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Chapter 19: Marine Archaeology

Array EIA Report

2024

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FINAL	Final	RPS	RPS	RPS

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19. MARINE ARCHAEOLOGY

19.1. INTRODUCTION

1. This chapter of the Array Environmental Impact Assessment (EIA) Report presents the assessment of the likely significant effects (LSE[1]) (as per the "EIA Regulations") on marine archaeology as a result of the Ossian Array which is the subject of this application (hereafter referred to as "the Array"). Specifically, this chapter assesses the LSE[1] of the Array on marine archaeology during the construction, operation and maintenance, and decommissioning phases.

2. The following technical chapter also informs the assessment presented in this chapter:

   - volume 2, chapter 7: Physical Processes.

3. This chapter summarises information contained within volume 3, appendix 19.1.

19.2. PURPOSE OF THE CHAPTER

4. The Array EIA Report provides the Scottish Ministers, statutory and non-statutory stakeholders with adequate information to determine the LSE[1] of the Array on the receiving environment. This is further outlined in volume 1, chapter 1.

5. The purpose of this marine archaeology Array EIA Report chapter is to:

   - present the existing environmental baseline established from desk studies, site-specific surveys, and consultation with stakeholders;
   - identify any assumptions and limitations encountered in compiling the environmental information;
   - present the potential impacts on marine archaeology arising from the Array and reach a conclusion on the LSE[1] on marine archaeology, based on the information gathered and the analysis and assessments undertaken; and
   - highlight any necessary monitoring and/or mitigation measures which are recommended to prevent, minimise, reduce or offset the likely significant adverse environmental effects of the Array on marine archaeology.

19.3. STUDY AREA

6. Figure 19.1 illustrates the marine archaeology study area for the Array which encompasses the:

   - Array (i.e. the area in which the wind turbines will be located); and
   - seabed areas that may be influenced by changes to marine archaeology due to the Array, which will encompass a wider domain.

7. The marine archaeology study area consists of the Array with an additional 2 km buffer. The marine archaeology study area was used as the search area for obtaining records of known marine archaeology receptors from relevant archive databases and for the Cumulative Effects Assessment (CEA). The marine archaeology study area allows for a greater understanding of the archaeological baseline environment, with the dual purpose of enabling any archaeological trends within the region to be recognised and to allow any archaeological sites identified to be represented in a broader archaeological context. On the advice of Historic Environment Scotland (HES), an additional wider 5 km buffer was used to collect data on recorded losses in the vicinity of the Array. This 5 km recorded losses study area was used for recorded losses only, due to the imprecise spatial information associated with these records (see response in Table 19.4 and discussion of the recorded losses in section 19.7.3). In addition to the marine archaeology study areas, the extent of the geophysical survey data overlaps with the Array and, in places, exceeds it. The extent of these data is referred to as the 'marine archaeology survey area'.

8. Understanding of the physical processes due to the Array (see volume 2, chapter 7) has shown that there are no significant impacts for other fixed-foundation offshore wind farm projects; therefore the impedance on tidal regimes for the Array, with floating foundation wind turbines, will be even less. Changes in marine physical processes beyond the 2 km marine archaeology study area can therefore be considered negligible and so a 2 km buffer is deemed adequate in which to assess potential impacts upon marine archaeology.

19.4. POLICY AND LEGISLATIVE CONTEXT

9. Volume 1, chapter 2 of the Array EIA Report presents the policy and legislation of relevance to renewable energy infrastructure. Policy specifically in relation to marine archaeology, is contained in the Sectoral Marine Plan for Offshore Wind Energy (SMP) (Scottish Government, 2020a), the Scottish National Marine Plan (NMP) (Scottish Government, 2015), the United Kingdom (UK) Marine Policy Statement (MPS) (UK Government, 2011), the overarching National Policy Statement (NPS) for Energy (NPS EN-1) (Department for Energy Security and Net Zero, 2023a) and the National Policy Statement for Renewable Energy Infrastructure (NPS EN-3) (Department for Energy Security and Net Zero, 2023b). Table 19.1 presents a summary of the legislative provisions relevant to marine archaeology, with other relevant policy provisions set out in Table 19.2 and Table 19.3.

10. Further detail is presented in volume 1, chapter 2. Full details of the legislation, policy and guidance relevant to marine archaeology are presented in volume 3, appendix 19.1.

Table 19.1: Summary of Legislation Relevant to Marine Archaeology

Summary of Relevant Legislation	How and Where Considered in the Array EIA Report
Protection of Wrecks Act 1973	
Section 1 of the Protection of Wrecks Act 1973 provides for the designation of a restricted area round the site of a vessel lying wrecked on or in the seabed and on account of the historical, archaeological or artistic importance or of any objects contained or formerly contained in it. Section 2 of the Protection of Wrecks Act 1973 provides for the designation of a prohibited area round a vessel lying wrecked of which is considered as dangerous due to their contents.	The marine archaeology baseline, which includes all known maritime vessels and military aircraft in the marine archaeology study area is presented in section 19.7.4. Full details are given in volume 3, appendix 19.1. The mitigation measures to be adopted as part of the Array (section 19.10) include the development of and adherence to a Written Scheme of Investigation (WSI) and Protocol for Archaeological Discoveries (PAD) (volume 3, appendix 19.2) which outlines the reporting procedure for archaeological discoveries which may be encountered during the construction, operation and maintenance, and decommissioning phases of the Array.
Protection of Military Remains Act 1986 (as amended)	
The Protection of Military Remains Act 1986, section 2 makes it an offence to interfere with any remains of an aircraft or vessel which are comprised in a place which is part of a controlled site or any remains of an aircraft or designated vessel which has crashed, sunken or stranded while in military service, unless a licence is obtained. Any crashed military aircraft will receive automatic protection under this Act (section 1(1)). Maritime vessels sunk or stranded during military service are not automatically protected, but the Secretary of State has powers to designate as a protected vessel (section 1(2)).	The marine archaeology baseline, which includes all known maritime vessels and military aircraft in the marine archaeology study area is summarised in section 19.7.4. The mitigation measures to be adopted as part of the Array (section 19.10) include the development of and adherence to an outline WSI and PAD (volume 3, appendix 19.2) which outlines the reporting procedure for archaeological discoveries which may be encountered during the construction, operation and maintenance, and decommissioning phases of the Array.

Summary of Relevant Legislation	How and Where Considered in the Array EIA Report
Merchant Shipping Act 1995	
This Act details the procedures for determining the ownership of maritime finds that turn out to be 'wreck' in the offshore, onshore, or the intertidal zone of UK territorial waters. 'Wreck' includes all craft, parts of these, their cargo or equipment. Section 236 of the Merchant Shipping Act 1995 stipulates that all wreck within the UK's territorial waters (up to 12 nm) and any wreck landed in the UK from outside the UK's territorial waters must be declared to the Receiver of Wrecks (RoW) who acts on behalf of the MCA in administering this section of the Act. If any maritime finds are brought onshore, the RoW must be notified, and the finds must be kept until the RoW determines ownership or requests that they be given to the RoW. This Act is administered by the MCA. All items which are raised from the seabed, regardless of age or importance, must be reported to the RoW who will act to settle questions of ownership and salvage.	The marine archaeology baseline, which includes all known maritime vessels and military aircraft in the marine archaeology study area, is presented in section 19.7.4. The mitigation measures adopted as part of the Array (section 19.10) include the development of and adherence to an outline WSI and PAD (volume 3, appendix 19.2). The outline WSI details the procedure for contacting and reporting to the RoW.
Marine (Scotland) Act 2010	
Section 67 of this act allows Scottish ministers to designate a historic marine protected area (HMPA). HMPAs consist of marine historic assets (e.g. historic shipwrecks) of national importance within Scottish territorial waters (section 73).	The HMPA dataset was consulted and considered in the assessment of the marine archaeological baseline (section 19.7).

Table 19.2: Summary of the MPS, SMP and Scottish NMP

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
MPS	
Heritage assets in the marine environment "*should be conserved through marine planning in a manner appropriate and proportionate to their significance*" and "*opportunities should be taken to contribute to our knowledge and understanding of our past by capturing evidence from the historic environment and making this publicly available, particularly if a heritage asset is to be lost*" [paragraph 2.6.6.3 of MPS] (UK Government, 2011)	The Array EIA Report has assessed the significance of all known and potential heritage assets within the marine archaeology study area. This is discussed further in section 19.7. The measures adopted as part of the Array including any future geophysical and geotechnical surveys to be undertaken will produce new archaeological data and understandings of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available.
"The absence of designation…does not necessarily indicate lower significance and the marine plan authority should consider them [non designated heritage assets] subject to the same policy principles as designated heritage assets…based on information and advice from the relevant regulator and advisors" [paragraph 2.6.6.5 of MPS] (UK Government, 2011)	The Array EIA Report has assessed the significance of all known and potential heritage assets within the marine archaeology study area. This is discussed further in section 19.7.3. Consultation to date with the relevant regulator and advisors is set out in Table 19.4.
The marine plan authority should "*identify and require suitable mitigating actions to record and advance understanding of the significance of the heritage asset before it is lost*" [paragraph 2.6.6.9 of MPS] (UK Government, 2011)	The measures adopted as part of the Array, including any future geophysical and geotechnical surveys to be undertaken will produce new archaeological data and understandings of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available. An outline WSI has also been prepared to support the Array EIA Report application which will set out the mitigation strategy for approval by the regulator and advisors (volume 3, appendix 19.1).
SMP	
"*The SA, SEA and HRA provide a list of suggested project-level mitigation measures, however, these will vary according to the scale, nature and location of the proposed development. The following types of potential negative impacts have been identified and assessed in the SEA, HRA and SEIA and will require further consideration (in addition to any specific potential impacts appropriate to the proposed development) at a project-level;* • *Loss of/damage to historic environment features and their settings;*" [SMP 4.1] (Scottish Government, 2020a)	The loss of and damage to historic environment features have been assessed as part of the assessment of significant effects in section 19.11 of this chapter. Measures adopted as part of the Array are presented in section 19.10 and include assigning AEZs and TAEZs to all known archaeological material of potential significance identified within the Array and the development and implementation of an outline WSI and PAD that sets out the reporting procedures should any as yet unknown archaeological material be encountered during the construction, operation and maintenance, and decommissioning phases of the Array (volume 3, appendix 19.2). These measures are designed to mitigate potential impacts that may otherwise contribute to loss of/damage to historic environment features.
Scottish NMP	
Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance [GEN 6 of the Scottish NMP] (Scottish Government, 2015)	The Array EIA Report has assessed the significance of all known and potential heritage assets within the marine archaeology study area. This is discussed further in section 19.7.3. The Applicant will assign AEZs and TAEZs, where appropriate, as stated in the measures adopted as part of the Array (section 19.10). AEZs are discussed further in the outline WSI and PAD of the Array EIA Report (volume 3, appendix 19.2). Ongoing monitoring of archaeological assets through subsequent surveys will enhance the resource by adding new knowledge and aiding understanding.
"*Marine planners and decision makers should consider implications and opportunities for the historic environment taking into account the potential impacts of development and use on:* • *Designated heritage assets – representing sites of national or international significance for which statutory requirements apply. Designated assets should be protected in situ within an appropriate setting. Substantial loss or harm to designated assets should be exceptional and should only be permitted if this is necessary to deliver social, economic or environmental benefits that outweigh the harm or loss* • *Undesignated heritage assets – those that meet designation criteria or make a positive contribution should also be protected in situ, wherever possible, and consideration given to the potential for new discoveries of historic or archaeological interest to arise.*" [Paragraph 4.23 Scottish NMP] (Scottish Government, 2015; Scottish Government, 2023b)	The Array EIA Report has assessed the significance of all known and potential heritage assets within the marine archaeology study area. This is discussed further in section 19.7.3. The Applicant will assign AEZs, to preserve *in situ* all potentially significant heritage assets identified within the marine archaeology study area, as stated in the measures adopted as part of the Array (section 19.10). AEZs are discussed further in the outline WSI and PAD of the Array EIA Report (volume 3, appendix 19.2).
Proposals for development that may "*affect the historic environment should provide information on the significance of known heritage assets and the potential for new discoveries to arise. They should demonstrate how any adverse impacts will be avoided, or if not possible, minimised and mitigated. Where it is not possible to minimise or mitigate impacts, the benefits of proceeding with the proposal should be clearly set out*" [Paragraph 4.24 of the Scottish NMP] (Scottish Government, 2015)	The significance of all known heritage assets within the marine archaeology study area and the potential for as yet unknown archaeological material to be encountered is presented in volume 3, appendix 19.1 and summarised in section 19.7.3 below. Avoidance is the preferred approach to known heritage assets, as such, the Applicant will adopt AEZs around all anomalies identified through the geophysical survey to be of medium or high archaeological potential so that there is no direct damage to these. AEZs are presented in section 19.7.3. All indirect impacts have been assessed as not significant in EIA terms (section 19.11) due to the measures adopted as part of the Array presented in section 19.10.

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
"*Where the case for substantial change to heritage asset is accepted, marine decision-making authorities should require applicants to undertake suitable mitigating actions to record and advance understanding of the significance of the heritage asset before it is lost, in a manner proportionate to that significance*" [Paragraph 4.25 of the Scottish NMP] (Scottish Government, 2015)	The measures adopted as part of the Array, including any future geophysical and geotechnical surveys to be undertaken will produce new archaeological data and understandings of the historic marine environment of the area. The results of these investigations will ultimately be made publicly available. This is discussed further in section 19.10. Measures adopted as part of the project also include provision for the ongoing monitoring of all proposed AEZs and of the archaeological assets within them through the acquisition of survey data throughout the lifetime of the Array. An outline WSI and PAD has also been prepared to support the EIA Report application which sets out the high level mitigation strategy for approval by the regulator and advisors (volume 3, appendix 19.2).

11. NPS EN-1 and EN-3 include guidance and what matters are to be considered in the assessment. These provisions are set out in Table 19.3. While NPS EN-1 and NPS EN-3 do not directly apply to the Array, they highlight a number of factors relating to mitigation measures and determination of applications.

Table 19.3: Summary of NPS EN-1 and NPS EN-3 Provisions and Policy Relevant to Marine Archaeology

Summary of Relevant Policy	How and Where Considered in the Array EIA Report
NPS EN-1	
"As a minimum, the applicant should have consulted the relevant Historic Environment Record) and assessed the heritage assets themselves using expertise where necessary according to the proposed development's impact" [EN-1 Paragraph 5.9.10] (Department for Energy Security and Net Zero, 2023a)	A marine archaeology desktop assessment and technical report has been produced which informs the archaeological assessment (volume 3, appendix 19.1). The archaeological review of geophysical data is included in section 19.7.5 and in volume 3, appendix 19.1.
"*Where a site on which development is proposed 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*" [EN-1 Paragraph 5.9.11] (Department for Energy Security and Net Zero, 2023a)	A marine archaeology desktop assessment and technical report has been produced which informs the archaeological assessment (volume 3, appendix 19.1). The archaeological review of geophysical data is included in section 19.7.5 and in volume 3, appendix 19.1. The outline WSI and PAD presents the archaeological input required prior to any site-specific work post-consent (volume 3, appendix 19.2).
"*The applicant should ensure that the extent of the impact of the proposed development on the significance of any heritage assets can be adequately understood from the application and supporting documents. Studies will be required on those heritage assets affected by noise, vibration, light and indirect impacts, the extent and detail of these studies will be proportionate to the significance of the heritage asset affected*" [EN-1 Paragraph 5.9.12] (Department for Energy Security and Net Zero, 2023a)	The impacts on marine archaeology receptors, including magnitude, extent, and duration are presented in section 19.11.
"The applicant is encouraged, where opportunities exist, to prepare proposals which can make a positive contribution to the historic environment, and to consider how their scheme takes account of the significance of heritage assets affected." In particular, this includes the consideration of how impacts can affect heritage assets and whether there may be opportunities to enhance access to or understanding the heritage assets affected by the scheme. [EN-1 Paragraph 5.9.13] (Department for Energy Security and Net Zero, 2023a)	Objectives of archaeological research, based on research frameworks are written into the outline WSI and PAD (volume 3, appendix 19.2). The objectives of the frameworks and the reporting on archaeological assessment of site-specific work within the Array will be reported to HES and the Online Access to the Index of Investigations (OASIS) and the Archaeology Data Service (ADS).
NPS EN-3	
Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options which should be undertaken. [EN-3 Paragraph 2.8.104] (Department for Energy Security and Net Zero, 2023b)	Consultation with relevant statutory stakeholders has been carried out from the early stages of the Array design process (section 19.5 and Table 19.4).
Assessments should include a desk based studies that take into account any geotechnical or geophysical surveys that have been undertaken to inform the wind farm design. [EN-3 Paragraph 2.8.170-171] (Department for Energy Security and Net Zero, 2023b)	A marine archaeology desktop assessment and technical report has been produced which informs the archaeological assessment (volume 3, appendix 19.1). The archaeological review of geophysical data is included in section 19.7.5 and in volume 3, appendix 19.1.
Assessment may also include the identification of any beneficial effects on the marine historic environment, for example through improved access or the contribution to new knowledge that arises from investigation. [EN-3 Paragraph 2.8.176] (Department for Energy Security and Net Zero, 2023b).	The overarching EIA methodology is presented in volume 1, chapter 6. The methodology for determining whether an effect may be adverse or beneficial is summarised in Table 19.13. This methodology has been applied in the assessment of significant effects (section 19.11).
The avoidance of important heritage assets to ensure their protection *in situ*, is the most effective form of protection. This can be achieved through the implementation of exclusion zones around known and potential heritage assets which preclude development activities within their boundaries. [Paragraph 2.8.252 – 253] (Department for Energy Security and Net Zero, 2023b).	Mitigation measures to be adopted as part of the Array include the provision of Archaeological Exclusion Zones (AEZs) around all anomalies from the site-specific geophysical survey data identified as having medium and high archaeological potential, these are presented in section 19.7.5. Temporary Archaeological Exclusion Zones (TAEZs) may be applied if appropriately significant previously unknown archaeological assets are discovered. These TAEZs will then be reviewed and implemented as AEZs or removed.
The Secretary of State should be satisfied that any proposed offshore wind farm and/ or offshore transmission project has appropriately considered and mitigated for any impacts to the historic environment, including both known heritage assets, and discoveries that may be made during the course of development.[Paragraph 2.8.325] (Department for Energy Security and Net Zero, 2023b).	Mitigation measures to be adopted as part of the Array are presented in section 19.10, these are designed to avoid and/or reduce the potential direct or indirect impacts that may arise from the Array. Mitigation measures include the development of and adherence to a PAD which outlines the reporting procedure for any discoveries that may be made during the construction, operation and maintenance, and decommissioning phases of the Array (volume 3, appendix 19.2).

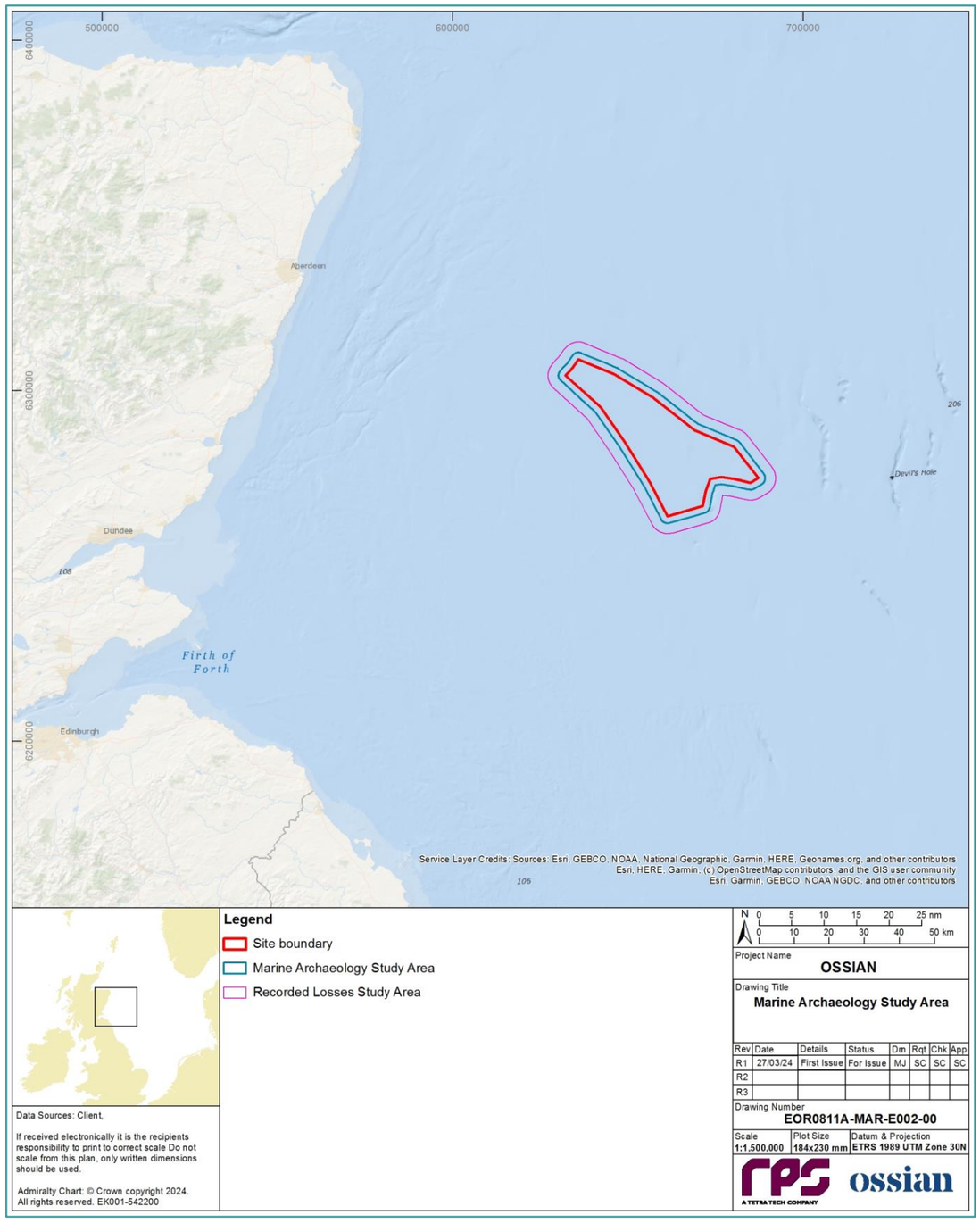

Figure 19.1: Marine Archaeology Study Areas

19.5. CONSULTATION

12. Table 19.4 presents a summary of the key issues raised during consultation activities undertaken to date specific to marine archaeology for the Array and in the Ossian Array Scoping Opinion (MD-LOT, 2023) along with how these have these have been considered in the development of this marine archaeology EIA Report chapter. Further detail is presented within volume 1, chapter 5.

Table 19.4: Summary of Issues Raised During Consultation and Scoping Opinion Representations Relevant to Marine Archaeology

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
Scoping Opinion			
June 2023	Historic Environment Scotland (HES) Scoping Representation (May 2023)	*Insufficient detailed evidence is given in the scoping report to allow us to agree that the designed in measures are suitable for managing and mitigating potential effects of the development on the marine archaeology receptors. It is clear that there would be potential effects on marine archaeology, and as detailed assessment has not been provided to identify these effects and their significance, and as the proposed Marine Archaeology Technical Report has not yet been supplied, we cannot be confident that the effects would be managed and mitigated.*	An assessment of significant effects has been carried out (section 19.11). The impacts relevant to marine archaeology have been identified (outlined in Table 19.10 and discussed in section 19.8.1) in order to assess for significant effects (presented in section 19.11). Additionally, the marine archaeology technical report (volume 3, appendix 19.1) was supplied to HES following receipt of the Ossian Array Scoping Opinion and forms part of this Array EIA Report. Mitigation measures adopted as part of the Array are presented in section 19.10.
June 2023	MD-LOT	*The Scottish Ministers, in line with HES representation, advise that the potential impacts to Marine Archaeology, as outlined in Table 7.13 of the Scoping Report, should not be scoped out of the EIA Report and that further archaeological assessment is required. The Scottish Ministers therefore advise that these impacts must be assessed in the EIA Report in line with HES advice.*	An assessment of significant effects on marine archaeology has been undertaken (section 19.11) as part of the Array EIA Report.
Relevant Consultation to Date			
14 June 2023	HES, stakeholder engagement meeting	*As standard, it is the expectation of HES that a Marine Archaeology chapter would be included as part of the Array EIA Report*.	The procedure for scoping out marine archaeology was clarified, but the final decision was taken that marine archaeology should not be scoped out of the Array EIA Report. This chapter, particularly the assessment of significant effects (section 19.11) demonstrates that the effects of impacts on marine archaeology receptors are not significant in EIA terms.
19 December 2023	HES, pre-application response	*The technical report includes a review of site-specific surveys (section 5) by a marine archaeologist (5.3). This includes criteria for identification of 'archaeological potential' at table 5.2. We note that in all the succeeding discussion of cultural heritage (sections 6, 7) analysis is presented in terms of 'archaeological potential' rather than cultural significance and sensitivity. It would be helpful if the assets identified in the surveys could be assessed in terms of their cultural significance and sensitivity*.	It is not always possible to ascribe cultural significance to a receptor, particularly where its origins are unknown. The precautionary approach taken here is to establish AEZs around all identified receptors of medium or high archaeological potential which ensures the best protection even if the cultural significance is unknown. Sensitivity of archaeological receptors is characterised during the assessment of significant effects and this this provided for all receptors considered in section 19.11.
19 December 2023	HES, pre-application response	*We are particularly concerned that there is no discussion of the issues surrounding potential aviation losses in the area, particularly relating to the Second World War, which are likely to be difficult to locate but extremely sensitive, given the probable presence of human remains*.	Reference has been made to the potential for aviation archaeology to be encountered in section 19.7.3. The archaeological baseline includes World War II aviation activity in the form of known utilised airfields from the period.
19 December 2023	HES, pre-application response	*A 2 km buffer is not adequate when assessing recorded losses (also known as casualties) and a 5 km buffer should be applied to take account of imprecise locational information*.	In addition to the 2 km marine archaeology study area used for known marine archaeology receptors, an additional 5 km 'recorded losses study area' was implemented for recorded losses only (including both maritime and aviation records). The recorded losses study area is shown in Figure 19.1 and the results of this expanded search are given in section 19.7.3.
19 December 2023	HES, pre-application response	*The report should note the possibility that the unknown wreck (Canmore ID 372944), described as 34.8 m in length, may represent the remains of Scottish Queen or Titan, which are approximate length. The report should also note the unknown wreck (Canmore ID 372595), described as 69.5 m in length, may represent the remains for Svein Jarl (Camore ID 314131) or Duva (Canmore ID 313790). The section on high potential anomalies should note the possibility of a tentative correlation between OS23_312 and the Scottish Queen or Titan, and reiterate the possible tentative correlation between OS23_314/Canmore ID 372595 and the Svein Jarl or Duva*.	The results of the desktop study (section 19.7.4) and the assessment of site-specific data (section 19.7.5) includes references to the possible correlations between the known wrecks on the seabed and the recorded losses from the area, based on their reported lengths and observed dimensions.
20 February 2024	HES, stakeholder engagement post-meeting email summary	*The outline WSI & PAD and proposed mitigation measures are a mechanism for controlling and responding to impacts on cultural heritage. However, they cannot be assumed to reduce all those impacts to insignificant.*	An assessment of significant effects (section 19.11) has been carried out and has concluded that due to the measures adopted as part of the Array (section 19.10) all effects on marine archaeology receptors will be reduced to not significant in EIA terms.

19.6. METHODOLOGY TO INFORM BASELINE

13. Topic specific information has been reviewed to inform this marine archaeology baseline (Table 19.5 and Table 19.6). In addition, consultation with stakeholders has been carried out to aid the collection of baseline information, such as the creation of a 5 km buffer recorded losses study area in order to capture additional potential marine archaeology receptors with imprecise positional data.

19.6.1. DESKTOP STUDY

14. Information on marine archaeology within the marine archaeology study area was collected through a detailed desktop review of existing studies and datasets which are summarised in Table 19.5. A dataset of wrecks and obstructions held by the United Kingdom Hydrographic Office (UKHO) was consulted, but there were no records within the marine archaeology study area. The marine archaeology technical report (volume 3, appendix 19.1) includes full details of the analysis undertaken to establish the marine archaeology baseline. The data were compiled into gazetteers (see volume 3, appendix 19.1, annexes A, B and C).

15. The National Record of the Historic Environment (NRHE) data have been classified between records where material is known to be on the seabed and 'recorded losses'. Recorded losses are records of vessels that have been lost in the area but have no verifiable positional data. They provide additional information on the historical maritime traffic of the area, but associated material is not known to survive on the seabed. Known losses are presented within a 2 km 'marine archaeology study area'. At the request of HES, a 5 km 'recorded losses study area' was implemented for these records only, in order to take account for the imprecise spatial data associated with these records. Both study areas are shown in Figure 19.1.

Table 19.5: Summary of Key Desktop Data

Title	Source	Extent	Year	Author
NRHE (National Record of the Historic Environment (Canmore) – including shipping and aviation wrecks and HMPAs (Historic Environment Scotland, 2023)	HES	2023	2023	HES
Protected Wrecks Map (Marine Directorate, 2023)	Marine Directorate	2024	2024	HES
Submerged Landscapes Data (EMODNet, 2023)	European Marine Observation and Data Network (EMODNet) Geology	2023	2023	British Geological Survey (BGS)
GeoIndex (Offshore) (British Geological Survey, 2023)	BGS	2023	2023	BGS

19.6.2. SITE-SPECIFIC SURVEYS

16. Site-specific surveys were undertaken to inform the marine archaeology EIA Report chapter for the Array. A summary of the surveys undertaken to aid in establishing the marine archaeology baseline of the Array are outlined in Table 19.6.

Table 19.6: Summary of Site-Specific Survey Data

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date	Reference to Further Information
Geophysical survey campaign	Across the Array (see Figure 19.3)	High resolution side scan sonar (SSS), multibeam echosounder (MBES), sub-bottom profiler (SBP); Two-Dimensional Ultra High Resolution Seismic (2D UHRS)	Ocean Infinity	2022	Ocean Infinity (2022) (volume 3, appendix 8.1, annex A)

19.7. BASELINE ENVIRONMENT

19.7.1. OVERVIEW OF BASELINE ENVIRONMENT

17. The following sections provide a summary of the marine archaeology baseline environment. Volume 3, appendix 19.1, includes full details of the analysis undertaken to establish the marine archaeology baseline within the marine archaeology study area. For the purposes of the marine archaeology baseline, recorded losses have been alone assessed within a 5 km 'recorded losses study area' due to the imprecise spatial information associated with those data.

18. Marine archaeology as considered in this assessment comprises the following categories:

- Submerged prehistoric archaeology: this includes palaeochannels and other inundated terrestrial landforms that may preserve sequences of sediment possessing palaeoenvironmental data as well as palaeolithic and Mesolithic sites and artefacts.
- Maritime archaeology: relates generally to watercraft or vessels, any of their associated structures, and/or cargo.
- Aviation archaeology: this comprises all military and civilian aircraft crash sites and related wreckage.

19. Archaeology is considered in terms of periods that represent timeframes which are defined and categorised by the culture of the people of the time. Notable changes in culture and activities are indicated by changes in chronological periods. Conventionally, geologic time is given in terms of years Before Present (BP); archaeological and historic periods are referred to as Before Christ (BC) or Anno Domini (AD^2). The chronological periods and their corresponding date ranges that are considered in this report are provided in Table 19.2 (Scottish Archaeological Research Framework (ScARF, 2012a).

19.7.2. SUBMERGED PREHISTORIC ARCHAEOLOGY POTENTIAL

20. The prehistoric archaeological record of the UK covers the period from the earliest hominin occupation (more than 866,000 years Before Present (BP)) to the Roman invasion of Britain in AD 43. The coastline of the UK underwent dramatic changes during this time, and areas of the seabed that are now fully submerged would have been exposed and allowed the opportunity for hominins to exploit and inhabit the landscape. Glacial events including the Anglian (480,000 to 430,000 BP), the Wolstonian (350,000 to 132,000 BP) and the Devensian (122,000 to 10,000 BP) and intervening periods of marine transgression have affected the coastline of the UK and therefore the archaeological potential of these areas (Historic England, 2023). The stages of the quaternary period, the associated date ranges and correspondence with archaeological periods are presented in detail in the marine archaeology technical report (volume 3, appendix 19.1).

21. The marine archaeology study area fluctuated between glacial and marine conditions during the Devensian and Holocene periods. While the area may have seen periods of sub-aerial exposure (e.g. during active phases as a glacial outwash plain), such environments are not associated with human activity; conversely, any archaeological material may have been at least reworked, if not obliterated during periods of ice sheet expansion.

22. Assessment of the site-specific survey data has shown that the marine archaeology study area is characterised by glacial deposits and ice sheet deformation during the Devensian, and therefore was inhospitable for humans, meaning that there is little to no potential for the survival of Palaeolithic material.

23. Following the Last Glacial Maximum (LGM) at around 18,000 BP, the marine archaeology study area may have been quickly submerged. The seabed within the marine archaeology study area, however, is 60 m deeper than the location of the palaeoshoreline from the Lateglacial Interstadial (circa 14,700 to 11,700 BP). The relative positions of the Array and the palaeoshoreline, and the stages of marine transgression, indicates that the marine archaeology study area has remained submerged from shortly after the LGM to the Present Day. Due to the relatively rapid submergence after the LGM, there is very low potential for human occupation or activity.

19.7.3. MARITIME AND AVIATION ARCHAEOLOGY POTENTIAL

24. The maritime archaeological record for the marine archaeology study area has been considered chronologically for the following broad temporal phases as described in Table 19.7. This archaeological baseline presents a summary of the information presented in full in volume 3, appendix 19.1.

Table 19.7: Archaeological Periods and Associated Date Ranges (Saville, 2008; ScARF, 2012a)

Period	Date Range
Palaeolithic	circa 12,700 to 8,400 BC
Mesolithic	8,400 to 4,100 BC
Neolithic	4,100 to 2,500 BC
Chalcolithic and Bronze Age	2,500 to 800 BC
Iron Age	800 BC to AD[2] 400
Roman presence	AD[2] 77 to 211
Medieval	AD[2] 400 to 1500
Modern	AD[2] 1500 to Present Day

Early Prehistoric (Palaeolithic to Mesolithic)

25. There is no evidence of maritime archaeological remains in the UK that pre-date the start of the Holocene, circa 10,000 BP (ScARF, 2012b). However, global examples suggest that watercraft were in use in early prehistory such as the suggestion that the colonisation of Australia by approximately 40,000 BC involved island hopping (Lourandos, 1997).

26. Although the Palaeolithic in England can be dated back as far as 866,000 BC (Westaway, 2011), there is no evidence for occupation of Scotland before 12,700 BC (Ballin *et al.*, 2010). During the Palaeolithic, it is possible that simple watercraft such as logboats or rafts were used for coastal journeys and fishing around Britain (Wessex Archaeology, 2007). A Palaeolithic blade (circa 12,000 BC) is known from the floodplain at Ravenscraig, Inverugie (Aberdeenshire) but as an isolated find it is unclear to what extent communities were accessing riverine and marine resources in this part of Scotland at this time. The discovery of a single flint scraper in a borehole core off Viking Bank (150 km north-east of Lerwick, Shetland) is unique not just for its depth, but also for its distance from the shore. The flint could date as far back as 13,000 BC (Long *et al.*, 1986). If not secondarily derived, the find suggests human occupation of the Scottish shelf in pre-Holocene times, or a stone tool lost during a fishing expedition (Finlayson and Edwards, 2003; Flemming, 2003). Towards the end of the Mesolithic, at about 5,000 BC the land bridge between the UK and Europe was severed for the last time (Wessex Archaeology, 2007). Contact across the new seas intensified the need for some form of vessel. The existence of watercraft during the Mesolithic is inferred by the presence of Mesolithic archaeological material on insular land masses such as Ireland, for example.

Neolithic, Chalcolithic, and Bronze Age

27. No evidence of Neolithic (4,100 to 2,500 BC), Chalcolithic or Bronze Age (2,500 to 800 BC) maritime activity has been recorded within the marine archaeology study area.

28. Direct archaeological evidence for the exploitation of the marine environment and maritime activity in the Neolithic period is rare and limited to logboat finds outside of Scotland (Bradley *et al.*, 1997; Johnstone, 1980; Wilkinson and Murphy, 1995). Logboats dating later than the Neolithic (as early as 1130 BC), to the Chalcolithic and Bronze Age, are known from around Scotland, such as at Carpow on the River Tay and maritime equipment associated with crannogs (Strachan, 2010).

Iron Age and the Roman Presence

29. No evidence of Iron Age (800 BC to AD[2] 400) or Roman (AD[2] 77 to 211) maritime activity has been recorded in the marine archaeology study area.

30. Broad geographical and chronological narratives have emphasised the importance of the Atlantic Ocean as a routeway and for communication in the pre-Roman Iron Age (Cunliffe, 2001). No remains of Iron Age vessels are yet known from Scotland; however, interaction with the sea can be inferred from other types of archaeological evidence from the Northern Isles of Orkney and Shetland.

31. The Roman period in Scotland is limited in both duration and extent when compared to the rest of the UK. Though Roman remains are known from beyond the Antonine Wall, these are temporary and the level of interaction by sea between the established frontier and the maritime areas of north-eastern Scotland are not well understood.

Medieval

32. No evidence of Medieval (AD[2] 400 to 1500) maritime activity has been recorded within the marine archaeology study area, but regional evidence suggests a lively period of engagement with the sea.

33. Maritime activity in the North Sea and in the vicinity increased during the earlier Medieval period. This was due in part, to Viking raiding, the intensification of regional trade and migration, and the growth of several ports on the east coast of the UK (Friel, 2003; Hutchinson, 1997; Kelly, 1992; Middleton, 2005).

34. Despite an increase in maritime activity during this period, archaeological evidence for vessels from this period is rare. The level of shipping passing through the marine archaeology study area during the earlier Medieval period is high enough to suggest that there is a moderate to good potential for archaeological remains to exist within the marine archaeology study area.

Modern

35. Prior to the advent of the Lloyds of London list of shipping casualties in 1751, there was no official record of ship losses (Department for Business Energy and Industrial Strategy (BEIS), 2022). Therefore, records of known wreck sites and losses in UK waters are biased towards the modern period (AD[2] 1500 to the Present Day), as a function of increased traffic and increased reporting due to the introduction of marine insurance, as well as a higher proportion of metal components in ships that allow for greater survival and detection (Burton *et al.*, 2007).

36. The growth of commercial maritime trade that began during the later Medieval period continued and expanded in the Modern period. Alongside overseas ventures which were expanding rapidly, inland and

local coasting trade continued to be important in the region. The number of vessels crossing the North Sea increased significantly, particularly during the later Medieval period and the merger of the Royal Scots Navy with the Kingdom of England's Royal Navy after the Acts of Union in 1707 (Murdoch, 2010). The marine archaeology study area was therefore an area of concentrated commercial and military maritime activity.

Modern Military Remains

37. The maritime archaeological record of the 20th century until the Present Day is dominated by remains associated with the two World Wars. Warships, submarines and U-boats along with cargo vessels, personnel transport vessels and aircraft, comprise the known vessel losses during this period. The majority of known shipwrecks in the North Sea basin within which the marine archaeology study area is located are the results of military activity.

Recorded Losses

38. Data for recorded shipping losses were obtained as appropriate from the NRHE held by HES (2024) (Canmore). The Canmore dataset provides a general picture of maritime casualties in the last 150 to 200 years. However, it is worth noting that there is potential for further shipping losses to have happened within the marine archaeology study area in addition to the ones recorded in this dataset.

39. Recorded losses are often grouped with reference to a geographic, hydrographic or other point of reference, making the positional data of these records unreliable. However, they do provide information on the historical marine traffic of the general region and therefore the archaeological potential. At the request of HES, a 5 km 'recorded losses study area' was implemented for recorded losses alone due to a lack of accurate positional data for recorded losses, and to take account for the fact that a wreck may be located far from its last recorded position (e.g. the location provided within the record itself). There are a total of six recorded losses located within the recorded losses study area. Four of these six are modern records of shipping casualties, and are all located within 2 km of the Array, i.e. within the marine archaeology study area. These are: *Svein Jarl* (Canmore ID 314131); *Titan* (Canmore ID 328826); *Duva* (Canmore ID 313790) and *Scottish Queen* (Canmore ID 313238). The two remaining records relate to aviation records which are discussed in paragraph 43.

Aviation Archaeology Potential

40. Thousands of military and civilian aircraft casualties have occurred in UK waters since the advent of powered flight in the early 20th century. The bulk of these are casualties of World War II and most are concentrated off the south and south-east coasts of England. However, there is clear potential for aircraft casualties the northern North Sea (Wessex Archaeology, 2008).

41. While there are no known aviation wreck sites within the marine archaeology study area, there are significant wartime aviation facilities in north-eastern Scotland. For example, aviation training and mission flights were conducted from eastern Scotland such as Royal Air Force (RAF) Dalcross, RAF Kinloss, RAF Lossiemouth, Crimond (HMS Merganser), and RAF Dyce during World War II, all of which may contribute as yet unlocated aviation losses within the marine archaeology study area (Scottish Aviation Trail, 2024).

42. While the aviation archaeology record is potentially very large, the ephemeral nature of aircraft wrecks ensures that many sites remain unknown and unrecorded. In addition, despite the potential extensive losses at sea, records are seldom tied to an accurate position. These difficulties complicate any assessment of the likely presence of aircraft wreckage on any particular area of seabed.

43. Since World War II, despite the volume of both military and civilian air traffic, there have been few aviation losses off the east coast of Scotland. Two aviation records are located within the expanded 5 km recorded losses study area. Details of all recorded losses are given in volume 3, appendix 19.1. Of these recorded aircraft losses, one record is of a Sikorsky helicopter which crashed on 14 November 1970 while en route to the oil rig Staflo. The second is of a RAF Phantom which crashed on 4 August 1978. Wreckage was sighted by a helicopter en route to an oil rig but was impossible to relocate due to visibility. Later, in 1983, wreckage identified as being from a RAF Phantom was brought up by a trawler but no further information is available.

19.7.4. RESULTS OF THE DESKTOP STUDY

44. No designated sites have been identified within the datasets for the marine archaeology study area.

45. The desktop study has identified two entries within the datasets that may indicate the presence of anthropogenic material within the marine archaeology study area. Two wrecks are present on the Canmore database. Their distribution is shown in Figure 19.2.

46. One previously unrecorded wreck (Canmore ID: 372595) is located within the Array. The wreck was originally identified during the site-specific survey operations for the Array and subsequently included in the Canmore database. Canmore ID 372595 is therefore confirmed to exist within the Array and is discussed further in section 19.7.5.

47. One wreck (Canmore ID: 372955) is located within the marine archaeology study area. The wreck was observed during previous geophysical survey operations but is out with the limits of the site-specific geophysical survey data, approximately 380 m from the northern boundary of the Array. As no geophysical data for this position exists, it is not corroborated by geophysical seabed features assessment detailed in section 19.7.5. It is considered that this wreck may exist at the location shown, but is located more than 100 m from the site boundary and as such there is no impact receptor pathway for direct impacts and does not require an AEZ.

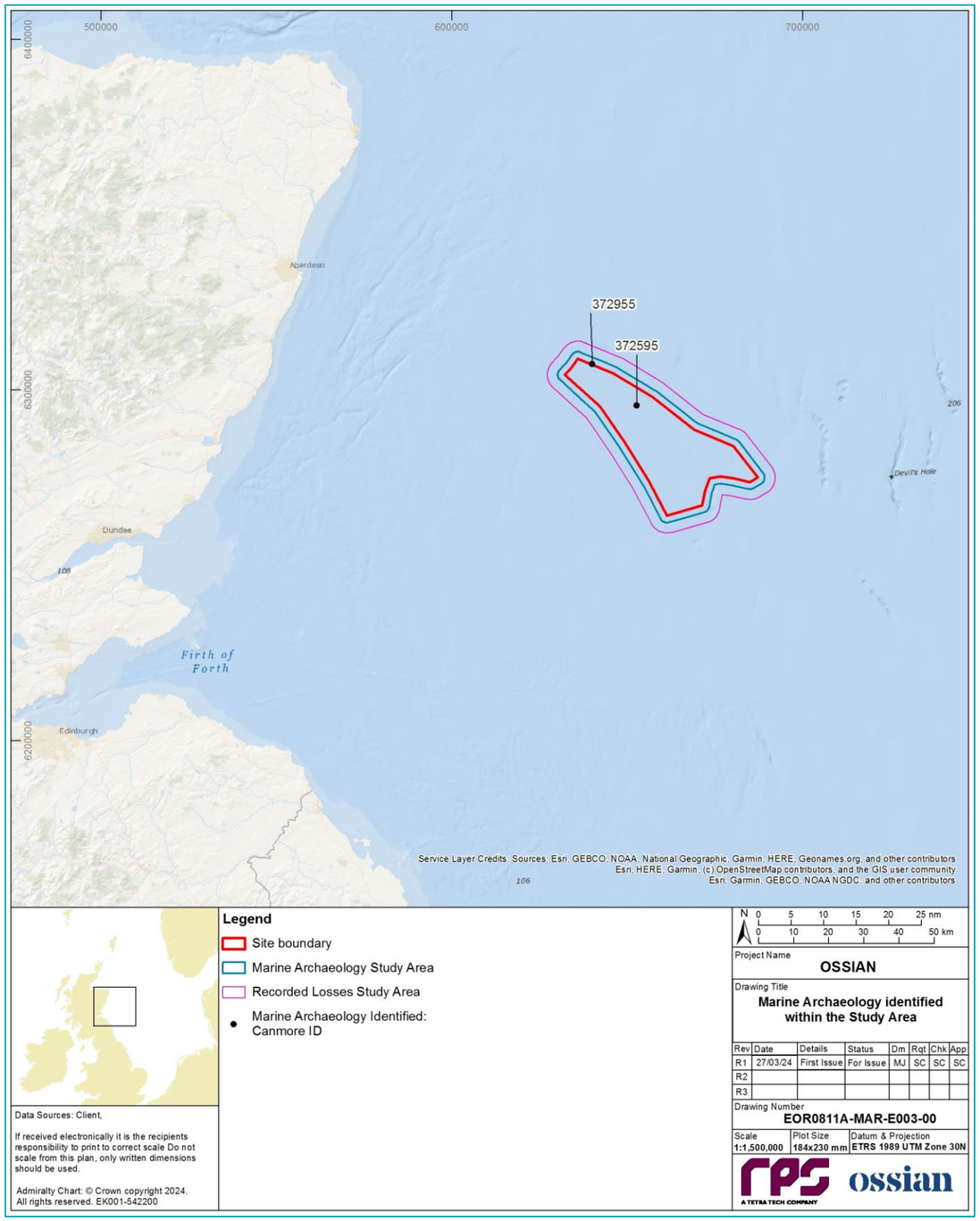

Figure 19.2: Marine Archaeology Identified Within the Marine Archaeology Study Area

19.7.5. RESULTS OF THE GEOPHYSICAL SEABED FEATURES ASSESSMENT

48. Geophysical data collected for the Array recorded 324 anomalies of archaeological interest. Of these, 295 are within the area of the Array and the remaining 29 anomalies lie outside of the area of Array but within the extents of the geophysical survey data. Of the 324 anomalies, three have been classified as high potential, 14 as medium potential, and the remaining 307 as low potential. The criteria for the assessment of archaeological potential are outlined in volume 3, appendix 19.1.

49. The distribution of anomalies with medium and high potential is shown in Figure 19.3. The locations of the low potential anomalies are presented in volume 3, appendix 19.1, annex C and are considered in the outline WSI and PAD (volume 3, appendix 19.2). The Applicant will share positional data of these anomalies with their contractors via the outline WSI and PAD (volume 3, appendix 19.2) for awareness during any works within the Array, and these anomalies will be avoided where practicable. Should avoidance be impractical, site investigation will be carried out prior to direct impacts. The details of measures adopted as part of the Array are given in section 19.10.

Low potential anomalies

50. The 307 low potential anomalies have been assessed against available evidence and consequently are considered unlikely to have any archaeological significance. Low potential anomalies are considered within the outline WSI and PAD (volume 3, appendix 19.2).

Medium potential anomalies

51. The 14 medium potential anomalies are presented in Table 19.8 and the distribution of these is shown in Figure 19.3. These medium potential anomalies could represent archaeological material such as debris. Full details of the medium potential anomalies can be found in volume 3, appendix 19.1. While none of these medium potential anomalies correspond with results from the desktop study, it is likely representative of material from maritime (and possibly aviation) traffic in the Modern period.

Table 19.8: Medium Potential Anomalies

ID	Category
OS23_035	Anthropogenic material
OS23_037	Anthropogenic material
OS23_049	Anthropogenic material
OS23_059	Possible anthropogenic material
OS23_062	Anthropogenic material
OS23_084	Anthropogenic material
OS23_101	Possible anthropogenic material
OS23_119	Anthropogenic material
OS23_168	Possible anthropogenic material
OS23_181	Anthropogenic material
OS23_184	Anthropogenic material
OS23_212	Anthropogenic material
OS23_248	Anthropogenic material
OS23_280	Anthropogenic material

High potential anomalies

52. Three high potential anomalies were identified within the marine archaeology survey area; two of these were located within the area of the Array and one was located within the marine archaeology survey area (e.g. extents of the geophysical data) but outside the Array. These anomalies of high potential are likely to represent archaeological material: two are classified as wrecks and one is classified as a potential wreck. These are shown in Figure 19.3 and presented in Table 19.9 below.

53. While positive correlation cannot be made between the known wrecks identified in the geophysical assessment and the recorded losses which occurred in the area, the possibility remains that the visible wreck material may relate to either *Scottish Queen* (Canmore 313238), *Duva* (Canmore 313790), *Titan* (Canmore 328826), or *Svein Jarl* (Canmore 314131).

Table 19.9: High Potential Anomalies Identified Through the Archaeological Assessment of Geophysical Data

ID	Name	Location	Description
OS23_092	Unknown	Marine archaeology survey area (but outside the Array)	OS23_092 is visible in the SSS dataset but outside the MBES acquisition area and has no associated magnetic anomaly. The anomaly appears as a prominent mound measuring 5.4 m x 15.6 m with a measurable height of 0.8 m. The location does not correlate with any UKHO or Canmore records.
OS23_312	Unknown	Array	OS23_312 is visible in the SSS and MBES data, has an associated magnetic anomaly of 202.4 nT, The anomaly measures 33.7 m x 6.6 m with a measurable height of 2.8 m but does not correlate with any UKHO or Canmore records. Based on the measurements of the anomaly, it is possible that OS23_312 may represent the remains of *Scottish Queen* (Canmore ID: 313238) or *Titan* (Canmore ID: 328826)
OS23_314	Unknown	Array	OS23_314 is visible in the SSS and MBES data, has an associated magnetic anomaly of 41.0 nT. The anomaly measures 69.3 m x 13.0 m and has a measurable height of 5.1 m. The location does not correlate with any UKHO records but has an associated Canmore record (Canmore ID: 372595) which was created by the survey contractor when the anomaly was originally observed during data acquisition. The measurements of the wreck leave open the possibility that this anomaly represents he remains of either *Svein Jarl* (Canmore ID 314131) or *Duva* (Canmore ID 313790).

54. Anomaly OS23_314 was subject to additional specialist shipwreck analysis which identifies the wreck as a MV coaster or submarine (McCartney, 2023). From the additional assessment, the most likely scenario is that the seabed anomaly represents a 'coaster' vessel that has inverted while sinking, and subsequently collapsed. Although an alternative scenario is also presented in which the anomaly represents a previously unknown wreck of a submarine (McCartney, 2023). Correspondence between desktop and site-specific data, together with any future data can refine the baseline and provide further information with which to establish significance. Based on the criteria for sensitivity set out in section 19.9.2, further analysis can provide more information about a wreck which can aid assessments of its sensitivity. Anomaly OS23_314, if a submarine and not the remains of *Svein Jarl* or *Duva*, would then potentially be designated as an archaeologically significant asset.

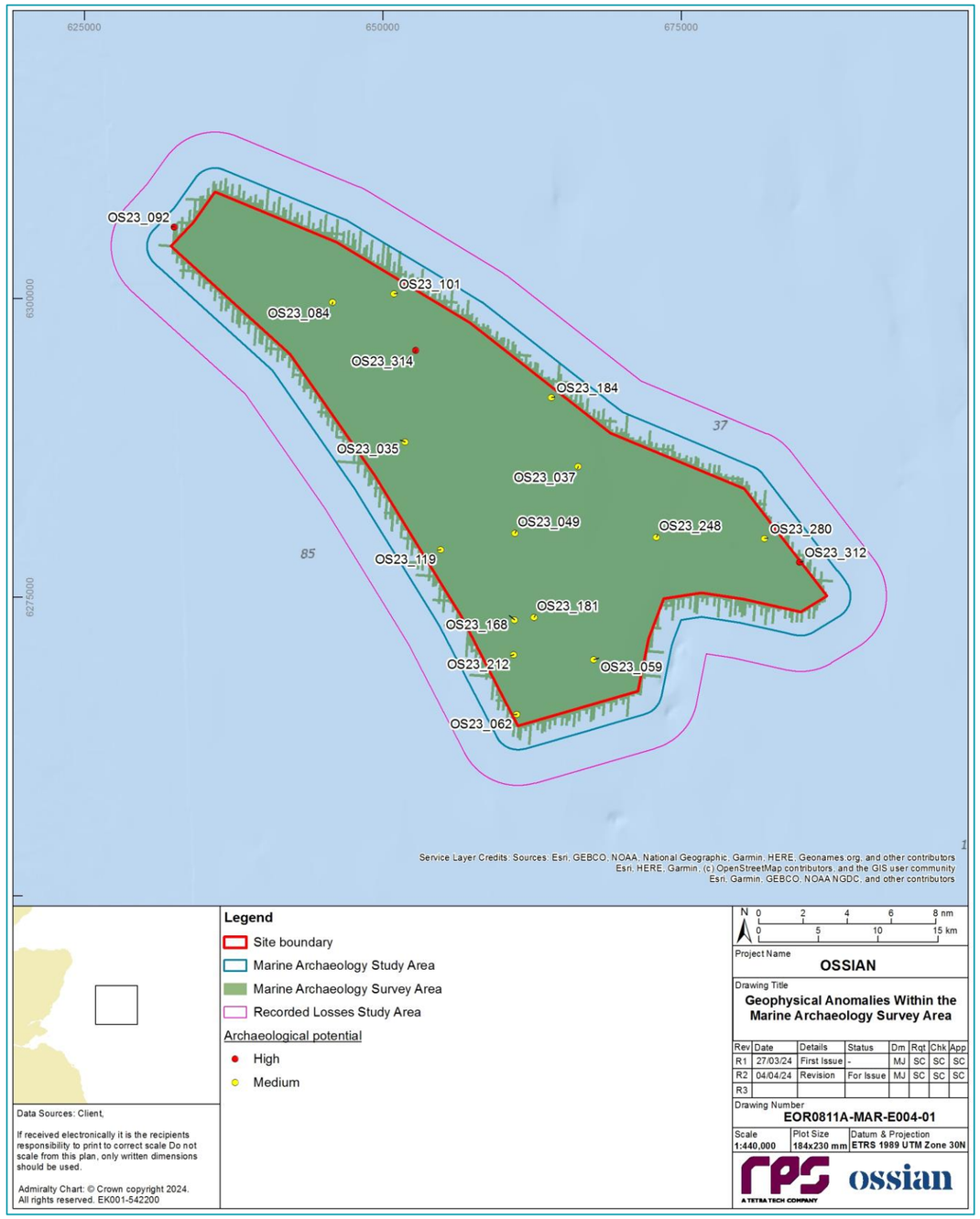

Figure 19.3: Medium and High Potential Geophysical Anomalies Within the Marine Archaeology Survey Area

19.7.6. FUTURE BASELINE SCENARIO

55. The EIA Regulations require that "*a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge*" is included within the Array EIA Report.

56. If the Array does not come forward, an assessment of the 'without development' future baseline conditions has also been carried out and is described within this section.

57. The current baseline as described in section 19.7.3 is assumed to change very slowly. The effects of climate change on the marine environment may cause impacts on marine archaeology receptors in the mid to long term (Department of Energy and Climate Change (DECC), 2016). It has been predicted that UK seas will be between 1.5° and 4°C warmer by the end of the twenty first century (Lowe *et al.*, 2009, Cornes *et al*., 2023). One effect of warmer seas is the northward migration of invasive and potentially damaging species, such as the blacktip shipworm *Lyrodus pedicellatus*. The blacktip shipworm is a species of shipworm that has begun to invade UK seas from more southerly latitudes as a result of sea temperature increase, recorded off Cornwall, Langstone Harbour (Hampshire) and Sandwich (Kent), and is considered to be a major threat to wooden wrecks and other wooden structures (Dunkley, 2013). The process, pattern, and speed of the blacktip shipworm introduction to Scottish waters is, however, uncertain (Historic Environment Scotland, 2019).

58. The baseline environment of the marine archaeology study area as described in section 19.7 above should be considered as a snapshot of the present marine archaeology environment within a gradually changing environment. It is unlikely that significant change will occur to marine archaeology within the marine archaeology study area over the next few decades (over the lifespan of the Array), including the decline of the archaeological resource should the shipworm inhabit Scottish waters. Firstly, sediment mobility will likely continue and this natural process will potentially expose marine archaeology over time, leading to its deterioration. Secondly, it is possible that sediment mobility will rebury the archaeology, resulting in its possible protection but increase its concealment. Finally, through these processes, currently unknown marine archaeology sites and wrecks will be exposed.

19.7.7. DATA LIMITATIONS AND ASSUMPTIONS

59. The records held by HES and other sources used in this assessment are not a record of all surviving archaeological assets, but a record of discovery of a diverse range of archaeological and historical components of the marine environment. The datasets used are incomplete records of the totality of potential marine archaeology present on the seabed and does not preclude the subsequent discovery of further elements of the historic environment that are, at present, unknown. This relates particularly to those archaeological features that are buried. Best practice and industry guidance were followed to ensure a robust and holistic understanding of the marine archaeology baseline.

60. The interpretation of geophysical and hydrographic data is, by its very nature, subjective. However, with experience and by analysing the form, size, and characteristics of an anomaly, a reasonable degree of certainty as to the origin of an anomaly can be achieved. Measurements can be taken in most data processing software; while this is reasonably accurate, some discrepancies may occur. Where there is uncertainty of an anomaly's potential or origin, a precautionary approach is taken to ensure the most appropriate mitigation for the historic environment is recommended. There may be instances where a contact may exist on the seabed but is not visible in the geophysical data. This may be due to the anomaly being buried or out of the sonar's line-of-sight. The desktop sources and the site-specific data examined represent a comprehensive and robust sequence of datasets and observations that allow for a detailed assessment of archaeological constraints associated with the Array.

19.8. KEY PARAMETERS FOR ASSESSMENT

19.8.1. MAXIMUM DESIGN SCENARIO

61. The maximum design scenarios (MDS) identified in Table 19.10 are those expected to have the potential to result in the greatest effect on marine archaeology receptors. These scenarios have been selected from the details provided in volume 1, chapter 3 of the Array EIA Report. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Description (volume 1, chapter 3) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

Table 19.10: Maximum Design Scenario Considered for Each Potential Impact as Part of the Assessment of Likely Significant Effects on Marine Archaeology

Potential Impact	Phase[1]			Maximum Design Scenario	Justification
	C	O	D		
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors)	✓	✓	✓	**Construction Phase** <u>Site preparation</u> Sand wave clearance totalling 7,104,614.74 m^3: • Offshore Substation Platform (OSP) foundations: sand wave clearance has been calculated on the basis of three large and twelve small OSPs. Total sand wave clearance volume of 104,294.74 m^3. • Inter-array cables: sand wave clearance along 252 km (20%) of cable length with a width of 24 m, and an average sand wave height of 1 m. Total sand wave clearance volume 5,867,520 m^3. • Interconnector cables: sand wave clearance along 47.2 km (20%) of total length with a width of 24 m and an average sand wave height of 1 m. Total sand wave clearance volume 1,132,800 m^3. In addition to sand wave clearance, boulder clearance to a width of up to 24 m will be used for an estimated 25% of inter-array cables (315.25 km) and interconnector cables (59 km) <u>Foundation installation</u> • Wind turbines: installation of 265 semi-submersible wind turbine foundations with driven pile anchors. 6 piles of 4.5 m diameter per foundation with 10% requiring drilling to a depth of 40 m at a rate of up to 1.0 m/hr. Drill arisings of 636 m^3 per pile. Total drill arisings volume of 131,122.22 m^3. • OSPs: installation of up to three large and 12 small OSPs with up to 24 piles of 4.5 m diameter for each large OSP, and up to 12 piles of 3 m diameter for each small foundation). Up to 100% of piles require drilling to a depth of 70 m at a rate of up to 1.0 m/hr. Drill arising of 300 m^3 per pile per large OSP foundation, 200 m^2 per OSP small foundation. Total drill arisings volume of 50,470 m^3. <u>Cable installation</u> • Inter-array cables: Installation via trenching of up to 1,222.4 km of cable with a trench width of up to 2 m. Total maximum trench clearance volume of 7,334,400 m^3. • Interconnector cables: installation via trenching of up to 236 km of cable with a trench width of up to 2 m. Total maximum trench clearance volume of 1,416,000 m^3. **Operation and Maintenance Phase** • Inter-array cables: Repair or replacement of up to 5% of 540 dynamic cable sections and reburial of 5% of total length on the seabed (61.12 km) of cable annually. • Interconnector cables: Repair or replacement of one interconnector cable every 5 years. Reburial of up to 5% of total length (11.8 km) annually. • Mooring lines – movement along seabed of up to 6 catenary mooring lines per up to 265 semi-submersible wind turbine foundations. The maximum length of each mooring line, per foundation, in contact with the seabed during operation is: – 680 m: which amounts to 6,120 m per foundation and up to 795,600 m of mooring line with the potential to be in contact with the seabed; or – 710 m during a one in 50 year Annual Exceedance Probability (AEP) storm: which amounts to 6,390 m per foundation and up to 830,700 m of mooring line with the potential to be in contact with the seabed.	**Construction Phase** <u>Site Preparation</u> • The volume of material to be cleared from individual sand waves will vary according to the local dimensions (e.g. height, length, and morphology) and the level to which the sand wave is to be reduced. While these details are not as yet fully known, based on available data it is anticipated that the sand waves requiring clearance are likely to be a maximum height of 2 m. In all cases the material cleared from the sand wave will be disposed of locally within the Array. <u>Foundation installation</u> • Installation of foundations via drilled operations results in the release of the largest volume of unrestrained sediment through the water column. The greatest volume of sediment disturbance by drilling at individual locations is associated with the largest diameter pile for turbine anchors and OSP foundations. • The selected anchor pile scenario represents the greatest volume of sediment to be released per drilling event. • The selected OSP scenario represents the greatest volume of sediment to be released per drilling event. • The greatest drilling rate associated with the largest pile diameter represents the maximum level of increase in suspended sediment concentration. • The MDS assumes that piles may require drilling to the full depth. However, it is noted that driven piling is more likely for only partial depth. <u>Cable installation</u> • Cable routes inevitably include a variety of seabed material, so the 3 m depth maximum may not be achieved. The maximum trench depth of 3 m would only be required at locations where significant seabed/sand wave mobility is identified. The assessment therefore considers the upper bound in terms of suspended sediment and dispersion potential. • Cables may be buried by ploughing, trenching, or jetting. Trenching or jetting mobilises the greatest volume of material to increase suspended sediment concentrations. **Operation and Maintenance Phase** The greatest foreseeable number of cable repair and reburial events is considered to be the MDS for sediment dispersion. The potential of an increase in suspended sediment concentrations (SSCs) may arise as a result of mooring lines or cables making contact with and moving on the bed, disturbing bed materials and causing scouring and increased SSCs within the water column. This may lead to associated deposition of these materials, although the potential for blockage to the overall sediment transport regime in the area is unlikely. There is the potential impact to physical features within the Array from the increase in SSCs. The greatest potential for the increase in SSCs is from catenary moorings which have the greatest length of mooring lines in contact with the bed. The MDS is considered to be the foundations with the greatest length of mooring line on the seabed per foundation, rather than over the site as a whole, as the effects are considered to be very localised.

[1] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Impact	Phase[1] C	O	D	Maximum Design Scenario	Justification
				Decommissioning Phase • Up to 19,270,962 m^2 (19.27 km^2) of hard substrate on the seabed will be removed in the decommissioning of the Array. This includes the following: – a total footprint area of 12,416,305 m^2 due to mooring lines on the seabed. Mooring lines on the seabed will cover a maximum total footprint of 46,854 m^2 per foundation (n = 265) based on semi-submersible wind turbines using catenary moorings; – a total footprint area of 25,288 m^2 due to anchors on the seabed (265 foundations with an anchor footprint of 95 m^2 each); – a footprint area of 632,196 m^2 due to scour protection for moorings and anchors; – a footprint area of 2,163 m^2 due to OSP jacket foundations (3 large OSPs with an area of 382 m^2 each and 12 small OSPs at 85 m^2 each); – a footprint area of 94,818 m^2 due to scour protection for all OSP jacket foundations; – a footprint area of 4,889,600 m^2 due to all inter-array cable protection and 944,000 m^2 of interconnector cable protection; – a footprint area of 24,000 m^2 due to all inter-array and interconnector cable crossing protection; – a total footprint area of 41,040 m^2 due to subsea junction boxes (228 boxes with a footprint area of 180 m^2 each); and – a footprint area of 201,552 m^2 due to scour protection for all subsea junction boxes. • SSC levels are expected to be similar or of a lower extent to the construction phase (given the absence of site preparation activities in the decommissioning phase).	**Decommissioning Phase** Parameters for decommissioning will be significantly lower than for the construction phase, as sand wave clearance and pre-lay preparation will not be required. At the end of the Array's operational lifetime, it is expected that all structures above the seabed (with the exception of driven piles and DEAs (depending upon anchor system used), scour protection and cable protection) will be fully removed where feasible. Driven piles and/or DEAs installed as part of the wind turbine anchoring system, static portions of inter-array cables, interconnector cables, scour protection and cable protection are either expected to remain *in situ* or method of decommissioning is yet to be determined. For the purposes of the MDS for sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors), total removal of all infrastructure has been assumed.
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)	✓	✓	✓	**Construction Phase** Up to 49,793,366 m^2 of seabed impact in total across the Array. • A footprint area of 14,723,348 m^2 due to boulder clearance and relocation and sand wave clearance; • a footprint area of 9,540,000 m^2 due to disturbance due to Drag Embedment Anchor (DEA) installation; • OSP foundations: up to 94,818 m^2 of disturbance from installation of up to 3 large and 12 small OSPs with a total seabed footprint (including scour protection) of 14,898 m^2 per large and 4,177 m^2 per small jacket; • A footprint area of 25,392,000 m^2 due to disturbance caused by the installation of 1,261 km of inter-array and interconnector cables; • Jack-up events: up to 43,200 m^2 of disturbance from the use of jack-up vessels during OSP foundation installation, with a footprint of 1,440 m^2 per position and up to two jack-up events at each of fifteen (three large, 12 small) OSPs. • In addition, up to 5,190 m^2 of seabed disturbance could occur due to crater formation from the clearance of Unexploded Ordinance (UXO). This value has not been included in the total of 49,948,548 m^2 as it has not been derived from the Project Description (volume 1, chapter 3). Instead, it has been calculated based on appropriate crater sizes from other projects, and applied to the 15 potential UXOs that may require clearance during the construction of the Array (Ordtek, 2018; Royal Haskoning DHV, 2022). **Operation and Maintenance Phase** • Operation and maintenance phase up to 35 years. • Mooring lines – Movement along seabed of up to 6 catenary mooring lines per semi-submersible wind turbine foundation, of which there are up to 265. The maximum length of each mooring line in contact with the seabed per foundation during operation is 680 m or 710 m during a 2% AEP storm. • Up to 63,460,305 m^2 of seabed impact in total across the Array comprising: – A footprint area of 12,416,305 m^2 of disturbance from mooring lines (46,854 m^2 per each of 265 wind turbine foundations);	Maximum footprint which would be affected during the construction, operation and maintenance and decommissioning phases. **Construction Phase** The MDS assumes that the width of disturbance for sand wave and pre-lay preparation (boulder and debris clearance) also includes subsequent burial. For the purposes of the MDS and to avoid double counting, the MDS assumes up to 25% of inter-array cable, 20% of mooring lines, and 25% of interconnector cable length will be subject to pre-lay preparation only. The area of seabed affected by the placement of sand wave clearance material has been calculated based on the maximum volume of sediment to be placed on the seabed, assuming none dispersed through tidal currents). For the purposes of this MDS, the total footprint of seabed affected has been calculated to assume a mound of uniform thickness of 0.5 m in height. **Operation and Maintenance Phase** The MDS for seabed impact associated with inter-array and interconnector cable maintenance includes repairs and reburial of cables. **Decommissioning Phase** Parameters for decommissioning will be significantly lower than for the construction phase, as sand wave clearance and pre-lay preparation will not be required. The MDS for removal of infrastructure differs between impacts (e.g. increased SSCs and associated deposition). At the end of the Array's operational lifetime, it is expected that all structures above the seabed (with the exception of driven piles and DEAs (depending upon anchor system used), scour protection and cable protection) will be fully removed where feasible. Driven piles and/or DEAs installed as part of the wind turbine anchoring system, static portions of inter-array cables, interconnector cables, scour protection and cable protection are either expected to remain *in situ* or method of decommissioning is yet to be determined.

Potential Impact	Phase[1] C	O	D	Maximum Design Scenario	Justification
				– 42,784,000 m^2 of disturbance from inter-array cable reburial affecting 1,222,400 m^2 per reburial event (assumes reburial of up to 5% of total length on the seabed (up to 61.12 km) annually); – 8,260,000 m^2 of disturbance from interconnector reburial affecting up to 236,000 m^2 per annual reburial event; (assumes reburial of up to 5% of total length (up to 11.8 km) annually) – assumes 20 m width seabed disturbance for repair and remedial burial. • A footprint area of 367,500 m^2 due to jack up vessel usage for operation and maintenance activities (10,500 m^2 per year over the 35 year lifecycle) **Decommissioning Phase** A total of up to 43,200 m^2 of seabed disturbance due to the footprint area of jack up vessel use for decommissioning activities.	
Direct damage to deeply buried marine archaeology receptors – submerged prehistoric receptors (e.g. palaeolandscapes and associated archaeological receptors)	✓	×	×	**Construction Phase** Wind turbine mooring and anchoring systems: up to 265 semi-submersible wind turbine foundations with associated mooring systems attached to up to 6 driven pile anchors per foundation with a diameter of 4.5 m. A total of up to 1,590 piles driven to a depth of 40 m. Seabed footprint of 25,287 m^2. OSP foundation installation: six OSP foundations requiring 24 piles of 4.5 m per foundation with up to 100% drilled to a depth of 85 m with a seabed and sub-seabed footprint of 2,290 m^2.	Maximum depth of pile penetration for foundation installation represents the maximum impact to submerged prehistoric archaeology receptors.
Alteration of sediment transport regimes	×	✓	×	**Operation and Maintenance Phase** • Wind turbine mooring and anchoring systems: 265 semi-submersible wind turbine foundations with associated mooring systems attached to driven pile anchors with a footprint of 95.43 m^2 per foundation. Scour protection to a height of 1.5 m. Total footprint of 2,385.65 m^2 per wind turbine foundation for a total seabed footprint of 632,196.43 m^2. • OSPs: three large OSPs with jacket foundations with a total topside area of 32,307 m^2; 12 small OSPs with jacket foundations with a topside area of 18,204 m^2. Up to 12 x 5 m jacket legs per large OSP, 6 x 5 m jacket legs per small OSP, and scour protection with a height of 1.5 m for a total footprint of 94,814 m^2. • Inter-array cables: cable protection along 244.48 km of the cable with a height of up to 3 m and up to 20 m width. Up to 12 cable crossings, each crossing has a height up to 4 m, a width of up to 20 m and a length of up to 50 m. • Interconnector cables: cable protection along 47.2 km of the cable, with a height of up to 3 m and up to 20 m width. Up to 12 cable crossings, each crossing has a height of up to 4 m, a width of up to 20 m and a length of up to 50 m.	The presence of infrastructure (e.g. wind turbines and mooring lines) provides the largest obstruction to flow in the water column. See also volume 1, chapter 3.

19.8.2. IMPACTS SCOPED OUT OF THE ASSESSMENT

62. On the basis of the baseline environment and the Project Description outlined in volume 1, chapter 3 of the Array EIA Report, no impacts are proposed to be scoped out of the assessment for marine archaeology.

63. For direct damage to deeply buried marine archaeology receptors – submerged prehistoric receptors (e.g. palaeolandscapes and associated archaeological receptors), the impact-receptor pathway is through construction activities penetrating the marine sediments to those which represent potentially submerged palaeolandscapes. For this reason, this impact is assessed for the construction phase, but scoped out for the operation and maintenance phase. The direct damage to deeply buried submerged prehistoric receptors is an unavoidable impact that occurs in the construction phase (but is mitigated through the preservation by record of the archaeological resource (see section 19.10.2)). Therefore, direct damage to deeply buried receptors is scoped out for the operation and maintenance and decommissioning phases.

64. For the alteration of sediment transportation regimes, the presence of infrastructure (e.g. wind turbines and mooring lines) provides the largest obstruction to flow in the water column. For this reason, construction and decommissioning activities are not assessed for this impact.

19.9. METHODOLOGY FOR ASSESSMENT OF EFFECTS

19.9.1. OVERVIEW

65. The marine archaeology assessment of effects has followed the methodology set out in volume 1, chapter 6 of the Array EIA Report. Specific to the marine archaeology, this assessment has been undertaken in accordance with the Principles of Cultural Heritage Impact Assessment (IEMA *et al.*, 2021).

19.9.2. CRITERIA FOR ASSESSMENT OF EFFECTS

66. When determining the significance of effects, a two stage process is used which involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 6 of the Array EIA Report and which are based on and have been adapted from those used in the Design Manual for Roads and Bridges methodology (Highways England *et al.*, 2019).

Magnitude of Impact

67. The criteria for defining magnitude in this chapter are outlined in Table 19.11. Each assessment considered the spatial extent, duration, frequency and reversibility of impact when determining magnitude which are outlined within the magnitude section of each impact assessment (e.g. a duration of hours or days would be considered for most receptors to be of short term duration, which is likely to result in a low magnitude of impact).

Table 19.11: Definition of Terms Relating to the Magnitude of an Impact

Magnitude of Impact	Definition
High	Loss of resource and/or quality and integrity of resource; severe damage to key characteristics, features or elements (Adverse)
	Large scale or major improvement or resource quality; extensive restoration or enhancement; major improvement of attribute quality (Beneficial)
Medium	Loss of resource, but not adversely affecting integrity of resource; partial loss of/damage to key characteristics, features or elements (Adverse)
	Benefit to, or addition of, key characteristics, features or elements; improvement of attribute quality (Beneficial)
Low	Some measurable change in attributes, quality or vulnerability, minor loss or, or alteration to, one (maybe more) key characteristics, features or elements (Adverse)
	Minor benefit to, or addition of, one (maybe more) key characteristics, features or elements; some beneficial impact on attribute or a reduced risk of negative impact occurring (Beneficial)
Negligible	Very minor loss or detrimental alteration to one or more characteristics, features or elements (Adverse)
	Very minor benefit to, or positive addition of one or more characteristics, features or elements (Beneficial)

Receptor Sensitivity/Value

68. The capability of a receptor to accommodate change and its ability to recover, if affected, is a function of its sensitivity. Receptor sensitivity is typically assessed by its:

- adaptability: the degree to which a receptor can avoid or adapt to an effect;
- tolerance: the ability of a receptor to accommodate temporary or permanent change without significant adverse impact;
- recoverability: the temporal scale over and extent to which a receptor will recover following an effect; and
- value: a measure of the receptor's importance, rarity and worth (Highways England *et al.*, 2019).

69. Marine archaeology receptors cannot adapt, tolerate, or recover from impacts resulting in damage or loss caused by development. As a result, the sensitivity of a receptor can only be determined through its value.

70. Based on current guidance, the significance of a historic asset embraces all the diverse cultural heritage values that people associate with it, or which prompt them to respond to it (English Heritage, 2008). Significance is determined by the following value criteria:

- evidential value: deriving from the potential of a place to yield evidence about past human activity;
- historical value: deriving from the ways in which past people, events, and aspects of life can be connected through a place to the present;
- aesthetic value: deriving from the ways in which people draw sensory and intellectual stimulation from a place; and
- communal value: deriving from the meanings of a place for the people who relate to it, or for whom it figures in their collective experience or memory. Communal values are closely bound up with historical and aesthetic values but tend to have additional and specific aspects.

71. Criteria of value for assessing if marine historic assets are of national importance derive from Designation Policy and Selection Guidance (Historic Environment Scotland, 2019) are:

- Intrinsic characteristics: how the physical remains of a marine historic asset contribute to our understanding of the past.
- Contextual characteristics: how a marine historic asset relates to its surroundings and/or to our existing knowledge of the past.
- Associative characteristics: how a marine historic asset relates to people, events and/or historic and social movements.

72. Criteria of value to shipwrecks specifically are given by Historic England (2012) guidance. These are:

- period;
- rarity;
- documentation;
- group value;
- survival/condition; and/or
- potential.

73. The criteria for defining sensitivity in this chapter are outlined in Table 19.12.

Table 19.12: Definition of Terms Relating to the Sensitivity of the Receptor

Value (Sensitivity of the Receptor)	Description
Very High	Very high importance and rarity, international receptor. Wrecked ships and aircraft that are protected under the Protection of Wrecks Act 1973, Ancient Monuments and Archaeological Areas Act 1979, or Protection of Military Remains Act 1968 with an international dimension of their importance, as well as as-yet undesignated sites that are demonstrably of very high archaeological value. Known submerged prehistoric sites and landscapes with a confirmed presence of largely *in situ* artefactual material or palaeogeographic features with demonstrable potential to include artefactual and/or palaeoenvironmental material, possibly as part of a prehistoric site or landscape.
High	High importance and rarity, international and / or national receptor. This category includes sites designated by the laws as above, as well as as-yet undesignated sites that do not have statutory protection or equivalent significance, but have a high potential archaeological interest based on an assessment of their importance in terms of the principles of build, use, loss, survival, and investigation (BULSI) (Wessex Archaeology, 2024). Prehistoric deposits with high potential to contribute to an understanding of the palaeoenvironment.
Medium	High or medium importance and rarity, regional receptor. Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, but have moderate potential based on an assessment of their importance in terms of BULSI. Prehistoric deposits with moderate potential to contribute to an understanding of the palaeoenvironment.
Low	Low or medium importance and rarity, local receptor. Includes wrecks of ships and aircraft that do not have statutory protection or equivalent significance, and have a low potential based on an assessment of their importance in terms of BULSI. Prehistoric deposits with low potential to contribute to an understanding of the palaeoenvironment.
Negligible	Very low importance and rarity, local receptor. Assets with little or no surviving archaeological interest.

Significance of Effect

74. The magnitude of the impact and the sensitivity of the receptor are combined when determining the significance of the effect upon marine archaeology. The particular method employed for this assessment is presented in Table 19.13.

75. Where a range is suggested for the significance of effect, for example, minor to moderate, it is possible that this may span the significance threshold. The technical specialist's professional judgement will be applied to determine which outcome defines the most likely effect, which takes in to account the sensitivity of the receptor and the magnitude of impact. Where professional judgement is applied to quantify final significance from a range, the assessment will set out the factors that result in the final assessment of significance. These factors may include the likelihood that an effect will occur, data certainty and relevant information about the wider environmental context.

76. For the purposes of this assessment:

- a level of residual effect of moderate or more will be considered a 'significant' effect in terms of the EIA Regulations; and
- a level of residual effect of minor or less will be considered 'not significant' in terms of the EIA Regulations.

77. Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process.

Table 19.13: Matrix Used for the Assessment of the Significance of the Effect

Sensitivity of Receptor	Magnitude of Impact: Negligible	Low	Medium	High
Negligible	Negligible	Negligible to Minor	Negligible to Minor	Minor
Low	Negligible to Minor	Negligible to Minor	Minor	Minor to Moderate
Medium	Negligible to Minor	Minor	Moderate	Moderate to Major
High	Minor	Minor to Moderate	Moderate to Major	Major
Very High	Minor	Moderate to Major	Major	Major

19.10. MEASURES ADOPTED AS PART OF THE ARRAY

78. As part of the Array design process, a number of designed in measures have been proposed to reduce the potential for impacts on marine archaeology (see Table 19.14). They are considered inherently part of the design of the Array and, as there is a commitment to implementing these measures, these have been considered in the assessment presented in section 19.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These designed in measures are considered standard industry practice for this type of development.

Table 19.14: Designed In Measures Adopted as Part of the Array

Designed In Measures Adopted as Part of the Array	Justification
Primary Measures (included as part of the Array design)	
The identification and implementation of AEZs around anomalies identified as having high and medium archaeological potential (see Table 19.15). Further details of AEZs are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To reduce the potential for direct impacts on sites of identified archaeological significance.
The identification and implementation of TAEZs based on all available information including the stated positional accuracy, the recorded size of the target and the potential archaeological significance around those records for wrecks and obstructions outside of the survey data coverage but within the site boundary. Further details of which are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To reduce the potential for impacts on sites of archaeological importance.
Archaeologists engaged by the Applicant to be consulted in the preparation of any pre-construction Remotely Operated Vehicle (ROV) surveys and, if appropriate, in monitoring/checking of data. Further details of which are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with HES.
Archaeological input into specifications for, and archaeological analysis of, any further site investigation. Further details of which are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with HES. To preserve by record on sediments of geoarchaeological/palaeoenvironmental importance and enhance knowledge of the offshore marine archaeological resource.
Mitigation of unavoidable direct impacts on known sites of archaeological significance through options which include i) preservation by record; ii) stabilisation; iii) detailed analysis and safeguarding of otherwise comparable sites elsewhere. Further details are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To mitigate the effects of disturbance/destruction of irreplaceable archaeological remains.
Operational awareness of the location of those archaeological anomalies identified as having a low potential. Reporting through the protocol (PAD) will be undertaken should material of potential archaeological interest be encountered. Further details of which are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To identify any sites of archaeological importance that may require further investigation, avoidance or engagement with HES.
Archaeologists to be consulted in the preparation of pre-construction clearance operations and, if appropriate, to carry out archaeological monitoring of such work. Further details of which are provided in the outline WSI and PAD (volume 3 appendix 19.2).	To record archaeological remains that may be affected by pre-construction clearance operations.
Tertiary Measures (measures required to meet legislative requirements, or adopted standard industry practice)	
Commitment to preparation and implementation of a WSI and PAD prior to any post-consent works within the Array.	The outline WSI and PAD will be submitted alongside the application and will contain details of monitoring requirements. The PAD will require the protection and, if necessary, recording of previously unknown sites/objects of archaeological significance affected by the Array.

19.10.1. ARCHAEOLOGICAL EXCLUSION ZONES

79. Best practice favours the preservation *in situ* of archaeological remains, therefore the ideal preferred mitigation for archaeological remains is avoidance. For the Array, AEZs have been proposed that prohibit development related activities within their extents, which vary depending upon the nature of the site. The final Array layout will take into account these preliminary zones, which may evolve or be removed as the Array progresses, subject to layout designs and additional subsequent surveys that may be required.

80. All AEZs proposed in the outline WSI, will be marked on the Development Specification and Layout Plan (DSLP). If impacts cannot be avoided, measures to reduce, remedy or offset disturbance will be identified where appropriate.

81. In view of the potential archaeological significance of anomalies within the Array, AEZs (either in the form of individual AEZs or clusters) will be placed around the two anomalies classified as being of high archaeological potential that are located within the Array and the 14 anomalies classed as being of medium potential. The third high potential anomaly that was identified in the geophysical survey data has not been assigned an AEZ as it is located more than 100 m from the Array boundary and therefore there is no pathway for direct impact to this receptor. These anomalies have been recommended AEZs based on the size of the anomaly, the extents of any debris, the potential heritage value of the anomaly, the potential impact of the development, and the seabed dynamics within the area.

82. Dependent of the form of the anomaly, AEZs have either been recommended as a 'radius' from the centre point of the anomaly or as a distance from the extents. Particularly in the case of shipwrecks, which tend to be longer in length than width, the use of a circle provides unequal protection around the extents. This not only impacts the protection afforded but does not present proportional mitigation, therefore distance from extents is used for proposed AEZs.

83. The proposed AEZs are listed in Table 19.15 and shown in Figure 19.4. Scope is allowed for their amendment in light of further evidence and with the involvement of consultees. Further details of AEZs and archaeological monitoring is provided in the outline WSI and PAD (volume 3, appendix 19.2). AEZs can be different sizes depending on the size of the archaeological anomaly and the extent to which there is associated debris present on the seabed.

84. The anomalies identified as requiring AEZs have been reviewed against desk based and site-specific data, and as a result of this review, AEZs have been identified of varying sizes according to the size and spread of the individual archaeological receptor. AEZs are presented as either extents or radius; extents indicates the distance proposed from the furthest extents of the archaeological anomaly whilst a radius AEZ is one that is measured as a circumference from the central point of the anomaly.

Table 19.15: Proposed Archaeological Exclusion Zones Within the Array

Anomaly ID	Description	Potential	ETRS89 30N		AEZ (m)
			X	Y	
OS23_035	Debris	Medium	651865	6288021	50 Radius
OS23_037	Debris	Medium	666377	6285964	25 Extent
OS23_049	Debris	Medium	661064	6280372	25 Extent
OS23_059	Debris	Medium	667679	6269756	25 Radius
OS23_062	Debris	Medium	661237	6265197	25 Extent
OS23_084	Debris	Medium	645773	6299724	35 Radius
OS23_101	Potential Debris	Medium	650935	6300407	25 Radius
OS23_119	Debris	Medium	654868	6278993	25 Extent
OS23_168	Debris	Medium	661027	6273087	25 Radius
OS23_181	Debris	Medium	662687	6273323	50 Extent
OS23_184	Debris	Medium	664141	6291722	25 Radius
OS23_212	Debris	Medium	660962	6270181	50 Extent
OS23_248	Debris	Medium	672919	6280043	35 Radius
OS23_280	Debris	Medium	682009	6279921	35 Radius
OS23_312	Wreck	High	684936	6277926	50 Extent
OS23_314	Wreck	High	652760	6295702	100 Extent

85. Additionally, TAEZs may be assigned during the construction, operation and maintenance, and decommissioning phases of the Array as anomalies that have been identified in the data do not necessarily represent all of the marine archaeological material that is on the seabed. For example, wooden wrecks can be buried under the seabed and may not appear in the geophysical data. Other previously unknown marine archaeology receptors may be discovered while carrying out construction, operation and maintenance, and decommissioning activities. As set out in The Crown Estate (The Crown Estate, 2021) guidance, AEZs may be altered (enlarged, reduced, moved, or removed) as a result of further data assessment or archaeological field evaluation covering those areas that are subject to AEZs. If new finds of potential archaeological significance come to light during the assessment of marine geophysical data or works associated with the Array during the course of construction, operation, or decommissioning phases, as reported through the PAD, they may be subject to the implementation of a TAEZ. There is no functional difference between an AEZ or TAEZ in any practical sense. A TAEZ will prevent impact to the seabed within their extents but allow activities in other areas to continue. The need for a TAEZ, its position and extent, the implementation of any new AEZs (or the conversion of a TAEZ to a permanent AEZ) or any alterations to existing AEZs will be subject to discussions between the Retained Archaeologist and the Applicant. In consultation with MD-LOT and HES, these will be confirmed with a formal response. Following alteration, a new plan giving details of the AEZs will be drawn up and issued to each relevant party.

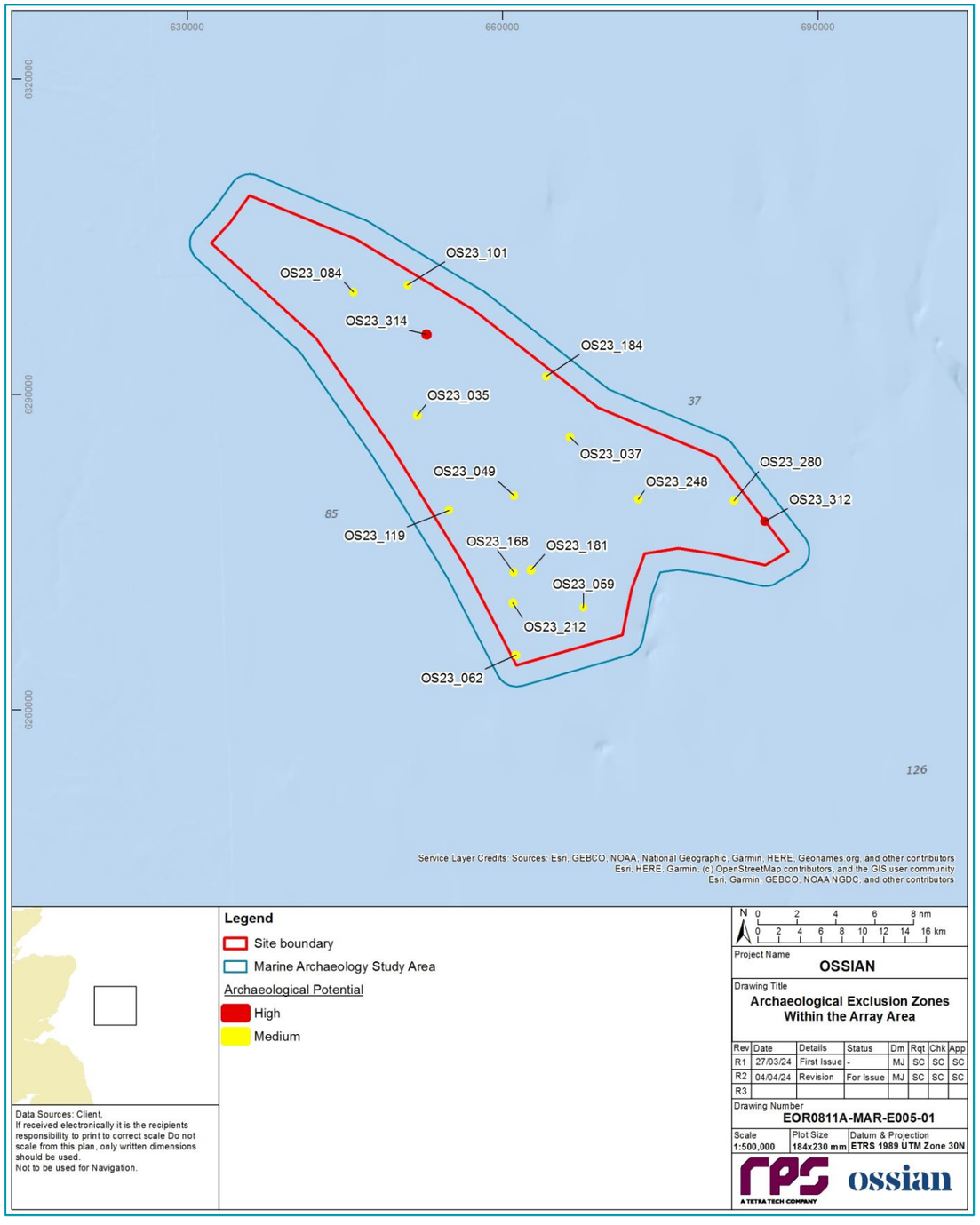

Figure 19.4: Archaeological Exclusion Zones in the Marine Archaeology Study Area

19.10.2. PRESERVATION BY RECORD

86. Where preservation *in situ* is not practicable, disturbance of archaeological sites or material will be mitigated by appropriate and satisfactory measures, also known as 'preservation by record'. In these circumstances, the effects of the Array will be mitigated by carrying out excavation and recording prior to the impact occurring (COWRIE, 2010).

87. It is possible that previously unknown wrecks, archaeological sites or material may only be encountered during the course of the construction, operation and maintenance and/or decommissioning of the Array. Procedures will therefore be put in place to allow for such eventualities.

88. The Offshore Renewables Protocol for Archaeological Discoveries (The Crown Estate, 2014) has been followed in the production of the PAD specific to the Array (volume 3, appendix 19.2, annex A). This PAD will involve the reporting of archaeological discoveries made during the lifetime of the Array. This protocol covers the reporting and investigating of unexpected archaeological discoveries encountered during construction, operation and maintenance and decommissioning activities, informed by the guidance of a marine archaeologist specialised in working with PADs for offshore wind farm projects. This protocol further makes provision for the implementation of TAEZs around areas of possible archaeological interest, for prompt archaeological advice and, if necessary, for archaeological inspection of important features prior to further construction, operation and maintenance or decommissioning activities in the vicinity. It complies with the Merchant Shipping Act 1995, including notification to the Receiver of Wreck, in accordance with the Code of Practice for Seabed Developers (JNAPC, 2006).

89. As there is potential for the presence of previously unidentified archaeological assets, archaeological monitoring is deemed as appropriate where seabed material is brought to the surface. These proposals may be refined on the basis of the results of any further marine geophysical, geotechnical or ROV surveys.

19.11. ASSESSMENT OF SIGNIFICANCE

90. Table 19.10 summarises the potential impacts arising from the construction, operation and maintenance and decommissioning phases of the Array, as well as the MDS against which each impact has been assessed. An assessment of the likely significance of the effects of the Array on the marine archaeology receptors caused by each identified impact is given below.

SEDIMENT DISTURBANCE AND DEPOSITION LEADING TO INDIRECT IMPACTS ON MARINE ARCHAEOLOGY RECEPTORS (THE EXPOSURE OR BURIAL OF RECEPTORS)

91. The seabed activities associated with the construction, operation and maintenance, and decommissioning phases of the Array may lead to sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors identified in section 19.7.3**.** The MDS is for site preparation activities such as sand wave clearance, mooring and anchoring systems, and cable installation. These activities are presented in Table 19.10.

92. The disturbance of sediment/seabed deposits can result in the exposure of known marine archaeology receptors (i.e. wreck sites) and the exposure of as yet unknown wreck sites and associated materials. Such activities can also result in the burial of known receptors.

All phases

Magnitude of impact

93. The site-preparation activities and installation of infrastructure within the Array may lead to increased suspended sediment concentrations (SSCs) and associated deposition. Although the impact is proposed to be scoped out for physical processes due to effects arising from the Array being so slight as to be considered insignificant (see volume 2, chapter 7). However, marine archaeology receptors are of high sensitivity and suspended sediment will still occur and can still cause indirect damage to marine archaeology receptors. The MDS for sand wave clearance is a total clearance volume of 7,104,614.74 m^3.

94. The MDS is for the drilled installation of 265 semi-submersible wind turbine foundations each with driven pile anchor systems shared between wind turbines; up to 10% of piles require drilling with total drill arisings volume of 131,122.22 m^3. For the installation of OSPs, drill arisings volume totals 43,260 m^3. The MDS for drilled installation of piles is a total volume of 181,592.22 m^3.

95. For the installation of inter-array cables (1,222.4 km) and interconnector cables (236 km), the MDS for sediment clearance volume from trenching is 8,750,400 m^3.

96. The MDS for the operation and maintenance phase is for reburial up to 61.12 km of inter-array and 11.8 km of interconnector cable annually. The mooring lines have the potential for movement along the seabed with a total of 795,600 m of mooring line with the potential to be in contact with the seabed for the whole of the Array or 830,700 m of mooring line during a one in 50 year AEP storm, for the whole of the Array.

97. Total removal of all infrastructure has been assumed during the decommissioning phase.

98. The implementation and adherence to the WSI and PAD as a mitigation measure, described in section 19.10, will require that any exposure of any as yet unknown marine archaeology receptors will be properly reported and impact mitigated through the establishment of a TAEZ. The burial of marine archaeology receptors could also occur and would have a beneficial impact as this would afford them more protection. Provision will also be made for the recording of any new discoveries through the PAD. These measures will ensure preservation by record and reduce the magnitude of the impact on as yet unknown marine archaeology receptors to low.

99. Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors as discussed in section 19.8.1 during the construction, operation and maintenance, and decommissioning of the Array would result in some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. It is predicted that the impact will affect marine archaeology indirectly. The magnitude of impact is therefore considered to be low.

Sensitivity of the receptor

100. The marine archaeology baseline presented in section 19.7 above indicates that this sub-region of the North Sea has historically been an area with a moderate intensity of maritime activity. The number of known shipwrecks, seabed anomalies in the geophysical data with medium potential, and recorded losses associated with the area indicate some potential for more discoveries to arise. However, the potential and as yet unknown marine archaeology receptors identified in section 19.7.3 are vulnerable sites that can be exposed further by disturbance activities. There is a low potential to encounter human-occupied palaeolandscapes within the marine archaeology study area. There does, however, remain the potential of submerged formerly terrestrial landforms which could provide crucial insights into the timing of glacial retreat and marine transgression in this area of the North Sea. Palaeoenvironmental evidence is so rare that any discoveries are considered important.

101. The marine archaeology study area retains several anomalies of archaeological potential and some identified wrecks, some of which were previously unknown before the site-specific surveys were undertaken. This indicates that there is potential for more discoveries to arise with the site preparation and construction works proposed. Shipwrecks are regarded as being important as they add to our understanding of ship construction, maritime routes, and movements of their period. Shipwrecks are also vulnerable sites that can be exposed by disturbance activities.

102. As there is potential for the discovery of currently unknown archaeological receptors, a precautionary approach is applied here. All marine archaeology receptors are therefore deemed to be of high vulnerability, no recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

103. Overall, the magnitude of the impact is deemed to be low and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary mitigation and residual effect

104. No marine archaeology mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

DIRECT DAMAGE TO MARINE ARCHAEOLOGY RECEPTORS (E.G. WRECKS, DEBRIS, SUBMERGED PREHISTORIC RECEPTORS (PALAEOLANDSCAPES AND ASSOCIATED ARCHAEOLOGICAL RECEPTORS))

105. Direct damage to marine archaeology receptors may arise through the construction, operation and maintenance and decommissioning phases of the Array. Activities that have the potential to directly impact archaeological material include the installation of the mooring and anchoring systems, OSP foundations, inter-array cables, interconnector cables and any installation and maintenance vessel anchoring and jack-up activities associated with these. The MDS for direct damage to marine archaeology receptors is presented in Table 19.10.

All phases

Magnitude of impact

106. The MDS for the construction phase comprises site preparation activities; installation of up to 265 semi-submersible wind turbines with associated mooring and anchoring systems and six OSPs, with associated scour protection; the installation of inter-array, interconnector and associated cable protection; and any associated jack-up vessel and vessel anchoring activities with a total of 45,016,619.62 m^2 of seabed disturbance.

107. For the purposes of this assessment, the impacts of operation and maintenance and decommissioning activities are predicted to be no greater than those for construction As the construction phase represents the maximum design scenario, any assessment of effect for the operation and maintenance and decommissioning phases would be lesser than or equal to the effects arising from the construction phase, as such these phases are presented together.

108. The activities described above have the potential to directly and permanently impact upon marine archaeology receptors and areas of archaeological potential that lie concealed within seabed sediments. These activities also have the potential to expose previously unrecorded marine archaeology receptors.

109. As described in section 19.10, measures adopted as part of the Array account for preservation, by record, of submerged prehistoric archaeology through data acquired from geotechnical surveys. The results of these surveys will be reviewed by the Retained Marine Archaeologist and the findings will be communicated to HES. The implementation and adherence to the PAD for any prehistoric discoveries, requires preservation by record, reducing the magnitude of the impact on submerged prehistoric archaeology to low.

110. AEZs will be established around each archaeological anomaly identified to be of high or medium potential and within which no activities will take place unless agreed by HES. This will reduce the magnitude of the impact on known marine archaeology receptors to 'no change'.

111. Pre-construction site investigation surveys will be reviewed by the Retained Marine Archaeologist to inform the refined layout of infrastructure around any newly identified archaeological constraints. Provision will also be made for the recording of any new discoveries via the PAD. These measures will preserve by record and reduce the magnitude of the impact on as yet unknown marine archaeology receptors to low.

112. In summary, direct damage to marine archaeology receptors would result in the loss of the resource and/or severe damage to key characteristics, features or elements. It is predicted that the impact will affect the receptor directly. Due to the AEZs that will be implemented through the measures adopted as part of the Array (section 19.10), the pathway for direct impact to known archaeological receptors is removed and the establishment of the PAD will provide the necessary measures for the reporting and protection of any as yet unknown archaeological material (including submerged prehistoric archaeology) that may be encountered during the construction, operation and maintenance and decommissioning of the Array. The magnitude is therefore considered to be negligible for known marine archaeology receptors, and low for previously unknown marine archaeology receptors.

Sensitivity of the receptor

113. The marine archaeology study area retains several anomalies of archaeological potential and some identified wrecks, some of which were previously unknown before the site-specific surveys were undertaken. This indicates that there is potential for more discoveries to arise with the site preparation and construction works proposed. Shipwrecks are regarded as being important as they add to our understanding of ship construction, maritime routes, and movements of their period.

114. There is very low potential for submerged prehistoric archaeological material to survive in relation to palaeolandscapes within the marine archaeology study area. However, if any discoveries were made they are so rare and have the potential to enhance the understanding of the prehistory of the North Sea. All marine archaeology receptors are therefore deemed to be of high vulnerability, no recoverability and high value. The sensitivity of the receptor is therefore considered to be high.

Significance of the effect

115. Overall, the magnitude of the impact is deemed to be negligible for known marine archaeology receptors, and low for previously unknown marine archaeology receptors (including submerged prehistoric archaeology), and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the effect will, therefore, be of **minor** adverse significance for both known and previously unknown marine archaeology receptors, which is not significant in EIA terms.

Secondary mitigation and residual effect

116. No marine archaeology mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

DIRECT DAMAGE TO DEEPLY BURIED MARINE ARCHAEOLOGY RECEPTORS – SUBMERGED PREHISTORIC RECEPTORS (E.G. PALAEOLANDSCAPES AND ASSOCIATED ARCHAEOLOGICAL RECEPTORS)

117. The seabed activities associated with the construction phase of the Array have the potential to directly damage palaeolandscapes and associated archaeological material deeply buried within the marine archaeology study area. This impact would only occur during the construction phase of the project, as it is assumed that there is unlikely to be an impact to deeply buried receptors during the operational phase. The direct damage to deeply buried submerged prehistoric receptors is an unavoidable impact that occurs in the construction phase (but is mitigated through the preservation by record of the archaeological resource (see section 19.10.2)). Therefore, direct damage is scoped out for the decommissioning phase.

Construction phase

Magnitude of impact

118. The MDS for the construction phase comprises seabed installation of up to 265 wind turbines with an anchoring system comprising six driven piles per wind turbine that have a seabed penetration depth of up to 40 m. Three large OSPs and twelve small OSPs are also to be constructed on jacket foundations with 12 legs per large foundation, 6 legs per small foundation, to a penetration depth of up to 70 m. These activities have the potential to directly and permanently impact palaeolandscapes locations that might lie deeply buried below the covering seabed sediment.

119. The measures adopted as part of the Array, as described in section 19.10, account for preservation by record of submerged prehistoric archaeology through data acquired from geotechnical surveys. The results of these surveys will be reviewed by the Retained Archaeologist and the findings communicated to HES. Implementation and adherence to the PAD will require preservation by record of any prehistoric or palaeoenvironmental discoveries, reducing the magnitude of the impact on submerged prehistoric archaeology to low.

120. Direct damage to deeply buried marine archaeology receptors would result in some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. It is predicted this would impact the receptors directly. Due to measures which include preservation by record the magnitude is therefore considered to be low.

Sensitivity of the receptor

121. There is very limited potential for submerged prehistoric archaeological material in relation to palaeolandscapes to survive within the marine archaeology study area. However, if any discoveries were made, they are so rare and have the potential to enhance the understanding of the prehistory of the North Sea they would be considered valuable. All marine archaeology receptors are therefore deemed to be of high vulnerability, no recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of the effect

122. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary mitigation and residual effect

123. No marine archaeology mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

ALTERATION OF SEDIMENT TRANSPORT REGIMES

Operation and maintenance phase

124. The presence of infrastructure on the seabed during the operation and maintenance phase of the Array has the potential to alter sediment transport regimes. As a result changes in sediment may indirectly impact archaeological material present in the marine archaeology study area through burial or exposure.

Magnitude of impact

125. The physical processes baseline environment presented in volume 2, chapter 7 of this EIA Report illustrated that due to the smaller-scale footprint of the anchoring structures when compared to fixed-foundation designs, there will only be minimal disruption to sediment transport and sediment transport pathways. OSP jackets are fixed-foundation and by being installed in the water column have the potential to alter sediment transport regimes.

126. Any alteration of sediment transport pathways could impact upon marine archaeology receptors. The implementation and adherence to the WSI and PAD as described in section 19.10, will require that the exposure of any as yet unknown marine archaeology receptors will be properly mitigated and reported. The burial of marine archaeology receptors would have a beneficial impact as this would afford them more protection.

127. AEZs will be established around each archaeological anomaly identified to be of high or medium potential and within which no activities will take place unless agreed by HES.

128. Pre-construction site investigation surveys will be reviewed by the Retained Marine Archaeologist to inform the refined layout of infrastructure around any newly identified archaeological constraints. Provision will also be made for the recording of any new discoveries via the PAD.

129. Alteration of sediment transport regimes would result in some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. It is predicted this would impact the receptors indirectly. Due to measures which include the establishment of the PAD will provide the necessary measures for the reporting and protection of any as yet unknown archaeological material that may be encountered in the course of the Array the magnitude is considered to be negligible.

Sensitivity of the receptor

130. The marine archaeology study area lies in a wider area that retains a number of shipwrecks and the potential for more to be discovered. Shipwrecks are vulnerable sites that can be exposed or buried by significant alteration of the sediment transport regimes.

131. While the potential for palaeolandscapes and associated submerged prehistoric archaeology is extremely low, if and where they do exist, the activities associated with the Array have the potential to directly impact marine archaeology receptors and any material of this nature is so rare that any discoveries would be considered important.

132. Although the potential to discover currently unknown receptors is low, a precautionary approach is applied here. All marine archaeology receptors are therefore deemed to be of high vulnerability, no recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

133. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the effect will, therefore, be of **minor** adverse significance, which is not significant in EIA terms.

Secondary mitigation and residual effect

134. No marine archaeology mitigation is considered necessary because the likely effect in the absence of mitigation is not significant in EIA terms.

19.12. CUMULATIVE EFFECTS ASSESSMENT

19.12.1. METHODOLOGY

135. The CEA assesses the LSE[1] associated with the Array together with other relevant plans, projects and activities. Cumulative effects are defined as the combined effect of the Array in combination with the effects from a number of different projects, on the same receptor or resource. Further details on CEA methodology are provided in volume 1, chapter 6.

136. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see volume 3, appendix 6.4 of the Array EIA Report). Volume 3, appendix 6.4 further provides information regarding how information pertaining to other plans and projects is gained and applied to the assessment. Each project or plan has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon data confidence, impact-receptor pathways and the spatial/temporal scales involved.

137. In undertaking the CEA for the Array, it should be noted that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside the Array. Therefore, a tiered approach has been adopted which provides a framework for placing relative weight upon the potential for each project/plan to be included in the CEA to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach which will be utilised within the Array CEA employs the following tiers:

- tier 1 assessment – Array with Proposed offshore export cable corridor(s) and Proposed onshore transmission infrastructure, and projects which became operational since baseline characterisation, those under construction and those with consent application(s) submitted but not yet determined;
- tier 2 assessment – All plans/projects assessed under Tier 1, plus those projects with a Scoping Report;
- tier 3 assessment – All plans/projects assessed under Tier 2, which are reasonably foreseeable, plus those projects likely to come forward where an Agreement for Lease (AfL) has been granted.

138. The specific projects scoped into the CEA for marine archaeology, are outlined in Table 19.16 and presented in Figure 19.5.

139. The range of potential cumulative effects that are identified and included in Table 19.18, is a subset of those considered for the Array alone assessment. This is because some of the potential impacts identified and assessed for the Array alone are localised and temporary in nature. The impact of direct damage to deeply buried marine archaeology receptors (submerged prehistoric receptors e.g. palaeolandscapes and associated archaeological receptors) has limited or no potential to interact with similar changes associated with other plans or projects. These have therefore not been taken forward for detailed assessment.

140. Similarly, some of the potential impacts considered within the Array alone assessment are specific to a particular phase of development (e.g. construction, operation and maintenance or decommissioning). Where the potential for cumulative effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with the Array during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no plans or projects have been identified that have the potential for cumulative effects during this period.

141. For the purposes of this Array EIA Report, a 2 km screening buffer around the Array was used to identify other plans and projects to be included within the CEA. This buffer is considered appropriate and precautionary as all of the screened-in impacts considered within the CEA will be localised in extent.

Table 19.16: List of Other Projects and Plans Considered within the CEA for Marine Archaeology

Project/Plan	Status [i.e. Application, Consented, Under Construction, Operational]	Distance from Array (km)	Description of Project/Plan	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Array [e.g. Project Construction Phase Overlaps with Array Construction Phase]
Tier 1						
Proposed offshore export cable corridor(s)	Planned	0.00	The Proposed offshore export cable corridor(s) for Ossian	2030 to 2037	2038 to 2072	Considered as part of the Tier 1 assessment alongside the Array. The construction, operation and maintenance phases of the Proposed offshore export cable corridor(s) overlap with those of the Array.
Tier 2						
Offshore Wind Projects and Associated Cables						
No Tier 2 Offshore Wind Projects or Associated Cables identified within the marine archaeology cumulative study area.						
Oil and Gas Activities						
No Oil and Gas Projects identified within the marine archaeology cumulative study area.						
Aggregate Extraction						
No Aggregate Extraction projects identified within the marine archaeology cumulative study area.						
Disposal Sites						
No Disposal Sites identified within the marine archaeology cumulative study area.						
Coastal Protection/Infrastructure						
No Coastal Protection/Infrastructure Projects identified within the marine archaeology cumulative study area.						
Subsea Cables (Telecommunications and Interlinks) and Pipelines						
No Subsea Cables (Telecommunications and Interlinks) and Pipelines Projects identified within the marine archaeology cumulative study area.						
Ministry of Defence sites						
No Ministry of Defence sites identified within the marine archaeology cumulative study area.						
Tier 3						
As above for Tier 2. No Tier 3 projects identified for the marine archaeology cumulative effects study area.						

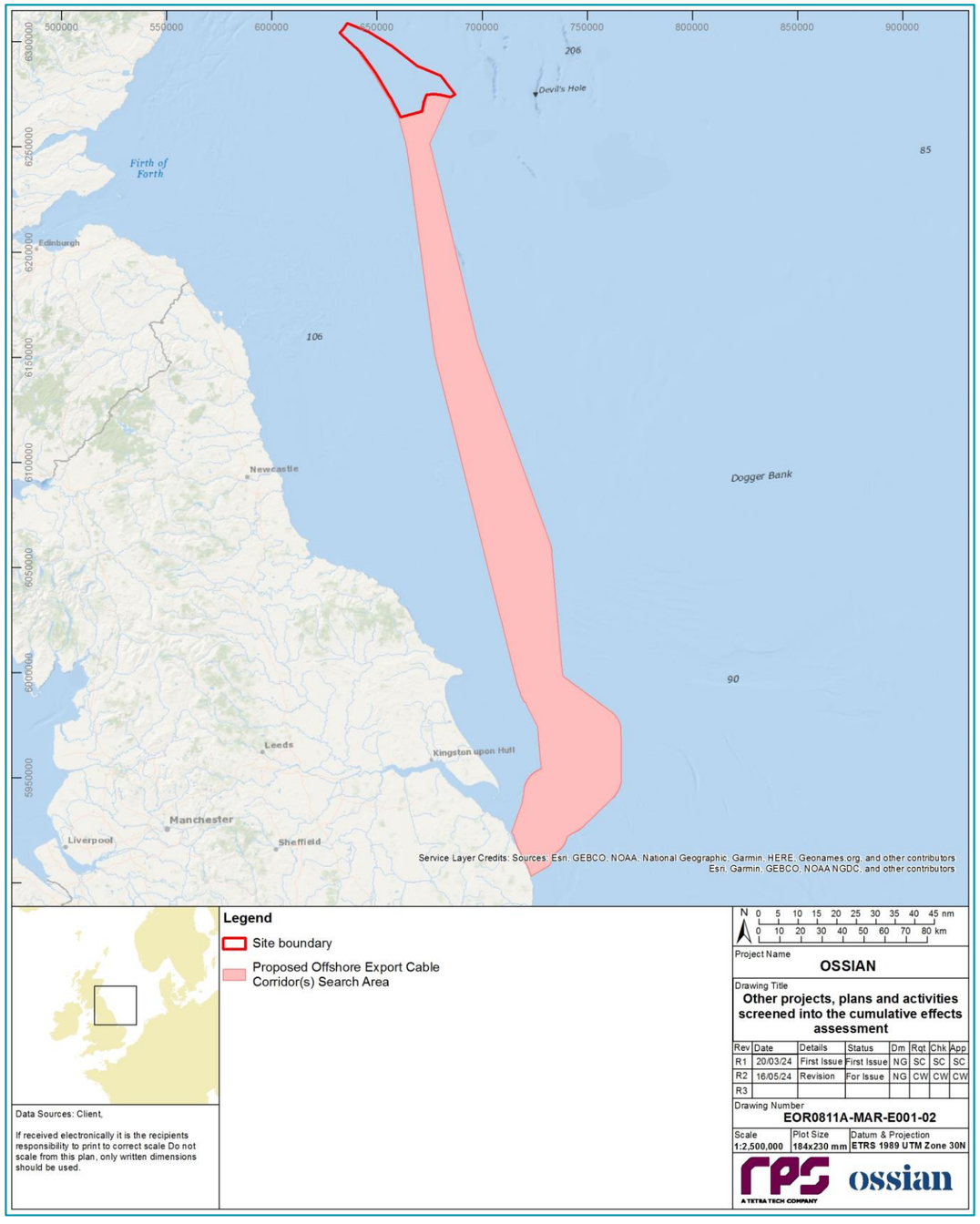

Figure 19.5: Other Projects/Plans Screened into the Cumulative Effects Assessment for Marine Archaeology

19.12.2. MAXIMUM DESIGN SCENARIO

142. The maximum design scenarios identified in Table 19.17 have been selected as those having the potential to result in the greatest impact on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the details provided in volume 1, chapter 3 of the Array EIA Report as well as the information available on other projects and plans (see volume 3, appendix 6.4), to inform a 'maximum design scenario'. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Description (volume 1, chapter 3) (e.g. different wind turbine layout), to that assessed here, be taken forward in the final design scheme.

143. Of the impacts set out in Table 19.10, the following have not been included in the CEA for any phase, as the Proposed offshore export cable corridor(s) does not contain infrastructure that will impact deeply buried deposits:

- direct damage to deeply buried marine archaeology receptors – submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors).

144. Of the impacts set out in Table 19.10, the following have not been included in the CEA for the construction and decommissioning phases due to the fact that it is the presence of infrastructure on the seabed which has the potential to alter sediment transport regimes, so only the phase where this occurs is assessed:

- alteration of sediment transport regimes.

145. This is due to the fact that it is the presence of infrastructure on the seabed which causes the impact, therefore there is no impact-receptor pathway outside of the operations and maintenance phase.

Table 19.17: Maximum Design Scenario Considered for Each Impact as part of the Assessment of Likely Significant Cumulative Effects on Marine Archaeology

Potential Cumulative Effect	Phase[2]			Tier	Maximum Design Scenario
	C	O	D		
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors	✓	✓	✓	1	The MDS is as described above for the Array alone (Table 19.10) and has been assessed cumulatively with the following plans and projects: **Operation and Maintenance Phase** • Proposed offshore export cable corridor(s).
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors))	✓	✓	✓	1	The MDS is as described above for the Array alone (Table 19.10) and has been assessed cumulatively with the following plans and projects: **Construction Phase** • Proposed offshore export cable corridor(s). **Operation and Maintenance Phase** • Proposed offshore export cable corridor(s). **Decommissioning Phase** • Proposed offshore export cable corridor(s).
Alteration of sediment transport regimes	✗	✓	✗	1	The MDS is as described above for the Array alone (Table 19.10) and has been assessed cumulatively with the following plans and projects: **Operation and Maintenance Phase** • Proposed offshore export cable corridor(s).

[2] C = Construction, O = Operation and maintenance, D = Decommissioning

19.12.3. CUMULATIVE EFFECTS ASSESSMENT

146. An assessment of the likely significance of the cumulative effects of the Array upon marine archaeology receptors arising from each identified impact is given below.

SEDIMENT DISTURBANCE AND DEPOSITION LEADING TO INDIRECT IMPACTS ON MARINE ARCHAEOLOGY RECEPTORS (THE EXPOSURE OR BURIAL OF RECEPTORS)

Tier 1

147. The Proposed offshore export cable corridor(s) together with the Array has the potential to produce cumulative effects that may indirectly impact marine archaeology receptors through sediment disturbance and deposition.

All phases

Magnitude of impact

148. The construction phase of the Array is due to occur simultaneously with the construction phase of the Proposed offshore export cable and therefore has the potential to increase sediment disturbance and deposition leading to a cumulative indirect impact on marine archaeology receptors. Construction activities may result in increased suspended sediment concentration, and therefore increased disturbance or deposition of sediment, however these activities would be of limited spatial extent and frequency and are unlikely to interact with sediment plumes from the Array.

149. The operation and maintenance phase of the Array is due to occur simultaneously with the operation and maintenance phase of the Proposed offshore export cable and therefore activities such as cable repair and reburial activities, any associated jack-up vessel and vessel anchoring have the potential to increase sediment disturbance and deposition leading to a cumulative indirect impact on marine archaeology receptors.

150. Measures adopted as part of the Array (section 19.10) include the implementation and adherence to the WSI and PAD, as described in section 19.10, so that any exposure of any as yet unknown marine archaeology receptors will be properly mitigated and reported. A separate, project-specific WSI and PAD would be produced and implemented for the Proposed offshore export cable. The burial of marine archaeology receptors could also occur and would have a beneficial impact as this would afford them more protection. Establishment of AEZs where appropriate and necessary, around new discoveries will protect the archaeological resource.

151. The cumulative effect is predicted to be of local spatial extent, short term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly and result in some measurable change in attributes, quality or vulnerability, minor loss of, or alteration to, one (maybe more) key characteristics, features or elements. The magnitude is therefore considered to be low.

Sensitivity of receptor

152. The sensitivities of marine archaeology receptors are as previously described above for the assessment of the Array alone (see section 19.11).

153. The receptors are deemed to be of high vulnerability, no recoverability and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

154. Overall, the magnitude of the cumulative effect is deemed to be low and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures it is considered that the cumulative effect will, therefore, be of **minor** adverse significance, which not significant in EIA terms.

Further mitigation and residual effect

155. No further marine archaeology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 19.10) is not significant in EIA terms.

DIRECT DAMAGE TO MARINE ARCHAEOLOGY RECEPTORS (E.G. WRECKS, DEBRIS, SUBMERGED PREHISTORIC RECEPTORS (PALAEOLANDSCAPES AND ASSOCIATED ARCHAEOLOGICAL RECEPTORS))

Tier 1

156. The Proposed offshore export cable corridor(s) together with the Array has the potential to produce cumulative effects that may directly impact marine archaeology receptors through direct damage.

All phases

Magnitude of impact

157. The construction phase of the Array is due to overlap with the construction phase of the Proposed offshore export cable corridor(s) and therefore have the potential to result in direct damage to marine archaeology receptors. Construction activities likely to be required for the Proposed offshore export cable corridor(s) include seabed preparation activities such as sand wave and boulder clearance, and cable installation have the potential to damage known and as yet unknown archaeological assets.

158. The operation and maintenance phase of the Array is due to overlap with the operation and maintenance phase of the Proposed offshore export cable corridor(s). Activities such as cable repair and reburial activities, and any associated jack-up vessel and vessel anchoring have the potential to cause direct damage and lead to a cumulative direct impact on marine archaeology receptors.

159. The decommissioning phase of the Array is due to overlap with the decommissioning phase of the Proposed export cable corridor(s) and therefore activities associated with the removal of infrastructure have the potential to interact with the seabed and therefore cause a cumulative direct impact on marine archaeology receptors.

160. Pre-construction site investigation surveys will be reviewed by the Retained Marine Archaeologist to inform the refined layout of infrastructure around any newly identified archaeological constrains. Provision will also be made for the recording of any new discoveries via the WSI and PAD. Establishment of AEZs where appropriate and necessary, around new discoveries will protect the archaeological resource.

161. The cumulative impact is predicted to affect the receptor directly and result in very minor loss or detrimental alteration to one (maybe more) characteristics, composition, or attributes. It is predicted that the impact will affect the receptor indirectly. Through avoidance by the establishment of AEZs and TAEZs, the possibility of direct damage to known marine archaeology receptors is effectively removed. The establishment of the PAD provides the mechanism by which previously unknown archaeological receptors are recorded and protected. The magnitude is therefore, considered to be negligible.

Sensitivity of receptor

162. The sensitivities of marine archaeology receptors are as previously described above for the assessment of the Array alone (see section 19.11).

163. Overall, marine archaeology resource is deemed to be of high vulnerability, no recoverability, and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

164. Overall, the magnitude of the cumulative effect is deemed to be low and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the cumulative effect will, therefore, be of **minor** adverse significance, which not significant in EIA terms.

Further mitigation and residual effect

165. No further marine archaeology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 19.10) is not significant in EIA terms.

ALTERATION OF SEDIMENT TRANSPORT REGIMES

Tier 1

166. The Proposed offshore export cable corridor(s) together with the Array has the potential to produce cumulative effects that may indirectly impact marine archaeology receptors through alteration of sediment transport regimes.

Operation and maintenance phase

Magnitude of impact

167. The operation and maintenance phase of the Array is due to occur during the operation and maintenance phase of the Proposed offshore export cable corridor(s). Presence of infrastructure on the seabed (e.g. cable protection) could influence sediment transport and therefore impact marine archaeology receptors. The burial of marine archaeology receptors would have a beneficial impact as this would afford them more protection. Volume 2, chapter 7 has assessed the magnitude of the Array alone to be low, anticipated to occur only during extreme storm conditions. Low sediment transport rates will ensure any disturbed native materials are redeposited locally after a short period of suspension, thus not impacting significantly on seabed morphology or the overall sediment transport regime. Although physical processes modelling has not been undertaken for the Proposed offshore export cable corridor(s), we can reasonably assume that there will be less infrastructure present on the seabed as a result of this development and therefore less potential for the alteration of sediment transport regimes. Should these two projects work in combination to increase the alterations to sediment transport regimes it is considered that this increase would be minor.

168. Measures adopted as part of the Array (as described in section 19.10) include the implementation and adherence to the WSI and PAD will ensure that any exposure of any as yet unknown marine archaeology receptors will be properly mitigated and reported. A separate, project-specific WSI and PAD would be produced and implemented for the Proposed offshore export cable corridor(s). The burial of marine archaeology receptors could also occur and would have a beneficial impact as this would afford them more protection. Where exposed, establishment of AEZs where appropriate and necessary, around new discoveries will protect the archaeological resource.

169. The cumulative effect is predicted is to be of local spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor indirectly and result in very minor loss or detrimental alteration to one or more characteristics, composition, or attributes. The magnitude is therefore considered to be negligible.

Sensitivity of receptor

170. The sensitivities of marine archaeology receptors are as previously described above for the assessment of the Array alone (see section 19.11).

171. Overall, marine archaeology resource is deemed to be of high vulnerability, no recoverability, and high value. The sensitivity of the receptor is therefore, considered to be high.

Significance of effect

172. Overall, the magnitude of the cumulative effect is deemed to be negligible and the sensitivity of the receptor is considered to be high. Based on professional judgement and implementation of designed in measures, it is considered that the cumulative effect will, therefore, be of **minor** adverse significance, which not significant in EIA terms.

Further mitigation and residual effect

173. No further marine archaeology mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section 19.10) is not significant in EIA terms.

19.13. PROPOSED MONITORING

174. This section outlines the proposed monitoring for marine archaeology. Proposed monitoring measures are outlined in Table 19.18 below.

175. Proposed monitoring relevant to marine archaeology also includes a commitment from The Applicant to contribute to the body of knowledge on the influence of offshore energy development marine archaeology, per Scottish Government policy objectives (Scottish Government, 2020; see Table 19.2).

Table 19.18: Proposed Monitoring and the Method of Implementation for Marine Archaeology

Potential Environmental Effect	Monitoring Commitment	Means of Implementation
Direct or indirect damage to marine archaeology receptors	Commitment to the ongoing monitoring of known archaeological receptors through the archaeological assessment of relevant spatial survey data (acquired by the Applicant for any purpose) where appropriate. This monitoring will include the appropriateness of, and adjustments that need to be made to, AEZs through the lifetime of the Array.	Changes to marine archaeology receptors during the lifetime of offshore wind projects are not well known. Industry guidance (Wessex Archaeology, 2007) suggests that monitoring methods, set out in the WSI, may include periodic reporting on adherence to exclusion zones and the results of watching briefs. Periodic reporting will provide a potential beneficial effect through regional mapping of accessible data and provision of publicly accessible data post-consent (though the nature of which data are to be made public is yet to be determined).

19.14. TRANSBOUNDARY EFFECTS

176. A screening of transboundary impacts has been carried out (see volume 3, appendix 6.6) and has identified that there were no likely significant transboundary effects with regard to marine archaeology from the Array upon the interests of European Economic Area (EEA) states.

19.15. INTER-RELATED EFFECTS (AND ECOSYSTEM ASSESSMENT)

177. A description of the likely inter-related effects arising from the Array on marine archaeology is provided in volume 2, chapter 20 of the Array EIA Report.

178. For marine archaeology, the following potential impacts have been considered within the inter-related assessment:

- sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors; and
- alteration of sediment transport regimes.

179. Direct damage to marine archaeology receptors has not been assessed as part of the inter-related effects assessment as there is no potential for direct damage to accumulate through the lifetime of the project or to interact, spatially and temporally, to create inter-related effects on a receptor.

180. Table 19.19 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance phase, and decommissioning of the Array and also the inter-related effects (receptor-led effects) that are predicted to arise for marine archaeology receptors.

181. Effects on marine archaeology do not have the potential to have secondary effects on other receptors.

Table 19.19: Summary of Likely Significant Inter-Related Effects for Marine Archaeology from Individual Effects Occurring Across the Construction, Operation and Maintenance and Decommissioning Phases of the Array (Array Lifetime Effects) and from Multiple Effects Interacting Across all Phases (Receptor-led Effects)

Description of Impact	Phase[3] C	O	D	Likely Significant Inter-Related Effects
Array Lifetime Effects				
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors	✓	✓	✓	The construction, operation and maintenance, and decommissioning phases of the Array may lead to sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors. The measures adopted as part of the project, described in 19.10, includes an outline WSI and PAD in order to protect any marine archaeology uncovered during the lifetime of the Array. Across the Array lifetime, the effects on marine archaeology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase. Therefore, across the lifetime of the Array, the effects on oil and gas operator receptors are not anticipated to interact in such a way as to result in inter-related effects of greater significance than the assessments presented for each individual phase. As a result, the inter-related effects are of minor adverse significance which is not significant in EIA terms.
Alteration of sediment transport regimes	✗	✓	✗	Across the project lifetime, the effects on marine archaeology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor led effects				
Potential exists for interactions between indirect impacts to marine archaeological receptors. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following: • combined effects of sediment disturbance and deposition and the alteration of sediment transport regimes during the operation and maintenance phase. The combination of sediment disturbance and deposition and alteration of transport regimes has the potential to further expose or bury marine archaeology receptors. The measures adopted as part of the Array will ensure procedures for the investigation, protection and recording of any as yet unknown marine archaeology through the WSI and PAD. It is therefore predicted that any inter-related effect will not be of any greater significance than those impacts already assessed in isolation (i.e. minor adverse). As a result, the receptor-led effects are of minor adverse significance which is not significant in EIA terms.			

[3] C = Construction, O = Operation and maintenance, D = Decommissioning

19.16. SUMMARY OF IMPACTS, MITIGATION, LIKELY SIGNIFICANT EFFECTS AND MONITORING

182. Information on marine archaeology within the marine archaeology study area was collected through a combination of desktop review of available sources and site surveys. This information is presented in Table 19.5 and Table 19.6.

183. Table 19.20 presents a summary of the potential impacts, designed in measures and the conclusion of LSE[1] in EIA terms in respect to marine archaeology. The impacts assessed include:

- sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors);
- direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors);
- direct damage to deeply buried marine archaeology receptors – submerged prehistoric receptors (e.g. palaeolandscapes and associated archaeological receptors); and
- alteration of sediment transport regimes.

184. Overall, it is concluded that there will be no LSE[1] arising from the Array during the construction, operation and maintenance or decommissioning phases.

185. Table 19.21 presents a summary of the potential impacts, designed in measures and the conclusion of likely significant cumulative effects on marine archaeology in EIA terms. The cumulative effects assessed include:

- sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors (the exposure or burial of receptors);
- direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors); and
- alteration of sediment transport regimes.

186. Overall, it is concluded that there will be no likely significant cumulative effects from the Array alongside other projects/plans.

187. No likely significant transboundary effects have been identified in regard to effects of the Array.

188. For marine archaeology, the following potential impacts have been considered within the inter-related assessment:

- sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors; and
- alteration of sediment transport regimes.

189. Overall, it is concluded that effects on marine archaeology do not have the potential to have secondary effects on other receptors,

Table 19.20: Summary of Likely Significant Environmental Effects, Secondary Mitigation and Monitoring

Description of Impact	Phase[4]	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors	Construction	Low	High	Minor adverse	No additional measures proposed.	Minor adverse	N/A
	Operation and maintenance	Low	High	Minor adverse	No additional measures proposed.	Minor adverse	N/A
	Decommissioning	Low	High	Minor adverse	No additional measures proposed.	Minor adverse	N/A
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors))	Construction	Negligible	High	Minor adverse	As above	Minor adverse	Commitment to the ongoing monitoring of known archaeological receptors through the archaeological assessment of relevant spatial survey data (acquired by the Applicant for any purpose) where appropriate. This monitoring will include the appropriateness of, and adjustments that need to be made to, AEZs through the lifetime of the Array.
	Operation and maintenance	Negligible	High	Minor adverse	As above	Minor adverse	
	Decommissioning	Negligible	High	Minor adverse	As above	Minor adverse	
Direct damage to deeply buried marine archaeology receptors – submerged prehistoric receptors (e.g. Palaeolandscapes and associated archaeological receptors)	Construction	Low	High	Minor adverse	As above	Minor adverse	N/A
Alteration of sediment transport regimes	Operation and maintenance	Negligible	High	Minor adverse	As above	Minor adverse	N/A

[4] C = Construction, O = Operation and maintenance, D = Decommissioning

Table 19.21: Summary of Likely Significant Cumulative Environment Effects, Mitigation and Monitoring

Description of Impact	Phase[5]	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Significance of Residual Effect	Proposed Monitoring
Sediment disturbance and deposition leading to indirect impacts on marine archaeology receptors	Operation and maintenance	1	Low	High	Minor adverse	No additional measures proposed.	Minor adverse	N/A
Direct damage to marine archaeology receptors (e.g. wrecks, debris, submerged prehistoric receptors (palaeolandscapes and associated archaeological receptors)	Construction	1	Negligible	High	Minor adverse	As above	Minor adverse	Commitment to the ongoing monitoring of known archaeological receptors through the acquisition of relevant spatial survey data (acquired by the Applicant for any purpose) where appropriate. This monitoring will include the appropriateness of, and adjustments that need to be made to, AEZs through the lifetime of the Array.
	Operation and maintenance		Negligible	High	Minor adverse	As above	Minor adverse	
	Decommissioning		Negligible	High	Minor adverse	As above	Minor adverse	
Alteration of sediment transport regimes	Operation and maintenance	1	Negligible	High	Minor adverse	As above	Negligible	N/A

[5] C = Construction, O = Operation and maintenance, D = Decommissioning

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