (70834) are both 19th century wreck sites lost by chance through isolated collision events, and their setting is limited to the immediate vicinity of the wrecks and not considered to contribute to the significance of the wrecks as heritage assets.

102. The study *East Coast War Channels in the First and Second World War* (Firth, 2014) examines the spatial extent of navigation channels and minefields between the Thames and the Scottish border during both wars and the heritage assets that are associated with these channels. Together with the presence of military installations within the intertidal zone, the context of the East Coast war channels represents the wider setting of 20th century military activity within which the study area is located. There are two wrecks lost during WWI, *Golden Oriole* (70342) and *Fulgens* (70962) both sunk in 1915, and seven during WWII HMS *Dunoon* (70360), *Phillipp M* (70459), *Rye* (70617), *Trevethoe* (70639), *Montferland* (70709) and *Sheaf Water* (70934). The use and loss of the wrecks against the wider backdrop of hostile military action along the east coast means that their setting should be considered to contribute to their significance.

103. There is also potential for the presence of wrecks associated with battles of the Anglo-Dutch wars which, if discovered, may be considered to have a setting as part of this wider Anglo-Dutch conflict. For example, a total of 20 Dutch ships and two English vessels were lost during the Battle of Lowestoft (1665) with three Dutch ships and four ships from the combined English and French fleet lost at the Battle of Sole Bay (1672). The location of both of these battles is recorded to the south of the study area.

104. Of the 17 previously recorded heritage assets within the intertidal zone, 16 relate to findspots of material no longer present at the recorded locations and their setting is not therefore considered to contribute to the significance of those assets. Similarly, the Happisburgh Low lighthouse (1045) was destroyed due to sea erosion and is no

longer *in situ*, represented by surviving masonry sections and rubble on the beach only, and its setting is not considered to contribute to its significance. The setting of intertidal heritage assets is therefore not considered further within this report.

17.6.5 Anticipated Trends in Baseline Conditions

105. The existing environment for offshore archaeology and cultural heritage as set out above has been shaped by a combination of factors, with the most prevalent being changes in global sea levels and associated climatic and environmental conditions which have affected the burial and preservation of prehistoric archaeology, and latterly that of maritime and aviation archaeology.

106. Although sea levels are comparatively stable at present, cycles of burial and exposure resulting from marine physical processes, including storm events which can result in the stripping of shallow sediment from the seabed and beach, have an ongoing effect upon the preservation of archaeological material. Exposed heritage assets are at greater risk from erosion and degradation as a result of the effects of physical processes than those which remain buried and are consequently provided with greater protection from continued sediment cover. These cycles of burial and exposure are anticipated to continue although the effect upon individual heritage assets is difficult to predict as this will depend upon site specific conditions and will vary depending upon the nature of any exposed archaeology.

107. Sea-level rise and climate change are two predominant factors thought to contribute to the rapid coastal erosion at this stretch of coastline, with historical records indicating the loss of over 250m of land between 1600 and 1850 at Happisburgh[1]. The parish of Whimpwell (formerly to the east of Happisburgh), has long since eroded away with many once terrestrial heritage assets lost to the sea. Cliff erosion in particular is therefore of heightened public concern in East Anglia and is having an adverse impact in terms of the erosion and exposure of archaeological remains from the cliffs. This trend is anticipated to continue although archaeology which is exposed, investigated and recorded to professional standards may also be considered a public benefit in terms of understanding of the archaeological record, as at Happisburgh and Pakefield for example.

108. Within the study area there has been minimal previous impact associated with sea-use and development activity. The HSC has recorded the presence of submarine telecommunication cables and gas supply pipelines. Marine aggregate dredging is also recorded by the HSC although there are no licenced areas within the study area with the offshore cable for Norfolk Vanguard passing north of marine aggregate extraction areas offshore from Great Yarmouth. Previous impacts are also likely to

[1] http://www.bgs.ac.uk/landslides/happisburgh.html

have occurred through fishing activities. Damage caused by trawling and nets snagged on wrecks, for example, are a primary cause of damage to archaeological materials in the marine environment.

109. Given that the study area extends across a marine area, fishing is likely to continue in most areas. Whilst fishing activities have the potential to result in the gradual degradation and / or disturbance of archaeological remains, due to the longevity of fishing activity within and surrounding the offshore project area, physical impacts upon archaeological remains are considered likely to have largely already occurred. This may have resulted in their loss in part or to disturbing the relationship between assets and their wider surroundings. Given modern improvements in navigation accuracy (GPS), the effective identification and recording of the locations of potential obstructions (such as wrecks) on the seabed and a desire to avoid interactions during fishing to prevent damage to fishing equipment, it is anticipated that ongoing impacts are less likely to occur in the future. Further impacts are, however, possible which may result in new and further loss and / or disturbance, especially where trawling is employed. The degree of impact from fishing, however, is difficult to predict based on available data and ability to anticipate the extent of future fishing activities.

110. The installation of modern infrastructure, such as submarine cables and pipelines, within the offshore project and surrounding areas has also shaped the existing environment, with the historic environment having been and continuing to be vulnerable to the impacts of development in both a physical (direct) and non-physical (indirect - e.g. relating to the setting of heritage assets or impacts associated in changes to physical processes) manner. With regards to physical impacts, developments undertaken to date have often resulted in the discovery of heritage assets, comprising wrecks and aircraft and associated debris, identified through geophysical survey for example. Those identified and archaeologically recorded to date are included within the baseline conditions described above.

111. However, due to the policy trend in the UK (see section 17.2), which recognises that heritage assets are an irreplaceable resource, it is anticipated that whilst the development of modern infrastructure could result in changes to buried archaeological remains, the information acquired from any archaeological site or feature subject to direct impact will be retained and made publicly available following proportionate mitigation approaches. Development also presents opportunities to develop and further enhance the archaeological record.

112. There is a requirement in UK policy to take into account the desirability of sustaining and enhancing the significance of heritage assets and their setting. As such, the historic character and setting of heritage assets may be subject to change, although the degree of change will depend on the public benefit of proposed developments as

part of a weighted approach to decision making, in order for sustainable development to take place and for heritage assets to be safe-guarded in a manner that is both proportionate and appropriate to the significance of known assets, as well as any new sites / remains identified, their level of survival, as well as other factors.

The baseline conditions for offshore archaeology and cultural heritage (particularly with respect to non-designated sub-surface remains) are therefore considered to be subject to a gradual decline on the basis of the effects of physical processes, ongoing marine activities and development within the offshore project and surrounding areas, although the degree to which any change is likely to occur is difficult to predict based on information available to date. The sensitivity of offshore archaeology and cultural heritage as a non-renewable resource has been considered within this chapter and informs the embedded and ongoing mitigation strategy to be further developed and adopted by the project post-consent (see section 17.7.2) so that impacts can be avoided, reduced or offset, as and where appropriate.

17.7 Potential Impacts

17.7.1 Types of Impact

113. Potential impacts to heritage assets within the study area include both direct and indirect impacts.

114. Direct impacts to heritage assets, either present on the seafloor or buried within seabed deposits, may result in damage to, or total destruction of, archaeological material or the relationships between that material and the wider environment (stratigraphic context or setting). These relationships are crucial to developing a full understanding of an asset. Such impacts may occur if heritage assets are present within the footprint of elements of the proposed scheme (i.e. foundations or cables) or within the footprint of activities such as seabed clearance, anchoring or the placement of jack up barges.

115. The proposed project also has the potential to directly and indirectly change the hydrodynamic and sedimentary process regimes, both locally and regionally. Changes in coastal processes can lead to re-distribution of erosion and accretion patterns, while changes in tidal currents, for example, may affect the stability of nearby morphological and archaeological features. Indirect impacts to heritage assets may occur if buried heritage assets become exposed to marine processes, due to increased wave/tidal action for example, as these will deteriorate faster than those protected by sediment cover. Conversely, if increased sedimentation results in an exposed site becoming buried this may be considered a beneficial impact.

116. Indirect impacts to setting may occur if a development affects the surroundings in which a heritage asset is experienced. Similarly, impacts to the historic seascape character may occur with the introduction of new elements causing a change in that character which may affect present perceptions of that seascape across an area.

117. Following consultation with Historic England, two further types of impact have also been assessed relating to the potential effects upon site preservation conditions; the potential for drilling fluid breakout during HDD (section 17.7.6.5) and impacts due to heat loss from electrical cables (section 17.7.7.5).

17.7.2 Embedded Mitigation

118. Norfolk Vanguard Limited has committed to a number of techniques and engineering designs/modifications inherent as part of the project, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process.

119. A range of different information sources has been considered as part of embedding mitigation into the design of the project (for further details see Chapter 5 Project Description, Chapter 4 Site Selection and Assessment of Alternatives) including engineering requirements, ongoing discussions with stakeholders and regulators, commercial considerations and environmental best practice.

120. In order to prevent significant impacts, the following mitigation has been embedded in the project design and secured through conditions set out in the DCO (and DML):

- 50m AEZs around the extents of known wreck sites (A1s) and 50m around the point locations of A1 magnetic only anomalies within which no development related activities will take place;
- Avoidance where possible of identified anomalies (A2s) or previously recorded sites that have not been seen in the geophysical data (A3s) by micro-siting of design;
- Further investigation of any identified anomalies (A2s) or previously recorded sites that have not been seen in the geophysical data (A3) that cannot be avoided by micro-siting of design;
- Further examination of potential prehistoric deposits including geoarchaeological recording of core samples, deposit modelling and archaeological input into any future sampling programme/s;
- In the event of impact to potential sites, the establishment of a formal protocol to ensure that any finds are promptly reported, archaeological advice is obtained, and any recovered material is stabilised, recorded and conserved;

- Watching briefs where seabed material is brought to the surface, for example during pre-lay grapnel runs;
- Watching briefs for any intrusive works carried out in the landfall zone (during long HDD); and
- The archaeological assessment of any further geophysical data.

121. As stated above, the primary means of preventing impacts to known heritage assets is avoidance. It is also noted that proposed AEZs may be reduced, enlarged or removed in agreement with Historic England if further relevant information becomes available. However, unless modified by agreement, it is important that AEZs are retained throughout the project lifetime and monitoring of AEZs may be required by the regulator and curator to ensure adherence both during construction and in the future operation of the wind farm.

122. If anomalies cannot be avoided then additional work may be required to further investigate the nature and extent of anomalies, to establish the archaeological interest and to record them prior to removal. The methodology for such works will be set out post-consent in a WSI in accordance with the outline WSI (document reference 8.6) and agreed with Historic England prior to works commencing. Historic England will also be consulted on the scope of all further post-consent geophysical and geotechnical surveys undertaken for the project in order to ensure that the data generated are sufficiently robust to enable professional archaeological interpretation and analysis.

123. In order to account for unexpected discoveries of archaeological material during construction, operation and decommissioning, a formal protocol will be established. It is recommended that if any objects of possible archaeological interest are encountered, that they should be reported using the established *Protocol for Archaeological Discoveries: Offshore Renewables Projects (The Crown Estate, 2014)* (ORPAD). This will establish whether the objects are of archaeological interest and recommend appropriate mitigation measures where necessary.

124. A draft Outline WSI (document reference 8.6) setting out the methodology for all proposed embedded mitigation has been prepared following consultation with Historic England for submission alongside the DCO application for the project. The WSI takes account of the standards and guidance presented in *Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects* (The Crown Estate, 2010).

17.7.3 Monitoring

125. An In-Principle Monitoring Plan (document reference 8.12) is submitted with the DCO application. The In–Principle Monitoring Plan confirms that the primary mechanism for delivery of monitoring for offshore archaeology is through agreement

on the offshore WSI (as required under [condition 14(1)(h) (DCO Schedules 9 and 10) and 9.(1) (h) (DCO Schedules 11 and 12)] of the DMLs). The offshore WSI will be agreed with Historic England and the MMO. An outline offshore WSI (document reference 8.6) has been submitted with the DCO application.

17.7.4 Worst Case

126. The worst case scenario for archaeology below MHWS is based upon the general assumption that the greatest potential footprint for the project represents the greatest potential for direct impacts (e.g. damage / destruction) to surviving archaeological material. This equates to:

- The greatest potential area of direct contact with the sea floor/landfall zone;
- The maximum number of locations at which direct contact may occur (e.g. maximum number of foundations, cables, jack up feet or anchors); and
- The greatest volume of disturbed seabed sediments and intertidal deposits.

127. The worst case scenario for indirect impacts equates to those aspects of the development which result in the greatest potential for increased scour and sediment stripping across an area as a result of changes to physical processes. Conversely, those aspects of the development which result in the greatest increase in sediment deposition also represent the greatest potential effect in terms of the beneficial impact of increased protection for archaeology.

128. The worst case scenario for the disturbance of setting and character equates to the maximum intrusive effect (e.g. number and type of new infrastructure elements, height of infrastructure) for the longest duration.

129. Offshore infrastructure for Norfolk Vanguard includes wind turbines, offshore electrical platforms, accommodation platforms, met masts, array cables, interconnector cables and export cables (see Table 17.16).

130. Norfolk Vanguard may be constructed as a single phase or two phases with a total capacity of up to 1800MW. The different phasing scenarios may affect the construction programmes as detailed in Chapter 5 Project Description. However, the infrastructure requirements are the same for each phase and therefore the phasing scenarios would have no effect on archaeology.

131. The full construction window is expected to be up to approximately four years, although this may include periods of no on site construction activity.

132. The layout of the wind turbines would be defined post-consent but would be based on the following maxima:

- Up to 1800MW in NV East, 0MW in NV West; or

- 0MW in NV East, up to 1800MW in NV West.

133. Any other potential layouts that are considered up to a maximum of 1800MW (e.g. 1,200MW in NV West and 600MW in NV East, 600MW in NV West and 1,200MW in NV East or 900MW in NV West and 900MW in NV East) lie within the envelope of these maxima scenarios.

134. The worst case assumptions relevant to the assessment of archaeology below MHWS are set out in Table 17.16. The parameters for the worst case scenarios are based upon the project description included in Chapter 5 and take account of the embedded mitigation described in section 17.7.2 above. As the embedded mitigation includes the avoidance of known heritage assets (through AEZs or through micrositing) where possible, impacts arising from the project layout would only become relevant if known heritage assets could not be avoided.

135. The worst case layout for each of NV West and NV East will be that which corresponds to the most number of known heritage assets which cannot be avoided. As this is location specific, this cannot be known until after the layout is defined. For this reason, the worst case for the project as a whole (i.e. the maximum overall potential disturbance of the seabed from individual parameters across the project) is considered in Table 17.16.

Table 17.16 Worst Case Assumptions

Impact	Parameter	Notes
Construction		
Direct impact to known heritage assets	Seabed preparation	Direct impacts to known heritage assets are not anticipated to occur due to the application of embedded mitigation comprising: • AEZs around A1 anomalies prohibiting development activities within their boundaries; and • Micrositing by design to avoid A2 and A3 anomalies.
	Installation of Wind Turbine foundations	
	Installation of ancillary infrastructure	
	Installation of offshore cabling	
	Seabed contact by legs of jack-up vessels and / or anchors (installation)	
	Cable installation at the landfall	
Direct impact to potential heritage assets	Disturbance footprints in the OWF sites due to cable laying operations, jack-up operations and seabed preparation works for turbine foundations	Maximum total seabed preparation area for 1800MW capacity (all in NV East, all in NV West or split between NV East and NV West): • 90 x 20MW floating platforms with gravity anchors foundations (requiring prep area of approximately 90 x 90m) = 729,000m^2. • Two offshore electrical platforms seabed preparation = 15,000m^2 (75m x 100m per platform) • Two accommodation platforms based on 60m diameter seabed preparation = 15,000m^2 (75m x

Impact	Parameter	Notes
		100m per platform) • Two met masts based with 40m diameter seabed preparation = 2,513m^2 • Array cable trench – 600km length with average 20m pre-sweeping width = 12,000,000m^2 • Interconnector cable trench 150km with 20m pre-sweeping width = 3,000,000m^2 (in the OWF sites and/or in the offshore cable corridor between NV East and NV West depending on the location of electrical platforms) • Jack up vessel footprints assuming 2 vessel movements per turbine = 316,800m^2 • Vessel anchor footprints (one vessel anchoring per turbine) = 30,000m^2 • Jack up vessel footprints assuming 2 vessel movements per offshore platform = 9,504m^2 • Boulder clearance – 53 boulders of up to 5m diameter = 1,041m^2 **Worst case scenario total disturbance footprint = 16.1km^2** Any other works associated with cable installation would be encompassed within the footprints outlined above. Maximum volume of seabed preparation: • 200 x 9MW turbines on GBS foundations (based on area described in Impact 1 and levelling depth of up to 5m) = 3,645,000m^3. • Two offshore electrical platforms based on area described in Impact 1 and 5m depth = 75,000m^3 • Two accommodation platforms based on area described in Impact 1 and 5m depth = 75,000m^3 • Two met masts based on area described in Impact 1 and 5m depth = 12,566m^3 • Array cable trench – 600km length with average 20m pre-sweeping width and 3m depth = 36,000,000m^3 • Interconnector cable trench 150km with average 20m pre-sweeping width and 3m depth = 9,000,000m^3 (in the OWF sites and/or in the offshore cable corridor between NV East and NV West depending on the location of the offshore electrical platforms) • Sediment disposal from export cable pre-sweeping in the OWF sites = 1,800,000m^3 **Worst case scenario total disturbance volume = 48,807,566m^3**
	Seabed preparation and cable installation in the offshore cable corridor	• Boulder clearance = 432m^2 (up to 22 boulders of 5m diameter) • Pre-sweeping area which could be outside the

Impact	Parameter	Notes
		ploughing area – 72,000m² (based on minimum overlap of pre-sweeping area and ploughing footprint, as described above) • Maximum temporary disturbance for cable installation by ploughing = 6,000,000m² based on: o Maximum total export cable trench length of 200km. o Maximum width of temporary disturbance is approximately 30m, based on the disturbance impact for ploughing of a 10m wide trench with approximately 10m of spoil either side for each export cable • Anchor placement – 600m² (based on four cable joints, two per cable pair with a footprint of 150m² each, assuming up to 6 anchors per vessel) **Worst case scenario total disturbance footprint - 6.1km²**
	Installation of Wind Turbine Generators	Total worst case turbine footprint (1800MW) with scour protection, based on 90 x 20MW tension floating platform with a gravity anchor of 70 x 70m (350 x 350m with scour protection) = 11,025,000m².
	Installation of ancillary infrastructure	• Maximum number of met masts = 2 on 20m diameter at seabed with scour protection (7,854m² per foundation, total 15,708m²) • Maximum number of LIDAR = 2 on 10m monopile foundations (total footprint 157m²) • Maximum number of anchored wave buoys = 2 (total footprint 300m²) • Maximum number of offshore electrical platforms = 2 with scour protection (total footprint 35,000m²) • Maximum number of accommodation platforms = 2 with scour protection (total footprint 35,000m²)
	Installation of offshore cabling	Cable installation footprints are described above. In addition, the following cable protection may be required: <u>Array cable protection</u> Up to 60km of cable protection may be required in the unlikely event that array cables cannot be buried (based on 10% of the length) resulting in a footprint of 300,000m² (based on protection width of 5m). Array cable protection at turbines 100m cable length x 5m width x 200 turbines = 100,000m² Array cable crossings protection 10 crossings x 100m x 10m = 10,000m² <u>Interconnector cable protection</u> Interconnector cable protection approaching platforms 100m cable length x 5m width x 2 platforms = 1,000m² Surface laid interconnector cable protection 5m width x 15,000m (10% of the length) = 75,000m² Interconnector cable crossings protection crossings – captured within export cable/array cable crossing total

Impact	Parameter	Notes
		Platforms and other infrastructure Two offshore electrical platforms with scour protection 35,000m^2 Two accommodation platforms with scour protection 35,000m^2 Two met masts with scour protection 15,708m^2 Two wave buoys 300m^2 Two LiDAR monopiles with scour protection 3,927m^2 Export cables • Crossings A total of eleven crossings are required for each cable pair (up to 22 crossings) resulting in a total footprint of 22,000m^2 (based on a width of 10m and length of 100m of cable protection per crossing). • Nearshore (within 10m depth contour) Cable protection may be required at each of the landfall HDD exit points. This would entail one mattress (6m length x 3m width x 0.3m height) plus rock dumping (5m length x 5m width x 0.5m height) at each exit point (up to two cable pairs) resulting in a footprint of 36m^2 • Unburied cables In the unlikely event that cable burial is not possible due to hard substrate being encountered, up to 10km per cable pair could require additional protection resulting in a footprint of 140,000m^2 (based on protection width of 5m). The need for reburial and/or protection would be significantly less where pre-sweeping is used.
	Cable installation at the landfall	The installation process for the ducts and cables will not involve any works taking place on the beach or intertidal zone. The HDD will pass under the cliffs and exit at an offshore location beyond 5.5m below LAT (Lowest Astronomical Tide) with approximately 1000m drill length, classified as a 'long HDD'. The maximum target depth of drill is 20m.
Indirect impact to heritage assets from changes to physical processes	2A. Sediment deposited from plume created by seabed preparation	The worst case for archaeology equates to the worst case for marine physical processes (see Chapter 8 Table 8.15)
	2B. Sediment deposited from plume created by drill arisings	
	2C. Fate of aggregated drill arisings that are not suspended during foundation installation	
	4A. Sediment deposited from	

Impact	Parameter	Notes
	plume created by offshore cable installation	
	6A. Sediment deposited from plume created by array cable installation	
	6B. Sediment deposited from plume created by interconnector cable (HVDC only) installation	
	7A. Jack-up footprints	
	7B. Anchor footprints	
	8A. Suspended sediment concentrations and coastal morphology	
Impacts to the setting of heritage assets and historic seascape character	Activities associated with construction	Maximum construction duration of approximately 4 years. Up to 1180 vessel movements.
Operation		
Direct impact to potential heritage assets	Maintenance in the OWF sites	Direct impacts to known heritage assets are not anticipated to occur due to the retention of AEZs throughout the project lifespan and restriction of activities to red line boundary. Maintenance of wind turbine generators would be required during O&M. An estimate of up to two locations visited per day during O&M using a jack up vessel with a footprint of 729m^2 which would lead to a total area of up to 0.58km^2 per year (assumes large jack up with six legs). Anchored vessels placed temporarily on site to maintain the wind turbines or during cable repairs. Worst case scenario is six anchors each with a footprint of 25m^2 equating to a total footprint of 150m^2 per installation.
	Cable repairs and reburial	Unplanned repairs and reburial of cables may be required during O&M: • Reburial of 25% of array cable is estimated once every 5 years – 3m disturbance width x 150km length = 450,000m^2. • Two array cable repairs per year are estimated. An array cable may be up to 6km (based on turbine spacing) – 3m disturbance width x 6,000m x 2 = 36,360m^2. • One interconnector repair per year is estimated – 10m disturbance width x 300m repair length = 3,000m^2. • One export cable repair per year with 300m sections removed and replaced. Disturbance width of 3m = 900m^2 per year. • Reburial of up to 20km length per export cable = 120,000m^2 based on two cables and a disturbance

Impact	Parameter	Notes
		width of 3m = 1,200,000m^2 (1.2km^2).
Indirect impact to heritage assets from changes to physical processes	1A. Tidal currents	The worst case for archaeology equates to the worst case for marine physical processes (see Chapter 8 Table 8.15):
	2A. Waves	
	3A. Sediment transport	
	5A. Seabed morphology	
	5A. Seabed morphology and sediment transport along array cables	
	5B. Seabed morphology and sediment transport along interconnector cables	
	6A. Seabed morphology and sediment transport along offshore export cables	
	7A. Coastal morphology	
	8A. Jack-up footprints	
	9B. Anchor footprints	
Impacts to the setting of heritage assets and historic seascape character	Presence of wind farm infrastructure Activities associated with operations and maintenance	Maximum number of wind turbines = 200 (based on 9MW turbines) Maximum height of wind turbines = 350 (Max upper blade tip above HAT (m) based on 20MW turbines) Indicative total number of vessel movements per year = 480 during operation and maintenance
Decommissioning		
Direct impact to known heritage assets	Complete removal of foundations and associated infrastructure	Direct impacts to known heritage assets are not anticipated to occur due to the retention of AEZs throughout the project lifespan and restriction of activities to red line boundary
	Seabed contact by legs of jack-up vessels and / or anchors on vessels during installation	
Direct impact to potential heritage assets	Removal of foundations and associated infrastructure	Removal of all part of the foundations (those above seabed level), removal of some or all of the array cables, interconnector cables, and offshore export cables. Scour and cable protection would likely be left *in situ*. Impacts will be less than during the construction phase.
	Seabed contact by legs of jack-up vessels and / or anchors on vessels during installation	As with construction, the worst case scenario is: • Vessel anchor footprints (one vessel anchoring per turbine) = 30,000m^2 • Jack up vessel footprints assuming 2 vessel movements per offshore platform = 9,504m^2
Indirect impact to heritage assets from changes to physical processes	Similar to construction phase.	The worst case for archaeology equates to the worst case for marine physical processes (see Chapter 8 Table 8.15).

Impact	Parameter	Notes
Impacts to the setting of heritage assets and historic seascape character	Complete removal of wind farm and infrastructure	Impacts will be less than during the construction phase. Maximum change to historic seascape character

17.7.5 Heritage Significance (Importance)

136. A narrative description of the assessment of importance for the heritage assets described in section 17.6 is included in section 9 of Appendix 17.1.

137. The results of the assessment of importance are presented in Table 17.17. For the purposes of assessment, the importance of potential discoveries has been defined as high importance for *in situ* sites and finds and medium importance for isolated finds within secondary contexts. However, each individual discovery would be considered independently and any requirements for further data gathering or analysis would be considered on a case by case basis according to the heritage significance of the discovery.

Table 17.17 Assessment of importance of heritage assets

Asset Type	Definition		Importance
Potential *in situ* prehistoric sites	Primary context features and associated artefacts and their physical setting (if found)		High
	Known submerged prehistoric sites and landscape features with the demonstrable potential to include artefactual material		High
Potential submerged landscape features	Other known submerged palaeolandscape features and deposits likely to date to periods of prehistoric archaeological interest with the potential to contain in situ material		High
Potential derived Prehistoric finds	Isolated discoveries of prehistoric archaeological material discovered within secondary contexts		Medium
Potential palaeoenvironmental evidence	Isolated examples of palaeoenvironmental material		Low
	Palaeoenvironmental material associated with specific palaeolandscape features or archaeological material		High
Known maritime heritage assets	Named wrecks (A1)	*Golden Oriole* (possibly) (70342); HMS *Dunoon* (possibly) (70360); *Phillipp M* (70459); *Rye* (70617); *Trevethoe* (70639); *Montferland* (70709); *Seagull* (70809); *Xanthe* (70834); *Sheaf Water* (70934); *Fulgens* (70962)	High
	Un-named wrecks (A1)	70021; 70255; 70262; 71334; 70565; 70645; 70659; 70704; 70744; 70954; 71480	High
	Magnetic anomalies (A1)	70058; 70615; 71297; 71299; 71314; 71323; 71325; 71479	High
	Debris fields (A1)	70460; 70618; 70640; 70784; 70785; 70810; 70832; 70833; 70958; 71301; 71332; 71333; 71336	High
	Previously recorded	70079; 71377	High

Asset Type	Definition		Importance
	wrecks not seen in geophysical data (A3)		
Additional anomalies	Anomalies identified by geophysical assessment that could be of anthropogenic origin (A2)		High
Potential wrecks	Wrecks within the study area that are yet to be discovered		High
Potential derived maritime finds	Isolated artefacts lost from a boat or ship or moved from a wreck site		Medium
Additional anomalies	Anomalies identified by geophysical assessment that could be of anthropogenic origin totalling 1,421 (A2)		High
Potential aircraft	Aircraft within the study area that are yet to be discovered		High
Potential derived aviation finds	Isolated artefacts lost from an aircraft or moved from a crash site		Medium
Intertidal assets	Findspots	Findspots consisting of single or multiple finds located within the intertidal zone.	Negligible
	Structures	Structures of a vernacular nature including: sea defences; and lighthouse	Low
Potential derived intertidal finds	Isolated artefacts and findspots dating to all periods which are located within the intertidal zone.		Medium

17.7.6 Potential Impacts during Construction

17.7.6.1 Direct impact to known heritage assets

138. With the application of the embedded mitigation as set out in section 17.7.2, it is anticipated that all direct impacts to known heritage assets as a result of the project would be avoided where possible.

139. AEZs are recommended for all of the 21 A1 wrecks and two of the A1 debris fields, comprising 50m around the extents of the anomalies as seen in the geophysical data (Table 17.18). Two further debris fields (70810 and 70958) and seven objects of debris (71332, 71333, 71336 70460, 70640, 70832 and 70833) likely to be related to the wrecks are covered by the AEZs recommended for the wrecks themselves.

140. The remaining ten A1 anomalies comprise two small objects of debris associated with very high magnetic anomalies (70784 and 70618) and eight magnetic only A1 anomalies (70058, 70615, 71297, 71299, 71314, 71323, 71325 and 71479). On the basis of their interpretation of the data, Wessex Archaeology did not assign AEZs to these anomalies as it was not possible to say with certainty that they are of archaeological interest and that, rather, they should be avoided through the scheme design (micrositing) where possible (Appendix 17.1, section 10.2). Following the PEIR and further consultation with Historic England, however, 50m AEZs around the point locations of the anomalies are also recommended for these ten anomalies as a precautionary measure and to facilitate the process of micrositing of design.

141. As stated above, proposed AEZs may be reduced, enlarged or removed in agreement with Historic England if further relevant information becomes available post-consent.

142. The known heritage assets described above are illustrated on Figures 17.8 to 17.17 and detailed in Table 17.18 below.

Table 17.18 Recommended AEZs and avoidance for A1 anomalies

WA ID	Type	Position		Recommendation	Area
		Easting	Northing		
70021	Wreck	496438	5859769	50m around extents	NV East
70058	Magnetic	494268	5856763	50m around point location	
70255	Wreck	496393	5847836	50m around extents	
70262	Wreck	498353	5847680	50m around extents	
71480	Wreck	503572	5848770	50m around extents	
71297	Magnetic	470549	5875951	50m around point location	NV West
71299	Magnetic	471001	5874207	50m around point location	
71301	Debris field	470711	5873567	50m around extents	
71314	Magnetic	471077	5871919	50m around point location	
71323	Magnetic	471157	5871003	50m around point location	
71325	Magnetic	470932	5870985	50m around point location	
71332	Debris	470686	5870865	Covered by AEZ for 71334	
71333	Debris	470763	5870863	Covered by AEZ for 71334	
71334	Wreck	470730	5870846	50m around extents	
71336	Debris	470736	5870812	Covered by AEZ for 71334	
71479	Magnetic	464147	5851155	50m around point location	
70342	Wreck	477521	5849048	50m around extents	Offshore cable corridor
70360	Wreck	466386	5846784	50m around extents	
70459	Wreck	446041	5844450	50m around extents	
70460	Debris	446039	5844401	Covered by AEZ for 70459	
70565	Wreck	431217	5841986	50m around extents	
70615	Magnetic	429652	5846468	50m around point location	
70617	Wreck	429617	5846348	50m around extents	
70618	Debris	429562	5846957	50m around point location	
70639	Wreck	428802	5847632	50m around extents	
70640	Debris	428758	5847714	Covered by AEZ for 70639	
70645	Wreck	428283	5848091	50m around extents	
70659	Wreck	426967	5850445	50m around extents	
70704	Wreck	422267	5849082	50m around extents	
70709	Wreck	421671	5849182	50m around extents	
70744	Wreck	419288	5849507	50m around extents	
70784	Debris	415366	5849564	50m around point location	
70785	Debris field	415354	5849572	50m around extents	
70809	Wreck	413550	5850143	50m around extents	
70810	Debris field	413518	5850156	Covered by AEZ for 70809	

WA ID	Type	Position		Recommendation	Area
		Easting	Northing		
70832	Debris	412148	5850351	Covered by AEZ for 70834	
70833	Debris	412143	5850353	Covered by AEZ for 70834	
70834	Wreck	412105	5850354	50m around extents	
70934	Wreck	406929	5852021	50m around extents	
70954	Wreck	406125	5853694	50m around extents	
70958	Debris field	406085	5852987	Covered by AEZ for 70962	
70962	Wreck	406058	5852977	50m around extents	

143. For features assigned as A2 and A3, AEZs are not recommended at this time, although the positions of these features would be avoided through the scheme design (micrositing) where possible. The archaeological assessment of pre-construction survey data, including high resolution geophysical data undertaken for the purposes of UXO identification, will further clarify the nature and extent of these anomalies and the scheme design would be modified to avoid heritage assets where possible. If features cannot be avoided, then additional work may be required to establish the archaeological interest of the feature (e.g. investigation of individual anomalies (ground truthing) through ROV and/or diver survey) and to record features prior to removal, as appropriate.

144. Within the intertidal zone, all known intertidal assets, such as the remains associated with the Happisburgh Low Lighthouse (1045) as observed during the walkover survey, will be avoided through the use of long HDD which will pass below the beach sands (minimum target penetration 10m).

145. In summary, Norfolk Vanguard Limited has committed to the application of AEZ for all known A1 features, and the avoidance of all A2 and A3 anomalies and previously recorded heritage assets. There will therefore be **no direct impact** to known heritage assets during construction.

17.7.6.2 Direct impact to potential heritage assets

146. It is not possible to avoid heritage assets that have not yet been discovered (potential heritage assets). Therefore, unavoidable direct impacts may occur if archaeological material is present within the footprint of the development associated with the following activities:

- Seabed preparation (including UXO survey and clearance);
- Installation of wind turbine foundations;
- Installation of ancillary infrastructure;
- Installation of offshore cabling;
- Seabed contact by legs of jack-up vessels and / or anchors; and

- Cable installation at the landfall.

147. The importance, and hence sensitivity, of potential heritage assets is summarised in Table 17.4 above.

148. *In situ* prehistoric, maritime and aviation sites are assessed as being of potentially high importance. The magnitude of effect is also assessed as potentially high. In practice, the magnitude of the effect will not be fully understood until after the potential heritage asset has been encountered and the impact has occurred. Therefore, as a precautionary approach, it should be assumed that total loss or substantial harm is possible and in accordance with the definitions in Table 17.5, the potential magnitude of effect can also be high. In accordance with the significance matrix in Table 17.6, direct impacts to potential in situ heritage assets have the potential to be of major adverse significance.

149. However, the embedded mitigation set out in section 17.7.2 includes the measures outlined below, in order to reduce the level of harm to features through reducing, remedying and offsetting potential impacts.

150. With regard to potential *in situ* prehistoric sites, submerged landscape features and palaeoenvironmental evidence, a number of palaeogeographic features of archaeological potential have already been identified within the project area, along with sediments of archaeological and palaeoenvironmental interest recovered within geotechnical samples acquired for the project (see section 17.6.1). A programme of geoarchaeological assessment is being undertaken to further ascertain the nature and determine the archaeological potential of sub-seabed deposits within the study area. Work undertaken to date, including the results of deposit modelling, are included in Appendix 17.2, Appendix 17.3 and Appendix 17.4.

151. Further examination of potential prehistoric deposits through the assessment of pre-construction geotechnical and geophysical data will further contribute to the body of scientific data available for the study of seabed prehistory within the East Coast region. If *in situ* prehistoric sites are identified as a result of such work then mitigation measures to record and/or protect such sites would be agreed in consultation with Historic England.

152. Similarly, the archaeological assessment of any further geophysical survey data as relevant to further identifying and understanding the nature of seabed features which may represent previously unidentified maritime or aviation heritage assets is also anticipated to form part of any pre-construction mitigation requirement for offshore archaeology.

153. Further reduction of potential impacts can also be achieved by means of receiving prompt archaeological advice in the event of a discovery and by recording and

conserving any objects that have been disturbed. In a marine environment, this is often achieved by means of implementing a protocol for reporting finds of archaeological interest. It is therefore proposed that if any objects of possible archaeological interest are recovered, that they should be reported using the established *Protocol for Archaeological Discoveries: Offshore Renewables Projects (The Crown Estate, 2014)* (ORPAD). This will establish whether the recovered objects are of archaeological interest and recommend appropriate mitigation measures where necessary.

154. With the application of such measures, the significance of the potential impact to *in situ* prehistoric, maritime and aviation heritage assets will be reduced to **minor adverse**. Any such mitigation would be agreed in consultation with Historic England in accordance with industry standards and guidance including *Model Clauses for Archaeological Written Schemes of Investigation: Offshore Renewables Projects.* (The Crown Estate, 2010). An Outline WSI setting out the methodology for all proposed embedded mitigation has been prepared in consultation with Historic England for submission alongside the DCO application for the project.

155. The Protocol for Archaeological Discoveries is also the primary means of mitigation relevant to isolated discoveries of archaeological material discovered within secondary contexts (chance finds). Isolated artefacts, either of prehistoric, maritime or aviation origin within reworked deposits may be considered less sensitive to change than *in situ* material, as their relationship with their context or physical setting is less relevant to understanding their significance. The sensitivity of isolated finds is therefore considered to be medium. The magnitude of the effect is assessed to be low as, through the means of the protocol, artefacts brought to the surface (during seabed preparation for example) will be retained for further assessment and provided with conservation as necessary to secure the long-term stabilisation of the artefact as proportionate to its significance. Although removal from the marine context will still result in the destruction of that contextual relationship, albeit a secondary context (i.e. not *in situ*), isolated artefacts have limited capacity to accommodate physical changes or influences therefore resulting in only a minor loss of, or alteration to, key characteristics, features or elements. The impact significance is therefore considered to be minor.

156. At the landfall, there is potential for the presence of archaeological material buried within intertidal deposits, associated with the Happisburgh Low lighthouse and military installations from WWI and WWII, for example. Potential *in situ* material should be considered to be of possible high importance. The borehole BH17-L1A-05 demonstrated the presence of 1.8m of beach sand above the glacial tills within which archaeological remains could be buried (Appendix 28.6).

157. However, the use of long HDD at the landfall means that no works will take place on the beach or within intertidal zone, with the HDD passing under the cliffs and exiting at an offshore location beyond 5.5m below LAT (up to 1000m in total drill length, minimum target depth 10m, maximum target depth 20m). Therefore, there will be no impacts to potential archaeological remains within the upper beach sand deposits.

158. Similarly, as described in section 17.6.3, due to the presence of a geological sinkhole, potential for encountering Palaeolithic archaeological material within this maximum 20m depth is anticipated to be low. However, the results of further ground investigations within the project boundary, to be planned post-consent in consultation with the steering group including members of the AHOB and PAB project teams, will contribute to a greater understanding of the deposits within the wider study area. Further requirements for geoarchaeological assessment will be established in consultation with the steering group, Historic England and Norfolk County Council's Historic Environment Service. The approach to geoarchaeological assessment to be undertaken post-consent is set out in the Outline WSI as submitted alongside the DCO.

159. In summary, although direct impacts to potential heritage assets (if present within the footprint of the development) are unavoidable, through the application of appropriate mitigation (e.g. further measures to reduce the level of harm through reducing, remedying and offsetting potential impacts and the implementation of a ORPAD) the residual impact is assessed as **minor adverse**.

17.7.6.3 Indirect impact to heritage assets from changes to physical processes

160. Potential indirect impact to heritage assets from changes to physical processes is assessed with reference to section 8.7.5 (Potential Impact during Construction) of Chapter 8 Marine Physical Processes.

161. During construction, increased sediment concentrations have the potential to deposit sediment and hence raise the seabed elevation. Within the immediate vicinity of activities there is therefore potential for the creation of 'mounds', as coarser sediments fall rapidly to the seabed (although this change in elevation is within the natural change to the bed caused by sandwaves and sand ridges and hence the blockage effect on physical processes would be negligible). Dispersion of finer grained material as part of a sediment plume results in only minimal deposition across a wider area; such deposition also has the potential to become re-mobilised thus reducing the effect further. The potential for beneficial effects upon archaeological receptors from increased sediment cover is therefore considered to be negligible.

162. During construction there is also potential for jack-up legs and anchors to leave indentations on the seabed. As the leg is retracted, some of the sediment would return to the hole via mass slumping and, over the longer term, the indentation would become shallower and less distinct due to infilling. If present within the footprint of the jack-ups or anchors, then heritage assets may be subject to direct impact of sediment deposition, as discussed above. Further impact from prolonged exposure within the indentations, however, is not anticipated to occur as any exposed archaeological material would become re-covered. It is therefore considered that there will be no impact upon archaeological receptors from exposure within indentations.

163. At the landfall, the selection of long HDD for cable installation will result in no effect upon the beach and nearshore zone, and hence no long-term effect on sediment transport processes. There will therefore be **no impact** upon archaeological receptors from changes in suspended sediment concentrations and coastal morphology at the landfall.

17.7.6.4 Impacts to the setting of heritage assets and historic seascape character

164. The historic character of the study area and the setting of marine heritage assets will be temporarily affected during the construction phase by the presence of vessels, personnel and infrastructure associated with construction activities. The worst case scenario anticipates that construction activities could have a duration of approximately four years, although this may include periods of no on site construction activity.

165. Construction activities may change perceptions of character with respect to the primary cultural processes which have been established and spatially defined through the HSC, as set out in Table 17.15 above. Overall, the local seascape character around and within the study area is considered to be of medium archaeological importance due to the area's important and prolonged maritime history and its continued use today. However, construction activities and additional vessel traffic would occur in the context of one of the busiest shipping channels between south east England and mainland Europe and furthermore, there is already an influence on the seascape from the existing features of the nearby gas rigs and their service vessels. The assessed capacity of each of the character sub-types to accommodate change during construction is set out in Table 17.19 below.

Table 17.19 Capacity of perceptions of character to accommodate change during construction

Character Sub-Types)	Perception of Character and Capacity for Change	Assessed Capacity to Accommodate Change
Landward mobile cliffs	Cliff erosion is of heightened public concern in East Anglia as a whole. However, studies undertaken for the project (e.g. the erosion study presented in Appendix 4.1) demonstrate that the installation of the cable using HDD will not cause additional erosion. As there will be no impact to the cliff from HDD, and no associated archaeological works at the landfall, the primary perception of cliffs as a repository for fossils will remain unchanged.	No change
Marine sand banks with sand waves Palaeolandscapes	The primary perceptions which associate marine cultural topography and palaeolandscapes with high archaeological potential could be enhanced through the accumulation of publicly available data in the event of unexpected discoveries reported through ORPAD during construction activities.	Potential beneficial change
Flood and erosion defences	Due to the use of long HDD, no construction activities will take place on the beach.	No change
Submarine telecommunication cables	As submarine telecommunications cables are mostly undetected in the marine environment it is unlikely that perceptions of this character type would be altered by construction activities.	No change
Aquaculture – cultivated shellfish Inshore fisheries Offshore fishing grounds – trawling, netting, longline, potting	The study area does not include areas where the heritage of the fishing industry is particularly perceived by the public (e.g. historic fishing ports, historic fleets or vessels) or of importance to tourism, for example. Chapter 14 (Commercial Fisheries) identifies that loss of fishing grounds is the principal concern of fishermen. The assessment of potential impacts identified that this will be mitigated during construction due to the use of rolling, temporary safety zones and through agreeing mutually acceptable terms with affected fishermen. As such, the potential impact is assessed to be negligible or minor adverse.	Character has capacity to accommodate change but likely to be dependent upon agreement of mutually acceptable terms.
Energy industry – gas supply pipeline	Overall, perceptions of the North Sea energy industry place greater emphasis upon nuclear power and renewable energy. The HSC states that Britain has the best offshore wind resource in Europe and the marine zone of East Anglia is well placed to take advantage of this. Changing perceptions associated with the construction of Norfolk Vanguard are therefore likely to be seen as part of this natural progression for energy generation and as a positive change from fossil fuels to renewable energy.	Potential beneficial change
Extractive industry – marine aggregates dredging	The HSC states that the established relationship between the aggregate industry and the heritage sector is a positive force for change in relation to safeguarding the historic environment. Similarly, a co-ordinated approach to mitigating potential effects from the offshore renewables industry can also be seen as enhancing public value through the accumulation of data. Perceptions are therefore similar across both industries and change, if any, is likely to be positive in terms of enhancing the historic environment.	Potential beneficial change

Character Sub-Types)	Perception of Character and Capacity for Change	Assessed Capacity to Accommodate Change
Military defence and fortification	Former military installations at the landfall have been destroyed through coastal erosion and now only survive as rubble on the beach. As a result of the long HDD, there are no works on the beach during construction and therefore no change to the perception of military character is anticipated.	No change
Maritime safety – lighthouse	There are two known lighthouses at the location of the landfall; the destroyed Happisburgh Low lighthouse and the extant Grade II listed Happisburgh Lighthouse onshore. As stated by the HSC, overall the area has a long history of maritime safety features which is at risk of being forgotten if not fully recorded. Short term construction activities at the landfall, however, are considered unlikely to result in a meaningful change to the perceived character.	No change
Navigation route	Construction activities and additional vessel traffic would occur in the context of one of the busiest shipping channels between south east England and mainland Europe and it is anticipated that no change to the perception of this character type would occur as a result of construction activities.	No change

166. The table above demonstrates that for most character sub-types, perceptions of historic character will remain unchanged or will result in a potential beneficial change. The exception is the loss of traditional fishing grounds, although the assessment of Commercial Fisheries in Chapter 14 concludes that with the agreement of mutually acceptable terms the effect of temporary displacement during construction upon affected fishermen will be minor adverse as a worst case scenario. This indicates that the character has capacity to accommodate this short term change.

167. In terms of setting, section 17.6.4 identifies how military wrecks within the study area collectively represent important features within a wider military seascape and as such, the importance of their setting can be considered high. However, with regards to sensitivity, the impacts during construction are temporary, non-physical and reversible. The change to setting and character during construction is therefore considered to be negligible (a minor alteration of an asset which does not affect its significance in any notable way) and of **minor adverse** significance.

17.7.6.5 Impacts to site preservation conditions from drilling fluid breakout

168. During HDD, drilling fluid (a combination of water and natural clays such as bentonite) will be employed to lubricate the drilling process and cool the drill head. Bentonite is a common drilling fluid employed for HDD and is a naturally occurring clay which, when mixed with water, provides a gel like lubricant known as 'drilling

mud' for the drilling process. The drilling mud typically contains less than 3-6% solids by volume and weight to water ratio. Bentonite typically has a neutral pH level of 7.0 –9.5, similar to that of water/seawater.

169. Fluid pressures will be monitored throughout the drilling process to minimise the potential for breakout of the drilling fluid and an action plan will be developed and procedures adopted during the drilling activity to respond to any drilling fluid breakout. High level studies have indicated that the total worst case drilling fluid losses to the sea could be up to 300m³ per duct (noting that ~95% of this fluid is water). Moreover, ground investigations and geoarchaeological assessments have shown that if the Cromer Forest Bed deposits associated with potential Palaeolithic archaeology are still extant, they are expected to occur beneath the glacial tills at significant depth (> 20mbgl) and beneath the HDD target depths.

170. The potential for drilling fluid to breakout and spread into/coat archaeological deposits, features and materials thereby causing a negative effect upon site preservation is assessed as **negligible**.

17.7.7 Potential Impacts during Operation

17.7.7.1 Direct impact to known heritage assets

171. With the application of the embedded mitigation set out in section 17.7.2, and the retention of AEZs throughout the project lifespan, it is anticipated that all direct impacts to known heritage assets will be avoided. Therefore, there will be **no direct impact** to known heritage assets during operation.

17.7.7.2 Direct impact to potential heritage assets

172. Direct impacts to potential heritage assets may occur if archaeological material is present within the footprint of jack-ups or vessel anchors deployed during planned or unscheduled maintenance activities. As for construction activities, impacts should be considered to have the potential to be of major adverse significance, although the application of embedded mitigation is anticipated to reduce this to **minor adverse**.

173. There will be **no direct impacts** at the landfall during the operation phase as there will be no disturbance of intertidal deposits.

17.7.7.3 Indirect impact to heritage assets from changes to physical processes

174. Indirect impacts to heritage assets from changes to physical processes are assessed with reference to section 8.7.6 (Potential Impact during Operation) of Chapter 8 (Marine Physical Processes).

175. During the operational phase of the proposed project, there is potential for the presence of the wind turbine foundations to cause changes to the tidal and wave regimes due to physical blockage effects. These changes could potentially affect the

sediment regime and/or seabed morphology. The worst case magnitude of effect upon tides is assessed as low (near-field) and no-change (far-field), and for waves as low (near-field) and negligible (far-field). The changes would be both low in magnitude and largely confined to local wake or wave shadow effects attributable to individual wind turbine foundations and therefore would be small in geographical extent. The potential for indirect impacts to archaeological receptors as a result of sediment stripping caused by changes to physical processes is, as a worst case, anticipated to be negligible.

176. In addition, there is potential for the temporary presence of engineering equipment, such as jack-up barges or anchored vessels, to have local effects on the hydrodynamic and sediment regimes during maintenance activities. However, the effects of the jack-up legs on waves, tides and sediment transport would be localised (since the legs are small) and would be temporary in nature. Once the maintenance activities are complete, the jack-up barges would be removed and no permanent effects on marine physical processes would remain. It is therefore concluded that there will be **no impact** upon archaeological receptors indirectly as a result of this effect.

17.7.7.4 Impacts to the setting of heritage assets and historic seascape character

177. The anticipated design life of the wind farm is approximately 30 years and the presence of the turbines during this operational phase will introduce a clear change to both the visual setting and the character of the seascape.

178. The setting of marine heritage assets will be affected during the operational phase by the presence of vessels, personnel and infrastructure associated with maintenance activities and by the presence of wind turbines and associated infrastructure. However, the baseline setting is already influenced by existing gas rigs and passing shipping vessels in this area, therefore reducing the sensitivity and potential magnitude of change. The potential impact to the setting of marine heritage assets is considered to be negligible (a minor alteration of an asset which does not affect its significance in any notable way) and of **minor adverse** significance.

179. As for construction above, maintenance activities and the presence of the wind farm infrastructure may change perceptions of character with respect to the primary cultural processes which have been established and spatially defined through the HSC and set out in Table 17.15. The assessed capacity of each of the character sub-types to accommodate change during operation is set out in Table 17.20 below.

Table 17.20 Capacity of perceptions of character to accommodate change during operation

Character Sub-Types)	Perception of Character and Capacity for Change	Assessed Capacity to Accommodate Change
Landward mobile cliffs	Cliff erosion is of heightened public concern in East Anglia as a whole and the HDD at the landfall has been designed to account for natural erosion. No change to perceptions of historic character are anticipated.	No change
Marine sand banks with sand waves Palaeolandscapes	The presence of the installed infrastructure may result in a change to the perception of these marine areas as being of high archaeological potential. The physical presence of cables and foundations, for example, will limit ease of access for future research within the project areas thereby reducing the perceived archaeological potential. This change will however be offset by the accumulation of publicly available data acquired by the project prior to construction which is considered to be of public value.	Character has capacity to accommodate change. Publication of data and completion of archaeological works to acceptable professional standards will help offset potential adverse impacts.
Flood and erosion defences	The presence of landfall infrastructure will remain largely undetectable and therefore not perceived by the public. No change to perceptions of the flood and erosion defences character are anticipated.	No change
Submarine telecommunication cables	As submarine telecommunications cables are mostly undetected in the marine environment there will be no change to perceptions of historic character.	No change
Aquaculture – cultivated shellfish Inshore fisheries Offshore fishing grounds – trawling, netting, longline, potting	The distance of the Norfolk Vanguard wind farm from the coast, and the minimal above ground infrastructure at the coast, means that the project will be largely undetectable by the public and historic perceptions of the traditional fishing industry, which the HSC described as having taken on a 'quaint' character, a memory of better days, will remain largely unchanged. Chapter 14 (Commercial Fisheries) identifies that loss of fishing grounds in the principal concern of fishermen themselves. Once constructed, however, there is the potential for fishing to resume within the Norfolk Vanguard site. In order to minimise loss of fishing grounds, all cables will be buried to prevent interaction with fishing gear, or provided with cable protection where burial is not possible. There will also be a minimum separation of 680m between wind turbines within rows, and a minimum of 680m between each row, and these would be arranged in a regular pattern to assist vessel transit.	Character has capacity to accommodate change.

Character Sub-Types)	Perception of Character and Capacity for Change	Assessed Capacity to Accommodate Change
Energy industry – gas supply pipeline	Overall, perceptions of the North Sea energy industry place greater emphasis upon nuclear power and renewable energy. The HSC states that Britain has the best offshore wind resource in Europe and the marine zone of East Anglia is well placed to take advantage of this. Changing perceptions associated with the presence of Norfolk Vanguard are likely to be seen as part of this natural progression for energy generation and as a positive change from fossil fuels to renewable energy.	Potential beneficial change
Extractive industry – marine aggregates dredging	There are aggregate dredging licences and exploration agreements approximately 27km south west of NV West and 42km south west of NV East. During operation there will be no physical overlap between activities associated with Norfolk Vanguard and those of the marine aggregate dredging industry and no change in the perception of this character type is anticipated.	No change.
Military defence and fortification	The presence of landfall infrastructure will remain largely undetectable and therefore not perceived by the public. No change to perceptions of the military defence and fortification character are anticipated.	No change
Maritime safety – lighthouse	The presence of landfall infrastructure will remain largely undetectable and therefore not perceived by the public. No change to perceptions of maritime safety are anticipated.	No change
Navigation route	Maintenance activities and additional vessel traffic would occur in the context of one of the busiest shipping channels between south east England and mainland Europe and it is anticipated that no change to the perception of this character type would occur.	No change

180. Table 17.20 demonstrates that for most character sub-types, perceptions of historic character will remain unchanged as a result of the proposed project, or will result in a potential beneficial change. The exceptions are the loss of traditional fishing grounds and the perceptions of the archaeological potential of the marine cultural topography to be reduced. As the offshore infrastructure will be designed to allow fishing activities to resume once construction is completed, this character types is assessed as having capacity to accommodate any change. The potential change to perceptions of the marine cultural topography is anticipated to be offset by the public value of the data generated from the project, dependent upon publication of data and completion of archaeological works to acceptable professional standards.

17.7.7.5 Impacts to site preservation conditions from heat loss from installed cables

181. For the export cables, at full load, total heat loss per meter for a pair of large HVDC cables is roughly 100W/m. For the inter array cables, at full load, total heat loss per meter for a large 66kV 3-core cable is 150W/m.

182. The thermal properties of sediment structure and final engineering design (e.g. cable types, install depths, installed capacity, technology, stabilised backfill) will determine the maximum heat loss and subsequent dissipation of heat through sediments. However, heat dissipation will be localised to the area immediately around the cables and ducts. Drying of sediments immediately around the cables as a result of heating dynamically returns a lower thermal conductivity of the soil and risks cable failure due to operating above safe temperatures. Soil drying cannot therefore extend beyond the immediate locality of the cables.

183. As the effect of heat loss is restricted to the immediate vicinity of the cables, and as all known heritage assets will be avoided through design as part of the embedded mitigation for the project (see section 17.7.6.1 above) there will be **no impact** to known heritage assets associated with the heat loss from cables. With regard to potential heritage assets, the area affected from heat loss will be spatially no greater than the footprint of direct impacts from cable installation. As the deposits within which potential archaeology could be buried will already have been disturbed as part of the construction phase, and appropriate mitigation applied (see section above), there will be **no further impact** during operation associated with the heat loss from cables.

17.7.8 Potential Impacts during Decommissioning

184. The scope of the decommissioning works is not yet known, however decommissioning works may involve removal of the accessible installed components. This is outlined in section 5.4.19 of Chapter 5 Project Description and the detail will be agreed with the relevant authorities at the time of decommissioning, and be subject to separate licencing based on best available information at that time. Offshore, decommissioning is likely to include removal of all of the wind turbine components, part of the foundations (those above seabed level) and removal of some or all of the array cables, interconnector cables, and offshore export cables. Scour and cable protection would likely be left *in situ*.

17.7.8.1 Direct impact to known heritage assets

185. With the application of the embedded mitigation as set out in section 17.7.2, and the retention of AEZs throughout the project lifespan, it is anticipated that all direct impacts to known heritage assets will be avoided. Therefore, there will be **no direct impact** to known heritage assets during decommissioning.

17.7.8.2 Direct impact to potential heritage assets

186. The scope of the decommissioning works would most likely involve removal of the accessible installed components. With regards to offshore cables, general UK practice would be followed; that is buried cables would be cut at the ends and left *in*

situ, with the exception of the intertidal zone across the beach where the cables would otherwise be at risk of becoming exposed over time.

187. As for construction and operation, direct impacts to potential heritage assets may occur if archaeological material is present within the footprint of jack-ups or vessel anchors deployed during decommissioning activities. Such impacts should be considered to have the potential to be of major adverse significance although the application of embedded mitigation is anticipated to reduce this to acceptable levels (**minor adverse**).

17.7.8.3 Indirect impact to heritage assets from changes to physical processes

188. The following impact is assessed with reference to section 8.7.7 (Potential Impact during Decommissioning) of Chapter 8 (Marine Physical Processes).

189. During the decommissioning phase, there is potential for wind turbine foundation and cable removal activities to cause changes in suspended sediment concentrations and/or seabed or shoreline levels as a result of sediment disturbance effects. The magnitude of effects would be comparable to, or less than, those identified for the construction phase. Accordingly, given that **no impact** was assessed for the identified marine physical processes receptors during the construction phase, it is anticipated that **no impact** can also be concluded for the decommissioning phase.

17.7.8.4 Impacts to the setting of heritage assets and historic seascape character

190. With the removal of the wind turbines and associated infrastructure a further change will occur with decommissioning. The presence of vessels, personnel and infrastructure associated with decommissioning activities will also temporarily affect the setting and character of the project area. However, as for construction these impacts are temporary and reversible and the change to setting and character during decommissioning is therefore considered to be negligible (a minor alteration of an asset which does not affect its significance in any notable way) and of **minor adverse** significance.

17.8 Cumulative Impacts

191. In addition to Norfolk Vanguard, Vattenfall (a parent company of Norfolk Vanguard Limited) is also developing the Norfolk Boreas OWF through one of its subsidiaries Norfolk Boreas Limited, located to the north of NV East; the submission of the Norfolk Boreas DCO application is currently expected in approximately Q2 2019. The development of Norfolk Boreas will use the same offshore cable corridor as Norfolk Vanguard with the addition of a spur to the Norfolk Boreas site. Norfolk Boreas will also make landfall at Happisburgh South. Co-location of infrastructure for the two projects will help minimise potential impacts of the projects.

192. Projects considered as part of the cumulative impact assessment for Norfolk Vanguard are presented in Table 17.22. This includes, in particular, further projects within the former East Anglia Zone (East Anglia ONE and East Anglia THREE). The cumulative impact assessment includes known consented and planned projects within 100km of Norfolk Vanguard, while developments beyond 100km are scoped out for the purposes of direct impacts. The COWRIE guidance (Oxford Archaeology, 2008) states that establishing a geographical boundary for cumulative impact assessment needs to be considered on a case-by-case basis. A 100km boundary has been selected for this project in order to facilitate a clear understanding of the types of projects in the 'region' that may affect not only the heritage assets themselves but also their settings and the perceptual values associated with the historic seascape character.

193. The cumulative impact assessment for marine physical processes is set out in section 8.8 of Chapter 8. The assessment below takes account of the results of this assessment in identifying the potential for indirect cumulative impact to heritage assets from the effect of marine physical processes and from sediment plumes and deposition.

194. Table 17.21 summarises the project specific impacts identified in section 17.7, alongside their potential to act cumulatively with other projects.

Table 17.21 Potential cumulative impacts

Impact	Potential for cumulative impact	Data confidence	Rationale
Construction - Direct impact to known heritage assets	No	High	Direct cumulative impacts to known heritage assets are unlikely to occur due to the avoidance of known archaeological sites and features identified through EIA for each of the constructed and planned projects as part of the consenting process.
Construction - Direct impact to potential heritage assets	Yes	Low (as yet unknown heritage assets)	Although the effect of unavoidable impacts will be mitigated by agreed measures as part of the consenting process for each of the constructed and planned projects, the impacts will still have occurred and permanent damage or destruction will have taken place. The assessment of cumulative impacts, therefore, needs to consider the effect of multiple unavoidable impacts from multiple projects upon the archaeological resource.
Construction - Indirect impact to heritage assets from changes to physical	No	High	The marine physical processes assessment in Chapter 8 concludes that the potential cumulative impact is negligible. This is considered insufficient to have a detectable impact upon heritage assets from additional

Impact	Potential for cumulative impact	Data confidence	Rationale
processes			sediment cover, for example.
Construction - Impacts to the setting of heritage assets and historic seascape character	Yes	High	Across the region, cumulative impacts to the setting of heritage assets and historic seascape character will occur as a result of the construction of multiple projects. This is discussed further in section 17.8.2.
Operation - Direct impact to known heritage assets	No	High	Direct cumulative impacts to known heritage assets are unlikely to occur due to the retention of AEZs throughout the life of constructed and planned projects.
Operation - Direct impact to potential heritage assets	Yes	Low (as yet unknown heritage assets)	There is potential for multiple unavoidable impacts associated with operations and maintenance activities (e.g. cable repairs and vessel anchors/jack up legs) during the operation phases of multiple projects.
Operation - Indirect impact to heritage assets from changes to physical processes	No	High	As described in Chapter 8, modelling for East Anglia ONE demonstrates that changes in tidal currents and waves due to the presence of foundation structures comparable to those proposed for Norfolk Vanguard are both small in magnitude and localised in spatial extent. The potential cumulative impact for marine physical processes between Norfolk Vanguard, East Anglia THREE and Norfolk Boreas is therefore considered to be negligible. There is therefore no potential for cumulative indirect impacts upon heritage assets.
Operation - Impacts to the setting of heritage assets and historic seascape character	Yes	High	Across the region, cumulative impacts to the setting of heritage assets and historic seascape character will occur as a result of the presence of multiple constructed projects. This is discussed further in section 17.8.2.
Decommissioning - Direct impact to known heritage assets	No	High	Direct cumulative impacts to known heritage assets are unlikely to occur due to the retention of AEZs throughout the life of constructed and planned projects.
Decommissioning - Direct impact to potential heritage assets	Yes	Low (as yet unknown heritage assets)	There is potential for multiple unavoidable impacts associated with decommissioning considered cumulatively with activities associated with other projects. This is discussed further in section 17.8.1.

Impact	Potential for cumulative impact	Data confidence	Rationale
Decommissioning - Indirect impact to heritage assets from changes to physical processes	No	High	As for Construction.
Decommissioning 4 Impacts to the setting of heritage assets and historic seascape character	Yes	High	Changes to the setting of heritage assets and historic seascape character will occur although the nature of this change will depend upon the decommissioning plans for multiple projects.

Table 17.22 Summary of projects considered for the CIA in relation to offshore and intertidal archaeology and cultural heritage

Project	Status	Indicative offshore development period	[2]Distance from Norfolk Vanguard site (km)	Project definition	Project data status	Included in CIA	Rationale
UK Windfarms							
East Anglia Three	Consented	2020-2028	0 (adjacent to the southern boundary of NV East)	Project Design Statement (PDS) available	Complete	Yes	Located within 100km of Norfolk Vanguard (and adjacent to NV East). For marine physical processes, there is potential for interaction during the construction of foundations and their operation and maintenance.
Norfolk Boreas	Pre-planning Application	2023-2040	1	Pre-application outline only	Incomplete	Yes	Located within 100km of Norfolk Vanguard. Shared offshore cable corridor and wind farm area adjacent to NV East. For marine physical processes, there is the potential for interaction during the construction and operation and maintenance phases.
Scroby Sands	Active/In Operation	N/A	45	Complete	Complete	Yes	Within 100km
East Anglia One	Consented	2018-2021	49	PDS available	Complete	Yes	Within 100km
Dudgeon	Commissioned	N/A	66	Complete	Complete	Yes	Within 100km
Hornsea Project Three	Pre-planning Application	Expected construction start of 2021	73	Pre-application outline only	Incomplete	Yes	Within 100km
Sheringham Shoal	Active/In	N/A	75	Complete	Complete	Yes	Within 100km

[2] Shortest distance between the considered project and Norfolk Vanguard – unless specified otherwise.

Project	Status	Indicative offshore development period	[2]Distance from Norfolk Vanguard site (km)	Project definition	Project data status	Included in CIA	Rationale
	Operation						
Galloper	Under Construction	Expected completion 2018	93	Approved PDS available	Complete	Yes	Within 100km
Hornsea Project One	Under Construction	Expected completion 2020	95	Approved PDS available	Complete	Yes	Within 100km
Greater Gabbard	Active/In Operation	N/A	96	Complete	Complete	Yes	Within 100km
Race Bank	Active/In Operation	N/A	99	Complete	Complete	Yes	Within 100km
EU Wind Farms							
Voorde Hollandse kust Zoekgebieden	Development Zone	Unknown	39		Incomplete	Yes	Within 100km
Hollandse Kust Noord Holland I	Concept/Early Planning	Tendering 2019	74		Incomplete	Yes	Within 100km
Hollandse Kust Noord Holland II	Concept/Early Planning	Tendering 2019	74		Incomplete	Yes	Within 100km
Hollandse Kust Zuid Holland I	Consented	Expected commissioning in 2021	76		Incomplete	Yes	Within 100km

Project	Status	Indicative offshore development period	[2]Distance from Norfolk Vanguard site (km)	Project definition	Project data status	Included in CIA	Rationale
Hollandse Kust Zuid Holland II (Tender 2017)	Consented	Expected commissioning in 2021	76		Incomplete	Yes	Within 100km
Hollandse Kust Zuid Holland III	Consented	Expected commissioning in 2022	76		Incomplete	Yes	Within 100km
Hollandse Kust Zuid Holland IV	Consented	Expected commissioning in 2022	76		Incomplete	Yes	Within 100km
Prinses Amaliawindpark	Fully Commissioned	N/A	79		Complete	Yes	Within 100km
Nord-Holland boven Noordzeekanaal Potentiele Zoekgebieden	Development Zone	Unknown	83		Incomplete	Yes	Within 100km
Zuid-en Noord-Holland onder het Noordzeekanaal Potentiele Zoekgebieden	Development Zone	Unknown	89		Incomplete	Yes	Within 100km
Minerals Aggregates							

Project	Status	Indicative offshore development period	[2]Distance from Norfolk Vanguard site (km)	Project definition	Project data status	Included in CIA	Rationale
29 x licence areas for marine aggregate dredging	Licenced	In operation	27km (Area 525) to 99km (Area 515/1-2)		Complete	Yes	Within 100km For marine physical processes, the offshore cable for Norfolk Vanguard passes north of marine aggregate extraction areas offshore from Great Yarmouth. There is potential for some interaction between their dredging plumes and plumes from cable installation
Oil and Gas							
Deborah Gas Storage	Licenced	In operation	28			Yes	Within 100km
118 x Oil and Gas Licences	Licenced	In operation or being decommissioned	0 to 100			Yes	Within 100km
Disposal Sites							
15 x licenced disposal sites	Licenced	In operation	0 (East Anglia THREE) to 99 (Race Bank OWF)			Yes	Within 100km

17.8.1 Cumulative direct impact to potential heritage assets

195. As stated in Table 17.21 cumulative direct impacts to known heritage assets are not anticipated to occur due to the avoidance of known archaeological sites and features identified through EIA for each of the constructed and planned projects as part of the consenting process. However, as direct impacts to potential heritage assets (those which are yet to be discovered) are unavoidable, then cumulative impacts may occur.

196. There is potential for cumulative direct impacts to discrete (potential) heritage assets within the offshore cable corridor from both Norfolk Vanguard and Norfolk Boreas. The specific mitigation which will be applied for both projects (as set out in section 17.7.2) is expected to reduce the level of harm through reducing, remedying and offsetting these potential impacts for both projects. Therefore, the potential cumulative impact is considered to be minor adverse. Cumulative direct impacts upon discrete (potential) heritage assets with other projects are not anticipated to occur as the footprints of projects do not overlap.

197. However, the extents of palaeolandscapes from various periods are largely unmapped and may either be confined within a project area, or may extend beyond the bounds of a project. For example, the assessment of sub-bottom profiler data within the study area has demonstrated the presence of landscape features which form part of the wider North Sea palaeolandscape and the submerged landscape of Doggerland in the Southern North Sea.

198. Similarly, multiple unexpected discoveries of maritime or aviation finds, including newly identified wrecks or crashed aircraft which may be impacted during offshore activities (defined here as projects/activities within 100km of Norfolk Vanguard), could result in a negative cumulative impact upon the overall *in situ* maritime/aviation archaeological resource of the region. As an example, multiple unexpected impacts to wrecks associated with First and Second World War East Coast war channels (see paragraph 102) across the projects and activities set out in Table 17.21 could result in a physical depreciation of the *in situ* archaeological resource relating to those war channels. This could correspond to a reduction in the heritage significance of those wrecks when considered in terms of their group value and associations if material is repeatedly lost as multiple impacts occur.

199. If multiple unavoidable impacts occur from the construction, operation or decommissioning of the projects listed in Table 17.22, then cumulative impacts may occur and it is possible that unique aspects of former landscapes, or of the *in situ* maritime and aviation archaeological resource, may be lost as a result. In addition, if a site is damaged or destroyed, comparable sites elsewhere may increase in

importance as a result of greater rarity and any future direct impacts will be of greater significance.

200. However, together with the accumulation of archaeologically interpreted geophysical and geotechnical data carried out for offshore developments in recent years, the information provided by chance discoveries is already seen to be contributing significantly to a greater understanding of the offshore archaeological resource. As such, any unavoidable impacts and the data and records produced in mitigating their effects can also be regarded as a significant, beneficial cumulative effect. Any positive effect, however, must be demonstrated by the completion of studies to professional archaeological standards and the results produced must be made publicly available.

17.8.2 Cumulative impacts to the setting of heritage assets and historic seascape character

201. The introduction of an OWF into the existing study area will result in a change to the presently perceived historic seascape character and an impact upon the setting of marine heritage assets, particularly in terms of the wider 20th century military setting of the east coast region. The impact assessment concludes that the setting and character offshore is already influenced by existing gas rigs and passing shipping vessels in this area, thereby reducing the sensitivity and potential magnitude of change.

202. Perceptions of character with respect to the primary cultural processes which have been established and spatially defined through the HSC are set out in Table 17.15, and the expected changes associated with construction and operation are set out in Table 17.19 and Table 17.20. This assessment demonstrated that only loss of fishing grounds and the loss of archaeological potential associated with the marine cultural topography are likely to results in a potential meaningful change in perceptions of the historic character within the study area. Overall, the presently perceived historic character, therefore, is considered to have high capacity to accommodate the change.

203. However, as listed in Table 17.22, within a 100km boundary of Norfolk Vanguard there are 13 further OWF projects within UK waters and 11 further EU OWF projects, 29 marine aggregate dredging areas, the Deborah gas storage project and 118 oil and gas licences and 15 offshore disposal projects. The installed or planned infrastructure and associated activities required for all these projects, when considered together, indicates the potential for a significant cumulative change from a historically perceived, open North Sea seascape to a seascape characterised by industrial infrastructure and activities. In particular, with respect to the large number

of planned OWF projects, perceptions of historic seascape character may change to reflect a perception of the southern North Sea as associated primarily with offshore renewables.

204. While the presently perceived historic character is considered to have high capacity to accommodate change, it should be acknowledged that within 100km of Norfolk Vanguard (and across the southern North Sea as a whole), cumulative impacts to the setting of heritage assets and historic seascape character will occur as a result of the construction of multiple projects. Whether this is considered a negative or positive effect may be entirely dependent upon individuals and whether or not they perceive a seascape associated with offshore renewables as a negative or positive change.

17.9 Transboundary Impacts

205. Transboundary impacts stemming from changes to marine physical processes have been scoped out (see Chapter 8). Tidal ellipses show that all movement is in a north south direction and so will not cross the international boundary.

206. Transboundary archaeological impacts may occur if wrecks or aircraft of non-British, European nationality are subject to impact from development. Such wrecks may fall within the jurisdiction of another country, and may include, for example, foreign warships lost in UK waters. As the implementation AEZs will prevent direct impacts to known archaeological receptors, transboundary impacts to known wrecks and aircraft are not expected to occur. It is possible that potential wrecks or aircraft from other countries may be subject to impact, if unexpected discoveries occur, although the archaeological assessment of pre-construction geophysical survey data in combination with the implementation of ORPAD reduces the likelihood of significant impacts occurring. If wrecks or aircraft of non-British nationality are discovered during the course of the development, further advice will be sought regarding the legal status of the remains in their country of origin.

207. In recent decades there have been considerable advances in research of submerged landscapes and it has been recognised that offshore wind activities represent a significant opportunity to both acquire data, and to implement targeted survey and sampling to inform understanding of North Sea submerged landscapes in accordance with co-ordinated strategies across national boundaries. For example, the potential for Mesolithic discoveries within the Dogger Bank and Outer Silver Pit areas of the UK sector should extend into the Elbe palaeovalley in the German Bight and the Danish sector south West of the Skagerrak where it connects to the Mesolithic archaeology in the straits connecting the Skagerrak with the Baltic Sea (Cohen *et al*. 2017: 176). Equally, Palaeolithic archaeology investigated in association with aggregate extraction in the southern North Sea is similarly expected to be found in

the Belgian sector and the south west of the Dutch sector associated with the palaeovalleys of the Rhine and the Meuse.

208. Similarly, initiatives such as the MACHU (Managing Cultural Heritage Underwater) project recognise the value of an integrated approach to North Sea underwater cultural heritage in both management and investigation. MACHU originated as a three-year project involving seven countries sponsored by the European Union's Culture 2000 programme. The project ran from September 2006 to August 2009 although the web resources remain. This collaborative working is also represented through joint ventures such as the 2017 excavations of the *Rooswijk*, a former Dutch East India Company ship wrecked on the Goodwin Sands in 1740, by the Dutch Cultural Heritage Agency and Historic England.

209. These examples highlight the potential for developments to cumulatively affect larger-scale archaeological features such as palaeolandscapes and the North Sea maritime and aviation resource, and to affect the setting of heritage assets and historic landscapes/seascapes which may extend across these international boundaries as outlined for cumulative impacts in section 17.8.1 above. The potential for integrated research and management, however, also represents a positive transboundary impact of OWF development across all sectors of the North Sea.

210. For example, in the Netherlands, the spatial planning of the North Sea has been laid down in the 'National Waterplan' which includes the *Policy Document on the North Sea 2016-2021* (The Dutch Ministry of Infrastructure and the Environment and The Dutch Ministry of Economic Affairs 2015). New wind farms can only be constructed at sites within designated wind farm zones and are subject to EIA. Rijkswaterstaat (the executive agency of the Ministry of Infrastructure and Environment) fulfils the role of competent authority with regard to archaeological heritage management and the Cultural Heritage Agency (RCE: Rijksdienst voor het Cultureel Erfgoed) acts as a consultant for Rijkswaterstaat. In order to support the EIA and permitting processes, the Cultural Heritage Agency of the Netherlands has commissioned the production of a policy advice map for the North Sea's submerged archaeological landscapes which will comprise landscape zoning for the North Sea accompanied by (geo-archaeological) research guidelines for each zone.

211. Alongside data produced through UK OWF development, and that of the Netherlands, Belgium and Germany, for example, data sharing across national boundaries has the potential to result in a significant beneficial transboundary impact. The positive effect of this, however, is dependent on the completion of studies to professional archaeological standards, and upon the publication of results, and raw data where appropriate, so that the benefit can be realised by those

engaged in marine archaeological research (and the OWF industry) for both commercial and non-commercial purposes.

17.10 Inter-relationships

212. Inter-relationships between offshore archaeology and Marine Physical Processes (Chapter 8) have been discussed as part of the impact assessment above. This has demonstrated that no significant impacts are expected for any single archaeological receptor as a result of the construction, operation or decommissioning of the Norfolk Vanguard project. As such, there is no potential for the accumulation of residual impacts on a single archaeological receptor.

17.11 Interactions

213. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic impacts as a result of that interaction. The worst case impacts assessed within the chapter take these interactions into account but, for clarity, the areas of interaction between impacts are presented in Table 17.23 , along with an indication as to whether the interaction may give rise to synergistic impacts.

Table 17.23 Interaction between impacts

Potential interaction between impacts Construction	1 Direct impact to known heritage assets	2 Direct impact to potential heritage assets	3 Indirect impact to heritage assets from changes to physical processes	4 Impacts to the setting of heritage assets and historic seascape character	5 Impacts to site preservation conditions from drilling fluid breakout
1 Direct impact to known heritage assets	-	No	No	No	No
2 Direct impact to potential heritage assets	No	-	Yes	Yes	Yes
3 Indirect impact to heritage assets from changes to physical processes	No	Yes	-	Yes	No
4 Impacts to the setting of heritage assets and historic seascape character	No	Yes	Yes	-	No

Potential interaction between impacts					
5 Impacts to site preservation conditions from drilling fluid breakout	No	Yes	No	No	-
Operation					
	1 Direct impact to known heritage assets	**2 Direct impact to potential heritage assets**	**3 Indirect impact to heritage assets from changes to physical processes**	**4 Impacts to the setting of heritage assets and historic seascape character**	**5 Impacts to site preservation conditions from heat loss from installed cables**
1 Direct impact to known heritage assets	-	No	No	No	No
2 Direct impact to potential heritage assets	No	-	Yes	Yes	No
3 Indirect impact to heritage assets from changes to physical processes	No	Yes	-	Yes	No
4 Impacts to the setting of heritage assets and historic seascape character	No	Yes	Yes	-	No
5 Impacts to site preservation conditions from heat loss from installed cables	No	No	No	No	-
Decommissioning					
It is anticipated that the decommissioning impacts will be similar in nature to those of construction.					

17.12 Summary

214. A summary of the impact assessment for offshore and intertidal archaeology is presented in Table 17.24. In accordance with the methodology for assessment presented in section 17.4.1 this table should only be used in conjunction with the additional narrative explanations provided in section 17.7.

Table 17.24 Potential Impacts Identified for Offshore and Intertidal Archaeology

Potential Impact	Receptor	Value/Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
Construction						
Direct impact to known heritage assets	Wrecks and Anomalies (A1)	High	High	Major adverse	50m AEZs	**No impact**
	A3 wrecks	High	High	Major adverse	Avoid location	**No impact**
	Additional anomalies (A2)	High	High	Major adverse	Avoid location	**No impact**
	Intertidal assets	Low	No impact	No impact	None	**No impact**
Direct impact to potential heritage assets	*In situ* prehistoric, maritime or aviation sites	High	High	Major adverse	Further assessment	**Minor adverse**
	In situ intertidal sites	High	Negligible	Minor adverse	Further (geoarchaeological) assessment	**Minor adverse**
	Isolated finds	Medium	Low	Minor adverse	Protocol to be established	**Minor adverse**
Indirect impact to heritage assets from changes to physical processes	Known and potential heritage assets	Low to High	Negligible	Negligible to Minor	None	**Negligible to Minor adverse/ beneficial**
Impacts to the setting of heritage assets and historic seascape character	Temporary changes to maritime and military setting of wrecks and to the historic seascape character from construction activities. The presently perceived historic character is considered to have a high capacity to accommodate changes associated with construction.					
Impacts to site preservation conditions from drilling fluid breakout	Intertidal assets	Low	Negligible / No impact	Negligible	None	**Negligible**
Operation						
Direct impact to known heritage assets	As for construction					**No impact**
Direct impact to potential heritage assets	*In situ* prehistoric, maritime or aviation sites	High	High	Major adverse	Further assessment	**Minor adverse**
Indirect impact to heritage	Known and potential	Low to High	Negligible	No impact to	None	**No impact to**

Potential Impact	Receptor	Value/Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
assets from changes to physical processes	heritage assets			Negligible		**Negligible**
Impacts to the setting of heritage assets and historic seascape character	Change to maritime and military setting of wrecks and to the historic seascape character during operation. The presently perceived historic character is considered to have a high capacity to accommodate changes associated with operation.					
Impacts to site preservation conditions from heat loss from installed cables	Known and potential heritage assets	Low to High	No impact	No impact	None	**No impact**
Decommissioning						
Direct impact to known heritage assets	As for construction					**No impact**
Direct impact to potential heritage assets	*In situ* prehistoric, maritime or aviation sites	High	High	Major adverse	Further assessment	**Minor adverse**
Indirect impact to heritage assets from changes to physical processes	As for construction (or less)					**Negligible to Minor adverse/ beneficial**
Impacts to the setting of heritage assets and historic seascape character	Temporary changes to maritime and military setting of wrecks and to the historic seascape character from decommissioning activities. The presently perceived historic character is considered to have a high capacity to accommodate changes associated with decommissioning.					
Cumulative						
Direct impact to known heritage assets	*In situ* prehistoric, maritime or aviation sites	Low to High	High	Major adverse	Avoidance	**No impact**
Direct impact to potential heritage assets	*In situ* prehistoric, maritime or aviation sites	Medium to High	High	Major adverse	Further assessment/reporting protocol	**Minor adverse (plus positive benefit from accumulation of data)**
Indirect impact to heritage assets from changes to	Known and potential heritage assets	Low to High	Negligible	No impact	None	**No impact**

Potential Impact	Receptor	Value/Sensitivity	Magnitude	Significance	Mitigation	Residual Impact
physical processes						
Impacts to the setting of heritage assets and historic seascape character	Within 100km of Norfolk Vanguard (and across the southern North Sea as a whole), cumulative impacts to the setting of heritage assets and historic seascape character will occur. Whether this is considered adverse/beneficial depends upon individual perceptions of a seascape associated with offshore renewables as a negative or positive change.					
Transboundary						
Direct impact to known heritage assets	Wrecks or aircraft of non-British origin	High	High	Major adverse	Avoidance	**No impact**
Direct impact to potential heritage assets	Wrecks or aircraft of non-British origin	High	High	Major adverse	Further assessment/ reporting protocol/ consideration of legal status in country of origin	**Minor adverse**
	Prehistoric, maritime and aviation archaeological resource (across national boundaries)	Medium to High	High	Major adverse	Further assessment/ reporting protocol	**Minor adverse (plus positive benefit from accumulation of data)**
Indirect impact to heritage assets from changes to physical processes	Tidal ellipses show that all movement is in a north south direction so will not cross the international boundary and transboundary impacts will not occur.					

17.13 References

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