The Great Grid Upgrade

Sea Link

# Sea Link

**Volume 9: Examination Submissions**

**Document 9.2**
**Supplementary Stage 1 and Stage 2 Marine Geoarchaeological Assessment**

**Planning Inspectorate Reference: EN020026**

**Version:A**
**May 2025**

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# Contents

# 1. Supplementary Stage 1 and Stage 2 Marine Geoarchaeological Assessment

## 1.1 Introduction

### Project Background

1.1.1 Wessex Archaeology was commissioned by National Grid Electricity Transmission plc, hereafter referred to as National Grid, to undertake a Stage 1 and 2 Marine Geoarchaeological Assessment of 2024 geotechnical data to support the offshore element of the proposed Sea Link project, hereafter referred to as the Proposed Project.

1.1.2 A Marine Archaeological Technical Report outlining the results of the Stage 1 Marine Geoarchaeological Assessment undertaken for geotechnical data acquired by MMT in September 2021 was prepared by Wessex Archaeology and was submitted with the application as Appendix 4.6.A (**Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report**) to the Marine Archaeology chapter of the Environmental Statement (**Application Document 6.2.4.6 Part 4 Marine Chapter 6 Marine Archaeology**).

1.1.3 A total of eight vibrocores were assigned a medium to high archaeological priority during the Stage 1 review, however the vibrocores were not retained for further geoarchaeological recording. It was therefore agreed with Historic England that the locations of these vibrocores would be retargeted during the 2024 geotechnical campaign undertaken by Next Geo to allow for Stage 2 geoarchaeological recording. The results of the Stage 2 recording are therefore presented in this standalone report.

1.1.4 During the 2024 geotechnical survey 11 additional vibrocores (nine planned plus two redrills) were obtained from four additional areas of the Offshore Scheme Boundary, that were not included in the original 2021 geoarchaeological survey.

1.1.5 An archaeological Method Statement was prepared for the retrieval and geoarchaeological assessment of the vibrocores, which was approved by Historic England prior to the survey commencing (**Application Document 7.6 Marine Archaeological Method Statements**).

## 1.2 Scope of Geotechnical Site Investigations

### 2021 Stage 1 Geoarchaeological Review

1.2.1 As part of the original 2021 marine survey, a combined marine geophysical and geotechnical archaeological assessment was undertaken to identify any anomalies (e.g. buried palaeolandscape features and associated deposits) of archaeological potential within the study area (**Figure 1** in Appendix A of this document). The results of the Stage 1 geoarchaeological review are outlined in **Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report** and summarised below.

1.2.2 A total of 69 vibrocores, 53 of which are located within the study area for this assessment, were reviewed during the Stage 1 assessment. From these a sequence of

Quaternary deposits was identified, comprising fluvial gravel, non-marine sands, oxidised shallow marine sands, shallow marine to coastal sediments, fine-grained alluvium and peat, typically capped by seabed sediments. Both organic and minerogenic alluvium, and shallow marine to coastal deposits were considered to have moderate archaeological and geoarchaeological significance, given their potential to contain and preserve organic and inorganic microfossils suitable for palaeoenvironmental assessment. A representative selection of vibrocore samples was recommended for geoarchaeological recording in order to ground-truth interpretations.

1.2.3 A single peat deposit recorded in VC-S6-005 was assigned a high priority status. Peat has a high potential to preserve waterlogged archaeology and material suitable for palaeoenvironmental analysis and radiocarbon dating. The peat sample was recommended for further geoarchaeological recording to determine the suitability of the deposit for palaeoenvironmental assessment.

1.2.4 Following the Stage 1 review, a series of geoarchaeological deposit models were constructed to target medium to high priority deposits. A total of five two-dimensional stratigraphic profiles ('transects') were produced across the study area (**Figure 6.4.4.6.A.7 Transect 1 through to Figure 6.4.4.6.A.11 Transect 5** in **Application Document 6.4.4.6.A Marine Archaeological Technical Report – Figures**). The transects largely targeted submerged palaeolandscape features of possible archaeological potential previously identified through interpreted sub-bottom profiler (SBP) geophysical data.

1.2.5 Despite their perceived significance, the vibrocores were not retained by MMT for archaeological recording purposes. An additional geoarchaeological survey was planned for October 2024, and the opportunity was taken to retarget the eight vibrocores previously assigned a medium or high geoarchaeological priority to allow for Stage 2 geoarchaeological recording.

## 2024 Additional Geotechnical Survey

1.2.6 A further programme of offshore geotechnical investigations (GI) was undertaken to confirm the nature and extent of seabed conditions across four of the five additional isolated survey areas (Areas 2-5) that had not been previously investigated. The additional areas are summarised in Table 1.1 and presented in **Figure 1** in Appendix A of this document.

## Table 1.1 Summary of additional survey areas

| Area name | Approximate area ($km^2$) | Water depth (m) | Centre of area (ETRS89 UTM 31N) | | 2024 GI undertaken |
|---|---|---|---|---|---|
| | | | Easting | Northing | |
| Area 1 – Aldeburgh Nearshore | 0.6 | 0-10 | 405608 | 5779964 | No* |
| Area 2 – East Shipwash | 11.30 | 18-23 | 407019 | 5758097 | Yes |
| Area 3 – North of the Sunk | 5.68 | 10-32 | 411523 | 5747293 | Yes |
| Area 4 – Grid Link Crossing | 1.83 | 12-14 | 399778 | 5693503 | Yes |
| Area 5 – Outer Pegwell Bay | 9.10 | 5-11 | 3955478 | 5686762 | Yes |

* Given the local environment conditions and the shallow water depth at the landfall, no vibrocores were obtained from Area 1.

### Scope of Investigation

1.2.7 The programme of intrusive marine GI works comprised:

- Eight vibrocores to replace previous high and medium priority vibrocores that were not retained for archaeological purposes (VC-S6-005, VC-021, VC-022, VC-046A, VC-050, VC-055A, VC-061 and VC-062A); and
- Nine vibrocores to a depth of 6 metres below sea floor (mbsf) from within four of the five additional survey areas identified as optimal for hazard avoidance (four vibrocores from Survey Area 2, one vibrocore from Survey Area 3, one vibrocore from Survey Area 4 and three vibrocores from Survey Area 5).

1.2.8 All logs arising from the geotechnical investigation are to be reviewed as part of the Stage 1 works outlined in the Geoarchaeological Method Statement (**Application Document 7.6 Marine Archaeological Method Statements**). Stage 2 geoarchaeological recording is to be undertaken on the eight vibrocores targeted for archaeological purposes. Geotechnical logs for the nine additional vibrocores are also to be reviewed to identify deposits of archaeological potential. Any deposits of archaeological potential are to be requested prior to geotechnical testing to allow for Stage 2 recording.

### Scope of Report

1.2.9 To help frame geoarchaeological investigations of this nature, Wessex Archaeology has developed a five-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results. The stages are summarised in Table 1.2.

1.2.10 This document outlines the results of the Stage 1 review of 2024 geotechnical vibrocores acquired from four additional survey areas and the Stage 2 recording of targeted archaeological vibrocores previously identified as containing deposits of high and medium geoarchaeological potential, with proposals made for Stage 3 geoarchaeological works (i.e. palaeoenvironmental assessment) if deemed necessary.

## Table 1.2 Staged approach to geoarchaeological investigations

| Stage | Description |
|---|---|
| Stage 1: Geoarchaeological review | Desk-based review of geotechnical and geological data. Establish likely presence/absence/distribution of archaeologically relevant deposits. Identify deposits or samples for Stage 2 works. |
| Stage 2: Geoarchaeological recording/monitoring | Target deposits or samples identified in Stage 1. Describe the sequences recovered and undertake deposit modelling (if suitable). Interpret depositional environment (if possible). Identify if suitable deposits are present for Stage 3 works. |
| Stage 3: Palaeoenvironmental assessment | Sub-sample deposits of archaeological interest for palaeoenvironmental assessment (e.g. pollen, plant macrofossils, foraminifera, ostracod, and diatoms) and associated scientific dating. Provide an outline interpretation of the archaeological and palaeoenvironmental context. Any proposals for Stage 4 works will depend on the potential for further analysis and the project research objectives. |
| Stage 4: Palaeoenvironmental analysis | Full analysis of samples and additional scientific dating as specified in Stage 3, together with a detailed synthesis of the results, in their local, regional or wider archaeological and palaeoenvironmental context. Publication would usually follow from a Stage 4 report. |
| Stage 5: Publication | Publication of the results of Stage 1-4 works for submission in a peer reviewed journal, book or monograph, depending on the archaeological significance of the work. The scope and location of the final publication will be agreed in consultation with the client and regulatory bodies where appropriate. |

## 1.3 Background

### Introduction

1.3.1 The following section provides an overview of the geoarchaeological and archaeological background for the study area, drawing on relevant information from the surrounding landscape.

1.3.2 Where age estimates are available for deposits these are expressed in millions of years (Ma), thousands of years (Ka) and within the Holocene epoch as either years Before Present (BP), or Before Christ (BC) and Anno Domini (AD). Where radiocarbon dates are included, they are quoted as calibrated (cal.) BC or AD. These dates are supplemented where relevant with the comparable Marine Isotope Stage (MIS) where odd numbers indicate an interglacial period and even numbers a glacial period.

### Geological Baseline and Palaeogeographic Potential

1.3.3 The study area stretches from its northern extent on the east Norfolk coast through the Outer Thames Estuary and into Pegwell Bay, east Kent (**Figure 6.4.4.6.A.1 Marine archaeological study area** in **Application Document 6.4.4.6.A Marine Archaeological Technical Report - Figures**). The Outer Thames Estuary lies within the Cenozoic London Basin which, although traditionally regarded as a distinct sedimentary basin, is likely a southern extension of the North Sea Basin (Emu Ltd, 2009). Stiff sandy silty clay of the London Clay Formation (Eocene; *c*. 56-49 Ma) is present across much of the study area, with chalk bedrock mapped to the south and extending from the east Kent coastline. Bedrock geology across the study area is unconformably overlain by both Pleistocene and Holocene sediments (Cameron, et al., 1992), predominantly comprising clays, silts, sands and gravels with occasional organic-rich deposits (peats), overlain by recent unconsolidated marine shelly sands.

1.3.4 The study area covers a significant expanse of the Outer Thames Estuary, an area associated with the Thames-Medway river system. Major drainage reorganisation during the Anglian glacial period (MIS 12) had a significant impact on the evolution of the Thames-Medway river systems and palaeogeography of the Outer Thames Estuary (Bridgland D. R., 2006). Prior to the Anglian period, the Thames-Medway rivers occupied a more northerly course entering the southern North Sea via the present northern coast of Norfolk (Bridgland & Gibbard, 1997) and the pre-Anglian stratigraphy of the Outer Thames Estuary is represented by Red Crag which are Plio-Pleistocene marine deposits (Stoker, Balson, Long, & Tappin, 2011) that pre-date the earliest known occupation of Britain.

1.3.5 The Pleistocene geological history of the North Sea basin is dominated by repeated glacial/interglacial cycles, resulting in rising and falling sea levels and deposition of terrestrial, marine and glacially derived sediments. The only evidence of ice contact in the study area is associated with the Anglian glaciation (478-424 ka BP or MIS 12). The southern extent of the Anglian glaciation is highly debated, however based on bathymetric data Dix and Sturt (2011) argue for an Anglian glacial origin for over-steepened valleys (tunnel valleys) identified within the Outer Thames Estuary.

1.3.6 The Quaternary stratigraphy in the Outer Thames Estuary is recorded by the British Geological Survey (BGS) as undifferentiated (Stoker, Balson, Long, & Tappin, 2011). However, following the results of the Outer Thames Estuary Regional Environmental Characterisation report, it was suggested that fluvial deposits associated with the submerged Thames-Medway river system were likely to dominate the Pleistocene and early Holocene sequence (Emu Ltd, 2009). Marine and estuarine deposits dating to the Pleistocene have been recovered at Gunfleet Sands Offshore Wind Farm (Heamagi, 2017), located west of the Proposed Project and approximately 6.8 km south of Clacton-on-Sea, however, no palaeoenvironmental assessments have been undertaken on such deposits.

1.3.7 Two distinct channel systems were identified from marine aggregate licence area 528: a northern and southern channel complex separated by high elevated bedrock (Wessex Archaeology, 2021). The channel complex is suggested to form part of the submerged Thames-Medway system postdating the Anglian glaciation (MIS 12). Given that the study area runs through Area 528, an equivalent complex stratigraphy is likely preserved across the Site.

1.3.8 In contrast, Holocene aged alluvium and peats recovered from the London Array OWF and Nemo Link areas, which transect the Proposed Project, were assessed with the earliest sequence dating to 8240-7840 cal. BC (Wessex Archaeology, 2016; Brown & Russell, 2019). The pollen assemblage from this earliest sequence mainly comprised boreal woodland taxa and ostracods reflecting a freshwater environment. A rise in sea level was recorded in later sequences between 6600-5970 cal. BP and 5890-5390 cal. BP with the development of a saltmarsh environment. The peats are of high geoarchaeological potential, preserving a range of palaeoenvironmental remains and material suitable for radiocarbon dating.

1.3.9 Across the Outer Thames Estuary and wider southern North Sea, Pleistocene and early Holocene sediments are capped by post-transgression marine sands. The progressive inundation of the North Sea occurred over an extended time scale, with particularly rapid sea-level rise during the early Holocene (11.5-7 ka), and with fully marine conditions occurring by around 6 ka (Sturt, Garrow, & Bradley, 2013).

## Archaeological Record and Palaeogeographic Potential

1.3.10 The southern North Sea off the east coast of East Anglia is known to contain relatively well preserved palaeolandscape features such as fluvial channels that formed during periods of lower sea level when the southern North Sea was free of ice and sea levels were significantly lower. The remains of these terrestrial landscapes are frequently recovered by dredging and fishing activities in numerous areas around the southern North Sea generally in the form of the remains of extinct megafauna (e.g. woolly mammoths, woolly rhinoceros, bison, horse, lion and hyena).

1.3.11 The discovery of actual human artefacts, such as stone tools and worked bone, and even remains, is a rarer occurrence, but artefacts have been recovered (e.g. Hublin et al. (2009)). Reported finds from offshore activity has, to date, produced a range of early prehistoric lithic artefacts indicating early prehistoric activity in submerged palaeolandscapes from Lower, Middle, and Upper Palaeolithic periods (Tizzard, Bicket, Benjamin, & De Loecker, 2014) with notable collections of more recent Mesolithic artefacts from submerged palaeolandscape contexts (Momber, et al., 2011; Wessex Archaeology, 2013).

1.3.12 The earliest records of Lower Palaeolithic archaeology from northern Europe are associated with terrestrial deposits on margins of the North Sea basin in East Anglia, most notably from Pakefield (Parfitt, et al., 2005) and Happisburgh Site 3 (Parfitt, et al., 2010). Whilst the archaeology at Pakefield was created during a fully interglacial, more Mediterranean climate, at around MIS 17, the remains at Happisburgh Site 3 are older (MIS 21 or MIS 25) and the environmental evidence is indicative of cool conditions at the edge the boreal zone (Candy, Silva, & Lee, 2011) which implies that these early hominins were capable of surviving in northern Europe in periods not associated with fully interglacial environments (Parfitt, et al., 2010). The importance of these sites is international, as they are currently unique at this latitude for this early date (Wessex Archaeology, 2013).

1.3.13 Cohen et al. (2012) highlighted the North Sea basin as a key region for understanding Pleistocene hominins within a northerly, coastal environment. The east of England, particularly East Anglia, but also the southeast of England, are important regions for later Middle Pleistocene, Lower Palaeolithic archaeology (MIS 13-MIS 9). During this timeframe British archaeology reflects repeated episodes of hominin occupation during temperate interglacial and cool conditions, separated by phases of hominin absence during fully glacial periods.

1.3.14 Archaeological evidence is particularly abundant during MIS 13 and MIS 11 (Wymer, 1999; Pettitt & White, 2012) Warmer climatic conditions prevailed during MIS 11, and Britain was again available to be recolonised by hominin communities, after a period of absence during the preceding Anglian glaciation (MIS 12). Lower Palaeolithic archaeological assemblages of this date tend to be characterised by handaxes, although during the earlier part of MIS 11, collections lacking handaxes (termed Clactonian) have been recognised. The foreshore, cliffs and hinterland at Clacton-on Sea (Essex) comprise an important Lower Palaeolithic site which is a designated geological Site of Special Scientific Interest (SSSI). Channel sediments from the area are also an important site for the Lower Palaeolithic Clactonian flint industry and have yielded a rare wooden spear alongside lithic artefacts. This archaeology dates from the Hoxnian interglacial period (MIS 11, c. 423–380 ka) (Bridgland, et al., 1999), and the type site for the Hoxnian (the Hoxne Brick Pit) is located a relatively short distance inland outside of Diss, Suffolk (Ashton, Lewis, Parfitt, Penkman, & Coope, 2008).

1.3.15 During the MIS 10 glaciation there appears to have been a hiatus in hominin activity in Britain (Pettitt & White, 2012). The post MIS 10 occupation Britain is associated with the emergence of the Neanderthals and their associated archaeology and patterns of behaviour. From the later part of MIS 9 the archaeological record attests to the development of Levallois core working strategies. This is also seen to mark the end of the Lower Palaeolithic and the beginning of the Middle Palaeolithic. The Levallois technique comes to dominate the British archaeological record during the early Middle Palaeolithic (late MIS 8 and MIS 7), with handaxe production occurring infrequently (Scott & Ashton, 2011).

1.3.16 The international importance of early Middle Palaeolithic archaeology in the southern North Sea is highlighted by the numerous sites preserved within the Thames river terraces (Scott, Ashton, Lewis, Parfitt, & White, 2011) and, in particular, by the submerged prehistoric Levallois lithic assemblage from marine aggregates licence Area 240 in the palaeo-Yare catchment. Over 120 artefacts have now been recovered from this locale, some of which are identifiable as Levellois, with many recovered from in situ or minimally disturbed contexts (Tizzard, Bicket, Benjamin, & De Loecker, 2014).

1.3.17 The substantial, mixed assemblage of handaxes also recovered from Area 240 may be of older Lower Palaeolithic origin (e.g. >MIS 9), or may date to the Later Middle Palaeolithic when handaxes re-emerge as one of the key components of the archaeological record (late MIS 4-MIS 3) (Boismier, Gamble, & Coward, 2012). Reanalysis of the entire lithic assemblage has demonstrated that at least two assemblages are present: a Levallois dominated Early Middle Palaeolithic assemblage, and a handaxe-dominated Late Middle Palaeolithic assemblage. As well as contrasts in technology, these vary in terms of condition, indicating that more than one site is preserved offshore in this locale (Shaw, Young, & Hawkins, 2023).

1.3.18 Palaeogeographically, Area 240 is one of the most northerly Neanderthal sites in northwest Europe and of primary archaeological importance for defining Middle Palaeolithic potential and the contemporary palaeogeography across the southern North Sea basin (Tizzard, Bicket, Benjamin, & De Loecker, 2014). The site highlights the archaeological potential of preserved Pleistocene fluvial deposits within the southern North Sea.

1.3.19 Within the Outer Thames Estuary, a large Palaeolithic assemblage including over 200 Levallois flakes was recovered from aggregate deposits forming the Clacton to Holland-on-Sea beach replenishing scheme (Bynoe, 2018). These deposits were originally sourced from marine aggregate License Area 447, located in an area where the confluent post-Anglian (<MIS 12) confluent Rivers Thames, Medway and Blackwater would have been located  (Bridgland & d'Olier, 1995; Bridgland D. R., The evolution of the River Medway, SE England, in the context of Quaternary palaeoclimate and the Palaeolithic occupation of NW Europe, 2003; Dix & Sturt, 2011). It is therefore likely that this Middle Palaeolithic assemblage originates from submerged Pleistocene deposits relating to this channel complex.

1.3.20 In contrast with Northern France, evidence of a hominin presence in Britain during the Ipswichian (MIS 5e) or the early Devensian (MIS 5d-a; Lewis et al., 2011) is limited but not unknown (Wenban-Smith, Bates, & Schwenninger, 2010; Wessex Archaeology, 2023; Shaw, Dobbie, Toms, & Wood, In Prep). Within the context of early prehistory and submerged palaeogeography, however, substantial areas of the southern North Sea basin would have been dry land during the warming and cooling limbs of the various sub-stages (MIS 5d to 5a) and archaeological sites of this age are relatively abundant in northern France (Lewis, Ashton, & Jacobi, 2011; Pettitt & White, 2012). Therefore, the potential exists for human activity to have occurred sporadically both within Britain and in any sub-aerially exposed parts of the southern North Sea basin, during the early Devensian.

1.3.21 From late MIS 4 to MIS 3 there is evidence in Britain for Neanderthal recolonization. This late Middle Palaeolithic archaeological record is associated with morphologically and technologically distinctive handaxes (White & Jacobi, 2002). A key site belonging to this period is Lynford Quarry, Norfolk where a palaeochannel containing mammoth remains and associated late Middle Palaeolithic stone tools and debitage have been recovered (Boismier, Gamble, & Coward, 2012).

1.3.22 In the early Upper Palaeolithic, at the end of the Late Pleistocene, Neanderthals were replaced in northern Europe by modern humans who, occupying and moving through what is now the southern North Sea, were present in in Britain from around 34 ka (Jacobi & Higham, 2011a; Bicket & Tizzard, 2015). Archaeological evidence for this period consists of blade point/leaf point assemblages, thought to be associated with the final Neanderthal occupation of Britain, and small number of findspots associated with Evolved Aurignacian and Gravettian lithic artefacts which were produced by modern humans (Jacobi & Higham, 2011a).

1.3.23 During the last glacial period, the study area will have been beyond, yet close to the maximum Devensian ice margin. At the maximum of the last glacial period, the environment within the southern North Sea was relatively poor for human colonisation, with humans absent from Britain during these peak cold conditions. However, there was increasing human exploitation after ~15 ka. Humans at this time were hunting game, such as mammoth and deer, and evidence of these animals has been reported through marine aggregate dredging, and the associated reporting requirements (Bicket & Tizzard, 2015).

1.3.24 The onshore archaeological record of later Upper Palaeolithic activity is marked by Creswellian/Final Magdalenian stone tool assemblages associated with the later Upper Palaeolithic recolonization of Britain (Jacobi & Higham, 2011b), and offshore locations may provide unique and important context for coastal and lowland human activity during this period.

1.3.25 The Mesolithic period began in the early Holocene and at around 10 ka, sea levels were approximately 35 m below current levels (Shennan, Bradley, & Edwards, 2018) sub-aerially exposing large parts of the southern North Sea and English Channel making them suitable for human occupation. Archaeological and palaeoenvironmental material from this period has been reported from North Sea contexts for over a century (Reid, 1913; Godwin & Godwin, 1933) . For example, a Barbed bone harpoon was recovered during trawling in the early 20th century and was later radiocarbon dated to around 12,000 years ago (Housley, 1991).

1.3.26 Between 8 and 5 ka, much of the landscape was inundated by eustatically driven sea-level change, and by 6 ka sea level was only approximately 7 m below the present level (Shennan, Bradley, & Edwards, 2018). Around this time, Britain became an island again (Coles, 1998). Settlements at the time were often transitory and seasonal and therefore leave little trace in the archaeological record. It is possible that the now submerged environment within the Proposed Project was occupied up until the final marine transgression thought to have occurred around 8,000 years ago.

1.3.27 It is clear from numerous research and development-led investigations that postglacial marine transgression has not destroyed Pleistocene and Holocene palaeogeography by default (Wessex Archaeology, 2013). Areas of preserved palaeogeographic features do remain, and detailed reconstructions of paleoenvironments and palaeogeography can be achieved for large parts of the North Sea basin (Tappin, et al., 2011; Limpenny, et al., 2011; Dix & Sturt, 2011).

1.3.28 Considerable attention has been paid to Mesolithic landscapes of the southern North Sea (Gaffney, Thomson, & Fitch, 2007; Tappin, et al., 2011) as the now-submerged palaeolandscapes provide key contextual evidence for recovered artefacts and a background landscape within which to place these human communities. Increasingly, a maritime perspective has developed for understanding the early prehistoric archaeological record, where coasts, estuaries and wetlands are key landscape elements (Ransley, Sturt, Dix, Adams, & Blue, 2013).

## 1.4 Aims and Objectives

### Overarching Aims

1.4.1 The principal aims of this Stage 1 and 2 Marine Geoarchaeological Assessment were to:

- provide information about the geoarchaeological potential of the study area;
- consider the possible significance of any geoarchaeological evidence present, or potentially present in the context of national and regional research priorities and agendas (e.g., the North Sea Prehistory Research and Management Framework (Landward Research Ltd and Wessex Archaeology, 2025); and
- inform possible requirements for further geoarchaeological work (i.e. palaeoenvironmental assessment) that may be required to further characterise and offset any impacts of the development, on the submerged geoarchaeological resource.

### Overarching Objectives

1.4.2 In order to achieve the above aims, the overarching objectives were to:

- review geotechnical vibrocore logs acquired from the 2021 survey and those acquired from the four additional survey areas during the 2024 survey, assigning high, medium and low priority status;
- model the character, extent and depth of deposits across the study area;
- describe the dedicated archaeological vibrocores identified as high and medium priority during the previous Stage 1 review and retargeted for Stage 2 geoarchaeological recording; and
- make proposals for Stage 3 palaeoenvironmental assessment and/or scientific dating, with reference to key research questions and regional or national period specific and maritime research agendas.

### Research Objectives

1.4.3 Selected research questions in the North Sea Prehistory Research and Management Framework (Landward Research Ltd and Wessex Archaeology, 2025) are relevant to the geoarchaeological assessment. In particular, the work has the potential to contribute to the following research questions:

- B. Where was there prehistoric human activity in the region;
- C. What are the chronologies for prehistoric human occupation; and
- E. What was the climatic, landscape and environmental context of prehistoric human activity.

1.4.4 In addition, the work has the potential to contribute to several of the Themes in the Maritime Archaeological Research Agenda for England (Ransley, Sturt, Dix, Adams, & Blue, 2013), particularly those associated with:

- Coastal change during the Palaeolithic and Mesolithic (Themes 1.1 and 2.1); and

- Maritime settlement and marine exploitation during the Palaeolithic and Mesolithic (Themes 1.2 and 2.2).

# 1.5 Methodology

## Coordinate system

1.5.1 All location information and figures are presented as projected coordinates in WGS UTM Zone 31N Eastings and Northings.

1.5.2 The vertical reference level is given as metres below sea floor (mbsf) which assumes the top of the vibrocore is equal to the level of the sea floor. Water depths are given as metres below Lowest Astronomical Tide (LAT). Location data for vibrocores is presented in Appendix C

## Coring Strategy

1.5.3 Including redrills, a total of 20 vibrocores (nine dedicated archaeological vibrocores and an additional 11 geotechnical vibrocores) were acquired during a geotechnical survey undertaken in October 2024. The location of all vibrocores recovered from the study area are presented in **Figures 2a-b** in Appendix A of this document and Appendix C.

### Additional 2024 Geotechnical Vibrocores

1.5.4 Nine additional geotechnical vibrocores were outlined in the proposed scope for the 2024 survey. However, a total of 11 vibrocores were acquired due to the shallow refusal of VC_004 (1.30 mbsf) and VC_005 (2.10 mbsf), which resulted in the redrill of the two vibrocores (VC_004_A and VC_005_A).

1.5.5 Vibrocores were acquired using a high-performance corer across the study area. The target depth of the vibrocores was 6.00 mbsf. The 11 geotechnical vibrocores were acquired in clear liners, split into 1.00 m sections offshore and transported to the laboratory of Next Geo where they were split open lengthways, photographed, and described in detail. Geotechnical logs and vibrocore photographs were provided to Wessex Archaeology for geoarchaeological review.

### Targeted Archaeological Vibrocores

1.5.6 Based on the initial Stage 1 geoarchaeological review undertaken in 2021, eight vibrocores were identified as containing deposits of medium or high archaeological priority and were targeted during the 2024 survey. However, nine vibrocores were acquired, as VC_046A was redrilled (VC_046A_A) due to refusal at 2.60 mbsf.

1.5.7 Furthermore, following changes to the Offshore Scheme Order Limits, the original positions of two vibrocores (748-NAT-VC-021 and 748-NAT-VC-022) were located outside this extent. It was confirmed with National Grid (21 October 2024) that the position of these vibrocores could be moved inside the Order Limits giving the opportunity to characterise the sediments of a channel feature (**75037**) and its northern extent.

1.5.8 The nine dedicated archaeological vibrocores retargeted during the 2024 survey remained unsplit and were delivered to Wessex Archaeology for Stage 2 geoarchaeological recording.

## Stage 1 Review of Geotechnical Data

1.5.9 The 2024 geotechnical survey was principally driven by engineering requirements, although provisions were made to acquire the dedicated archaeological vibrocores previously assigned a medium to high geoarchaeological priority. A Stage 1 review of all 2024 geotechnical vibrocores was therefore undertaken. Interpretations of deposits within the re-acquired archaeological vibrocores were however deemed tentative, given liners remained unsplit with only preliminary geotechnical logs available for review.

1.5.10 The geotechnical vibrocore logs were reviewed by a trained geoarchaeologist to determine their potential for further geoarchaeological works. Deposits recovered were assigned either a high, medium or low priority status based on their perceived geoarchaeological significance, as itemised in Appendix D and shown on **Figures 3a-b** in Appendix A of this document. Vibrocore photographs were provided for all nine additional geotechnical vibrocores. No photographs were necessary for the targeted vibrocores as these were retained for archaeological purposes only.

## Stage 2 Geoarchaeological Recording

1.5.11 Following a Stage 1 review of the additional geotechnical vibrocores, a selection of vibrocore sections identified as containing deposits of medium or high potential were requested for Stage 2 geoarchaeological recording and delivered to Wessex Archaeology.

1.5.12 Stage 2 geoarchaeological recording was undertaken by a suitably trained geoarchaeologist in person at Wessex Archaeology in November 2024. Each vibrocore section was split into two halves, photographed and described under normal UV light conditions following (Hodgson, 1997) and (Wessex Archaeology, 2007), to include information such as:

- Depth;
- Texture;
- Composition;
- Colour;
- Inclusions;
- Structure (bedding etc.); and
- Contacts between deposits (where visible).

1.5.13 Interpretations were made regarding the probable depositional environments and formation processes of the sampled deposits. This data is presented in Appendix E.

1.5.14 When required, sub-samples were taken from the centre of the vibrocore avoiding any material in contact with the vibrocore liner to minimise disturbance. Samples were taken with clean (but not sterile) instruments and care was taken to avoid incorporating material from above or below the sample depth. Samples were double-bagged and clearly labelled with depth and vibrocore ID.

1.5.15 Deposits recovered in vibrocores were interpreted in terms of their geoarchaeological potential. Of greatest geoarchaeological potential are sediments from former terrestrial depositional environments, as well as certain features or inclusions of possible archaeological and palaeoenvironmental interest, specifically:

- Peat layers;
- Deposits containing other organic material such as wood fragments, roots, dark organic staining, etc.;
- Clay or silt deposits, especially those containing laminated features such as lacustrine varves or tidal rhythmites;
- Inorganic fossils such as molluscs;
- Concentrations of charcoal;
- Individual artefacts such as pieces of flint or pottery (though finding these within vibrocore samples is rare); and
- Any other feature thought to indicate a terrestrial depositional environment.

### Deposit Modelling

1.5.16 The results from the Stage 1 review and Stage 2 geoarchaeological recording of dedicated archaeological vibrocores were used to produce an updated deposit model using RockWorks v24, outlining the character, extent and depth of deposits within the study area.

1.5.17 The cross-sections are composed of two-dimensional stratigraphic profiles ('transects') that provide vertical visualisations of the stratigraphic records, along lines drawn through selected vibrocores across the study area. A total of four cross-sections were produced, focusing on areas that show the stratigraphic relationship between deposits and with palaeogeographic features identified in the SBP geophysical data. The location of each cross-section is illustrated alongside the deposit models in **Figures 4-7** in Appendix A of this document.

## 1.6 Results

### Stage 1 Review

1.6.1 The Stage 1 review below comprises a summary of the key Quaternary deposits identified within the additional geotechnical vibrocores and targeted archaeological vibrocores acquired in October 2024.

#### Additional 2024 Geotechnical Vibrocores

1.6.2 A total of 11 additional geotechnical vibrocores, including two redrilled vibrocores (VC_004A_A and VC_005A_A), were acquired from survey areas 2-5. These vibrocores were reviewed as part of the Stage 1 works, with the aim of identifying deposits of geoarchaeological potential. Outline descriptions based on geotechnical logs are presented in Appendix D accompanied by an interpretation of deposits.

1.6.3 The Quaternary lithostratigraphic sequence identified in the additional geotechnical vibrocores comprised:

- Seabed sediments (Recent);
- Non-marine sand (?Pleistocene/Holocene);
- ?Reworked fluvial sands and gravels (?Pleistocene/Holocene);

- Fluvial sands and gravels (?Pleistocene/Holocene); and
- Bedrock (Eocene and Upper Cretaceous).

1.6.4 Stiff dark greyish brown fissured clay was recorded in seven vibrocores (VC_001 to VC_005_A) at depths of between seabed and 6.00 mbsf. Due to the high strength nature and presence of fissures, these units were collectively interpreted as clay bedrock. Overlying the clay in three vibrocores (VC_002, VC_005 and VC_005_A) was sandy gravelly clays, often forming a veneer over bedrock. These deposits were interpreted as representing the upper surface of clay bedrock, reworked by later marine processes, as indicated by the presence of shell fragments. To the south of the study area, structureless chalk was recovered in four vibrocores, the upper surface of which was recorded at depths of between 0.15 mbsf (VC_009_A) and 1.70 mbsf (VC_006).

1.6.5 In a single vibrocore (VC_003), olive brown slightly silty sandy fine to coarse gravel was recorded overlying clay bedrock at a depth of between 1.95 mbsf and 4.95 mbsf. The angularity of this deposit was described as rounded to angular, however this was visually corrected, based on the vibrocore photograph, as subangular to subrounded. Although occasional shell fragments are recorded, the coarse-grained and poorly sorted nature of this deposit suggests deposition occurred in a high-energy fluvial environment.

1.6.6 In three vibrocores to the south of the study area (VC_006, VC_007 and VC_008), sandy gravel with shell fragments was recorded overlying bedrock. The thickness of this unit varies between 0.30 m (VC_008) and 1.20 m (VC_006) and is characteristic of deposition in a high-energy fluvial setting. However, based on the thin nature of these deposits, the depositional history is uncertain. Despite this, these units are tentatively interpreted as possible fluvial sands and gravels.

1.6.7 Slightly clayey gravelly sands becoming sandy gravel with pockets of clay were also identified in VC_001 between seabed and 2.80 mbsf. The clay content is likely an artefact of high-energy conditions eroding the underlying clay bedrock. This combined with the presence of frequent shell fragments suggests that these likely fluvially derived coarse deposits were subsequently reworked by later post-depositional marine processes.

1.6.8 Overlying the fluvial sands and gravels in VC_003 is a thick (1.25 m) deposit of greyish brown stained black clayey silty sand with occasional clay laminae. The fine-grained and laminated structure recorded indicates that deposition occurred in a low-energy rhythmic, possibly fluvial setting. The depositional history of this deposit is unclear based on the lithology alone but has been interpreted as Non-Marine Sand, possibly representing deposition in a low-energy fluvial environment.

1.6.9 In five vibrocores (VC_003, VC_006, VC_007, VC_008 and VC_009_A), Quaternary sequences were capped by shelly gravelly sands which reached a maximum thickness of 0.80 m (VC_007). These deposits are interpreted as representing modern seabed sediments and are considered to be low potential.

### Targeted Archaeological Vibrocores

1.6.10 A total of nine dedicated archaeological vibrocores, including a single re-drilled vibrocore (VC-046A_A), were also reviewed as part of the Stage 1 works. However, as vibrocores were retained for archaeological purposes the geotechnical logs are preliminary. Therefore, interpretations for each deposit in this section are considered tentative. Outline descriptions based on the preliminary geotechnical logs are presented in Appendix D.

1.6.11 In six vibrocores (VC-022A, VC-046A, VC-046A_A, VC-050, VC-061 and VC-S6-005), deposits characterised as light greenish grey slightly silty clay, occasionally with frequent organic matter (VC-S6-005), were recorded at depths of between 0.10 mbsf and 5.63 mbsf. These fine-grained sediments were likely deposited in a low-energy alluvial environment, as indicated in the previous Stage 1 review. However, this is uncertain given geotechnical logs are preliminary logs.

1.6.12 Fine to coarse sands were recorded in five vibrocores between seabed and 5.50 mbsf. This unit stratigraphically overlies and underlies alluvial clay in VC-050 and VC-S6-005, however thicker sequences of finer sands were also recorded in VC-055A and VC-062A. The sands are typically minerogenic, although wood fragments and pockets of organic clay were observed in VC-S6-005 which may suggest a more marginal environment. The depositional history of the sand was unclear given that geotechnical logs are preliminary. Despite this, the variation in grain size and presence/absence of shell suggests that these deposits may be associated with a range of environments, including low-energy fluvial, estuarine, intertidal to coastal or shallow marine. As such, these deposits were collectively defined as ‘alluvial sand’.

1.6.13 Two units of yellow-brown gravelly medium to coarse sands were recorded in a single vibrocore (VC-021A); between 1.20-1.50 mbsf and 2.10-4.60 mbsf. These gravelly sands are interbedded with a thin (0.60 m) unit of greyish brown silty fine sand, tentatively interpreted as alluvial sand. The clast lithology was described as fine to coarse subangular to subrounded gravel and was characteristic of high-energy fluvial deposition. The gravelly sands in VC-021A were therefore interpreted as fluvial sands and gravels.

## Stage 2 Geoarchaeological Recording

### Introduction

1.6.14 Stage 2 geoarchaeological recording was undertaken on dedicated archaeological vibrocores that were identified as medium to high priority during the previous Stage 1 geoarchaeological review. The selected vibrocores were not initially retained for archaeological purposes (i.e. were retained as bulk sample unsuitable for geoarchaeological recording). As such, the vibrocores geoarchaeologically recorded by Wessex Archaeology are those retaken during the October 2024 survey.

### Fluvial Sands and Gravels

1.6.15 A sequence of deposits interpreted as oxidised shallow marine sands overlain by a thin unit of fine-grained organic alluvium was initially identified in VC-021 during the previous Stage 1 review and subsequently recommended for geoarchaeological recording.

1.6.16 In VC-021A however, a sequence of sandy gravel and gravelly sand was recorded overlying clay bedrock between 1.15 mbsf and 4.57 mbsf. The lithology of the gravel was described as fine to coarse angular to subrounded flint and quartz in a medium to coarse sand matrix. The sands and gravels also observed a weak sub-horizontal structure indicating a degree of sorting characteristic of deposition in a fluvial environment, as opposed to a high-energy marine setting where associated deposits are often unstructured.

### Non-Marine Sand

1.6.17 Two vibrocores (VC-021A and VC-061) contained units of sand absent of shell and were interpreted as Non-Marine Sand.

1.6.18 In VC-021A, fine to medium sands with occasional flint gravel were stratigraphically located between coarse fluvial sands and gravels between 1.45 mbsf and 2.25 mbsf. These sediments were interpreted as Non-Marine Sand, however given their stratigraphic position and absence of shell, likely represent alluvial sands, or a braidplain feature (e.g. bars), associated with the overlying and underlying fluvial sands and gravels.

1.6.19 During the previous Stage 1 review, a lower unit of silty sand was identified underlying alluvium in VC-061. This was visually corroborated during Stage 2 recording, during which silty fine to coarse sands with rare subangular gravel clasts grading upwards into sandy silts were identified between 3.28 mbsf and 4.10 mbsf. Based on the presence of coarse sand with rare gravel, it is possible this deposit represents alluvial sands associated with a low-energy fluvial or floodplain environment.

### Minerogenic and Organic Alluvium

1.6.20 Vibrocores VC-S6-005, VC-022A, VC-046A, VC-046A_A, VC-050, VC-055A and VC-061 were assigned a medium priority status during the previous Stage 1 review as they comprised deposits interpreted as either minerogenic or organic alluvium.

1.6.21 VC-S6-005 recovered a thick sequence of interbedded sands, silts and clays with occasional to frequent laminae. The organic content varied in this sequence with minerogenic sandy clays also containing few thin organic laminae. The organic units were typically amorphous, however the organic unit between 3.55 mbsf and 3.60 mbsf comprised fibrous plant material. This unit stratigraphically underlies peat and likely represents the initial development of vegetation within a low-energy waterlogged environment. The interbedded nature of this sequence coupled with the presence of organics suggests deposition within a relatively stable environment and likely represent channel fill deposits.

1.6.22 In VC-022A, laminated silty clay with common whole shells was recorded between 1.20 mbsf and 5.65 mbsf. Shell species including tellin mussels indicative of estuarine conditions were recorded. Although minerogenic, laminae containing detrital organics locally reworked into the sequence were observed between 1.98 mbsf and 5.25 mbsf. The blue-grey colouration indicative of anaerobic conditions, coupled with the presence of laminae and shells, suggests deposition occurred in an estuarine setting. This sequence was also overlain by shallow marine to coastal sands, suggesting increasing marine influence, likely in response to rising sea levels.

1.6.23 VC-046A comprises black becoming grey clayey silt beneath modern seabed sediments between 0.17 mbsf and 2.60 mbsf. Faint laminations were observed throughout, and very occasional organic material (possible rooting) was recorded to 1.48 mbsf. Fragmented and whole shells were also recorded and coupled with the presence of fibrous material may suggest deposition in either a marginal intertidal or fluvial setting. Evidence of desiccation indicative of repeated dehydration was also exhibited and may represent episodic exposure.

1.6.24 In VC-050, fine-grained minerogenic alluvium was recorded stratigraphically overlying and underlying shallow marine to coastal sands between 2.85 mbsf and 4.14 mbsf. These deposits were characterised by faintly laminated sandy silt which fined upwards to soft shelly clay with possible organics (i.e. rooting). This sequence demonstrates a transition from a marginal marine-influenced setting to low-energy deposition, likely within an estuarine environment.

1.6.25 In VC-055A, a thin unit of very soft blackish grey slightly organic slightly sandy clay was recorded as stratigraphically overlying a sequence of shallow marine to coastal sands between 0.19 mbsf and 0.40 mbsf. Occasional partings of fine sand which thickened with depth were also recorded indicating a variable rhythmic energy regime. This thin deposit was interpreted to represent deposition in either an estuarine or fluvial setting.

1.6.26 VC-061 recorded sandy and clayey silt between 2.82 mbsf and 4.10 mbsf, with soft silty clay observed below seabed sediments from 0.25 mbsf to 2.82 mbsf. This demonstrated a fining upwards sequence, suggesting increasingly stable conditions in a semi-terrestrial environment. The clay deposits also comprised frequent laminations, which suggests that deposition occurred within a low-energy waterlain (estuarine or intertidal) environment.

### Peat

1.6.27 A single vibrocore (VC-S6-005) contained peat with high archaeological and geoarchaeological potential. This peat was identified during the previous Stage 1 geoarchaeological review and targeted during the 2024 survey for archaeological purposes.

1.6.28 In VC-S6-005, peat was recorded between 3.12 mbsf and 3.55 mbsf and was characterised as brown-black pseudo-fibrous to fibrous peat with wood fragments, detrital leaves and seeds. The latter demonstrates a high preservation potential of organic material suitable for palaeoenvironmental assessment and scientific dating.

### Shallow Marine to Coastal

1.6.29 Six vibrocores (VC-S6-005, VC-021A, VC-022A, VC-050, VC-055A and VC-062A) were assigned medium priority status as they comprised of deposits interpreted as shallow marine to coastal sands.

1.6.30 In VC-S6-005, laminated slightly organic sands with occasional plant material and shell fragments were recorded stratigraphically underlying organic alluvium between 3.60 mbsf and 4.95 mbsf. The presence of wood fragments and detrital plant matter suggests that deposition may have occurred on the periphery of a marginal setting, likely in an intertidal tidally-influenced environment. Slightly organic and clayey sandy gravel was recorded overlying peat between 3.00 mbsf and 3.12 mbsf. This unit contained common whole and fragmented shell and coupled with the coarse lithology, suggests high-energy deposition (or possibly a storm event) in a shallow marine to coastal setting.

1.6.31 In VC-021A, silty fine sands with rare angular to subrounded flint gravel and shell fragments were recorded overlying a sequence of fluvial sands and gravels between 0.75 mbsf and 1.00 mbsf. This deposit is typically characteristic of sediments laid down in a shallow marine environment but may also represent deposition in a coastal setting.

1.6.32 Slightly gravelly fine to coarse sands with frequent whole and fragmented shells were recorded below seabed sediments between 0.23 mbsf and 2.85 mbsf in VC-050A. Intertidal species including common periwinkle and baltic tellin were both observed along with frequent beds of shell, indicative of deposition in a rhythmic high-energy marine-influenced environment. A sequence of alluvium was recorded between 2.85 mbsf and 4.14 mbsf in this vibrocore, however a unit of fine to medium sand was recorded underlying these silts and clays between 4.14 mbsf and 5.50 mbsf. The depositional history of this deposit is unclear, however was tentatively interpreted as shallow marine to coastal given the presence of shell.

1.6.33 In VC-055, very fine to medium sands with flaser bedding and sub-horizontal lenses of brownish grey sandy clay were recorded between 1.00 mbsf and 4.60 mbsf. No shells were observed in these deposits which may suggest deposition in a terrestrial landscape. However, flaser bedding is typically associated with sediments laid down in intertidal or coastal settings and as such, was interpreted as shallow marine to coastal sands.

1.6.34 In VC-062, a thick sequence of deposits previously suggested to represent non-marine sands were reinterpreted based on the Stage 2 recording as shallow marine to coastal sediments. The lowermost sequence between 4.26 mbsf and 5.00 mbsf comprised very shelly slightly clayey sand with frequent whole bivalves and gastropods. The inclusion of clay and frequency of whole shells is indicative of a high-energy and erosive wave-dominated setting. The shell content decreased upwards with well-sorted fine sands with frequent rippled laminations between 2.25 mbsf and 3.08 mbsf indicating a transition to a low-energy tidally-influenced setting. The presence of wood fragments in this deposit also suggests deposition occurred in proximity to a marginal environment. In the upper sequence between 0.44 mbsf and 2.25 mbsf, well-sorted sands with whole bivalves and tusk shells were recorded, the latter of which are indicative of shallow marine conditions and represent the gradual inundation of the landscape in response to rising sea levels.

## Deposit Modelling

1.6.35 To ensure the delivery of archaeological objectives of the original MMT survey, a series of geoarchaeological deposit models were constructed for the study area (discussed further in the Marine Archaeological Technical Report, **Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report**). The initial deposit models were included in the previous Stage 1 review following recommendations from Historic England to include features of archaeological potential identified in the geophysical SBP data The deposit models have been updated in this document to include the additional 2024 geotechnical and dedicated archaeological vibrocores, as illustrated in **Figure 6.4.4.6.A.7 Transect 1**, **Figure 6.4.4.6.A.8 Transect 2**, **Figure 6.4.4.6.A.9 Transect 3**, **Figure 6.4.4.6.A.10 Transect 4** and **Figure 6.4.4.6.A.11 Transect 5,** in **Application Document 6.4.4.6.A Marine Archaeological Technical Report - Figures.**

1.6.36 The southern-most transect presented in the previous Stage 1 review (**Figure 6.4.4.6.A.11 Transect 5** in **Application Document 6.4.4.6.A Marine Archaeological Technical Report - Figures**) was not updated as no new geotechnical data was made available for this area.

1.6.37 Transect 1 (**Figure 4** in Appendix A of this document) comprises 10 vibrocores and crosses a series of palaeolandscape features including a complex channel system. Vibrocores within this palaeochannel are shown to contain thick sequences of minerogenic and organic alluvium, with peat representing waterlogged conditions in VC-S6-005. The vertical extent of the channel is unknown; however, the margin of the channel is illustrated in VC-009, with oxidised shallow marine sands overlying bedrock at *c*. -27.50 m LAT. To the north of the channel, two areas of acoustic blanking are associated with two isolated vibrocores (VC-005 and VC-007), both of which contain organic and minerogenic alluvium, respectively. The relationship of the vibrocores to the complex channel is unclear but could represent floodplain or overbank deposits.

1.6.38 Transect 2 (**Figure 5** in Appendix A of this document) comprises 16 vibrocores and traverses three distinct submerged features, including two isolated channels. Interpreted SBP data also shows acoustic blanking overlapping to the south of channel feature **75015**. Vibrocore VC-022A is mapped within the acoustic blanking and contains a thick (3.27 m) sequence of laminated silty clay with detrital plant material which may represent the channel floodplain. Coarse fluvial sands and gravels are interbedded and overlain by non-marine sands, which most likely represent low-energy alluvial sands, in VC-021A and VC_003. The base of this channel is recorded between -29.05 m LAT (VC-021A) and -29.48 m LAT (VC_003) where fluvial sands and gravels directly overly London Clay. The deposits in VC_001 are not associated with any mapped features and although interpreted as possible reworked fluvial sands and gravels, may reflect a sand bank feature overlying outcrops of London Clay.

1.6.39 Transect 3 (**Figure 6** in Appendix A of this document) comprises nine vibrocores predominantly containing London Clay bedrock overlain by a veneer of seabed sediments. Three vibrocores however contain superficial sediments. To the northeast, a single vibrocore located within a channel feature (**75020**) records fluvial sands and gravels to a maximum depth of -41.82 m LAT. The lateral extent of the channel is unclear with bedrock subcrops recorded in adjacent vibrocores VC-039 and VC-041. To the southwest, clay bedrock is overlain by oxidised shallow marine sediments in VC-043. This vibrocore is located within a complex cut and fill feature (**75023**) which could represent a remnant fluvial feature, although this is unclear based on the available geotechnical data. A simple cut and feature was located to the southwest, within which minerogenic alluvium was recorded (VC-046A) and may reflect infilling of an isolated depression within an exposed landscape.

1.6.40 Transect 4 (**Figure 7** in Appendix A of this document) comprises 18 vibrocores which largely contain shallow marine to coastal sediments. The transects covers an extensive area (*c*. 28 km) where a series of palaeolandscape features, including a complex channel and isolated channels, have been identified. Thin units of alluvium are recorded to the north (VC-050 and VC-055A) and represent episodes of stability, or possibly increasing estuarine conditions, in a shallow marine to coastal environment. To the south in VC-062A, minerogenic alluvium overlies non-marine sands which likely represent low-energy fluvial channel fill associated with feature **75032**.

## 1.7 Discussion

### Introduction

1.7.1 The results from the Stage 2 recording of additional 2024 geotechnical and dedicated archaeological vibrocores are consistent with the expected stratigraphy in the study area (Table 1.3; Appendix E). These deposits collectively comprise a sequence of Plio-Pleistocene oxidised shallow marine sands correlated to the Red Crag Formation, overlain by Pleistocene to Early Holocene sediments, including Fluvial Sands and Gravels (Unit 3a), Non-Marine Sand (Unit 3b), Shallow Marine to Coastal Sand, Alluvium (minerogenic and organic) and Peat (Unit 3d). These Quaternary deposits are collectively capped by modern seabed sediments, which often form a veneer over superficial deposits. The stratigraphy of deposits recovered in the study area has been summarised in Table 1.3.

1.7.2 The oldest Quaternary deposits recovered in the study area are Oxidised Shallow Marine Sands correlated to the Red Crag Formation. These deposits are late Pliocene to early Pleistocene in age with low archaeological potential and as such, will not be discussed below.

## Table 1.3 Shallow stratigraphy within the study area

| WA Unit | Lithofacies | Sediment Description | Geophysical Characteristics | Formation | Epoch |
|---|---|---|---|---|---|
| Unit 4 | Seabed sediment | Silty gravelly sand with shell fragments | Observed as a thin veneer to large sand waves and sand banks across the study area. Boundary between surficial sediments and underlying units not always discernible | Seabed sediment | Modern/Late Holocene |
| Unit 3d | Alluvium and Peat | Soft dark brown organic silt and clay with organic material and occasional shell fragments (fine-grained organic)<br>Soft brown silt and clay with thin beds or laminae of silty sand (fine-grained minerogenic)<br>Dark brown peat with fibrous material | Pleistocene and Holocene sediments. Distinct channel and cut and fill features, with fills characterised by parallel internal reflectors, sometimes acoustically unstructured and chaotic. | n/a | Early Holocene/ Pleistocene |
| Unit 3c | Shallow marine to coastal | Silty sand with beds and/or thick laminae of occasionally organic silty clay /silty sand | | n/a | |

| WA Unit | Lithofacies | Sediment Description | Geophysical Characteristics | Formation | Epoch |
|---|---|---|---|---|---|
| | | with shell fragments | | | |
| Unit 3b | Non-marine sand | Silty sand with no shell and occasional pockets and laminae of sand and clay | | n/a | |
| Unit 3a | Fluvial sands and gravels | Silty sandy gravel and gravelly sand with shell fragments | | n/a | |
| Unit 2 | Oxidised shallow marine sand | Orange silty sand with many shell fragments | Acoustically unstructured and sometimes stratified | Red Crag Formation | Plio-Pleistocene |
| Unit 1b | Pre-Quaternary Bedrock | Firm to stiff gravelly sandy silty clay with shell | Sub-parallel internal reflectors | London Clay Formation | Eocene |
| Unit 1a | Pre-Quaternary Bedrock | Intact structureless chalk or reworked silt and sand with chalk gravel and shell fragments | Acoustically unstructured and sometimes stratified close to the surface | Chalk | Upper Cretaceous |

## Fluvial Sands and Gravels

1.7.3 To the north of the study area offshore from Harwich, sub-horizontally bedded coarse-grained sands and gravels were recovered in two vibrocores (VC-021A and VC_003). These deposits are characteristic of high-energy deposition within a braided river system, with occasional interbedded units of sand representing possible sand banks or bars. In VC_003, upper sands overlie sandy gravels and may reflect a transition to a period of infilling of hollows and cut-off channels, with a river that is shifting towards anastomising channel patterns with relatively stable channels.

1.7.4 The age of these sand and gravel deposits is unclear; however, they were likely deposited in the Pleistocene during a period of reduced sea level, resulting in the partial or complete exposure of the study area. Vibrocores VC-021A and VC_003 are located within an area mapped (based on interpreted SBP and bathymetric data) as the offshore extension of the palaeo-Gipping-Orwell and Stour channel system, suggested to pre-date the Anglian glaciation (MIS 12) based on morphostratigraphic evidence (Emu Ltd, 2009). These deposits therefore present an opportunity to further refine the chronostratigraphic framework for this extensive channel system. Determining the age of these sediments is also crucial to understanding their relationship with fluvial deposits recovered in Area 447, located *c*. 20 km southwest of the VC-021A and VC_003, which have produced internationally significant Early Middle Palaeolithic stone tools (Bynoe, Grant, & Dix, 2022) dating to late MIS 7/early MIS 6.

## Non-Marine Sand

1.7.5 The formation history and age of the Non-Marine Sand is unresolved, however it is suggested that these sediments likely formed in a sub-aerially exposed landscape. Non-Marine Sand was identified in three 2024 vibrocores, including two archaeological vibrocores (VC-021A and VC_061) targeted based on the location of palaeolandscape features interpreted through SBP geophysical data, and a single geotechnical vibrocore (VC_003).

1.7.6 Based on lithostratigraphy, the Non-Marine Sand in both VC_003 and VC-021A were interpreted as alluvial sands reflecting low-energy deposition within a braidplain channel. The depositional history of the Non-Marine Sand associated with the overlying and underlying fluvial sand and gravel is uncertain based on the geotechnical vibrocores alone, however regional context suggests these deposits may reflect floodplain sediments associated with the offshore continuation of the palaeo Gipping-Orwell and Stour channel system, identified by Dix and Sturt (2011) through high-resolution SBP and bathymetric datasets acquired from the Thames region. This is further reinforced by the identification of channel features **75014** and **75015**, within which VC_003 and VC-021A are located. Chronological evidence from the Gipping-Orwell and Stour palaeovalley is limited, however a sequence of sands and gravels recovered local to VC_003 and VC-021A has produced an OSL age of 163 ± 49 ka dating to the late Saalian Glaciation (MIS 6c; (Dix & Sturt, 2011).

1.7.7 In VC-061, Non-Marine Sand characterised by gravelly silty sand fining upwards to sandy silt was recovered. The normal grading observed in this deposit suggests a change in energy regime likely within a low-energy fluvial environment. This is reinforced by the location of VC-061, which was recovered from a channel feature (**75032**) situated adjacent to a more extensive channel complex (**75029**-**75031**). No structure was recorded in this unit, although the overlying clayey silt may indicate the progressive inundation of the landscape with a transition to the development of tidal channels. However, this is unclear in the absence of palaeoenvironmental evidence. The depositional age of this deposit is also uncertain, although is located in an area associated with the Thames-Medway system, which post-dates the Anglian glaciation and constrains these deposits to between MIS 12 and MIS 1 (Emu Ltd, 2009).

## Alluvium and Peat

1.7.8 Soft interbedded sands and clays, silty clay, clayey silt and slightly sandy clay were recovered in seven of the dedicated archaeological vibrocores (VC-S6-005, VC-022A, VC-046A, VC-046A_A, VC-050, VC-055A and VC-061). Alluvium was also identified in an additional eight vibrocores during the Stage 1 review (**Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report**). These alluvial deposits are typically minerogenic, although occasionally contain thin units of organic alluvium. Thick sequences of organic silts and clays were also recorded. Alluvium is collectively assigned a medium archaeological potential.

1.7.9 At the northern extent of the study area, four vibrocores are located within two palaeochannel features, including **75006** (VC-S6-003 and VC-S6-005) and **75005** (VC-008A and VC-009). Although mapped as distinct features based on interpreted seismic data, it is likely these features form part of the same channel system. The depositional history of these palaeochannels is uncertain in the absence of secure chronological information, however the upper channel fill illustrated in the vibrocores is suggestive of lower-energy estuarine conditions and may reflect the progressive inundation of fluvial systems in the early Holocene observed across the southern North Sea (Wessex Archaeology, 2022) (Eaton, Barlow, Hodgson, Mellett, & Emery, 2024) . The alluvium is also lithologically similar to the channel fill sediments representing the offshore extension of the palaeo-Alde and Hundred river system to the east of Aldeburgh (Coastal and Offshore Archaeological Research Services, 2024). Based on both interpreted geotechnical and seismic data, these fine-grained alluvial sediments overlie possible Pleistocene age fluvial sands and gravels, however no such deposits were recovered in the vibrocores.

1.7.10 In VC-S6-005, shallow marine to coastal sand is overlain by a thin unit of peat, which is followed by a veneer of clayey sandy gravels. This lower sequence is unique as it demonstrates a local change in land-ocean interaction, with a return to a semi-terrestrial environment with enhanced peat development. This change in environment does not necessarily imply sea-level fall as it can relate to changing coastal configuration or increased sediment supply (Bicket, Mellett, Tizzard, & Waddington, 2017). The peat is overlain by a veneer of clayey sandy gravel reflecting high-energy conditions likely in response to increasing marine influence. The upper channel fill is represented by interbedded sands, silts and clays which are predominantly organic in nature and suggests possibly channel reactivation likely in response to relative sea-level rise. These organic sediments are in turn replaced by minerogenic alluvium with increasingly estuarine conditions. Such local changes in palaeogeography are likely amplified in the southern North Sea due to an extensive array of palaeochannels dissecting the landscape, as reinforced in the SBP data for the study area.

1.7.11 The peat in VC-S6-005 is characterised as pseudo-fibrous to fibrous with fragments of wood, and detrital leaves and seeds suggesting deposition within a semi-terrestrial environment, with development likely during the Holocene prior to final marine transgression. The age of the peat is uncertain, although organic deposits acquired from the London Array offshore windfarm and the Nemo Link UK-Belgium Electrical Interconnector in the Outer Thames Estuary returned dates of between 8915 ± 30 BP (8240–7960 cal. BC) and 8855 ± 35 BP (8210–7840 cal. BC) (VC7) and 7680 ± 35 cal BP and 7532 ± 26 cal BP (VC606) (Wessex Archaeology, 2016), indicating development of a semi-terrestrial environment between the early and late Mesolithic. To the south of Sizewell, relatively shallow palaeochannels (<2 m in depth) were identified offshore during an archaeological evaluation for Greater Gabbard Offshore Wind Farm (Atfield, 2008). Basal peats were identified within these channels during the investigation, however their relationship with the peat in VC-S6-005 is unclear given the absence of elevation data and palaeoenvironmental evidence.

1.7.12 Peat deposits have the highest potential for preserving material for radiocarbon dating, along with a range of palaeoenvironmental remains (e.g. pollen and plant macrofossils) suitable for reconstructing past landscape and environmental change and investigating evidence for human activity and migration patterns into Britain after the Last Glacial Maximum.

1.7.13 In VC-022A, a thick (3.27 m) sequence of laminated silty clay was recorded stratigraphically underlying very shelly gravelly sands interpreted as representing deposition in a shallow marine to coastal environment. The vibrocore is located on the margin of channel feature **75015** where acoustic blanking (feature **75016**) possibly representing the preservation of organic horizons was identified in the SBP data. The alluvial sequence may reflect a floodplain or bank feature associated with this palaeochannel, however the relationship is unclear in the absence of both chronological and palaeoenvironmental evidence. Based on geographic location, this alluvial sequence may represent fill of the palaeo Gipping-Orwell and Stour, laid down during periods of exposure during the Pleistocene and early Holocene (Dix & Sturt, 2011).

1.7.14 To the south of the study area, an extensive channel complex system (features **75029-75031**) has been identified through interpreted SBP data. The channel fill is largely characterised as shallow marine to coastal sands which are occasionally overlain by thin units of alluvium. The depositional history of the alluvium is unclear, although likely also represents deposition in an early Holocene transgressive landscape. This extensive channel complex likely represents the palaeo Thames-Medway system, which post-dates the Anglian with associated deposits therefore dating to between MIS 12-1 (Emu Ltd, 2009).

### Shallow Marine to Coastal

1.7.15 In 16 vibrocores silty, often laminated sands were recovered which can be differentiated from non-marine sand due to presence of shell fragments. Stratigraphically, these sands can be located above and below alluvium and are interpreted as representing shallow marine to coastal sands.

1.7.16 Under the influence of rising sea levels during the early Holocene, the Outer Thames Estuary and wider southern North Sea flooded with transgressive, marginal marine environments with migrating coastlines forming. The deposits associated with these environments vary between high-energy wave-impacted sands and gravels to laminated sands laid down in rhythmic shallow water, likely intertidal, settings. The shallow marine component of this unit is considered to have low archaeological potential, however coastlines, estuaries and wetlands are considered as key landscape elements in the submerged prehistoric record (Ransley, Sturt, Dix, Adams, & Blue, 2013) and are assigned a medium archaeological priority.

1.7.17 Organic fragments including plant debris and wood were observed in shallow marine to coastal sands identified in VC-062A and VC-S6-005. These organics are detrital in nature although suggests that a more marginal environment which has allowed vegetation to establish is present locally. Although such environments may contain organic beds with geoarchaeological significance, as no organic horizons or units are present within these sediments, they are considered to have low priority with limited potential for palaeoenvironmental assessment.

### Seabed Sediments

1.7.18 As sea levels stabilised during the Mid-Holocene, marine processes began to rework the uppermost deposits in places, forming gravelly sands with frequent shell and shell fragments that are observed in a number of vibrocores across the study area. Although there is potential for these deposits to contain reworked archaeology or bury palaeolandscape features, their archaeological potential is considered low.

## 1.8 Conclusion

1.8.1 The results and proposed next steps of this Supplementary Stage 1 and Stage 2 Geoarchaeological Assessment do not change the results of the impact assessment presented in the Environmental Statement, as detailed within the Marine Archaeology chapter (**Application Document 6.2.4.6 Part 4 Marine Chapter 6 Marine Archaeology**) and supported by the Marine Archaeological Technical Report submitted with the application (**Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report**).

1.8.2 No further palaeoenvironmental assessment is recommended for the following units assigned as low geoarchaeological potential: Fluvial Sands and Gravels, Shallow Marine to Coastal Sands and Seabed Sediments.

1.8.3 However, mitigation is required for two deposits, Non-Marine Sand and Alluvium, which were assigned medium geoarchaeological potential, and Peat deposits which were assigned high geoarchaeological potential. This mitigation is outlined in the proposed next steps below.

## 1.9 Proposed Next Steps

1.9.1 The Quaternary lithostratigraphy defined based on deposits recovered from vibrocores within the study area is presented in Table 1.4.

1.9.2 The proposed next steps for the Stage 3 palaeoenvironmental assessment of these deposits are outlined in Table 4, and methods presented in Appendix B. As discussed in **Document 9.2.1 Supplementary Stage 1 and Stage 2 Geoarchaeological Assessment - Technical Note**, since palaeogeographic features do not require mitigation in the form of avoidance, the increased knowledge that this geoarchaeological assessment provides (supplementary to the results within the Marine Archaeological Technical Report that was submitted with the application as Appendix 4.6.A (**Application Document 6.3.4.6.A Appendix 4.6.A Marine Archaeological Technical Report**)), will offset any further impact on paleogeographic features, as detailed within the Marine Archaeology chapter of the Environmental Statement (Application Document 6.2.4.6 Part 4 Marine Chapter 6 Marine Archaeology).

1.9.3 The proposed next steps, comprising the proposed Stage 3 palaeoenvironmental assessment, are considered part of the ongoing mitigation for the Proposed Project, rather than a limitation to the routing of the design, and will satisfy the requirements of the final Offshore Written Scheme of Investigation (**Application Document 7.5.5 Outline Offshore Written Scheme of Investigation (OWSI)**) as approved by the Archaeological Curator, Historic England.

1.9.4 The depositional history of the Non-Marine Sand is unclear, however may represent alluvial deposits associated with the palaeo Gipping-Orwell and Stour channel system mapped off Harwich (VC_021a) and Thames-Medway system to the south (VC-061). To develop an absolute chronology, a single OSL date is recommended from the base of VC_021a (1.45–1.75 mbsf) and VC-061 (3.28–4.10 mbsf). It is also recommended that six sub-samples are assessed for foraminifera and ostracods in VC_021a and four sub-samples for each diatoms and foraminifera and ostracods in VC-061 to understand changes in salinity and climate.

1.9.5 Palaeoenvironmental assessment is also recommended for a series of deposits interpreted as Alluvium in VC-061 and VC-S6-005. In VC-S6-005, the alluvial sequence comprises interbedded sand, silt and clay and was initially interpreted as low-energy fluvial sediments associated with a channel feature. To determine the depositional environment, a series of sub-samples are recommended for pollen, diatom, and foraminifera and ostracod assessment. A series of sub-samples from the Alluvium in VC-061 are also recommended for diatom, foraminifera and ostracod assessment. The Alluvium in VC-061 stratigraphically overlies Non-Marine Sand and may inform on changes in salinity and depositional environment.

1.9.6 Peat was recovered in a single vibrocore (VC-S6-005) located in an extensive palaeochannel identified through interpreted SBP data in the north of the study area. Limited dates are available for peat deposits in the Outer Thames Estuary and therefore this deposit may provide a better understanding of vegetation change and the timings of final submergence in both the study area and wider southern North Sea. To establish a chronology, it is recommended that a single sub-sample is taken from the peat deposit for radiocarbon dating. Furthermore, to assess palaeoenvironmental change, the sub-sample is also recommended for pollen and plant macrofossil assessment.

## Table 1.4 Proposed samples for Stage 3 palaeoenvironmental assessment

| Vibrocore ID | Unit | 14C dating | OSL dating | Plant macrofossils | Pollen | Diatoms | Foraminifera & ostracods |
|---|---|---|---|---|---|---|---|
| VC-021A | Non-Marine Sand | | 1 | | | | 6 |
| VC-061 | | | 1 | | | 4 | 2 |
| VC-061 | Alluvium | | | | | 4 | 4 |
| VC-S6-005 | | | | | 4 | 4 | 4 |
| VC-S6-005 | Peat | 1 | | 2 | 4 | | |

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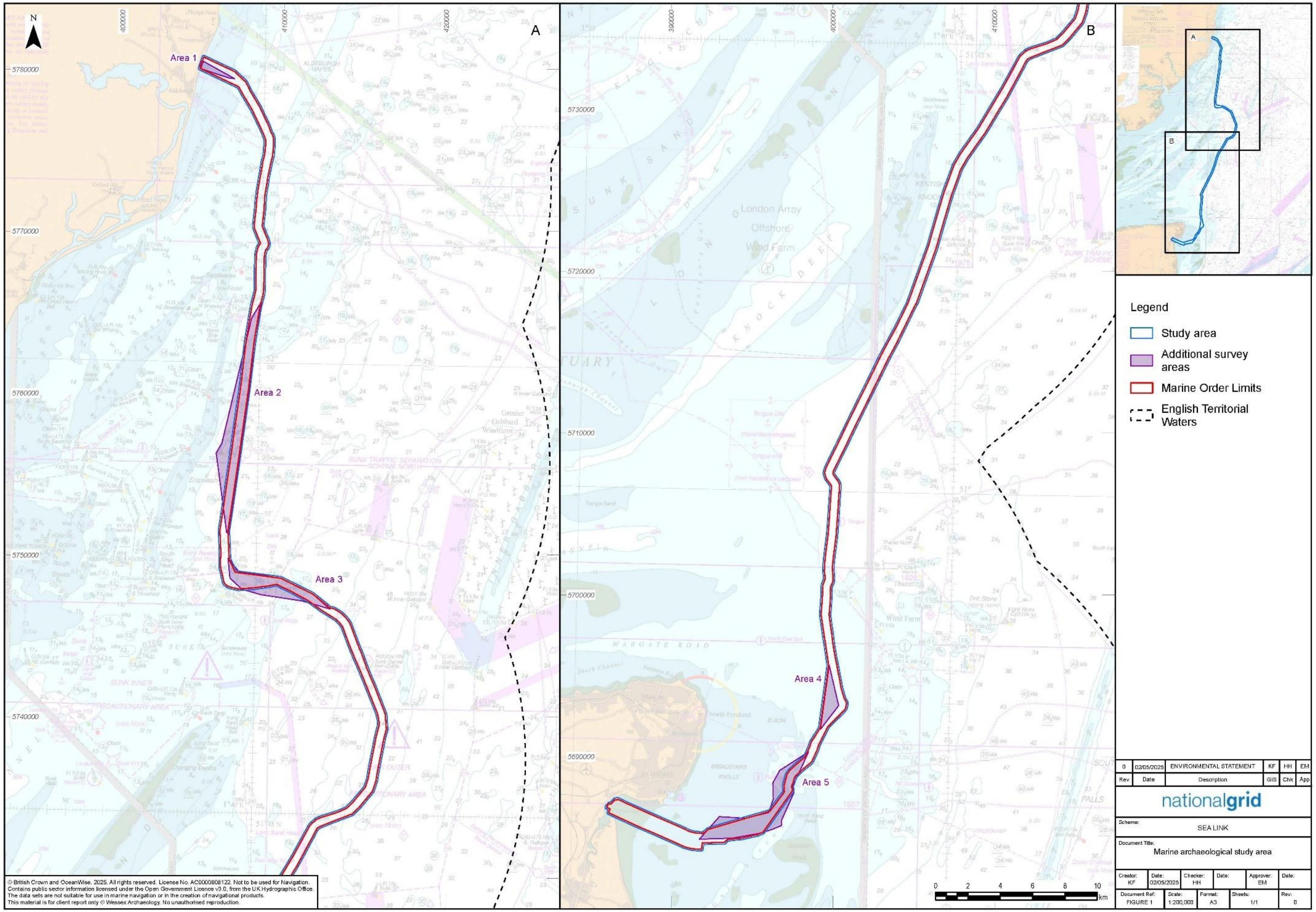
# Appendix A Figures

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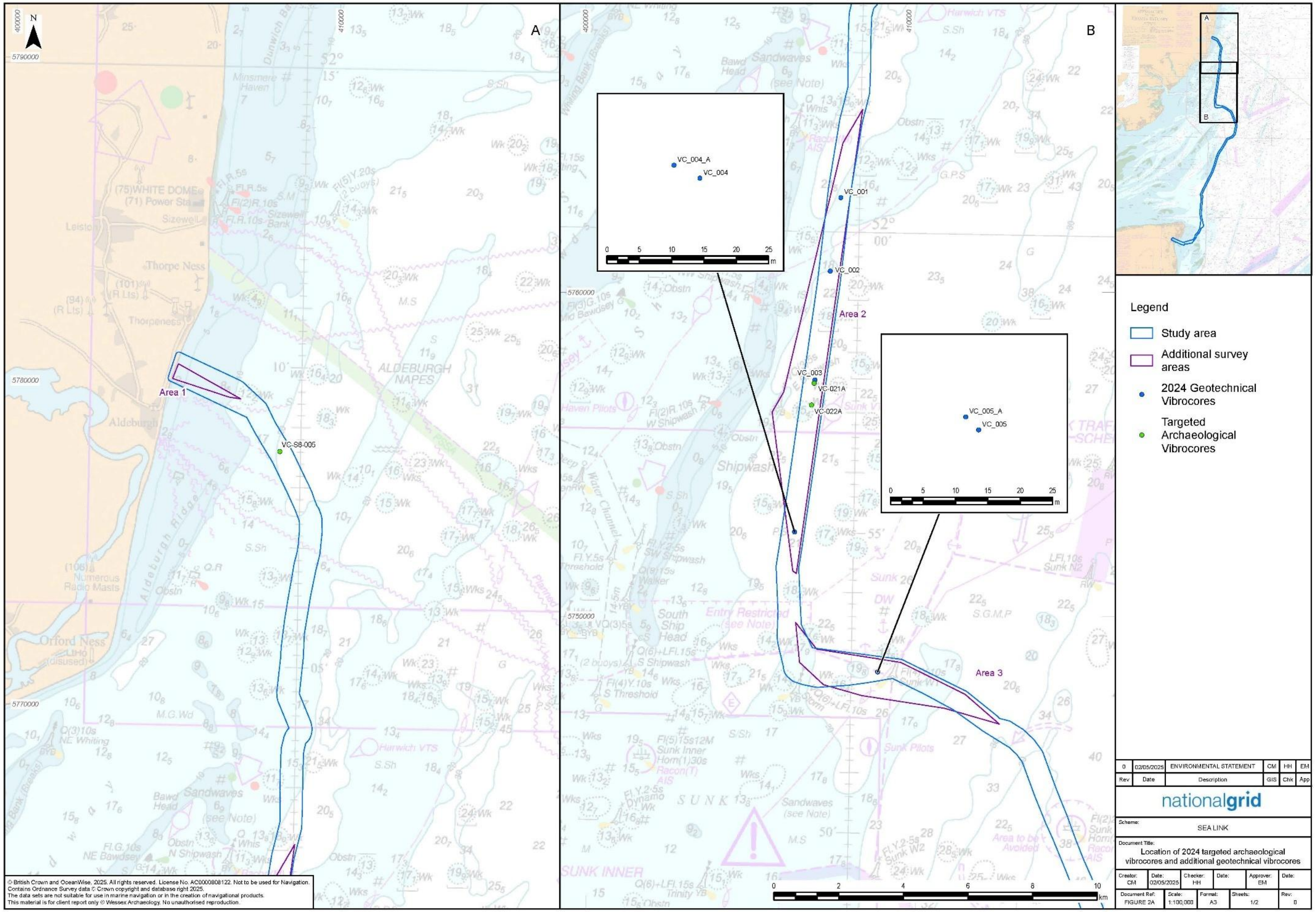


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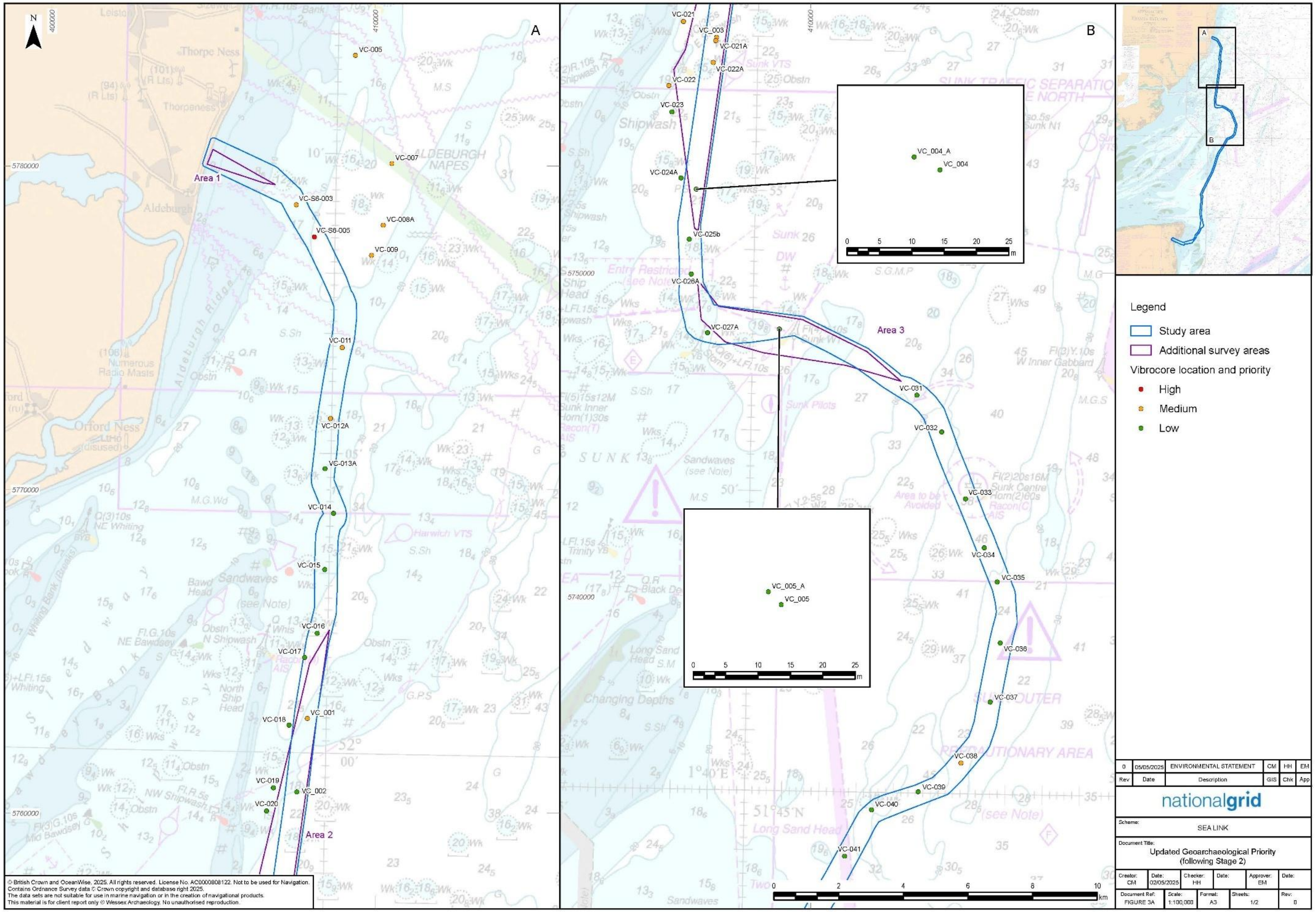


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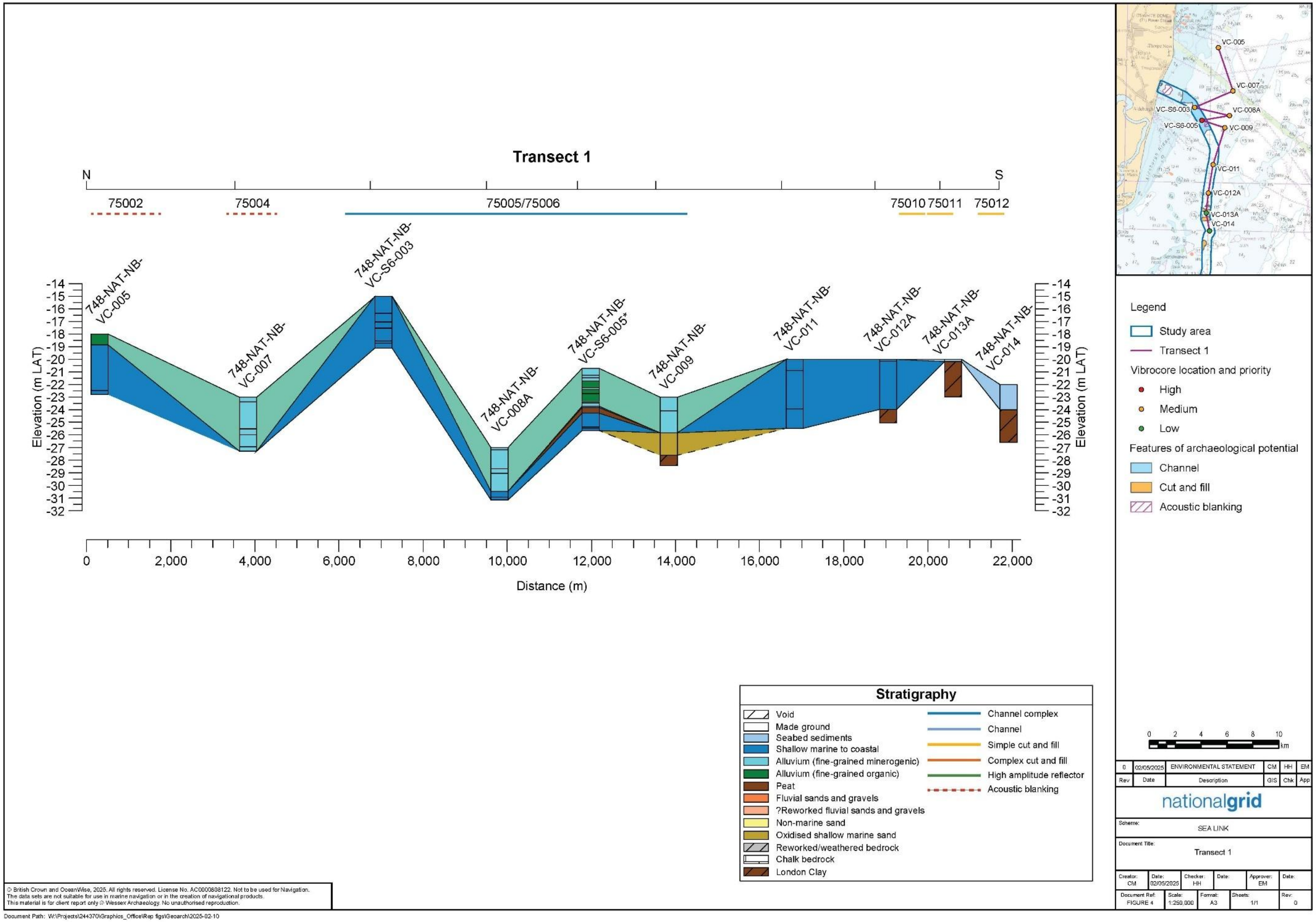

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Distance (m)
Stratigraphy
Void
Made ground
Seabed sediments
Shallow marine to coastal
Alluvium (fine-grained minerogenic)
Alluvium (fine-grained organic)
Peat
Fluvial sands and gravels
?Reworked fluvial sands and gravels
Non-marine sand
Oxidised shallow marine sand
Reworked/weathered bedrock
Chalk bedrock
London Clay
Channel complex
Channel
Simple cut and fill
Complex cut and fill
High amplitude reflector
Acoustic blanking
VC-005
VC-007
VC-S6-003
VC-008A
VC-S6-005
VC-009
VC-011
VC-012A
VC-013A
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Study area
Transect 1
Vibrocore location and priority
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Features of archaeological potential
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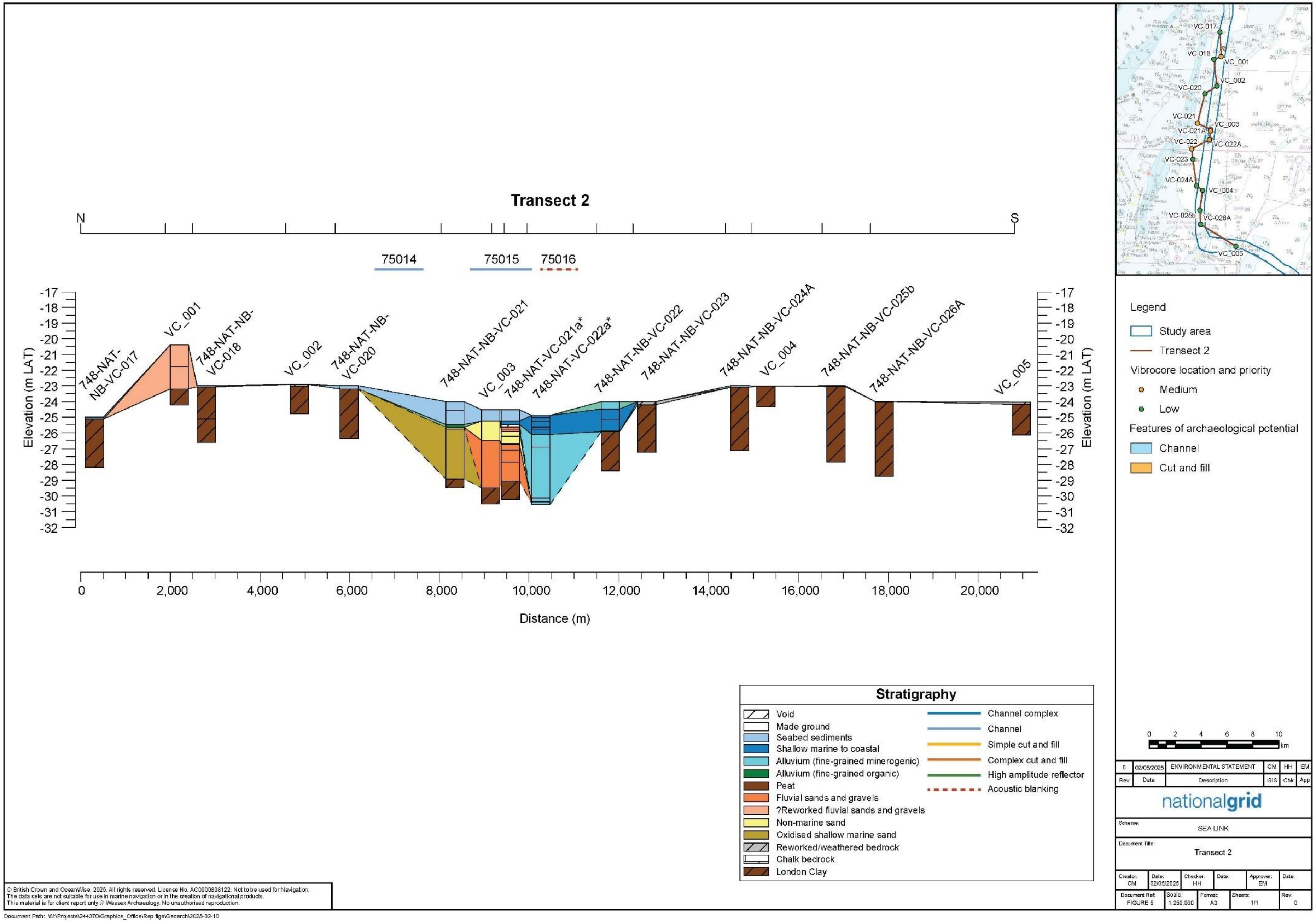
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VC_002
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748-NAT-NB-VC-021
VC_003
748-NAT-VC-021a*
748-NAT-VC-022a*
748-NAT-NB-VC-022
748-NAT-NB-VC-023
748-NAT-NB-VC-024A
VC_004
748-NAT-NB-VC-025b
748-NAT-NB-VC-026A
VC_005
Stratigraphy
Void
Made ground
Seabed sediments
Shallow marine to coastal
Alluvium (fine-grained minerogenic)
Alluvium (fine-grained organic)
Peat
Fluvial sands and gravels
?Reworked fluvial sands and gravels
Non-marine sand
Oxidised shallow marine sand
Reworked/weathered bedrock
Chalk bedrock
London Clay
Channel complex
Channel
Simple cut and fill
Complex cut and fill
High amplitude reflector
Acoustic blanking
Legend
Study area
Transect 2
Vibrocore location and priority
Medium
Low
Features of archaeological potential
Channel
Cut and fill
km
0 02/05/2025 ENVIRONMENTAL STATEMENT CM HH EM
Rev Date Description GIS Chk App
nationalgrid
Scheme: SEA LINK
Document Title: Transect 2
Creator: CM Date: 02/05/2025 Checker: HH Approver: EM
Document Ref: FIGURE 5 Scale: 1:250,000 Format: A3 Sheets: 1/1 Rev: 0
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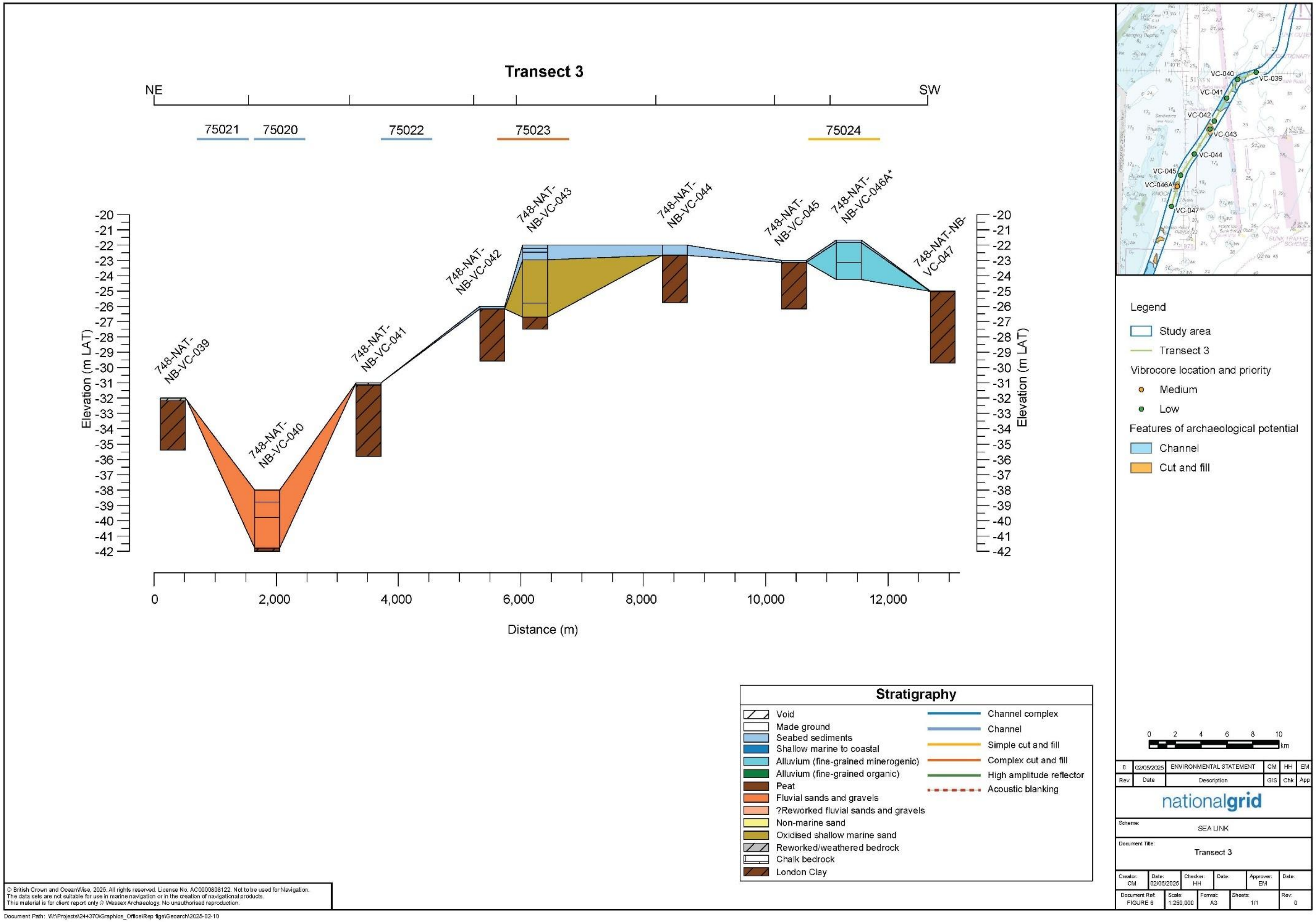

Transect 3
NE
SW
75021
75020
75022
75023
75024
748-NAT-NB-VC-039
748-NAT-NB-VC-040
748-NAT-NB-VC-041
748-NAT-NB-VC-042
748-NAT-NB-VC-043
748-NAT-NB-VC-044
748-NAT-NB-VC-045
748-NAT-NB-VC-046A*
748-NAT-NB-VC-047
Elevation (m LAT)
Distance (m)
0
2,000
4,000
6,000
8,000
10,000
12,000
Stratigraphy
Void
Made ground
Seabed sediments
Shallow marine to coastal
Alluvium (fine-grained minerogenic)
Alluvium (fine-grained organic)
Peat
Fluvial sands and gravels
?Reworked fluvial sands and gravels
Non-marine sand
Oxidised shallow marine sand
Reworked/weathered bedrock
Chalk bedrock
London Clay
Channel complex
Channel
Simple cut and fill
Complex cut and fill
High amplitude reflector
Acoustic blanking
VC-039
VC-040
VC-041
VC-042
VC-043
VC-044
VC-045
VC-046A
VC-047
Legend
Study area
Transect 3
Vibrocore location and priority
Medium
Low
Features of archaeological potential
Channel
Cut and fill
km
0 02/05/2025 ENVIRONMENTAL STATEMENT CM HH EM
Rev Date Description GIS Chk App
nationalgrid
Scheme: SEA LINK
Document Title: Transect 3
Creator: CM Date: 02/05/2025 Checker: HH Date: Approver: EM Date:
Document Ref: FIGURE 6 Scale: 1:250,000 Format: A3 Sheets: 1/1 Rev: 0
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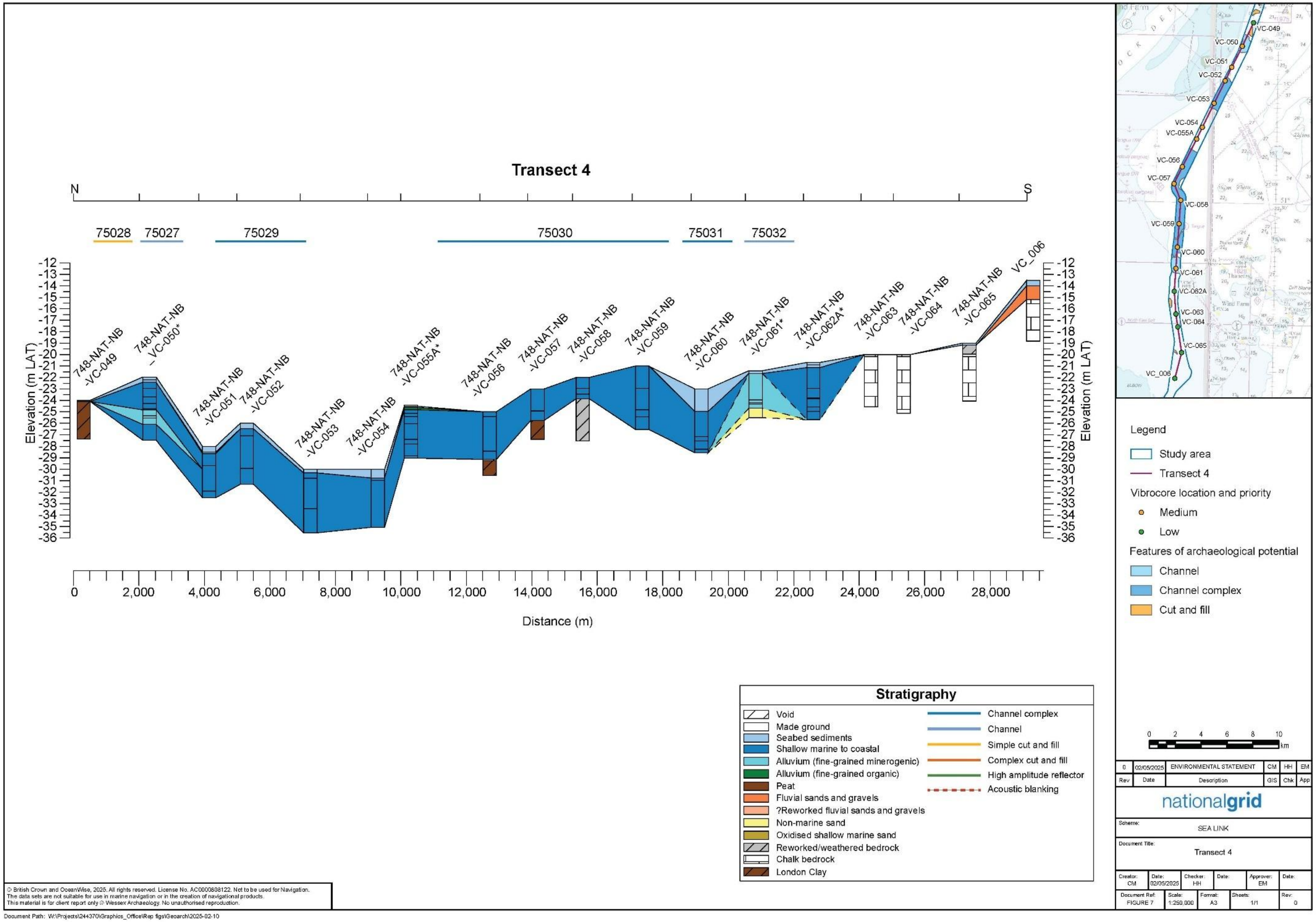

Transect 4
N
S
75028
75027
75029
75030
75031
75032
748-NAT-NB -VC-049
748-NAT-NB _VC-050*
748-NAT-NB -VC-051
748-NAT-NB -VC-052
748-NAT-NB -VC-053
748-NAT-NB -VC-054
748-NAT-NB -VC-055A*
748-NAT-NB -VC-056
748-NAT-NB -VC-057
748-NAT-NB -VC-058
748-NAT-NB -VC-059
748-NAT-NB -VC-060
748-NAT-NB -VC-061*
748-NAT-NB -VC-062A*
748-NAT-NB -VC-063
748-NAT-NB -VC-064
748-NAT-NB -VC-065
VC_006
Elevation (m LAT)
Distance (m)
Stratigraphy
Void
Made ground
Seabed sediments
Shallow marine to coastal
Alluvium (fine-grained minerogenic)
Alluvium (fine-grained organic)
Peat
Fluvial sands and gravels
?Reworked fluvial sands and gravels
Non-marine sand
Oxidised shallow marine sand
Reworked/weathered bedrock
Chalk bedrock
London Clay
Channel complex
Channel
Simple cut and fill
Complex cut and fill
High amplitude reflector
Acoustic blanking
Legend
Study area
Transect 4
Vibrocore location and priority
Medium
Low
Features of archaeological potential
Channel
Channel complex
Cut and fill
km
ENVIRONMENTAL STATEMENT
nationalgrid
SEA LINK
Transect 4
FIGURE 7
1:250,000
A3
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# Appendix B Palaeoenvironmental Analytical Techniques

B.1.1 The palaeoenvironmental analytical techniques anticipated for the Proposed Project require relatively small volumes of sediment to be extracted, with a series of samples taken at set intervals from undisturbed vibrocores. Bag samples are not appropriate, as the material lacks the spatial resolution required for palaeoenvironmental investigations.

B.1.2 The principal aim of analysis is to date key deposits and determine the preservation and concentration of the various remains outlined below. This provides a framework for establishing the potential of any given deposit to contribute towards themes and questions outlined in national and regional archaeological research agenda.

## Plant macrofossils

B.1.3 For plant macrofossils, 2 cm thick sections of a vibrocore will be extracted from peat deposits and processed through a nest of sieves to recover plant remains. Sampling usually focuses on one half of a split vibrocore in order that sufficient material remains for other techniques. Large plant remains preserved in peat are typically of plants growing locally and at the assessment stage are primarily assessed for the purpose of selecting suitable short-lived material for AMS (Accelerator Mass Spectrometry) radiocarbon dating.

B.1.4 However, plant macrofossils also provide information on local vegetation and evidence for possible human activity (perhaps suggested by the presence of edible plants). Plant macrofossils can occur in alluvial deposits, but these could have been transported over long distances in the water column and are not considered appropriate for AMS dating.

## Radiocarbon dating

**B.1.5** Suitable terrestrial plant remains (representing short-lived plants) are submitted for AMS dating providing a secure chronological context for the deposits under investigation. Where thick peats (e.g. more than a few centimetres) are present in a vibrocore sample, AMS dates from the top and base of a peat deposit are recommended, whereas one date usually suffices from thin and relatively short-lived peats.

## Pollen analysis

**B.1.6** Pollen is one of the principal techniques used in environmental archaeology to investigate past vegetation environments and the impact of human communities on the landscape; in the case of the North Sea this is likely to include evidence for manipulation of the vegetation by hunter-gatherers as part of food procurement strategies. Pollen is best preserved in the peat and each pollen sample requires a 1 cm3 volume for laboratory extraction. Several pollen samples may be taken depending upon the thickness of the deposit.

## Diatoms, foraminifera and ostracods

B.1.7 Diatoms (unicellular algae), foraminifera (marine protozoa) and ostracods (bivalve Crustacea) occur in a wide range of marine and semi-terrestrial environments (e.g. saltmarsh) and provide important indicators on past coastal and riverine change. For example, they can help to distinguish freshwater from marine environments and help to understand past patterns of sea-level and coastal change.

B.1.8 These techniques each require roughly 50 g of sediment per sample and can be taken from a range of substrates, except very coarse sediments, depending on the preservation condition.

## Optically Stimulated Luminescence

B.1.9 Optically Stimulated Luminescence (OSL) dating is an established technique for dating sediments that are too old to be dated using conventional methods such as radiocarbon dating. The advantage of OSL dating is that the method does not require organic material and has an upper range from around 100,000 to 300,000 years. OSL dating is therefore a key dating technique to provide a chronological framework for the long-term physical development of southern North Sea landscapes over multiple glacial-interglacial cycles

.

# Appendix C Vibrocore Locations

## Appendix Table C.1 Vibrocore Locations

| Vibrocore ID | Easting | Northing | Elevation (m LAT) | Starting Depth (m) | Ending Depth (m) |
|---|---|---|---|---|---|
| VC_001 | 407891.74 | 5762931.2 | -20.39 | 0.00 | 3.85 |
| VC_002 | 407565.08 | 5760657.7 | -22.93 | 0.00 | 1.85 |
| VC_003 | 407088.24 | 5757294.7 | -24.53 | 0.00 | 6.00 |
| VC_004 | 406462.17 | 5752605.4 | -23.02 | 0.00 | 1.30 |
| VC_004_A | 406458.24 | 5752607.3 | -22.70 | 0.00 | 1.05 |
| VC_005 | 409029.05 | 5748275.9 | -24.03 | 0.00 | 2.10 |
| VC_005_A | 409026.86 | 5748278.4 | -23.80 | 0.00 | 1.60 |
| VC_006 | 399645.47 | 5692792.7 | -13.50 | 0.00 | 5.30 |
| VC_007 | 397819.29 | 5689447.1 | -14.90 | 0.00 | 5.70 |
| VC_008 | 395718.85 | 5686181.2 | -14.40 | 0.00 | 4.10 |
| VC_009_A | 394178.15 | 5685482.9 | -12.40 | 0.00 | 5.70 |
| 748-NAT-NB-VC-062A | 399606.58 | 5699518.4 | -20.69 | 0.00 | 5.00 |
| 748-NAT-NB-VC-061 | 399729.68 | 5701283.5 | -21.39 | 0.00 | 4.20 |
| 748-NAT-NB-VC-055A | 401331.52 | 5711276.1 | -24.42 | 0.00 | 4.60 |
| 748-NAT-NB-VC-046A_A | 407234.84 | 5725169.9 | -21.16 | 0.00 | 1.90 |
| 748-NAT-NB-VC-046A | 407231.5 | 5725168 | -21.67 | 0.00 | 2.60 |
| 748-NAT-NB_VC-050 | 404873.47 | 5718438.1 | -21.97 | 0.00 | 5.50 |
| 748-NAT-VC-02Aa | 406985.63 | 5756519.9 | -24.9 | 0.00 | 5.63 |
| 748-NAT-VC-021A | 407066.02 | 5757193.9 | -24.48 | 0.00 | 5.73 |

| | | | | | |
|---|---|---|---|---|---|
| 748-NAT-NB-VC-S6-005 | 408108.59 | 5777806.7 | -20.72 | 0.00 | 4.95 |

# Appendix D Stage 1 Review

## Appendix Table D.1 Stage 1 Review

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Priority |
|---|---|---|---|---|---|
| VC_001 | 0.00 | 1.40 | Dark greyish brown slightly clayey gravelly medium to coarse SAND with many shell fragments | ?Reworked fluvial sands and gravels | Low |
| VC_001 | 1.40 | 2.80 | Greyish brown sandy medium to coarse SA-SR GRAVEL with many shell fragments | ?Reworked fluvial sands and gravels | Medium |
| VC_001 | 2.80 | 3.85 | High shear strength slightly silty CLAY | Clay bedrock | Low |
| VC_002 | 0.00 | 0.10 | Soft dark greyish brown sandy gravelly CLAY with shell fragments | Reworked bedrock | Low |
| VC_002 | 0.10 | 1.85 | Stiff dark greyish brown CLAY with fissures | Clay bedrock | Low |
| VC_003 | 0.00 | 0.70 | Dark greyish brown silty sandy fine to coarse A-R GRAVEL with many shell fragments | Seabed sediments | Low |
| VC_003 | 0.70 | 1.95 | Dark greyish brown stained black clayey silty SAND with clay laminae | Alluvial sand | Medium |
| VC_003 | 1.95 | 4.95 | Light olive brown slightly silty sandy fine to coarse A-R GRAVEL with occasional shell fragments | Fluvial sands and gravels | Medium |
| VC_003 | 4.95 | 6.00 | Stiff dark greyish brown CLAY with fissures | Clay bedrock | Low |
| VC_004 | 0.00 | 1.30 | High shear strength grey CLAY | Clay bedrock | Low |
| VC_004_A | 0.00 | 1.05 | Stiff dark greyish brown CLAY with fissures | Clay bedrock | Low |
| VC_005 | 0.00 | 0.15 | Dark greyish brown sandy gravelly CLAY with shell fragments | Reworked bedrock | Low |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Priority |
|---|---|---|---|---|---|
| VC_005 | 0.15 | 2.10 | Stiff dark greyish brown CLAY with fissures | Clay bedrock | Low |
| VC_005_A | 0.00 | 0.40 | Dark greyish brown clayey gravelly SAND with shell fragments | Reworked bedrock | Low |
| VC_005_A | 0.40 | 1.60 | Stiff dark greyish brown CLAY with fissures | Clay bedrock | Low |
| VC_006 | 0.00 | 0.50 | Olive brown to dark greyish brown slightly silty gravelly fine to coarse SAND with shell fragments | Seabed sediments | Low |
| VC_006 | 0.50 | 1.70 | Dark greyish brown slightly silty sandy fine to coarse A-R GRAVEL with shell fragments | Gravel lag | Low |
| VC_006 | 1.70 | 5.30 | Structureless CHALK | Chalk bedrock | Low |
| VC_007 | 0.00 | 0.80 | Light olive brown slightly silty slightly gravelly SAND with shell fragments | Seabed sediments | Low |
| VC_007 | 0.80 | 1.60 | Dark greyish brown sandy fine to coarse A-R GRAVEL with shell fragments and cobbles | Gravel lag | Low |
| VC_007 | 1.60 | 5.70 | Structureless CHALK | Chalk bedrock | Low |
| VC_008 | 0.00 | 0.35 | Olive brown slightly silty slightly gravelly fine to coarse SAND with shell fragments | Seabed sediments | Low |
| VC_008 | 0.35 | 0.65 | Olive brown sandy fine to coarse A-R GRAVEL with shell fragments and cobbles | Gravel lag | Low |
| VC_008 | 0.65 | 4.10 | Structureless CHALK | Chalk bedrock | Low |
| VC_009_A | 0.00 | 0.15 | Dark yellowish brown slightly silty sandy fine to coarse A-R GRAVEL with shell fragments | Seabed sediments | Low |
| VC_009_A | 0.15 | 5.70 | Structureless CHALK | Chalk bedrock | Low |
| 748-NAT-VC-021A | 0.00 | 0.70 | Yellowish brown gravelly fine to coarse SAND | Seabed sediments | Low |
| 748-NAT-VC-021A | 0.70 | 1.20 | Greyish brown silty fine SAND | Alluvial sand | Medium |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Priority |
|---|---|---|---|---|---|
| 748-NAT-VC-021A | 1.20 | 1.50 | Yellowish brown gravelly medium to coarse SAND. Gravel is fine to medium SA-SR mixed lithologies | Fluvial sands and gravels | Medium |
| 748-NAT-VC-021A | 1.50 | 2.10 | Greyish brown silty fine SAND | Alluvial sand | Medium |
| 748-NAT-VC-021A | 2.10 | 4.60 | Yellowish brown gravelly medium to coarse SAND. Gravel is fine to medium SA-SR mixed lithologies | Fluvial sands and gravels | Medium |
| 748-NAT-VC-021A | 4.60 | 5.73 | Grey slightly silty CLAY | Bedrock | Medium |
| 748-NAT-VC-022A | 0.00 | 0.90 | Greyish brown slightly gravelly medium to coarse SAND | Seabed sediments | Low |
| 748-NAT-VC-022A | 0.90 | 5.63 | Grey CLAY | Alluvial clay | Medium |
| 748-NAT-VC-046A | 0.00 | 0.20 | Light greenish grey silty SAND with shell fragments | Seabed sediments | Low |
| 748-NAT-VC-046A | 0.20 | 2.60 | Dark greenish grey CLAY | Alluvial clay | Medium |
| 748-NAT-VC-046A_A | 0.00 | 0.10 | Light greenish grey silty SAND with shell fragments | Seabed sediments | Low |
| 748-NAT-VC-046A_A | 0.10 | 1.90 | Dark greenish grey CLAY | Alluvial clay | Medium |
| 748-NAT-VC-050 | 0.00 | 2.80 | Light greenish grey silty fine to coarse SAND | Alluvial sand | Medium |
| 748-NAT-VC-050 | 2.80 | 4.10 | Dark greenish grey CLAY | Alluvial clay | Medium |
| 748-NAT-VC-050 | 4.10 | 5.50 | Light greenish grey silty fine to medium SAND | Alluvial sand | Medium |
| 748-NAT-VC-055A | 0.00 | 4.60 | Light greenish grey silty fine SAND with occasional shell fragments | Alluvial sand | Medium |
| 748-NAT-VC-061 | 0.00 | 0.20 | Dark greenish grey silty SAND | Seabed sediments | Low |
| 748-NAT-VC-061 | 0.20 | 4.20 | Dark greenish grey CLAY | Alluvial clay | Medium |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Priority |
|---|---|---|---|---|---|
| 748-NAT-VC-062A | 0.00 | 2.00 | Yellow fine SAND with occasional organic matter | Alluvial sand | Medium |
| 748-NAT-VC-062A | 2.00 | 2.80 | Very pale brown slightly silty fine to coarse SAND with rare organic matter | Alluvial sand | Medium |
| 748-NAT-VC-062A | 2.80 | 5.00 | Light grey silty fine SAND with occasional organic matter and shell fragments | Alluvial sand | Medium |
| 748-NAT-NB-VC-S6-005 | 0.00 | 0.50 | Greyish brown slightly silty fine SAND | Seabed sediments | Low |
| 748-NAT-NB-VC-S6-005 | 0.50 | 1.50 | Very dark grey slightly silty CLAY with frequent organic matter | Alluvial clay | Medium |
| 748-NAT-NB-VC-S6-005 | 1.50 | 2.50 | Grey fine SAND with pockets of organic clay and shell fragments | Alluvial sand | Medium |
| 748-NAT-NB-VC-S6-005 | 2.50 | 3.50 | Very dark grey clayey SAND with many whole shells and wood fragments | Alluvial sand | Medium |
| 748-NAT-NB-VC-S6-005 | 3.50 | 4.95 | Grey medium to coarse SAND with frequent shell fragments | Alluvial sand | Medium |

# Appendix E Stage 2 Recording

## Appendix Table E.1 Stage 2 Recording

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| VC-021A | 0.00 | 0.05 | Soft mid dark brownish grey shelly slightly gravelly sandy CLAY with fine angular flint gravel. Shell is fragmented. Sand is medium fine to medium coarse. Sharp weakly bowled boundary with 2102. | Made ground (coring artefact) | 2101 |
| | 0.05 | 0.75 | Loose mid orangish brown very shelly gravelly coarse to very coarse SAND. Gravel is abundant predominantly brown angular to subangular flint and quartz. Whole shell is common, with bivalves (tellin and oyster) and spired gastropods. Oyster appears to have frequent sub-horizontal orientation. Sharp sub-horizontal erosional boundary with 2103. | Seabed sediments | 2102 |
| | 0.75 | 1.00 | Well compacted (firm) mid dark greyish brown silty very fine to fine SAND with sparse angular to subrounded flint gravel and uncommon fragmented shells. Massive structure. Lower boundary is unclear. | Shallow marine to coastal | 2103 |
| | 1.00 | 1.15 | No recovery | N/A | 2104 |
| | 1.15 | 1.30 | Moderately compacted shelly mid yellowish brown gravelly medium SAND with gravel being abundant angular to subrounded black brown red flint with common off-white quartz. Shell is fragmented. Clear sub-horizontal to 2106. | Fluvial sands and gravels | 2105 |
| | 1.30 | 1.45 | Moderately compacted slightly shelly medium coarse to coarse SAND AND GRAVEL with gravel | Fluvial sands and gravels | 2106 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | being very abundant angular to subrounded black brown red flint and quartz. Shell is uncommon and fragmented. Abrupt sub-horizontal to 2107. | | |
| | 1.45 | 1.75 | Well compacted (firm) mid yellowish greyish brown weakly normally graded silty very fine to medium SAND with rare fine shell fragments. Diffuse to 2108. | Non-marine sand | 2107 |
| | 1.75 | 2.20 | Moderately well compacted (slightly firm) weakly normally graded fine to medium SAND with occasional angular to subrounded dark grey flint gravel. Rare fine shell fragments. Clear to 2109. | Non-marine sand | 2108 |
| | 2.20 | 2.25 | Moderately well compacted (firm) mid greyish brown very fine to medium SAND. Abrupt to 2110. | Non-marine sand | 2109 |
| | 2.25 | 2.60 | Moderately poorly compacted medium coarse to coarse SAND AND GRAVEL. Gravel is very abundant angular to subrounded black brown red flint and off-white quartz. Weak sub-horizontal bedding. Clear wavy shallowly inclined to 2111. | Fluvial sands and gravels | 2110 |
| | 2.60 | 3.35 | Moderately poorly compacted medium coarse to coarse SAND AND GRAVEL. Gravel is very angular to subrounded black brown red flint and off-white quartz. Gradually becoming coarser and more gravelly with depth. Clear undulate to 2112. | Fluvial sands and gravels | 2111 |
| | 3.35 | 4.57 | Loose medium coarse to coarse sandy GRAVEL. Gravel is very angular to rounded black brown red off-white flint and off-white yellow quartz. Rare fine bivalves. Abrupt to 2113. | Fluvial sands and gravels | 2112 |
| | 4.57 | 5.73 | Slightly firm to firm slightly fissile dark greyish brown CLAY. | London Clay Formation | 2113 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| VC-022A | 0.00 | 0.15 | Very soft to loose friable damp mid dark greyish brown slightly clayey gravelly fine to medium SAND with abundant fragmented shell and common. Gravel is fine to medium subangular brown flint. Clear wavy boundary with 2202. | Shallow marine to coastal | 2201 |
| | 0.15 | 0.36 | Moderately well consolidated very shelly mid greyish brown slightly gravelly clayey medium fine SAND. Gravel is angular to subangular brown flint. Shell is fragmented and whole molluscs, bivalves (tellin mussel) and gastropods. Clast supported. Shallowly angled sharp boundary with 2203. | Shallow marine to coastal | 2202 |
| | 0.36 | 0.73 | Loosely compacted mid greyish orangish brown very shelly slightly gravelly medium to coarse SAND. Shell is fragmented with rare whole bivalve and gastropods. Gravel is subangular to subrounded brown dark grey flint and pale yellow quartz. Band of soft dark brownish grey silty clay between 0.53-0.55m. Gradual boundary to 2204. | Shallow marine to coastal | 2203 |
| | 0.73 | 0.88 | Moderately loosely compacted to loose mid greyish orangish brown fine to medium SAND with common coarse sand-sized fragmented shells and rare coarse sand-sized subangular flint gravel. Massive. Abrupt very shallowly angled boundary with 2205. | Shallow marine to coastal | 2204 |
| | 0.88 | 1.20 | Loosely compacted mid greyish orangish brown very shelly gravelly medium to coarse SAND. Gravel is abundant angular to subangular brown and dark grey flint and quartz. Shell is abundant predominantly fragmented coarse sand-sized including bivalves and | Shallow marine to coastal | 2205 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | oysters. Sharp sub-horizontal to 2206. | | |
| | 1.20 | 1.98 | Very soft blueish brownish grey silty CLAY with dark grey very fine <2mm laminations throughout. Rare fine gravel-sized bivalve shells. Occasional medium (<10mm) sand laminae between 1.20-1.28m. Indistinct presumed clear boundary with 2207. | Alluvium (fine-grained minerogenic) | 2206 |
| | 1.98 | 5.25 | Very soft slightly organic sub-horizontally laminated brownish grey silty CLAY. Laminations contain compressed brown leafy detrital plant material. Laminations are closely spaced and contain coarse sand-sized whole gastropods. Weak sulphurous odour becoming stronger with depth. Clear undulate boundary with 2208. | Alluvium (fine-grained minerogenic) | 2207 |
| | 5.25 | 5.47 | Very soft to soft very shelly mid dark brownish blueish grey CLAY. Shell is generally whole corrugated bivalve with uncommon fragments of oyster and tallin. Rare gastropods. Clear boundary with 2209. | Alluvium (fine-grained minerogenic) | 2208 |
| | 5.47 | 5.65 | Very soft to soft sub-horizontally laminated slightly shelly mid dark blueish brownish grey silty CLAY. Shell is common whole fine gravel-sized corrugated bivalve with weak sub-horizontal orientation. Laminations well defined, ≤2mm. Foliation from hydration/dehydration cycles. | Alluvium (fine-grained minerogenic) | 2209 |
| VC-046A | 0.00 | 0.17 | Fairly loose 2.5Y 5/2 greyish brown slightly silty gravelly fine to coarse SAND. Gravel is rounded and subrounded, occasional subangular, fine to coarse flint. Fairly diffuse lower boundary. | Seabed sediments | 4601 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | 0.17 | 1.48 | Firm 2.5Y 2.5/1 black clayey SILT with occasional fine subrounded flint clasts, very occasional preserved organic material (roots?), occasional to moderate coarse sand to fine gravel-sized shell fragments, occasional medium sand to medium gravel sized whole shell (bivalve halves, gastropods - columnar) and occasional small pockets of medium sand. Peddy structure (desiccation?), possibly laminated. Distinct 1.48-1.50 m lower boundary - bleeds into 4603. | Alluvium (fine-grained minerogenic) | 4602 |
| | 1.48 | 2.60 | Fairly firm 5Y 5/2 grey slightly clayey SILT with very occasional medium to coarse sand sized subrounded flint and possible faint laminations. | Alluvium (fine-grained minerogenic) | 4603 |
| VC-046A_A | 0.00 | 0.23 | Very soft to poorly consolidated mid dark greyish brown mottled dark grey slightly shelly slightly clayey slightly gravelly fine to medium SAND. Gravel is common subrounded to rounded brown flint. Shell fragments are occasional and coarse sand-sized. Poorly sorted. Abrupt sub-horizontal to 46002. | Seabed sediments | 46001 |
| | 0.23 | 0.35 | Firm to locally stiff wet sub-horizontally fissile mid dark brownish grey CLAY. Sharp to 46003. | Alluvium (fine-grained minerogenic) | 46002 |
| | 0.35 | 0.58 | Loose to locally firm slightly shelly waterlogged dark blackish grey clayey fine to medium SAND indistinctly mixed with brownish grey CLAY. Shell is whole and fragmented coarse sand to gravel-sized bivalves generally corrugated single valves. Sharp firmness boundary with 46004. | Alluvium (fine-grained minerogenic) | 46003 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | 0.58 | 1.90 | Firm to locally stiff mid dark brownish grey CLAY with sparse to common whole fine gravel-sized bivalves (tellin and corrugated) and rare coarse sand-sized gastropods. | Alluvium (fine-grained minerogenic) | 46004 |
| VC-050 | 0.00 | 0.23 | Loose friable mid orangish brown very shelly gravelly SAND. Gravel is angular to rounded flint. Shell is fragmented and whole, bivalve and gastropod mostly corrugated bivalve (scallop). Sand is coarse to very coarse. Lens of dark greyish brown shelly slightly gravelly sandy clay at 0.2-0.23m. Sharp to 5002. | Seabed sediments | 5001 |
| | 0.23 | 0.45 | Loose friable very shelly medium to coarse SAND with uncommon angular to subangular flint gravel. Sand is medium. Whole and fragmented shell of gastropod and bivalve, whole shell generally winged hinge corrugated orange scallop. Shell orientated sub-horizontal. Possible worm tube bioturbated sub-vertical at 0.28-0.37m. Clear to 5003. | Seabed sediments | 5002 |
| | 0.45 | 1.00 | Loose friable mid greenish brownish grey shelly medium to coarse SAND with occasional angular to subangular flint gravel. Shell is fragmented but whole shells (≤5cm) gastropod and bivalve (corrugated orange and smooth white) are observed. One off-white coral branch at 0.6m. Possible flat periwinkle noted. Frequent beds of whole and fragmented shell at intervals ≤2cm thick. Gradual to 5004. | Shallow marine to coastal | 5003 |
| | 1.00 | 1.71 | Loose friable slightly shelly mid greyish brown medium to coarse SAND. Becoming more shelly at 1.50m with shell beds ≤2cm as 5003. Shell beds at 1.55, 1.59, | Shallow marine to coastal | 5004 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | and 1.63-1.68. Shell beds generally fragmented shell with frequent whole shell ≤5cm bivalve. Shell orientated sub-horizontal. Whole shell brown corrugated scallop, black elongate smooth bivalve (mussel) and smooth striped grey bivalve (baltic tellin). Sharp sub-horizontal to 5005. | | |
| | 1.71 | 2.30 | Loose friable mid dark greyish brown slightly organic very shelly coarse to very coarse SAND with occasional angular to subrounded flint. Shell is fragmented with rare whole bivalve, mussel, baltic tellin, scallop and possible oyster shells ≤4cm. Shell orientated sub-horizontal. Weak organic odour, no fibrous organics. Clear to 5006. | Shallow marine to coastal | 5005 |
| | 2.30 | 2.73 | Loose friable mid greyish brown very shelly coarse to very coarse SAND with occasional angular to subrounded flint. Shell is fragmented with abundant whole bivalve, mussel, oyster, baltic tellin, scallop shell ≤4cm. Shell orientated sub-horizontal. Sharp to 5007. | Shallow marine to coastal | 5006 |
| | 2.73 | 2.85 | Slightly consolidated dark brownish grey shelly slightly clayey gravelly SAND. Gravel is angular to subangular black flint. Shells are whole and fragmented bivalves, corrugated scallop and baltic tallin. Abrupt to 5008. | Shallow marine to coastal | 5007 |
| | 2.85 | 3.37 | Soft dark slightly brownish grey (2.5Y 2.5/1 black) CLAY with common sub-horizontally orientated cream corrugated whole and fragmented bivalves ≤2cm in diameter. Rare fine gravel-sized (<1cm) gastropods. Shell band 2.95. Occasional possible rooting and preserved organics. | Alluvium (fine-grained minerogenic) | 5008 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | Occasional faint laminations. Diffuse to 5009. | | |
| | 3.37 | 3.57 | Soft 5Y 5/1 grey sandy SILT. Sand is fine. Diffuse to 5010. | Alluvium (fine-grained minerogenic) | 5009 |
| | 3.57 | 4.14 | Firm sandy SILT with occasional subrounded fine-medium gravel-sized sandstone and possible laminations. Sand is fine. Sharp to 5011. | Alluvium (fine-grained minerogenic) | 5010 |
| | 4.14 | 5.50 | 5Y 5/3 olive fine to medium SAND with rare to occasional fine shell fragments grading to 2.5Y 5/4 light olive brown medium SAND. | ?Shallow marine to coastal | 5011 |
| VC-055A | 0.00 | 0.10 | Very soft dark brownish grey with some mid brown fine sandy CLAY coated with brown medium shelly sand. Shell is fragmented. Sharp sub-horizontal to 5502. | Made ground (coring artefact) | 5501 |
| | 0.10 | 0.19 | Loose mid yellowish brown shelly medium SAND. Shell is fragmented with rare whole shells. Abrupt sub-horizontal to 5503. | Seabed sediments | 5502 |
| | 0.19 | 0.40 | Very soft dark brownish to blackish grey very slightly organic slightly sandy CLAY. Partings are slightly discontinuous, ≤3mm, composed of medium fine sand and get thicker with depth. Weak organic odour (amorphous organics). Sharp to 5504. | Alluvium (fine-grained organic) | 5503 |
| | 0.40 | 0.70 | Loose to very soft mid yellowish brown shelly medium fine to medium SAND. Clear wavy boundary with 5505. | Shallow marine to coastal | 5504 |
| | 0.70 | 1.00 | Well consolidated (firm) mid greyish brown very fine to fine SAND with semi-frequent bands and flaser lenses of dark brownish grey sandy clay. Sparse fragmented shell. Lenses/bands are between 3-5mm thick and are | Shallow marine to coastal | 5505 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | sub-horizontal to inclined. Boundary not seen with 5506. | | |
| | 1.00 | 1.60 | Well consolidated (firm) mid greyish yellowish brown very fine to fine SAND. Massive structure. Undulate sharply angled boundary with 5507 - ?flame structure ?burrowing. | Shallow marine to coastal | 5506 |
| | 1.60 | 3.00 | Well consolidated (firm) mid greyish brown very fine to fine SAND with sparse bands and flaser lenses of dark brownish grey sandy clay. Lenses are between 3-5mm thick and are sub-horizontal. Lower boundary is unclear. | Shallow marine to coastal | 5507 |
| | 3.00 | 3.35 | Well consolidated (firm) mid greyish yellowish brown very fine to fine SAND. Massive structure. Gradual boundary with 5509. | Shallow marine to coastal | 5508 |
| | 3.35 | 4.40 | Well consolidated (firm) mid greyish brown very fine to fine SAND with sparse bands and flaser lenses of dark brownish grey sandy clay. Lenses/bands are between 3-5mm thick and are sub-horizontal. Clear undulate boundary with 5510 - ?deformation structure. | Shallow marine to coastal | 5509 |
| | 4.40 | 4.60 | Well consolidated (firm) mid dark greyish brown very fine to fine SAND with bands of dark brown sandy clay at 4.50-4.54m and 4.58-4.60m made up of very closely spaced sub-horizontal and angled flaser lenses. | Shallow marine to coastal | 5510 |
| VC-061 | 0.00 | 0.25 | Soft GLEY1 3/N very dark grey slightly sandy gravelly SILT. Sand is fine, gravel is coarse sand to medium gravel sized whole (bivalve) and comminuted shell. Diffuse, wavy lower boundary. | Seabed sediments | 6101 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | 0.25 | 2.58 | Firm to soft 2.5Y 5/1 grey slightly gravelly silty CLAY with very occasional preserved organic material (detrital) towards base of unit. Gravel is medium sand to very occasional coarse gravel sized whole (bivalve and gastropod) and occasional comminuted shell. Strongly laminated. Sharp, straight lower boundary. | Alluvium (fine-grained minerogenic) | 6102 |
| | 2.58 | 2.82 | Firm 2.5Y 2.5/1 black silty CLAY. Diffuse lower boundary, grades into 6103. | Alluvium (fine-grained minerogenic) | 6103 |
| | 2.82 | 2.90 | Firm 2.5Y 3/1 dark grey very slightly gravelly very clayey SILT. Gravel is fine to medium gravel sized shell fragments. Fairly sharp, wavy lower boundary. | Alluvium (fine-grained minerogenic) | 6104 |
| | 2.90 | 3.28 | Fairly firm 2.5Y 5/2 greyish brown clayey SILT with occasional preserved organic material (detrital). Sharp, diagonal lower boundary (3.28-3.58m). | Alluvium (fine-grained minerogenic) | 6105 |
| | 3.28 | 4.10 | Firm 5Y 4/1 dark grey sandy SILT grades into gravelly silty SAND. Sand is fine to coarse, gravel is subangular to tabular fine to coarse siltstone. | Non-marine sand | 6106 |
| VC-062A | 0.00 | 0.18 | Loose friable weakly consolidated mid slightly greyish yellowish brown very fine to fine SAND with uncommon fine gravel-sized fragmented shells. Clear undulate to 6202. | Seabed sediments | 6201 |
| | 0.18 | 0.44 | Loose to slightly firm well consolidated mid greyish brown shelly slightly gravelly fine SAND with lenses of mid dark brownish grey slightly clayey sand. Gravel is fine to coarse rounded to subrounded flint. Shell is whole and fragmented bivalve and tusk shells. Sharp to 6203. | Seabed sediments | 6202 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | 0.44 | 2.25 | Moderately well compacted (firm) mid yellowish brown very fine to fine well sorted SAND with rare fragmented and whole bivalve and tusk shells to 1.00m. Shell is absent between 1.00 and 2.25m. Weak FeO staining in places. Staining is orangish yellow to brownish orange. Gradual to 6204. | Shallow marine to coastal | 6203 |
| | 2.25 | 3.08 | Moderately well consolidated (firm) friable mid dark brownish grey very fine well sorted SAND with frequent dark brownish grey sub-horizontal to concave laminations (ripples). Laminations indistinct between 2.40-2.58m. Detrital wood sparsely distributed throughout unit. Band at 2.59-2.61 contains dark brown coarse sand to fine gravel-sized detrital wood angled and sub-horizontal. Boundary not seen with 6205. | Shallow marine to coastal | 6204 |
| | 3.08 | 3.15 | Loose to slightly consolidated mid brownish grey fine to medium SAND with occasional very weak fine gravel-sized fragmented gastropods shells. Clear to 6206. | Shallow marine to coastal | 6205 |
| | 3.15 | 3.90 | Moderately well consolidated (firm) friable damp mid brownish grey very fine to fine well sorted SAND. Diffuse to 6207. | Shallow marine to coastal | 6206 |
| | 3.90 | 4.26 | Well consolidated (firm) friable mid dark brownish grey very fine to fine well sorted very slightly clayey SAND. Sharp weakly undulate sub-horizontal with 6208. | Shallow marine to coastal | 6207 |
| | 4.26 | 5.00 | Moderately well consolidated (firm) mid dark brownish grey extremely shelly very fine to fine well sorted very slightly clayey SAND with whole bivalves and gastropod shells. Shell has weak sub-horizontal orientation in bands. | Shallow marine to coastal | 6208 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| VC-S6-005 | 0.00 | 0.53 | [VOID 0-0.12 m]. 5Y 3/1 Soft SILT. Clear lower boundary. | Alluvium (fine-grained minerogenic) | 501 |
| | 0.53 | 0.76 | Soft 5Y 3/2 silty fine SAND with thin laminae of silt between 0.73-0.75m. Sharp lower boundary. | Alluvium (fine-grained minerogenic) | 502 |
| | 0.76 | 1.00 | Soft 5Y 2.5/1 SILT. Lower boundary is unclear. | Alluvium (fine-grained minerogenic) | 503 |
| | 1.00 | 1.54 | Very soft dark greyish black organic silty becoming sandy CLAY. Slight organic odour, no seen fibrous components (amorphous). Frequent thin to thick beds of sand and clayey sand. Beds are localised with abrupt boundaries and contain occasional fine shell fragments. Sand is very fine to fine. Abrupt to 505. | Alluvium (fine-grained organic) | 504 |
| | 1.54 | 1.70 | Well compacted mid yellowish brown fine to medium SAND with rare irregular bands of organic blackish grey sandy clay. Rare shell fragments (molluscs and bivalves) which appear more frequent in coarser sand. Clear to 506. | Alluvium (fine-grained minerogenic) | 505 |
| | 1.70 | 2.00 | Very soft blackish brownish grey organic sandy CLAY with frequent thin to medium beds (4-15mm) of mid dark brown very sandy clay and silty sand. Sand is very fine to medium. Slight organic odour and amorphous. Abrupt to 507. | Alluvium (fine-grained organic) | 506 |
| | 2.00 | 2.60 | Soft dark brownish blackish grey organic interbedded clayey SAND and sandy CLAY. Sand is very fine to fine. Occasional fragmented and whole shells (gastropods). Black band of pseudo-amorphous slightly sandy peat at 2.29-2.30m. Sharp horizontal to 508. | Alluvium (fine-grained organic) | 507 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | 2.60 | 2.66 | Soft well consolidated mid dark greyish brown clayey fine SAND with shell fragments. Sharp horizontal to 509. | Alluvium (fine-grained minerogenic) | 508 |
| | 2.66 | 2.75 | Very soft dark blackish brown slightly organic slightly sandy CLAY, with sand being very fine. Dirty streak weak organic odour, no frag shell, gravel or fibrous organics seen. Sharp to 510. | Alluvium (fine-grained organic) | 509 |
| | 2.75 | 3.00 | Very soft to soft mid dark greyish brown well compacted clayey SAND. Regular bands of clay (2.81-2.84m and 2.96-2.98m). Common shell fragments particularly at base of coarse bands. Very weak organic odour. Lower boundary is unclear. | Alluvium (fine-grained minerogenic) | 510 |
| | 3.00 | 3.12 | Moderately compacted mid dark brownish grey slightly organic slightly clayey sandy GRAVEL. Sand is medium fine. Gravel is angular to rounded black flint. Common whole and fragmented bivalve and gastropod shells. Matrix supported, apparent weak normal sorting. Lenses of dark brown peat from below context at base of unit (erosive?). Sharp undulate horizontal to 512. | Shallow marine to coastal | 511 |
| | 3.12 | 3.15 | Firm horizontally fissile dark brownish black pseudo-fibrous to fibrous PEAT with strong organic odour. Woodchip seen, orientated sub-horizontally across fissile fracture. Weak streak, well compacted, slightly spongey. Sharp sub-horizontal to 513. | Peat | 512 |
| | 3.15 | 3.55 | Firm horizontally fissile dark orangey pseudo-fibrous to fibrous PEAT with moderate organic odour. Woodchip, detrital leaf and seeds, orientated sub-horizontally across fissile fracture. Very weak | Peat | 513 |

| Vibrocore ID | Depth from (m) | Depth to (m) | Description | Interpretation | Context no. |
|---|---|---|---|---|---|
| | | | streak, well compacted, slightly spongey. Abrupt horizontal to 514. | | |
| | 3.55 | 3.60 | Slightly soft mid dark brownish grey friable slightly organic slightly clayey medium fine SAND with fibrous greyish brown/green plant detritus. Massive. Clear horizontal boundary to 515. | Alluvium (fine-grained organic) | 514 |
| | 3.60 | 4.64 | Firm moderately consolidated friable mid dark grey medium fine to medium SAND. Very rare fine gravel-sized woody black plant detritus. Massive structure. Lens of dark brownish grey slightly clayey fine sand at 4.30m. Common shell fragments at lower boundary. Clear boundary to 5016. | Shallow marine to coastal | 515 |
| | 4.64 | 4.75 | Firm mid dark greyish brown laminated dark greyish brown slightly organic fine SAND with sparse detrital plant matter. Very weak organic odour dirty streak. Rare shell fragments. Sharp to 5017. | Shallow marine to coastal | 516 |
| | 4.75 | 4.95 | Moderately loosely compacted mid dark brownish grey medium fine to medium SAND with abundant fragmented and whole (bivalve) shells. Band of slightly clayey fine sand at 4.90m. | Shallow marine to coastal | 517 |

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