European Offshore Wind Deployment Centre
Environmental Statement

Appendix 18.2: Marine and Maritime Archaeology EIA Technical Report

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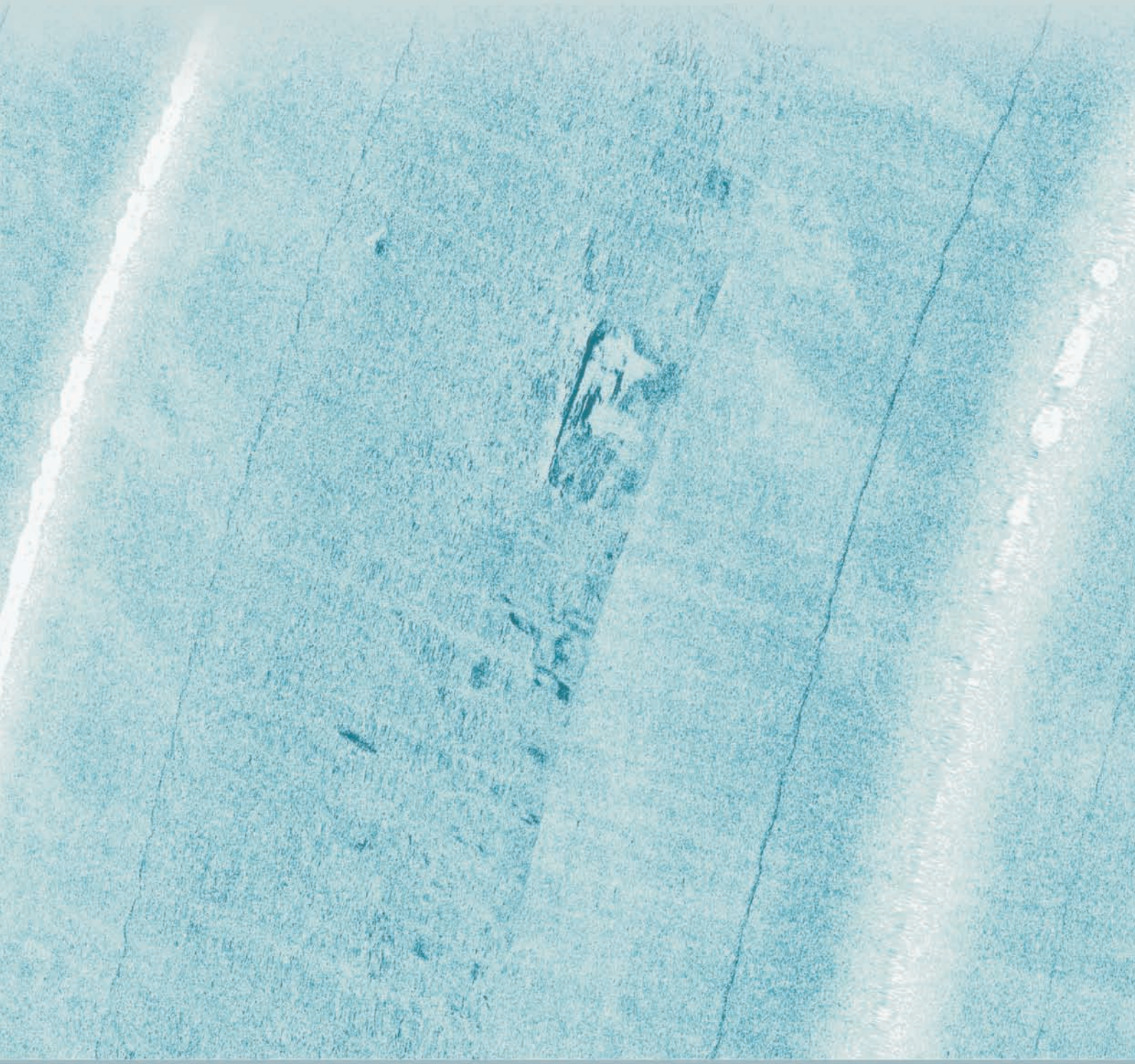
Wessex Archaeology

European Offshore Wind Deployment Centre: Impact Assessment



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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

TECHNICAL REPORT

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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

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EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE: IMPACT ASSESSMENT

TECHNICAL REPORT

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Dr Andrew Bicket produced this report. David Howell and Patrick Dresch processed and reviewed the geophysical data and further contributed to the report. Kitty Brandon prepared the illustrations. Dr Jonathan Benjamin managed the project for Wessex Archaeology, and quality assurance was conducted by Euan McNeill and Candice Hatherley.

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Details of archaeological sites within the study area were received from the National Monuments Record Scotland and UKHO. Copyright restrictions apply to this data (http://www.rcahms.gov.uk/crown-copyright.html).

The following acknowledgments and licences apply:

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1 MARINE & MARITIME ARCHAEOLOGY

1.1 Information for the Non-Technical Summary

1 Impacts to marine and maritime cultural heritage receptors have been assessed for the proposed European Offshore Wind Deployment Centre (EOWDC). Primary direct impacts relate to the construction, operation and decommissioning phases of wind turbine foundations and inter-array and export cable routes. Indirect impacts may derive from changes to the seabed produced by direct impacts. Secondary impacts are likely to be restricted to the seabed footprint of vessels involved in all phases of development.

2 Cultural heritage receptors in the Marine Study Area (MSA) have been grouped under three themes, based on the known and potential cultural heritage resource discussed in the baseline technical report (Wessex Archaeology 2011) – Prehistoric Archaeology; Maritime Archaeology and Aviation Archaeology. Under these themes, several receptors have been identified; these are outlined in Table 1.

3 Each archaeological feature is unique. Importance varies and may not be well understood; although they can still be assessed in terms of the general wreck resource or, in terms of prehistory, the regional potential for prehistoric material and the likely presence of sediments which may contain them.

4 Without mitigation, impacts upon these receptors, especially *known wreck sites*, are likely to be adverse and permanent. With mitigation adverse impacts may be avoided and/or their effects reduced. Adverse impacts relating to the damage and disturbance of heritage assets have been identified primarily with respect to the unidentified wreck (WA 7071) which lies in close proximity to Wind Turbine 8 and with respect to the associated potential inter-array cable routes between wind turbines (Figure 1).

5 Adverse impacts to prehistoric archaeology receptors are likely to be of *moderate* significance. Following mitigation this is likely to be significantly reduced and adverse impacts are likely to be of *minor* significance.

6 Avoidance, where practicable, is the preferred mitigation strategy for known cultural heritage assets (Wessex Archaeology 2007).

7 There is the potential to encounter currently unknown and unidentified cultural heritage assets in the Marine Study Area (MSA) (defined in the archaeological baseline technical report prepared by Wessex Archaeology for Aberdeen Offshore Wind Farm Ltd, 2011). The geophysical survey has identified several anomalies which may be man-made or natural features. Strategies have been proposed to mitigate adverse impacts to these receptors.

8 Research, particularly the geoarchaeological examination of vibrocores and grab samples from sub-seabed sediments taken for engineering purposes provides a cost-effective opportunity to directly investigate the age and archaeological potential of sub-seabed sediments of potential prehistoric archaeological importance. The integration of this kind of geoarchaeological analysis early in the sequence of development activities is advisable to provide the most effective mitigation strategy (Gribble and Leather 2011).

9 Monitoring may be achieved through remote means such as geophysical or ROV surveys. In addition, the Crown Estate has recently published a reporting protocol for finds from offshore renewable developments (The Crown Estate/Wessex Archaeology 2010). Best-practice and effective monitoring may be partly achieved by implementing this protocol. Added value will also be provided to the National Monuments Record.

1.2 Introduction

10 The baseline conditions for the Cultural Heritage Receptors assessed in this report have been reported in the Baseline Technical Report (Wessex Archaeology 2011, report ref: 65391.02).

11 This Impact Assessment should be read in conjunction with the Baseline Technical Report (Wessex Archaeology 2011).

12 The objectives of this impact assessment, in line with existing guidance (Wessex Archaeology 2011, and summarised in section 1.2.1), are to:

- Summarise the adverse and beneficial impacts of the development that are relevant to the submerged archaeology of the area, including
  - Direct
  - Indirect
  - Secondary
  - Cumulative Effects
- Summarise the sensitivity of the archaeological heritage that may be impacted by the development
- Assess the magnitude and scale of impacts on the archaeological heritage of the identified impacts
- Comment on the significance of effects upon the archaeological heritage
- Propose mitigation measures to remove or reduce significant adverse impacts

13 In-combination Effects, in this case, are not applicable to cultural heritage assets, and only apply to European sites associated with the EU Habitats Directive.

1.2.1 Key Guidance Documents

- The Code of Practice for Seabed Developers, Joint Nautical Archaeology Policy Committee 2006 (JNAPC 2006)
- Historic Environment Guidance for the Offshore Renewable Energy Sector, COWRIE 2007 (Wessex Archaeology 2007)
- Guidance for Assessment of Cumulative Impacts on the Historic Environment; from Offshore Renewable Energy, COWRIE 2008 (Oxford Archaeology & George Lambrick Archaeology and Heritage 2008)
- Offshore Geotechnical Investigations and Historic Environment Analysis: Guidance for the Renewable Energy Sector. (Leather & Gribble/COWRIE 2011)
- Protocol for Archaeological Discoveries: Offshore Renewables Projects, The Crown Estate, 2010 (TCE, Wessex Archaeology 2010)

1.2.2 Data Information and Sources

- Archaeological records for the MSA available in the maritime section of the CANMORE database held by the Royal Commission for Ancient and Historic Monuments Scotland (RCAHMS) which constitute the National Monuments Record for Scotland (NMRS), also interrogated via a map interface, CANMAP
- Archaeological records for the MSA held locally in the Aberdeenshire, Moray and Angus Sites and Monuments Record (SMR)
- Records of wrecks and obstructions collated by the UK Hydrographic Office (UKHO)
- Records of Protected Places and Controlled Sites provided by the Ministry of Defence
- SeaZone datasets including basemapping and wreck information (derived from UKHO records)
- British Geological Survey (BGS) mapping and UKHO charts
- Various secondary sources relating to the palaeo-environment of the area and to the Palaeolithic and Mesolithic archaeology of Northern Europe
- Secondary sources relating to wrecks and the maritime environment and the history and archaeology of Aberdeen and its surrounding area
- Other readily available published sources

1.2.3 Impact Assessment Methodology

1.2.3.1 Cultural Heritage Receptors

14 In order to provide a targeted impact assessment, the cultural heritage receptors in the MSA have been grouped under three themes, based on the known and potential cultural heritage resource discussed in the baseline technical report (Wessex Archaeology 2011) – Prehistoric Archaeology; Maritime Archaeology and Aviation Archaeology. Known and potential receptors are outlined in Table 1.

Table 1: Cultural Heritage Receptors Defined for the MSA

Prehistoric Archaeology	Maritime Archaeology	Aviation Archaeology
Post-glacial submerged landscape features & fills	Known wreck sites	Unknown aircraft crash sites
Isolated prehistoric sites & finds	Unknown wreck sites	

15 Each archaeological feature is unique. Importance varies and it may not be possible to accurately assess importance given the available data; although the importance of each receptor can still be assessed in terms of the 'potential' for encountering them relative to baseline conditions (Wessex Archaeology 2011). This may be examined in relation to the general wreck resource or, in terms of prehistory, the regional potential for prehistoric material and the likely presence of sediments which may contain them (Wessex Archaeology 2011).

1.2.3.2 Criteria for Assessing Significance of Impact

16 The criteria that will be used in the impact assessment are summarised below:

Spatial Extent of Effect

17 The terms used in the impact assessment are:

- national/international effect
- a regional effect
- a local effect (within 5 km of the site)
- a site-specific effect

Duration of Effect

18 The terms used in the impact assessment are:

- long-term / permanent effect (more than 10 years)
- medium-term effect (existing for 5 to 10 years)
- short-term effect (existing for 1 to 5 years)
- temporary effect (existing for less than a year)

Recoverability of the Receptor

19 Generally impacts have adverse effects upon archaeological materials but some effects can be beneficial. The terms used in the impact assessment for receptor recoverability are:

- High
- Medium
- Low or
- None

20 Cultural heritage receptors are a finite non-renewable resource, they cannot recover following adverse impacts upon them, such as substrate removal and physical damage. The security of the context in which they are found is also a key factor in assessing their value and importance. Therefore against adverse effects, recoverability will be low to none.

Importance of the Receptor

21 Archaeological importance is gauged on the extent, rarity and perceived significance of the resource. For example, finds of Mesolithic and Palaeolithic age are rare compared to material from more recent archaeological periods. As a result they are likely to be of national to international importance (e.g. Parfitt *et al*. 2010; Ballin *et al*. 2010).

22 In contrast, vessels from the 20th century are relatively numerous and well-recorded therefore their archaeological importance may be lower. However, such wrecks may be significant for other reasons such as wartime importance (e.g. protected under the Protection of Military Remains Act (PMRA 1986) or technological advances.

23 There may also be significant local, regional and national importance associated with vessels that were lost with their crew (e.g. the Solway Harvester). http://news.bbc.co.uk/1/hi/scotland/south_of_scotland/8448887.stm

24 The terms used in the impact assessment are summarised within the definitions of Table 2.

1.2.3.3 Assessment of Significance

Sensitivity of the Receptor

25 Assessment of the sensitivity of the cultural heritage receptors is guided by the definitions in Table 2 developed from COWRIE guidance (Wessex Archaeology 2007, COWRIE 2008). Cultural heritage receptors may also be important for other reasons such as wartime history (e.g. protected under PMRA 1986).

26 Where the archaeological importance or sensitivity is unknown or cannot be clearly defined (e.g. for unknown distributions of prehistoric archaeological materials or unidentified wrecks), a precautionary approach is taken and the receptors' archaeological potential is assessed.

Table 2: Sensitivity of Receptors – Definition of terms (adapted from Wessex Archaeology 2007, COWRIE 2008).

Sensitivity	Definition
Very High	Feature of International Importance OR best known example and/or significant potential to contribute to knowledge and understanding and/or outreach
High	Feature of National Importance OR above average example and/or high potential to contribute to knowledge and understanding and/or outreach
Medium	Feature of Regional Importance OR average example and/or moderate potential to contribute to knowledge and understanding and/or outreach
Low	Feature of Local Importance OR below average example and/or low potential to contribute to knowledge and understanding and/or outreach

27 For some cases, a *negligible* significance of impact may be surmised in association with Table 4. In relation to cultural heritage assets this would be defined as a "poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach".

Magnitude of Effect

28 The magnitude of effect is assessed relative to the worst realistic case where possible (see section 1.2.4) and the impact of development upon specific or regional cultural heritage assets relative to baseline conditions. The terms are defined in Table 3.

Table 3: Magnitude of Effect – Definition of terms (adapted from Wessex Archaeology 2007, COWRIE 2008).

Magnitude	Definition
Very High	Total loss or very major alteration to key elements/features of the baseline conditions such that post development character/composition/attributes will be fundamentally changed and may be lost from the site altogether.
High	Major alteration to key elements/features of the baseline (pre-development) conditions such that post development character/composition/attributes will be fundamentally changed.
Medium	Loss or alteration to one of more key elements/features of the baseline conditions such that post development character/composition/attributes of baseline will be partially changed.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible but underlying character/composition/attributes of baseline condition will be similar to pre-development circumstances/patterns.
Negligible	Very slight change from baseline condition. Change barely distinguishable, approximating to the 'no change' situation.

29 Based upon these criteria a judgment on the receptors' sensitivity (Table 2) and the magnitude of effect (Table 3) is made. The significance of impact is guided by the matrix shown in Table 4.

Table 4: Matrix for Significance of Impact

	Sensitivity of Receptor				
Magnitude of Effect based on spatial, duration and scale of effect		**Very High**	**High**	**Medium**	**Low**
	Very High	Major	Major	Major	Moderate
	High	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Moderate	Minor
	Low	Moderate	Minor	Minor	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

1.2.3.4 Cumulative and In-combination Impact Assessment Methodology

30 Aspects of development activities within the proposed EOWDC in conjunction with other activities and development projects in the region may create cumulative impacts upon cultural heritage receptors.

31 Several offshore activities within the region are considered under cumulative impacts, external or adjacent to the current proposed EOWDC development. A proposed application for an ocean laboratory to the south of Wind Turbine 1 is also discussed. Developments considered include:

- Other offshore wind developments
- Ocean Laboratory, EOWDC
- Maritime and Coastguard Agency designated anchorage area
- Commercial fisheries activity
- Subsea cables
- Port/harbour dredging operations

32 Where possible a brief statement of the nature of the cumulative impacts is made. Recent or future developments are likely to require undertaking EIA and the development of mitigation strategies. These processes in many cases will aid the reduction or avoidance of adverse impacts to cultural heritage assets.

33 In-combination effects, in this case, are not applicable to cultural heritage assets only to European sites associated with the EU Habitats Directive.

1.2.4 Worst Realistic Impact

34 The exact specification of the wind turbines has not been established at this time and a variety may be used. A maximum specification is used to examine the worst case scenario.

35 With respect to cultural heritage receptors within the MSA, the worst realistic impact would derive from activities producing the greatest spatial extent of seabed disturbance and greatest volume of seabed and sub-seabed sediment removal.

Impacts from Cable Trenching

36 As outlined in the Rochdale envelope for the proposed development, cable installation involving ploughing of up to 3 m depth and 10.38 m width would induce the greatest disturbance to the seabed (up to c. 202,500 m^3 depending upon configuration of cable network and method used) and it is considered that the proposed cable trenches have the greatest potential for impacts upon unknown cultural heritage assets.

37 Up to four export cables routes are proposed. Between the designated anchorage and Blackdog rifle range exclusion zones the area for routing these export cable trenches is constrained to a corridor roughly 250 m wide. If all four export cable trenches are excavated the relative area of seabed and sub-seabed sediments under disturbance will be intensified in this area.

38 Not all possible routes for inter-array cabling will be installed. This will enable mitigation through avoidance of cultural heritage assets or micro-siting of wind turbines and therefore the associated inter-array cable routes.

Impacts from Wind Turbine Foundations

39 Depending upon the type of wind turbine foundation used impacts upon the seabed and sub-seabed sediments will vary. The most horizontally-extensive (giving the largest seabed disturbance) wind turbine foundation proposed is a gravity base structure of up to 40 m in diameter. This base can also extend to depths of up to 2 m, so there is a high potential for unknown and buried cultural heritage receptors within this footprint to be adversely affected.

40 Seabed preparation may be required for construction of gravity base foundations which would involve groundworks to the seabed beneath the proposed location by dredging seabed sediments, partly to provide ballast for the gravity bases themselves. Any archaeological or palaeoenvironmental assets within sediment affected by this process would be lost or damaged.

41 In addition, an unknown width of scour protection (dumped aggregates) may also be deposited around the foundation footprint of wind turbine foundations increasing the area of effect further. The volume and extent of this scour protection will ultimately depend on local hydrographic conditions. Cultural heritage assets within

these footprints are likely to be adversely affected by compression under significant volumes of scour-protecting aggregates.

Vessel Footprint

42 Secondary adverse impacts from vessel footprint are also an important consideration, during all phases of the project. If during construction, operation and decommissioning vessels jack-up on legs or anchor to the seabed, either directly onto cultural heritage assets or their protective, sedimentary overburden, then the asset or its archaeological context may be significantly damaged or destroyed within this footprint.

Changes to Seabed Sediment Distribution

43 The prevailing wind and tide directions suggest that cultural heritage receptors in the lee of wind turbine foundations (i.e. sheltered) could be exposed to turbulence and scour produced by water flow around the foundations, removing protective sediment cover and deleteriously affecting the condition of cultural heritage receptors.

1.3 Impact Assessment

44 Cultural heritage receptors are a finite resource, they cannot recover following adverse physical impacts upon them and the security of the context in which they are found is critical to their value and importance. Generally impacts will be adverse in nature upon archaeological materials, but some impacts can be beneficial (Table 5). For example, indirect adverse impacts may manifest as scour around wreck sites created by turbulence induced by changes to water flow around wind turbine foundations leading to adverse effects from erosion (Table 5). In the case of sediment plumes created during trenching for cabling (or other disturbance to the seabed where sediments are entrained in the water column), when they resettle they can provide additional protection to archaeological materials. Clearly this action can not be easily quantified and does not imply direct or comparable mitigation of adverse impacts.

45 With respect to the MSA and cultural heritage receptors in marine contexts, only the impacts to resources on the seabed are considered here, i.e. the specifications of the wind turbine foundations, cable trenching methodologies and secondary impacts from vessels will be the critical factors for assessing impacts, not the above-water configuration of wind turbines.

46 The nature of impacts upon cultural heritage receptors can be seen to derive from two main activities during the lifetime of the proposed development. Impacts will derive from:

- inter-array and export cabling installation; and
- wind turbine foundation installation

47 Impacts from the installation of the inter-array and export cabling, primarily the seabed excavation aspect of the process, are likely occur at shallower depths but more spatially extensive with respect to the distribution of cultural heritage receptors on or beneath the seabed.

48 Impacts from the installation of the wind turbine foundations will be more restricted to the footprint of each wind turbine with respect to the distribution of cultural heritage receptors.

49 Depending upon the wind turbine foundation types ultimately used, pile foundations will have a smaller lateral footprint but will be considerably deeper than a shallower but wider gravity base structure (GBS). GBS foundations are regarded as the worst case scenario and form the focus of the impact assessment (see section 1.2.4). Adverse impacts are likely to be similar within the footprint of pile foundations but penetrate to a greater depth of seabed sediment. As the archaeological importance of the seabed sediment cannot be accurately assessed with the available data, the assessment of pile-driven wind turbine foundations is not developed further and general statements of impact are made within units of sediment of archaeological potential are made.

50 Secondary impacts from the seabed footprint of attending vessels are also likely to occur during construction, operation and decommissioning of the development. Secondary impacts are likely to interact with the seabed and shallow sub-seabed sediments in localised areas by jack-up legs and/or anchoring. Depending upon the methods used, any cultural heritage assets under this footprint are likely to be significantly and adversely impacted. It is not possible to accurately predict exactly where these impacts will affect the seabed at this time.

51 There is also scope for the construction of an Ocean Laboratory to the south-west of Wind Turbine 1. This will be applied for via a separate consent application but this will be considered under cumulative impacts (Figure 1 and 2).

52 The impacts upon cultural heritage receptors considered in this assessment are summarised in Table 5.

Table 5: Summary of the Nature and Type of Impacts

Impact	Nature of Impact	Type of Impact
Direct damage to both *in situ* cultural heritage assets and assets in secondary contexts	Adverse	Direct
Disturbance of relationships between structures, artefacts and their surroundings or contexts	Adverse	Direct
Destabilisation and erosion of sites through changes to seabed characteristics	Adverse	Indirect
Burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors	Beneficial	Indirect

1.3.1 Impacts on Submerged Prehistoric Archaeology

1.3.1.1 Construction & Decommissioning Phase

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage

53 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

54 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Post-glacial Submerged Landscape Features & Fills

55 There are currently no known prehistoric artefacts or sites recorded from below Mean Low Water Spring (MLWS) in the MSA (Wessex Archaeology 2011).

56 For clarity, Table 6 from the baseline technical report (Wessex Archaeology 2011) is included here for reference:

Unit	Description
1	Recent (Holocene) seabed sediments, silty sand.
2	Late Devensian / Early Holocene fluvio-deltaic and marine sands (Forth Formation (FH), St. Andrew's Bay Member)
3	Late Devensian Till (Wee Bankie Formation)
4	Devonian Bedrock (Old Red Sandstone)

57 Unit 4 is bedrock and therefore is not considered to be of archaeological interest. There may be potential for encountering older archaeological material of Devensian age in secondary contexts which has been reworked from terrestrial contexts into Unit 3 (Wee Bankie Formation) sediments. However, because the Unit 3 sediments are glacial in origin the potential to encounter archaeological material of Devensian age is regarded as being low to negligible.

58 In general terms the upper, and lower extent of Unit 2 in the region of the proposed wind turbine locations, is in at least 20m of water. The proposed Wind Turbine locations 1 – 3 are located close to the 20 m bathymetric contour, with the rest of the proposed wind turbine locations in progressively deeper water to the east (up to *c.* 30 m bathymetric contour). Groundworks and construction activity required for the installation of the wind turbine foundations will have an additional footprint that may impact the seabed out with the footprint of the wind turbines themselves. Unit 2 sediments will be locally affected by this activity; the magnitude of the impact will be partly dependent upon the method of foundation construction.

59 In the very early Holocene, c. 10,000 BP, the positions of the westernmost wind turbines (1, 2, 3, 5, 6 and 9) may have been in, or close to, the inter-tidal zone, with the remaining wind turbines in increasingly offshore positions moving east. Sub-seabed feature WA_7505 represents a prograding series of sedimentary units. Sea level models from the region suggest that the bathymetry of this feature would have been submerged by around 10,000 BP (Wessex Archaeology 2011: Figure 7) which focuses the potential for archaeological materials roughly landwards of, and in the vicinity of the 20m bathymetric contour. Incorporating estimates of isostatic readjustment from the same sea level dataset suggests that land uplift in north-east Scotland is around 0.5 mm/yr (Gehrels 2010) which is equivalent to sediments undergoing 2.5 m of uplift from their initial position in 5,000 years which would go some way to juxtapose the depth of Unit 2 beneath more recent Unit 1 seabed sediments and using modern bathymetry as a reference point for archaeological palaeo-landscapes potential.

60 This palaeogeographical relationship indicates a reduced potential of directly impacting upon submerged archaeological landscapes that may be preserved in the vicinity of the proposed wind turbine locations within the context of the currently known period of human activity in Scotland. This potential is constrained by Holocene relative sea level modelling, isostatic readjustment and the sediments of Unit 2 and which are comparable to the St Andrews Bay Member of the Forth Formation. In addition, construction, operation and maintenance, and decommissioning impacts from associated activities such

as the footprints of vessels servicing the wind turbines and cable trenching will extend landward into areas of higher potential.

61 Five shallow geological cut and fill features were also identified (WA 7500 – 7504) during the geophysical assessment (Wessex Archaeology 2011). These features are concentrated in the south-west of the MSA and may be small, isolated infilled basins (as they do not appear on adjacent survey lines). There is some potential for archaeological material (perhaps in secondary contexts) to be found within them, but this is likely to be low. Unless directly impacted by export cabling routes, impacts to these palaeolandscape features by the development are likely to be negligible.

62 As Unit 2 deposits underlie much of the MSA and may be adversely affected by the export cables, they are potentially of high value as they form the primary sedimentary resource for preserving *in situ* early prehistoric (of Mesolithic and perhaps Upper Palaeolithic age) archaeological assets. Without further evidence clarifying the age of these sub-seabed sediments and an assessment of their archaeological contents (if present and preserved), a more detailed statement of importance is not currently possible.

63 Locally, the effect of potential sediment removal during cable installation (see section 1.2.4 for worst case) could have a major adverse impact if Unit 2 sediments are affected. However, across the development as a whole, this will be restricted to a relatively small area in the vicinity of development activities.

64 Encountering *post-glacial submerged landscape features and fills* during wind turbine foundation installation is restricted by the potential for the westernmost wind turbines to overly a previously inter-tidal zone as suggested by Holocene sea level models and palaeogeographical literature (Wessex Archaeology 2011). The scale of the impact is judged to be medium for these cases, restricted to a site-specific spatial extent. Importance cannot currently be assessed and is therefore, medium.

65 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

66 The potential impact has been assessed of **medium** magnitude, **high** sensitivity and of ***moderate*** significance.

Isolated Prehistoric Sites & Finds

67 As discussed in the archaeological baseline report for the proposed EOWDC (Wessex Archaeology 2011), there is potential for encountering isolated, chance finds of lithic scatters and other prehistoric archaeology associated with Unit 2 sediments across the MSA, and also remobilised finds in secondary contexts within the seabed sediments deriving from coastal geomorphology.

68 Within the context of the post-glacial sea-level change and associated palaeo-geography of the MSA, this potential is likely to be focused in the coastal shelf region to the west of the proposed wind turbine locations in less than 20 m of water. The route of the export cabling (a maximum of four export cables are proposed) will therefore be an important factor for assessing the impacts on cultural heritage receptors in the MSA. Unit 2 sediments are

extensively preserved across the MSA in varying thickness, beneath around 1 m of seabed sediment.

69 Although seafloor disturbance is likely to be shallow, if cable trenching and wind turbine bases interacted with Unit 2 sediments there would be a localised, major adverse impact. The depth of the cable would be between 0.6 m and 3 m. Therefore, where cable installation groundworks remove more than *c.* 1 m vertical depth of seabed sediment there is a greater potential that sediments of potential prehistoric archaeological significance will be adversely affected.

70 There is potential for encountering isolated prehistoric finds but the distribution of such material cannot currently be assessed. As a result the scale of impact is described as medium as a precaution. This receptor is primarily associated with Unit 2 sediments (Wessex Archaeology 2011) that may be adversely impacted by wind turbine foundation activities, their spatial extent is across most of the MSA, and is therefore of local-scale.

71 Under current proposals cable routes would be left *in situ* after decommissioning, with maintenance and exposed connections made safe. The significance may be reduced as impacts would already have occurred during the construction phase. Secondary impacts from vessel footprints on the seabed would be the main impact to cultural heritage assets.

72 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

73 The potential impact has been assessed of **medium** magnitude, **medium** sensitivity and therefore of ***moderate*** significance.

Table 6: Summary of Significance of adverse impacts upon prehistoric archaeology receptors.

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor	Importance of the Receptor	Sensitivity of the Receptor	Magnitude of Effect	Significance of Impact
Prehistoric Archaeology	Post-glacial submerged landscape features & fills	Site-specific to Local	Permanent	None	Medium	Medium	High	**Moderate**
	Isolated prehistoric sites & finds	Local	Permanent	None	Medium	Medium	Medium	**Moderate**

Table 7: Summary of Significance of beneficial impacts upon prehistoric archaeology receptors.

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Prehistoric Archaeology	Post-glacial submerged landscape features & fills	Site-specific to Local	Temporary to long-term	-	Medium	Low	Low	Negligible
	Isolated prehistoric sites & finds	Local	Temporary to long-term	-	Medium	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

74 Effective mitigation and monitoring during cable trenching and wind turbine installation activities is problematic. Sediment plumes obscure the observation of impacted cultural heritage receptors. The ephemeral nature of potential archaeological materials such as Mesolithic period microliths also precludes ease of monitoring.

75 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies.

76 Following geotechnical/geoarchaeological assessment of grab samples, vibrocores and other sediment samples it may be possible to gauge the potential for encountering prehistoric archaeology assets further. However, if prehistoric archaeological assets are an important feature of the impacted sub-seabed sediments, then the significance of impact may increase from the scenario described here.

77 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

78 The potential for encountering prehistoric archaeology is likely to be restricted to the west of the proposed wind turbine locations, in less than 20m water depth. The impact of export cabling excavated through sub-seabed sediments of archaeological potential could be reduced by geoarchaeological assessment of geotechnical cores taken for engineering purposes (Gribble

and Leather 2011). This would permit a more accurate assessment of the age and archaeological potential of the sub-seabed sediments, particularly Unit 2.

79 Mitigation during construction phase would already apply in relation to the decommissioning phase.

Residual Impacts

80 After mitigation the impacts would likely be restricted to secondary impacts from vessel footprint during the decommissioning phase.

81 After mitigation the impacts would be of ***minor*** significance.

Cumulative Impacts

- **Other Offshore Wind Developments**
  - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
  - Abutting the MSA to the south is the MCA anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon buried Prehistoric Archaeology Receptors in conjunction with vessel footprints from the EOWDC project. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**
  - There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
  - It is considered that cumulative impacts are likely to be of ***low-negligible*** significance.
- **Subsea Cables**
  - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
  - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
  - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of *minor* significance depending upon the type of the foundation used (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development. Submerged landscape features associated with Unit 2 sediments

would be most affected in a similar manner to wind turbine foundation installation impacts.
- The potential impact has been assessed of **medium** magnitude, **high** sensitivity and of ***moderate*** significance.
- After mitigation the impacts would be of ***minor*** significance.

Monitoring

82 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to prehistoric archaeology receptors.

83 Post-decommissioning, a geophysical survey is recommended to examine the condition of the seabed following the removal of infrastructure, which may largely be the wind turbine foundations as cable routes may be left *in situ*. Geophysical survey data should be reviewed by an archaeological specialist to assess cultural heritage receptors within the development area.

1.3.1.2 Operational Phase

Potential Impacts

84 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

85 Mitigation during construction phase would already apply (see page 16).

Residual Impacts

86 As construction and decommissioning phase (see page 17).

Cumulative Impacts

87 As construction and decommissioning phase (see page 17).

Monitoring

88 Periodic geophysical survey is recommended to review the state of the seabed following development activities. This could be undertaken in conjunction with other development requirements such as for engineering or geotechnical purposes.

1.3.2 Impacts on Maritime Archaeology

1.3.2.1 Construction & Decommissioning Phase

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage

89 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

90 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Known Wreck Sites

91 There is one known wreck site (WA 7071), and one seabed feature (WA 7072) which may be wreck debris in the MSA. Both have been verified by geophysical assessment and characterised as being *Anthropogenic origin of archaeological interest* (Wessex Archaeology 2011).

92 The single known wreck (WA 7071) is unidentified; thus importance cannot be currently assessed. The scale of the impact assessment is therefore site-specific in this case.

93 Cable trenching between wind turbine locations 8 and 9, 8 and 11 and 8 and 5 pass within around 40 m of the wreck location where buried debris may be located. There may also be positional uncertainties associated with both the position of the survey vessel at the time of data capture, and also in the position of the trenching machinery suggesting a cautious approach is advisable with this receptor (Figure 1 and 2).

94 The footprint of a gravity base foundation (40 m diameter) at Wind Turbine 8 would pass within around 40m of the wreck location where buried debris may be located. Once the skirt (up to 2m) and if an unknown width of scour protection is added, the proximity of to the wreck site may ultimately be as little as a few metres (Figure 1). There may also be positional uncertainties associated with both the position of the survey vessel at the time of data capture, and also the position of the installation vessels suggesting a cautious approach is advisable with this cultural heritage asset.

95 Depending upon the particular foundation construction methods and footprint of service vessels during operation, maintenance and decommissioning the likely interaction between this receptor and adverse impacts is likely to be high on a site-specific scale.

96 There may be secondary adverse impacts from the vessel footprint from jack-up legs or anchoring.

97 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

98 The potential impact has been assessed of **high** magnitude, **high** sensitivity and therefore of ***major*** significance.

Unknown Wreck Sites

99 There are large numbers of *recorded losses* (vessels thought to have been lost in the region, but without accurate recorded locations) in the vicinity of the MSA (Wessex Archaeology 2011). Following geophysical assessment of the seabed, the level of interaction between this receptor and impacts is thought to be low. However, there are significant numbers of magnetic anomalies on the seabed and particularly a medium-sized magnetic anomaly (WA 7070). The importance of this anomaly cannot currently be assessed but it is in close proximity to the proposed location of Wind Turbine 3 and could represent ferrous debris from an unknown wreck site.

100 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

101 The potential impact has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

Table 8: Summary of Significance of adverse impacts upon maritime archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor	Importance of the Receptor	Sensitivity of the Receptor	Magnitude of Effect	Significance of Impact
Maritime Archaeology	Known wreck sites	Site-specific	Permanent	None	High	High	High	**Major**
	Unknown wreck sites	Local	Permanent	None	Low	High	Low	**Minor**

Table 9: Summary of Significance of beneficial impacts upon maritime archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Maritime Archaeology	Known wreck sites	Site specific	Temporary to long-term	-	Medium	Low	Low	Negligible
	Unknown wreck sites	Local	Temporary to long-term	-	Low	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

102 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies in line with current planning policies.

103 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

104 A precautionary exclusion zone of 50 m around the visible extent of the wreck and debris is proposed in order to avoid inadvertent adverse impact to cultural heritage assets WA 7071 and WA 7072 during all phases of the project before their importance can be determined (Dix *et al*. 2007). As the wreck is

unidentified and importance cannot currently be assigned, importance is classified as **high** as a precautionary approach.

105 These precautionary exclusion zones also provide a buffer in case of positional uncertainties associated with both the position of the survey vessel and towfish at the time of geophysical data capture, and also the position of the trenching machinery.

Inter-array and export cabling

106 The inter-array cable routes between Wind Turbine 8 and 9, 8 and 11 and 8 and 5 intersect the precautionary exclusion zones, passing around 40m from the wreck position (WA 7071) (Figure 1 and 2).

107 The network of inter-array cabling routes indicates there will be repeated direct impacts from these networks of trenches. Mitigation strategies set out above for maritime archaeology receptors may offset repeated adverse impacts form the inter-array cable trenching as known wreck assets have been verified by geophysical survey.

108 Avoidance of the identifiable maritime archaeological receptors could most effectively be achieved by routing the export cabling through the area without geophysical anomalies in the south-west of the MSA (Wessex Archaeology 2011: Figure 4).

109 Further research could be undertaken on the unidentified wreck (WA 7071). The site may be unobtrusively examined by Remotely Operated Vehicle (ROV) or diver survey of the wreck site to ascertain more clearly the type, likely age, identity and importance. Integrating this with other necessary activities such as geotechnical sampling and other early-stage engineering works could provide a cost-effective solution. If the importance of the wreck can be gauged from this kind of survey, further mitigation strategies could be developed or requested by the local or national curators.

110 Up to four export cable routes are proposed passing through the same region of the MSA, but constrained between the Maritime and Coastguard Agency designated anchorage to the south, the proposed wind turbine locations to the north-east and the Blackdog Rifle range and seabed cables within the rifle range exclusion zone. They will be an area roughly 250m wide at the narrowest point. The volume of sediment removed by export cable trenching will be concentrated here, potentially creating increased significance of impact in this area. Known wrecks are absent from this region and the geophysical assessment indicates a lack of seabed anomalies. Sub-seabed palaeolandscape features are also restricted to the south. There is potential for isolated prehistoric finds within the sub-seabed sediments. A geotechnical/geoarchaeological assessment outlined above may serve as a form of mitigation for cumulative impacts to prehistoric archaeology receptors that may be encountered by export cable trenching.

111 Where redeposited sediment volumes may be more significant, such as at the margins of cable trenches, the beneficial impact of protection may reach a level where the added overburden could damage cultural heritage assets, particularly wrecks and aircraft. The suggested mitigation strategies outlined here, especially avoidance and precautionary exclusion zones, would be sufficient to prevent the beneficial impact of sediment redeposition becoming an adverse impact upon cultural heritage assets.

Wind Turbine foundations

112 Mitigation may be achieved by micro-siting the entire footprint of Wind Turbine 8 out with the precautionary exclusion zones around WA 7071 and 7072 and as a result, the inter-wind turbine cabling too. Depending upon the type of foundation and width of scour protection necessary this may be at least 20 m to the east or south-east. The configuration of inter-wind turbine cabling is relatively flexible and not all of the potential connections between wind turbines will be required. Avoidance may effectively be achieved by appropriate configuration of the cable routes outwith the precautionary exclusion zones.

113 Assuming a worst realistic case, a gravity base structure up to 40 m in diameter at the seabed with skirting and an unknown, site-specific width of scour protection would extend close to the wreck site (WA 7071). If damage is likely to occur by entering the precautionary 50 m exclusion zones then a thorough assessment of the wrecks importance is advised.

114 Repeated direct impacts will occur where cable routes and wind turbine foundations are connected. Generally the significance of impact is not thought to increase from those cited for unknown cultural heritage receptors. In site-specific cases where known cultural heritage assets are involved, i.e. wreck site (WA 7071). Both inter-array cable trenching and wind turbine foundation construction in addition to secondary impacts from attending vessel footprints may, without mitigation, repeatedly and significantly adversely impact this unidentified wreck adjacent to Wind Turbine 8 (Figure 1).

Residual Impacts

115 If avoidance of the unidentified wreck (WA 7071) and debris (WA 7072) by micro-siting Wind Turbine 8, and by association the inter-array cabling routes that could be connected to Wind Turbine 8, is undertaken then there should be no direct and likely no indirect adverse impacts upon this cultural heritage receptor.

116 If it is decided to inspect the site under a WSI in order to identify the type, identity and therefore archaeological importance of the wreck then further mitigation strategies will have to be proposed. The wreck represents a physical hazard to trenching machinery and therefore avoidance would appear to be the preferred mitigation strategy as there may be buried debris in the vicinity of the wreck.

117 After mitigation the impacts would be of ***minor-negligible*** significance

Cumulative Impacts

- **Other Offshore Wind Developments**
  - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
  - Abutting the MSA to the south is the MCA Designated Anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon Maritime Archaeology Receptors in conjunction with vessel footprints from the EOWDC project if mitigation is undertaken. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**

- There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
- It is considered that cumulative impacts are likely to be of ***low*** significance.

- **Subsea Cables**
  - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
  - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
  - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of *minor* significance depending upon the type of the foundation used for the (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development.
  - There are no known wrecks in the location of the proposed ocean laboratory and therefore no significant impacts.
  - Following geophysical assessment the potential impact upon *unknown wreck sites* has been assessed of **low** magnitude, **high** sensitivity and of ***minor*** significance.
  - After mitigation the impacts would be of ***negligible*** significance.

Monitoring

118 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to known wreck receptors.

1.3.2.2 Operational Phase

Potential Impacts

119 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

120 Mitigation during construction phase would already apply (see page 21).

Residual Impacts

121 As construction and decommissioning phase (see page 23).

Cumulative Impacts

122 As construction and decommissioning phase (see page 23).

Monitoring

123 As construction and decommissioning phase (see page 24).

1.3.3 Impacts on Aviation Archaeology

1.3.3.1 Construction & Decommissioning Phase

Potential Impacts

- Adverse, direct damage to both *in situ* cultural heritage assets and assets in secondary contexts
- Adverse, direct disturbance of relationships between structures, artefacts and their surroundings or contexts
- Adverse, indirect destabilisation and erosion of sites through changes to seabed characteristics
- Beneficial, indirect burial of sites due to re-deposited sediment, potentially protecting and promoting the favourable preservation of cultural heritage receptors

Secondary Impacts

- Produced by vessel footprints; direct, adverse impacts will also affect cultural heritage receptors in association with cable trenching. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage.

124 During decommissioning the cable routes will primarily be buried and/or cut and left *in situ*. In some cases it may be necessary to remove cables which would be done involving excavation of the cable route by similar methods to the construction phase. Assuming that the same area of seabed that was impacted during the laying of the cables in the construction phase was excavated to remove a cable then the impacts to cultural heritage receptors would already have taken place. However, there may be secondary impacts from the vessel footprint from jack-up legs or anchoring in surrounding areas of seabed not previously affected.

125 During decommissioning wind turbine foundations are to be cut and/or craned from the seabed. Assuming that this does not disturb additional areas of seabed out with that affected by construction activities, adverse impacts may be restricted to secondary impacts from vessel footprints.

Unknown Aircraft Crash Sites

126 There are currently no records of aircraft crash sites within the MSA (Wessex Archaeology 2011).

127 There is potential for aircraft crash sites and debris to be present in the MSA (Wessex Archaeology 2008) based on significant numbers of magnetic anomalies on the seabed and particularly WA 7070, adjacent to Wind Turbine 3. Such remains would automatically be protected under the PMRA 1986 (Wessex Archaeology 2011).

128 Importance cannot currently be assessed but the potential for encountering unknown crash sites following the geophysical assessment is gauged to be low.

129 The redistribution of sediment from development activities is likely to be a beneficial impact as the protective covering of sediment is slightly increased where sediment settles out from the water column.

130 The potential impact has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

Table 10: Summary of Significance of adverse impacts upon aviation archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor	Importance of the Receptor	Sensitivity of the Receptor	Magnitude of Effect	Significance of Impact
Aviation Archaeology	Unknown aircraft crash sites	Regional	Permanent	None	Low	High	Low	**Minor**

Table 11: Summary of Significance of beneficial impacts upon aviation archaeology receptors

Theme	Receptor	Spatial Extent of Effect	Duration of Effect	Recoverability of the Receptor*	Importance of the Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Impact
Aviation Archaeology	Unknown aircraft crash sites	Regional	Temporary to long-term	-	Low	Low	Low	Negligible

* For beneficial impacts such as sediment redeposition settling from the water column onto cultural heritage receptors (Table 5), recoverability is not applicable.

Mitigation

131 Avoidance is seen as the primary method of mitigation for offshore developments (Wessex Archaeology 2007) where this is not practicable other methods may be required. Local and national curators may request specific mitigation strategies in line with current planning policies.

132 A finds reporting protocol should be adopted in order to record any material of potential archaeological interest discovered during all phases of development activity. A protocol for offshore developments has recently been commissioned and published by the Crown Estate (The Crown Estate/Wessex Archaeology 2010). Information from reported finds serves to enhance the National Monuments Record and allows more informed and effective management of offshore cultural heritage assets for the benefit of industry, heritage and the public.

Residual Impacts

133 If avoidance of the anomaly WA 7070 is undertaken then there should be no direct and likely no indirect adverse impact upon this feature of possible archaeological interest.

134 If it is decided to inspect the site to attempt identification of the anomaly and therefore archaeological importance of the feature then further mitigation strategies will have to be proposed.

135 After mitigation the impacts would be of ***minor-negligible*** significance.

Cumulative Impacts

- **Other Offshore Wind Developments**
  - There are no other existing or planned offshore wind farm developments in the vicinity of the MSA.
- **Maritime and Coastguard Agency Designated Anchorage**
  - Abutting the MSA to the south is the MCA Designated Anchorage (Figure 1 and 2). Cumulative impacts from anchoring within this area are unlikely to impact upon Aviation Archaeology Receptors in conjunction with vessel footprints from the EOWDC project if mitigation is undertaken. Consultation with the Aberdeen Harbour Board has already been recommended in Scoping Opinion (Marine Scotland 2011).
- **Commercial Fisheries Activity**
  - There may be cumulative impacts in association with commercial fisheries activities that impact the seabed, such as trawling. However, more likely in this nearshore area would be inshore fisheries activities. Scoping for the development indicates some minor fishing vessel activity in the vicinity of the MSA, partially linked to the designated anchoring area or passage en-route to other areas rather than concentrated fishing activities (AOWF 2010: Figure 14).
  - It is considered that cumulative impacts are likely to be of ***low*** significance.
- **Subsea Cables**
  - Subsea cables are present within the Blackdog Rifle range exclusion zone but impacts to cultural heritage receptors from that past development are unknown and no assessment can currently be made.
- **Port/harbour Dredging Operations**
  - Dredging activities may be undertaken for the maintenance of Aberdeen Harbour to the south of the MSA. Archaeological assets are likely to have been already be removed and impacted by earlier phases of sediment removal. New areas of dredging will be required to undergo EIA and define mitigation strategies.
- **Proposed Ocean Laboratory, EOWDC**
  - The installation of an Ocean Laboratory to the south-west of Wind Turbine 1 (shown on Figure 1 and 2) would lead to cumulative impacts of a site-specific nature upon the unknown *aviation crash sites*. Following geophysical assessment there appears to be no anomalies or known cultural heritage assets in the given location. Cumulative impacts may be of minor significance depending upon the type of the foundation used for the (spatial extent and volume of seabed sediment disturbed or removed) and cable linkages to other elements of the proposed development. Assuming a GBS is used under the worst case scenario the magnitude of impact upon *unknown aircraft crash sites*, buried in the GBS footprint would be of high magnitude.
  - The potential impact upon unknown aircraft crash sites has been assessed of **low** magnitude, **high** sensitivity and therefore of ***minor*** significance.

- Following mitigation outlined above specifically incorporating a finds reporting protocol this impact may be reduced to ***negligible*** significance.

Monitoring

136 ROV or suitably qualified divers may provide sufficient monitoring of enacted mitigation strategies. Geophysical survey could also be applied to monitor any development in seabed scour and other impacts to identified anomalies such as **WA 7070** in the vicinity of Wind Turbine 3.

1.3.3.2 Operational Phase

Potential Impacts

137 Operational impacts are likely to be restricted to secondary impacts invoked by vessel footprint. Jack-up legs and/or anchoring may also impact adversely upon cultural heritage receptors on or shallowly buried under, the seabed through physical damage. The significance may be reduced as impacts would already have occurred during the construction phase.

Mitigation

138 Mitigation during construction phase would already apply (see page 27).

Residual Impacts

139 As construction and decommissioning phase (see page 27).

Cumulative Impacts

140 As construction and decommissioning phase (see page 28).

Monitoring

141 As construction and decommissioning phase (see page 29).

1.3.4 EOWDC Future Research and Monitoring Opportunities

142 There would be beneficial research opportunities for assessing the nature and potential of submerged palaeo-landscapes of archaeological potential from geotechnical samples associated with the wind turbine locations and cable routes. This work would provide added value on local, regional and potentially national scale, to the development through publication in scientific, international journals and dissemination by other types of media to a broad audience of the public and specialists.

143 The unidentified wreck (WA 7071) also provides an opportunity to develop the study of maritime wreck sites where nothing is known about the vessel in question. This work would provide added value to the development through improving the historic environment records, publication in scientific, international journals and dissemination by other types of media to a broad audience of the public and specialists. Additionally, data from ongoing monitoring of the wreck, in conjunction with ecological monitoring for example, would provide ongoing sources of data for research and collaborative projects.

1.3.5 Summary of Impact Assessment

Table 12: Impact Assessment – Adverse Impacts

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Mitigation	Significance after Mitigation	Monitoring	Cumulative Impacts
Construction – Cable Trenching, Wind Turbine Foundations & Secondary Impacts from Vessel Seabed Footprints										
Post-glacial submerged landscape features	High	Medium	Long-term	Site-specific to Local	Medium	Moderate	Avoidance, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Isolated prehistoric sites & finds	High	Medium	Long-term	Local	Medium	Moderate	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-
Unknown wreck sites	High	Low	Long-term	Local	Low	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab

Unknown aircraft crash sites	High	Low	Long-term	Regional	Low	Minor	Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	Existing subsea cabling, MCA anchorage, inshore fisheries, ocean lab
Operation – Secondary Impacts from Vessel Seabed Footprints										
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-
Decommissioning - Secondary Impacts from Vessel Seabed Footprints										
Known wreck sites	High	High	Long-term	Site-specific	High	Major	Avoidance, Research, Reporting protocol	Minor	Geophysical survey, ROV, finds reporting protocol	-

Table 13: Impact Assessment – Beneficial Impacts

Potential Impact / Activity	Sensitivity of Receptor	Scale	Duration	Spatial Extent	Magnitude of Effect	Significance	Mitigation	Significance after Mitigation	Monitoring	Cumulative / In-combination
Construction – Cable Trenching & Wind Turbine Foundations										
Post-glacial submerged landscape features	Low	Medium	Temporary to long-term	Site-specific to Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Isolated prehistoric sites & finds	Low	Medium	Temporary to long-term	Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Known wreck sites	Low	High	Temporary to long-term	Site-specific	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Unknown wreck sites	Low	High	Temporary to long-term	Local	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Unknown aircraft crash sites	Low	High	Temporary to long-term	Regional	Low	Negligible	-	-	Geophysical survey, ROV, finds reporting protocol	-
Operation										
-	-	-	-	-	-	-	-	-	-	-
Decommissioning										
-	-	-	-	-	-	-	-	-	-	-

1.4 Summary

144 Impacts to cultural heritage receptors have been assessed for the proposed EOWDC.

145 The significance of adverse impacts to potential prehistoric archaeology receptors, *isolated prehistoric sites and finds* and *submerged landscape features*, are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

146 Adverse impacts relating to the damage and disturbance of known cultural heritage assets have been identified primarily with respect to the unidentified wreck (WA 7071) in close proximity to Wind Turbine 8 and associated inter-array cable routes between Wind Turbines 8 and 9, 8 and 11 and 8 and 5 (Figure 1). Without mitigation adverse impacts to this heritage asset are likely to be major. With mitigation, impacts may be avoided or significantly reduced. Further research and site inspection of this feature may be an effective method for ascertaining the archaeological importance of this unidentified wreck and ultimately the most appropriate methods for impact mitigation.

147 The significance of adverse impacts to potential maritime archaeology and aviation archaeology receptors – *unknown wreck sites* and *unknown aircraft crash sites* – are assessed to be moderate. Following mitigation the significance of impacts is likely to be minor.

148 Avoidance, where practicable, is the preferred mitigation strategy for known cultural heritage assets. Minor amendments to the position of cable trenching and the configuration or placement the foundation of Wind Turbine 8 have been outlined.

149 There is potential for encountering previously unknown archaeology in the MSA (defined in the archaeological baseline technical report prepared by Wessex Archaeology for Aberdeen Offshore Wind Farm Ltd in 2011). Strategies have been proposed to mitigate adverse impacts to these receptors.

150 Research, particularly the geoarchaeological examination of vibrocores and grab samples from sub-seabed sediments, taken for engineering or other development purposes provides a cost-effective mitigation strategy to directly investigate the age and archaeological potential of sub-seabed sediments of potential prehistoric archaeological importance. The integration of this kind of geoarchaeological analysis early in sequence of development activities is advisable to provide the most effective mitigation strategy (Gribble and Leather 2011).

151 Monitoring may be achieved through remote means such as geophysical or ROV survey. In addition, the Crown Estate has recently published a reporting protocol for finds from offshore developments (The Crown Estate/Wessex Archaeology 2010). Best-practice and effective monitoring may be partly achieved by implementing this protocol. Added value will also be provided to the National Monuments Record.

1.5 References

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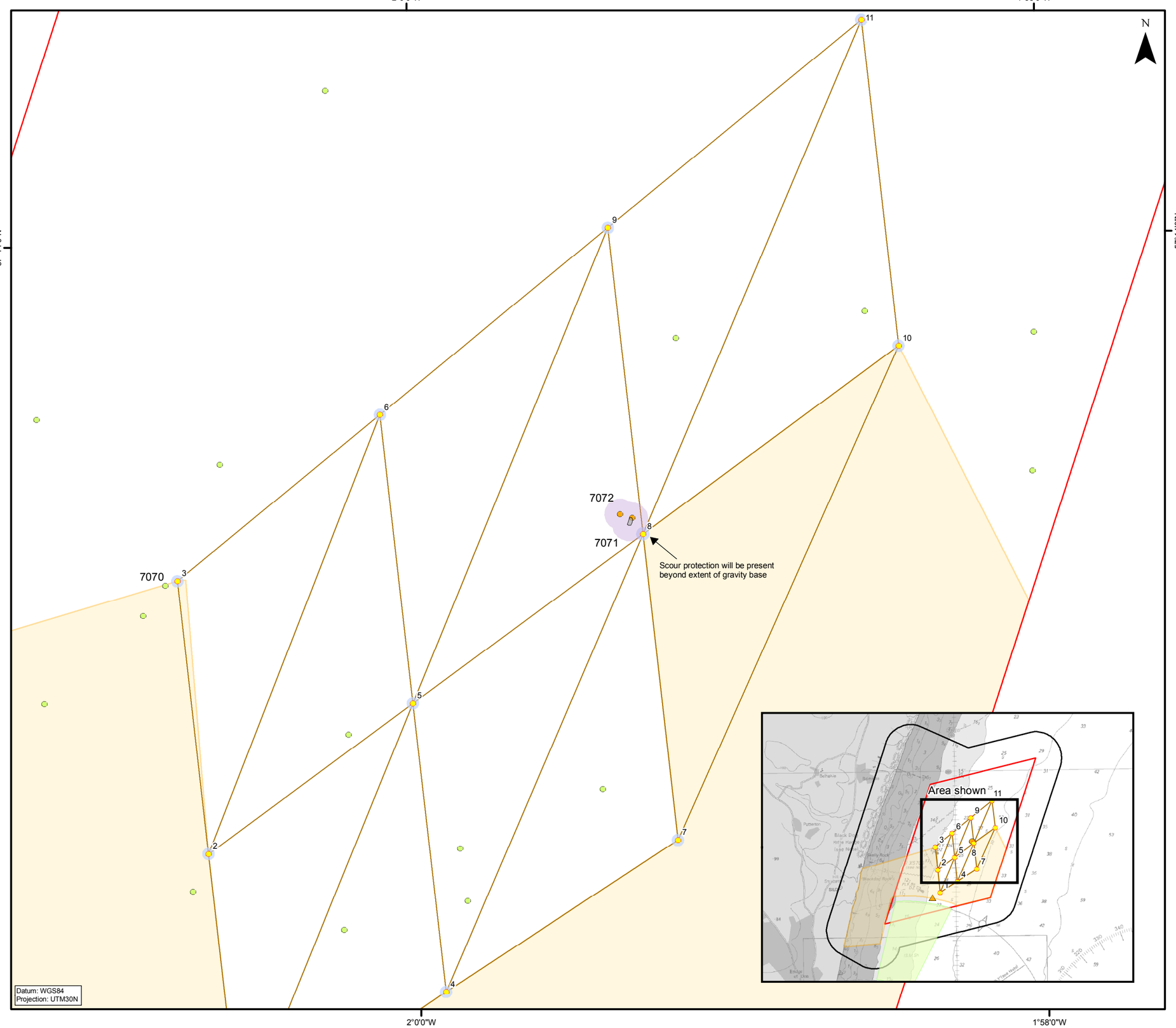

Technip areg Aberdeen Renewable Energy Group VATTENFALL

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 1

Detail of unidentified wreck (WA 7071) and relationship to proposed cable trenching and turbine foundation 8

Legend

- Lease boundary
- Wind turbine
- Wind turbine gravity base and skirting (42 m diameter)
- Proposed ocean laboratory
- Indicative export cable corridor
- Proposed cable trench routes
- Anchorage Area
- Marine Study Area
- A2 - Uncertain origin of possible archaeological interest
- A1 - Anthropogenic origin of archaeological interest
- 7071 extents
- Precautionary exclusion zones (50 m buffer)

Datum: WGS84
Projection: UTM30N

Notes
1 Do not scale

0 0.2 km 0 0.2 nm Original A3 Plot Scale 1:12,500

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Figure 1

EUROPEAN OFFSHORE WIND DEPLOYMENT CENTRE

FIGURE 2

Detail of indicative cable route corridor highlighting documented wrecks, seabed geophysical anomalies and sub-seabed features WA 7500 – 7505

Legend

- Lease boundary
- Wind turbine
- Proposed ocean laboratory
- Indicative export cable corridor
- Proposed cable trench routes
- Anchorage Area
- Marine Study Area
- A1 - Anthropogenic origin of archaeological interest
- A2 - Uncertain origin of possible archaeological interest
- A3 - Historic record of possible archaeological interest
- Precautionary exclusion zones (50 m buffer)
- Possible prograding reflector within Forth Formation (WA 7505)
- Possible shallow cut and fills

Area shown

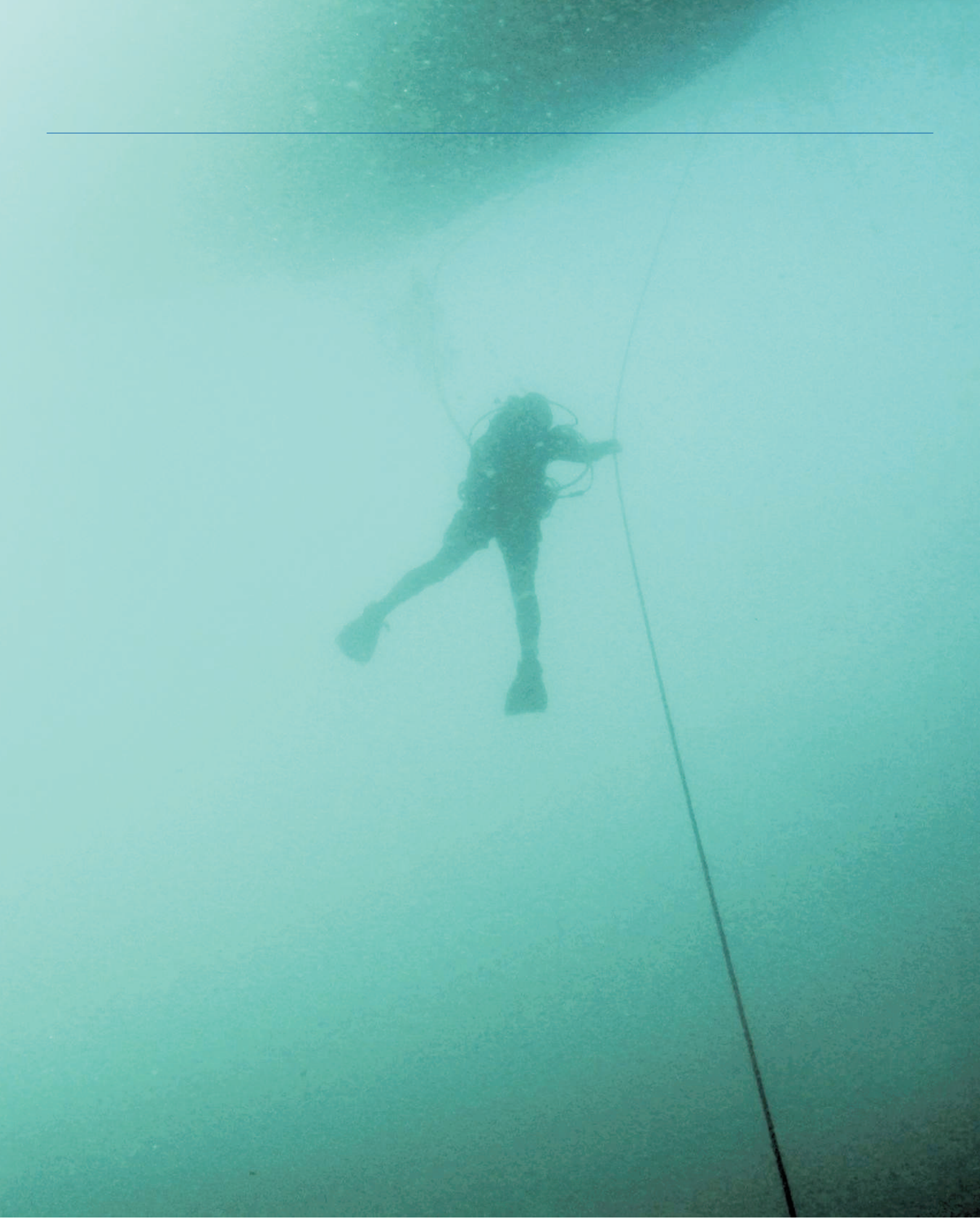
Datum: WGS84
Projection: UTM30N

Notes
1 Do not scale

0 0.2 km 0 0.2 nm

Original A3
Plot Scale
1:25,000

Drg No	6129-530-PW-010			**Figure 2**
Rev	C	Date	03/05/2011	
By	KB	Layout	LABER039	



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