FIVE ESTUARIES
OFFSHORE WIND FARM

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ENVIRONMENTAL STATEMENT

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Five Estuaries OSWF

Geoarchaeological Monitoring of GI Works

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Summary

A programme of geoarchaeological monitoring of GI works and deposit modelling was undertaken on behalf of Five Estuaries Offshore Windfarm Ltd and North Falls Offshore Windfarm Ltd (hereafter referred to as the 'Client') associated with the Five Estuaries Offshore Windfarm onshore cable route (the 'Scheme'). The principal aims of the geoarchaeological monitoring and subsequent deposit modelling were focused on refining understanding of the nature and distribution of superficial sediments at the GI locations, to assess the geoarchaeological potential of the deposits, and to inform on the requirements for any further archaeological and geoarchaeological investigations.

Geoarchaeological monitoring of GI works was undertaken on a total of seven boreholes and associated hand-dug test pits, followed by a programme of geoarchaeological deposit modelling for the Site. No archaeology was identified in the hand-dug starter pits or boreholes. Kesgrave Sands and Gravels were encountered in four boreholes at depths between 1.2 and 2.0 m bgl, directly overlying London Clay bedrock. These deposits are considered likely to be equivalent to the Cooks Green Gravel of MIS 13–14 date (563-478 Kya), and have the potential to contain Lower Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential.

Brickearth was encountered at depths between 0.2 and 1.0 m bgl in five boreholes. The mode of deposition and age of these deposits is currently uncertain, though they may include a significant aeolian (loess) component and deposits formed through both colluvial and alluvial processes. They may include deposits formed in various stages of the Pleistocene. Dependent on specific age the Head-Brickearth has the potential to contain Lower or Middle Palaeolithic archaeology and fossiliferous sediments of significant geoarchaeological potential.

The scope of any further archaeological evaluation and mitigation will need to be considered when the construction impact of the proposed development is known, as this will have a direct impact on the requirement for and extent of any further evaluation. Given the wider archaeological potential of the deposits, there is potential for the deposits identified during the borehole monitoring to contain significant Palaeolithic archaeology. Recommendations for targeted geoarchaeological evaluation of appropriate deposits will be made in an updated GDBA. This GDBA will incorporate data on various phases of geoarchaeological monitoring and evaluation undertaken on the proposed route, and an assessment of design proposals and expected below ground impacts.

In addition, where appropriate opportunities arise during any subsequent GI works on the project, the opportunity to monitor these for geoarchaeological purposes should be considered.

Acknowledgements

Wessex Archaeology thanks Five Estuaries Offshore Windfarm Ltd and North Falls Offshore Windfarm Ltd, in particular James Eaton, for commissioning the work detailed in this report. We are grateful to Socotec for undertaking the GI works and facilitating access for the monitoring geoarchaeologist. The fieldwork was managed on site by Miriam Weinbren. Deposit modelling was undertaken by Miriam Weinbren and Dr Daniel Young. The report was compiled by Dr Daniel Young and Miriam Weinbren and reviewed by Dr Andy Shaw. Figures were produced by Kitty Foster. The project was managed on behalf of Wessex Archaeology by Marie Kelleher and Dr Daniel Young.

Five Estuaries OSWF

Geoarchaeological monitoring of GI works

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by Five Estuaries Offshore Windfarm Ltd and North Falls Offshore Windfarm Ltd (hereafter referred to as the 'Client') to produce a report outlining the results of geoarchaeological monitoring of geotechnical Ground Investigation (GI) works associated with the Five Estuaries Offshore Windfarm onshore cable route (the 'Scheme').

1.1.1 The onshore cable route (hereafter Onshore ECC) and substation works for the Five Estuaries Offshore Wind Farm (hereafter VE). The cable route will cover a distance of approximately 22km and will run from the coast to the south east of Great Holland (between Holland on Sea and Frinton on Sea) to an Onshore Substation (OnSS) located between Ardleigh and the A120. This will be connected to a new National Grid Substation.

1.1.2 The Five Estuaries Offshore Wind Farm will comprise an array of offshore wind turbine generators (WTGs) and offshore electrical platforms which will be connected to the shore by offshore export cables installed within an offshore cable corridor. The project also requires onshore infrastructure in order to connect the offshore wind farm to the National Grid. The entirety of the project area (hereafter described as 'the Red Line Boundary' (RLB)) is split into three areas:

- Landfall Zone
- Onshore Export Cable Corridor (Onshore ECC); and
- Onshore Substation (OnSS) Search Areas.

1.1.3 The North Falls Offshore Wind Farm (OWF) is a similar project which will utilize the same or a very similar Onshore Project Area to VE.

1.1.4 The GI monitoring areas investigated here are located at farmsteads to the west (Little Clacton and Railway Crossing) and north-west (Swan Road) of the village of Great Holland within the northern half of the Landfall Zone as defined in the initial archaeological desk-based assessment (WA 2022a) (see **Figures 1** and **2**).

1.1.5 The works follow on from an archaeological desk-based assessment (Wessex Archaeology 2022), geoarchaeological desk-based assessment (GDBA; Wessex Archaeology 2022b) and geophysical survey (Wessex Archaeology 2023a) for the Site.

1.2 Scope of works

1.2.1 The scope of works associated with the geoarchaeological monitoring of the GI works was outlined within the Written Scheme of Investigation (WSI; Wessex Archaeology 2023b). The GI works were originally proposed to include nine cable percussion boreholes with hand

dug inspection pits which required archaeological and geoarchaeological monitoring (**Figure 3**):

- BHLC-1, BHLC-2 BHLC-3, BHR-N, BHR-N, BHR-S, BHSR-1, BHSR-2, BHSR-3 and BHSR-4

1.2.2 Of these, boreholes BHLC-2 and BHSR-2 were descoped due to ecological constraints (nesting lapwing) and access issues, with the remainder monitored between the 27th April and 27th May 2023.

1.2.3 The geoarchaeological monitoring provided further information on the archaeological and geoarchaeological resource that may be impacted by the proposed development, and facilitate an informed decision with regard to the requirement for, and methods of, any further archaeological and geoarchaeological work that may be required; or the formation of a mitigation strategy (to offset the impact of the development on the archaeological resource) or a management strategy.

1.3 Scope of document

1.3.1 To help frame archaeological investigations of this nature, Wessex Archaeology has developed a four-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The borehole survey reported on here represents Stage 2 of this process (**Table 1**).

1.3.2 In format and content, the work follows the methodology set out within the WSI (Wessex Archaeology 2023b), and conforms to current best practice, including the guidance in *Management of Research Projects in the Historic Environment* (MoRPHE, Historic England 2015a), the Chartered Institute for Archaeologists' (CIfA) *Standard and guidance for archaeological field evaluation* (CIfA 2014a), Historic England's technical guide to Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record (Historic England 2015b) and Deposit Modelling and Archaeology (Historic England 2020).

1.3.3 The work was undertaken with reference to wider regional and national guidance and research frameworks relevant to the Site, including the East of England Regional Research Framework (EERRF; 2021), the Research and Conservation Framework for the British Palaeolithic (English Heritage 2008) and the Greater Thames Estuary Historic Environment Research Framework (English Heritage 2010).

Table 1 Staged Approach to Geoarchaeological Investigations

Stage 1: Geoarchaeological Desk-based Assessment (GDBA) and deposit modelling	A Geoarchaeological Desk-Based Assessment (GDBA) examines a range of data (published and unpublished ("grey literature"), LiDAR, historic maps) and models existing Ground Investigation (GI) data to inform on the possible Palaeolithic archaeological and geoarchaeological potential of a site. The GDBA may include, dependant on the site and complexity of a site, a Geoarchaeological Landscape Characterisation (GLC) which divides a study area into different zones (Geoarchaeological Characterization Zones – GCZs) based on variations in deposits and potential. The GDBA establishes the requirements for and scope of Stage 2 archaeological and geoarchaeological field elevation. Geoarchaeological potential is defined as potential for paleoenvironmental and dating evidence. Should Stage 2 evaluation be required, appropriate and proportionate recommendations for each GCZ are provided.
Stage 2: Geoarchaeological monitoring of GI works and/or Geoarchaeological borehole survey	Field evaluation to establish the geoarchaeological and archaeological potential of Quaternary deposits within an evaluation area, which informs on the requirements and scope of further works at Stage 2 (e.g. purposive borehole survey), Stage 3 palaeoenvironmental assessment and/or Stage 4 mitigation. The principal methods of geoarchaeological evaluation are through monitoring of Ground Investigation (GI) works or targeted boreholes. A geoarchaeological evaluation report is produced, which includes deposit modelling (where sufficient data allows) and recommendations for further work at Stage 2 or Stage 3 if required. Further works may include additional interventions (stepped trenches, test pits or boreholes) to retain additional/suitable samples for assessment.
Stage 3: Palaeoenvironmental assessment	Palaeoenvironmental samples recovered during Stage 2 are assessed to inform on the archaeological and geoarchaeological potential of deposits and guide the scope and need for Stage 4 analysis. A report is produced outlining the palaeoenvironmental potential of the deposits including targeted and proportionate recommendations for Stage 4 analysis.
Stage 4: Palaeoenvironmental analysis	Based on the results of the Stage 3 palaeoenvironmental assessment, palaeoenvironmental analysis on selected deposits/samples may be required. In addition to full analysis of suitable samples identified during the assessment work at Stage 4 may include additional scientific dating where appropriate/required. A final analysis report is provided on completion of mitigation program. Where appropriate, this may include recommendations for publication or other forms of dissemination.
Publication	The scope and location of a publication report will be agreed in consultation with the client and LPA advisor. The publication report may comprise a note in a local journal or a larger publication article or monograph, dependant on the significance of the archaeological and geoarchaeological work.

2 GEOARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 The WSI (Wessex Archaeology 2023b) identified the potential for superficial deposits in the GI locations that are of both Pleistocene and Holocene date. These epochs form parts of the Quaternary, a period covering the last 2.6 Mya, and defined by repeated fluctuations between cold (glacial) and warm (interglacial) climate stages (**Table 2**).

2.1.2 Where age estimates are available for deposits these are expressed in millions of years (Mya), thousands of years (Kya) and within the Holocene epoch as either years Before Present (BP), 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.

Table 2 British Quaternary chronostratigraphy

Geological Period	Chronostratigraphy		Age (Kya)	MIS
Holocene	Holocene interglacial		11.7 – present	1
Late Pleistocene	Devensian Glaciation	Loch Lomond Stadial	11.7 – 12.9	2 – 5d
		Windermere Interstadial	12.9 – 15	
		Dimlington Stadial	15 – 26	
		Upton Warren Interstadial	40 – 43	
		Early Devensian	60 – 110	
	Ipswichian interglacial		115 – 130	5e
Middle Pleistocene		Unnamed cold stage	130-374	6
		Aveley interglacial		7
		Unnamed cold stage		8
		Purfleet interglacial		9
		Unnamed cold stage		10
	Hoxnian interglacial		374 – 424	11
	Anglian glaciation		424 – 478	12
	Cromerian Complex		478 - 780	13 – 19

2.1.3 The geoarchaeological background to the Scheme is summarised in a GDBA (Wessex Archaeology 2022b), with information relevant to the GI monitoring areas outlined in the WSI (Wessex Archaeology 2023b). Relevant information is summarised here.

2.2 Previous investigations

Geoarchaeological Desk-Based Assessment (Wessex Archaeology 2022b)

2.2.1 A GDBA was prepared by Wessex Archaeology (2022b) for the North Falls Offshore Wind Farm (OWF), a similar project which will utilize the same or a very similar Onshore Project Area to the Five Estuaries Offshore Windfarm onshore cable route, including the onshore cable corridor and onshore substation zone (the 'Onshore Project Area').

2.2.2 On the basis of available data, including BGS archive boreholes, mapping of superficial deposits, analysis of Lidar data and baseline character mapping, the wider are of the Scheme has been divided into nine Geoarchaeological Character Zones (GCZs) (see Wessex Archaeology 2022b).

2.2.3 The present GI monitoring is located within three separate GCZs:

- Boreholes BHLC-1 and BHLC-3 are located within GCZ 2;
- Boreholes BHR-N and BHR-S are located within GCZ 3; and
- BHSR-1, BHSR-3 and BHSR-4 are located within GCZ 4.

2.2.4 These GCZs were summarised in the GDBA as follows:

GCZ 2

2.2.5 There is no available stratigraphic data for this zone and assessing the survival and potential of Quaternary deposits is not currently possible. BGS mapping indicates that no superficial deposits are present, although there is potential for unmapped Pleistocene deposits of the Holland Brook (post-MIS 12) or the Cooks Green Gravel (MIS 14–13), and Pleistocene Head and/or Holocene Colluvium.

2.2.6 Lower Palaeolithic archaeology from Daking's Pit (TERPS 31918–31920) and Bradley Hall Farm (TERPS 31921/HER MEX6960 and TERPS 319222) demonstrate the potential of the Wivenhoe/Cooks Green Gravels to contain deposits of minimally disturbed archaeology reflecting human activity during one of the earliest periods of the settlement history of Britain and north-west Europe. Such deposits also have the potential to contain organic and other fossiliferous sediments of significant geoarchaeological potential.

GCZ 3

2.2.7 Pleistocene deposits likely equivalent to the Cooks Green Gravel (MIS 14–13) and Brickearth are likely to be present in this zone, as well as Head and/or Holocene Colluvium on valley slopes.

2.2.8 The deposits of the Cooks Green Gravel and Brickearth have the potential to contain Lower and Lower/Middle Palaeolithic archaeology respectively, and organic and other fossiliferous sediments of significant geoarchaeological potential. Where archaeological finds are reworked within fluvial gravels and colluvial sediments, such material would be of moderate signficance. If minimally disturbed/in situ, such as within finer grained fluvial sediments or associated with stable land surfaces within the Brickearth, such archaeology would be of high significance.

2.2.9 Deposits of Pleistocene Head and/or Holocene Colluvium are most likely to contain reworked archaeological finds, potentially of multiple periods; the significance of such material is likely to be low-moderate. However, if they include stable land surfaces, these could be associated with archaeological layers, features and/or lithic scatters of higher signficance. The palaeoenvironmental potential of these deposits is likely to be low, except where calcareous units are identified.

GCZ 4

2.2.10 There is no available stratigraphic data for this zone and, similar to GCZ 2, gauging the survival and potential of Quaternary deposits is not currently possible. BGS mapping records outcrops of the Kesgrave Sands and Gravels within this zone, likely of the Cooks Green/Wivenhoe Gravels (MIS 14 –13), however, their extent may be greater than mapped. Unmapped deposits of either Pleistocene Head and/or Holocene colluvium may occur within valleys that are located in the zone.

2.2.11 As described above, the Cooks Green/Wivenhoe Gravels have the potential to contain Lower Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential. Where archaeological finds are reworked within fluvial gravels, such material would be of moderate significance; if minimally disturbed/in situ, such archaeology would be of high significance.

2.2.12 Deposits of Pleistocene Head and/or Holocene Colluvium are most likely to contain reworked archaeological finds, potentially of multiple periods; the significance of such material is likely to be low-moderate. However, if they include stable land surfaces, these could be associated with archaeological layers, features and/or lithic scatters. The palaeoenvironmental potential of these deposits is likely to be low, except where calcareous units are identified.

Geoarchaeological monitoring of Landfall GI works (Wessex Archaeology 2022c)

2.2.13 Wessex Archaeology undertook geoarchaeological monitoring of Ground Investigation (GI) works in April and May 2022 associated with the Landfall for the Five Estuaries Offshore Windfarm (OWSF), at its closest point c. 1 km to the south of the present investigation.

2.2.14 The monitoring of the GI works identified a sequence of superficial deposits including Kesgrave Sands and Gravels and Holocene alluvium between c. 0.0 and -8.0 m OD, including peat between c. -2.0 and -5.0 m OD. The alluvial sequence represents sediment accumulated under the influence of rising post-glacial sea-levels and deposited within an estuarine environment. The peat deposits within the Holocene alluvial sequence were considered to be of high geoarchaeological potential.

2.2.15 The surface of the underlying Sands and Gravels were considered to be of medium geoarchaeological potential, with the deposits of the gravel body itself considered to be low geoarchaeological potential. The gravel deposits were deeply buried, and conventional archaeological evaluation of this buried land surface was not considered practical.

2.3 Geoarchaeological background

2.3.1 Quaternary superficial deposits are mapped in the GI monitoring areas by the British Geological Survey (BGS) that include both Pleistocene and Holocene sediments (**Figure 2**). Deposits likely to be of Pleistocene date include 'Coversands' (referred to in this report as Brickearth) and sands and gravels of the Kesgrave Catchment Subgroup. Alluvium of Holocene date, and potentially Pleistocene fluvial deposits, may be present associated with the Holland Brook and its tributaries.

2.3.2 In the three areas associated with the GI works, the mapped deposits are limited to Coversands and sands and gravels of the Kesgrave Catchment Subgroup.

Bedrock

2.3.3 The solid geology underlying the GI monitoring areas is mapped by the British Geological Survey (BGS) as belonging to the Thames Group – described as Clay, Silt and Sand (**Figure 1**). This is a sedimentary bedrock formed approximately 34 to 56 Mya in the Palaeogene Period.

Kesgrave Sands and Gravels

2.3.4 The bedrock is overlain by superficial deposits of the Kesgrave Catchment Subgroup. The Kesgrave Sands and Gravels are the sediments of the pre-Anglian River Thames (MIS 12; 478-424 Kya). At the time of their deposition this river system flowed south-eastwards from

Wales and the West Midlands, eastwards through the middle Thames valley, north-eastwards into East Anglia, then progressively eastwards to a contemporaneous shoreline in Suffolk and Essex (Rose et al. 1999).

2.3.5 Terraces associated with this river system were formed between c. 1.81 Mya and 460 Kya (late Early to early Middle Pleistocene), forming the older Sudbury and younger Colchester Formations, until they were overridden by the Anglian ice sheet (Rose et al 1999). On the basis of their altitude and position, Whiteman (1992) identified 10 terrace landforms associated with the Sudbury and Colchester Formations. In the area of the Scheme Rose et al (1999) show the Gravel terraces potentially underlying the Site as those of the Colchester Formation (c. 860-460 Kya; **Table 3**).

Table 3 Eastern Essex Quaternary Stratigraphy (after Bridgland 1988; 1994; Bridgland and Allen 1996; Bridgland et al. 1990; 1999; and Westaway 2014)

High-Level East Essex Gravel (HEEG)				**Thames**	**Thames/Medway Confluence**
Postulated Marine Isotope Stage (MIS)	**Southend area**	**Dengie Peninsula**	**Mersea Island**	**Tendring Peninsula**	**Tendring Peninsula**
MIS 12-11-10 MIS 11	Southchurch Gravel Southend Channel	Asheldham Lower and Upper Gravel Ashheldham Channel	Mersea Island Gravel		Wigborough Channel Clacton Channel
MIS 12 (Anglian Ice)	Chalkwell Gravel	Caidge Gravel		Upr St Osyth Gravel	Upr Holland Gravel
MIS 12 (early)				Lwr St Osyth Gravel	Lwr Holland Gravel
MIS 13 MIS 13 MIS 14	Canewdon Gravel	St Lawrence Gravel		Wivenhoe Upper Gravel Wivenhoe Interglacial deposits Wivenhoe Lower Gravel	Cooks Green Gravel
MIS 14 MIS 15 MIS 16	Belfairs Gravel Ashingdon Gravel	Mayland Gravel		Ardleigh Upper Gravel Ardleigh Interglacial deposits Ardleigh Lower Gravel	Colluvium Little Oakley Silts & Sands
MIS 16	Oakwood Gravel			Waldringfield Gravel	(Offshore)
MIS 18	Daws Heath Gravel				(Offshore)

MIS 20/22	Claydon Gravel				(Offshore)

Brickearth

2.3.6 The BGS show deposits of clay, silt and sand overlying the overlying the Kesgrave Sands and Gravels in the area of the Site, particularly in the northern area, described as Coversands. These form part of the sequence of 'Brickearth' deposits that are widespread in this part of Essex, the mode of deposition and age of which is uncertain. 'Brickearth' is a generic term used to describe a range of deposits. These are post-Anglian (<MIS 12) Pleistocene deposits, but their specific age range is uncertain. They are likely to include a significant aeolian (loess) component, but may also include deposits formed through both colluvial and alluvial processes.

2.3.7 Loess is a silt-sized wind-blown sediment transported in periglacial conditions close to the margins of ice sheets (Antoine et al 2003). Loess is present widely across southern England where it reaches a maximum thickness of 4m at Pegwell Bay, East Kent (Pilcher et al 1954; Antoine et al 2003). The majority of Loess is found in Kent and Sussex where it dates to the Late Devensian (MIS 2) between 18.8 to 14.6 Kya (Parks and Rendell 1992; Bateman 1998). Older loess deposits principally dated to MIS 6 and MIS 12 are known in southern England, however. Antoine et al (2003) interpret the deposits of Brickearth in this region as the result of local aeolian reworking of sandy glacial outwash sediments during the Late Devensian glaciation.

2.3.8 Primary loess is directly lain down as windblown sediments and this can be subsequently reworked downslope by colluvial processes. In both instances these deposits can contain or bury stabilisation horizons (which can be associated with soil formation) that may be associated with minimally disturbed Palaeolithic archaeology and palaeoenvironmental evidence.

2.3.9 O'Connor (2015) describes the basal element of the Brickearth throughout much of the Tendring District as a thin, fine sand, likely to have an aeolian origin and equivalent to the Coversand described by the BGS. Resting on top of the Coversand is a predominantly silty deposit (loess), usually less than 0.75 m thick but reaching over 1.0 m in thickness at Walton (O'Connor 2015). In places the Brickearth contains small stones worked upwards from the underlying gravels due to frost action (O'Connor 2015).

2.3.10 Fossiliferous brickearth deposits occur at Wrabness. Pleistocene faunal material has been known from this site since the 18th century (Lufkin 1701), with reports of 'diverse bones of extraordinary bigness'. Descriptions also suggest that a whole mammoth may have been identified within cliffs on the eastern side of Wrabness Bay (Christy 1907, Wymer 1985), where sands and fine gravel was recorded.

2.3.11 The fauna from Wrabness has been reported to contain *Equus ferus* (horse), *Cervus elaphus* (red deer), *Bos* or *Bison* (aurochs or bison), *Palaeoloxodon antiquus* (straight-tusked elephant), *Mammuthus primigenius/Mammuthus trogontherii* (woolly/steppe mammoth) (O'Conner 2015). This range of species, including both straight tusked elephant and potentially steppe mammoth, may be indicative of an MIS 7 date (243-191 Kya).

2.4 Archaeological background

2.4.1 Detailed archaeological and geoarchaeological desk-based assessments have been completed (Wessex Archaeology 2022a; 2022b) which includes finds and sites located

across the wider Scheme. The following is a summary of notable findspots and sites (ADS 2023) relevant to the GI monitoring locations.

Palaeolithic (450,000–12,000 BC)

2.4.2 No Palaeolithic artefacts are recorded from the immediate vicinity of the GI monitoring locations. However, a review of the Pleistocene deposits underlying the wider Scheme (Wessex Archaeology 2022b) has demonstrated that fluvial deposits of the Colchester Formation are likely to be present underlying the GI monitoring areas, and these have the potential contain significant Lower Palaeolithic archaeology.

2.4.3 The specific Palaeolithic archaeological potential of the overlying Brickearth is poorly characterised. However, such deposits in the wider area (for example at Wrabness – see **section 2.2.11**) have produced Middle Palaeolithic artefacts, indicative of Palaeolithic archaeological potential.

Mesolithic, Neolithic, Bronze Age and Iron Age (12,000 BC–AD 43)

2.4.4 At Great Holland a sub-rectangular enclosure was visible as a cropmark on air photographs. Orientated roughly northwest-southeast, it has been suggested to represent a cursus, although with all four sides visible, it would appear to be rather short and broad compared to most known cursus monuments. The long western side also continues south as a field boundary, the latter also partially marked by trees extant on photographs taken in 1976. The whole area is dominated by cropmarks of geological origin, although a few linear features presumably representing field boundaries are also visible (**MN1339656**). In 1976 a Neolithic axe was discovered at Thorpe Le Soken to the north west of the Site (**TM 12 SE 25**).

Romano-British, Saxon and Medieval (AD 43–1485)

2.4.5 At Frinton-on-Sea in 1904, a trench filled with black earth containing Romano British potsherds, was observed in the cliff top nearly opposite Connaught Avenue. It was seen again in 1910, during alterations to Kelvin Lodge, Fourth Avenue. This line running west-southwest coincides with a former farm hedge bank and ditch which can still be traced in the greensward and in private gardens on the west of Fourth Avenue (**MN389498**). A medieval hearth and oven was discovered during excavation of a cable route at Little Clacton to the west of the Site area (**MN1569389**).

Post-medieval and Modern (AD 1486–1485)

2.4.6 At Frinton and Walton are two smock mill for the milling of cereals. One, moved to it's present position in 1840, the mill ceased production in 1913. The building has since being converted into a house (**TM 21 NW 20**), the other built in the mid 19th century only remains as the stump of the mill (**TM 21 NW 16**).

3 AIMS AND OBJECTIVES

3.1.1 As outlined within the WSI (Wessex Archaeology 2023b), the aims of the geoarchaeological monitoring of the GI works were as follows:

- To determine, as far as is reasonably possible, the nature of the detectable archaeological resource in the area of the GI works;
- Refine understanding of the presence, nature and distribution of Quaternary superficial deposits in the area of the GI works;

- Assess the archaeological and geoarchaeological potential of the deposits in the area of the GI works;
- Correlate the results of the GI works to produce a deposit model for the site, mapping the extent of superficial deposits across the area of the GI works;
- Inform on the need for and scope of any further archaeological or geoarchaeological investigation of the Quaternary deposits in the area of the GI works.

3.1.2 These aims were addressed by achieving the following objectives:

- Undertaking geoarchaeological monitoring of seven of the originally proposed nine cable percussion boreholes (BHLC-1, BHLC-3, BHR-N, BHR-S, BHSR-1, BHSR-3 and BHSR-4);
- Archaeological monitoring of hand dug starter pits associated with each borehole;
- Recording the sequence of Quaternary deposits within each borehole and associated hand-dug test pit;
- To undertake deposit modelling of the data arising from the borehole survey, integrating any available BGS archive boreholes, in order to map the extent, thickness and depth of Quaternary deposits;
- Interpret the probable environments represented;
- Identify the presence of deposits of high archaeological potential;
- Make specific recommendations for further work, where appropriate, which may include additional geoarchaeological boreholes, palaeoenvironmental assessment and/or scientific dating.

4 METHODOLOGY

4.1 Introduction

4.1.1 Health and safety override archaeological considerations in all works since, as stated in CIfA guidance, *Health and Safety regulations and requirements cannot be ignored no matter how imperative the need to record archaeological information; hence Health and Safety will take priority over archaeological matters* (CIfA 2020a, 11).

4.1.2 All works were undertaken in accordance with the detailed methods set out within the WSI (Wessex Archaeology 2023b). Any significant variations to these methods were agreed in writing with the County Archaeologists and client, prior to being implemented. The fieldwork was carried out under the supervision of an experienced geoarchaeological specialist.

4.1.3 The monitored GI works comprised:

- Seven boreholes undertaken using a cable percussion drilling rig;
- Seven associated hand-dug starter pits.

4.2 Geoarchaeological monitoring

4.2.1 An experienced member of the Wessex Archaeology geoarchaeology team monitored the GI works. The attending geoarchaeologist liaised closely with the geotechnical team in order to ensure effective communication was maintained throughout the works.

4.2.2 Hand-dug starter pits were excavated to a depth of 1.2 m below ground level (bgl) prior to drilling. All hand-dug pits were monitored by the attending geoarchaeologist and recorded as described below. Cable percussion drilling commenced from the base of the test pit. The boreholes were drilled to depths between 20.0 and 25.45 m bgl.

4.2.3 The supervising geoarchaeologist recorded and interpreted the sequence of deposits encountered in order to allow assessment of likely geoarchaeological potential.

4.2.4 Any exposed archaeological deposits and features were recorded using a pro forma recording system. A record of the datum (either m above Ordnance Datum or m below ground level) levels of the archaeological deposits was recorded by the monitoring geoarchaeologist. This data was tabulated by test pit/borehole and depth.

4.3 Sediment description

4.3.1 The GI interventions were recorded using Wessex Archaeology's pro-forma digital recording system. For each stratigraphic unit descriptions and interpretations of the deposits are provided. Descriptions of deposits included information such as:

- *Depth*
- *Texture*
- *Composition*
- *Colour*
- *Inclusions*
- *Structure*
- *Shape and nature of contacts between deposits*

4.3.2 Interpretations included, where possible, probable depositional environments and formation processes.

4.3.3 A full photographic record was made using a digital camera equipped with an image sensor of not less than 10 megapixels. This recorded both the detail and the general context of the principal lithological and stratigraphic features, and the evaluation area as a whole.

4.3.4 Digital images were subject to managed quality control and curation processes which will embed appropriate metadata within the image and ensure long term accessibility of the image set. Photographs were taken of all areas, including access routes, to provide a record of conditions prior to and on completion of the borehole survey.

4.4 Review of GI logs

4.4.1 The results of the geoarchaeological monitoring were supplemented by a review of the stratigraphic logs arising from the GI works. These logs were combined with a review of British Geological Survey (BGS) archive boreholes undertaken during the previous GDBA (Wessex Archaeology 2022b), resulting in a total of 59 additional borehole logs. Of these,

only a single borehole was included in the deposit model (see below) on the basis of proximity to the current works.

4.4.2 The log review was undertaken by a suitably qualified geoarchaeologist, with an assessment of the quality of the sediment descriptions and a geoarchaeological interpretation of the deposits cross-referencing the GI locations with nearby monitored interventions, existing BGS mapping and their topographic context.

4.4.3 The results of this review were compiled in an Excel spreadsheet for deposit modelling purposes.

4.5 Deposit modelling

4.5.1 Following a review of a total of 59 British Geological Survey (BGS) archive boreholes undertaken for the wider area of the Scheme during the previous GDBA (Wessex Archaeology 2022b), a geoarchaeological deposit model was constructed for the GI monitoring areas using a total of eight stratigraphic records, including the seven new boreholes and a single BGS online archive borehole (http://mapapps.bgs.ac.uk/geologyofbritain/home.html). The deposit modelling was undertaken following the guidelines in Historic England (2020).

4.5.2 All available data points were entered into industry standard geological utilities software (Rockworks™ 17). Each stratigraphic unit was given a colour and pattern allowing cross correlation and grouping of the different sedimentary units. The grouping of these deposits is based on lithological descriptions, which define distinct depositional environments referred to as 'stratigraphic units'.

4.5.3 Sedimentary units from the boreholes were classified into five stratigraphic units: (1) Bedrock, (2) Sands and Gravels, (3) Brickearth, (4) Made Ground and (5) Topsoil. The classified data for groups 1 to 5 were then input into a database within the RockWorks™ 2023 program.

4.5.4 A single two-dimensional stratigraphic profile ('transect') showing the eight selected boreholes across the Site were generated using RockWorks™ 2023 showing the main stratigraphic units and their lateral and vertical variability across these areas of the Site (**Figure 4**).

4.5.5 The key aims of the modelling were to interpret the data, identify the probable depositional environments represented, and determine areas of higher and/or lower archaeological potential where further work may be required (e.g. deposits with potential for the recovery of significant archaeological and palaeoenvironmental remains).

5 RESULTS

5.1 Introduction

5.1.1 This section summarises the results of the geoarchaeological monitoring of GI works, integrating the results of the geoarchaeological deposit modelling and drawing on the results of a previous GDBA relevant to the present monitoring (Wessex Archaeology 2022b). A total of seven boreholes and associated hand-dug starter pits (**Appendix 1**) were monitored as outlined in **Section 4.2**, with a programme of geoarchaeological deposit modelling for the GI monitoring areas building on the work of the previous GDBA.

5.1.2 No archaeology was identified in the hand-dug starter pits or boreholes. The results of the geoarchaeological deposit modelling, comprising a single transect aligned broadly northwest to southeast, are shown in **Figure 4**.

5.2 Stratigraphic sequence

5.2.1 The full sequence of superficial geological deposits recorded during the monitoring of the GI works, and forming the basis of the deposit modelling, comprises:

- Topsoil/Made Ground (Recent);
- Brickearth (Pleistocene and/or Holocene);
- Fluvial Sands and Gravels (Pleistocene); and
- Bedrock (London Clay Formation).

Bedrock

5.2.2 A unit of stiff, brown, occasionally silty clay was reached in all boreholes at elevations ranging from 11.16 m OD in BHR-S to 24.32 m OD in BHSR-4 (see **Figure 4**). These deposits are interpreted as London Clay bedrock.

Fluvial Sands and Gravels

5.2.3 A unit described as an orangish brown, in places clayey coarse sand with flint gravel was recorded in boreholes BHLC-1, BHLC-3, BHSR-3 and BHSR-4. The deposits ranged in thickness from 0.90 m in BHSR-4 to 4.40 m in BHLC-3. They were recorded at elevations between c. 19 and 24 m OD in boreholes BHLC-1 and BHLC-3 towards the south, and between c. 23 and 25 m OD in boreholes BHSR-3 and BHSR-4 towards the north. No distinct fine-grained or organic units were recorded within the Sands and Gravels.

5.2.4 Similar but thicker deposits were identified during the previous GDBA (Wessex Archaeology 2022b) in TM22SW12, located to the southeast of BHR-S, at between c. 15 and 21 m OD.

5.2.5 These deposits are interpreted as Pleistocene Fluvial Sands and Gravels of the Kesgrave Catchment Subgroup. These are sediments of the pre-Anglian River Thames, with terraces associated with this river system formed between c. 1.81 Mya and 460 Kya (late Early to early Middle Pleistocene), forming the older Sudbury and younger Colchester Formations, until they were overridden by the Anglian ice sheet (Rose et al 1999). The deposits here are likely those of the Colchester Formation of Rose et al (1999) (c. 860-460 Kya; **Table 3**).

5.2.6 In the previous GDBA these Sands and Gravels were recorded at elevations between c. 25 and 35 m OD towards the north of the Scheme, and at between c. 15 and 25 m OD towards the south (see Wessex Archaeology 2022b). The records for the Sands and Gravels identified here are consistent with this 'southern' group, and are considered likely to be equivalent to the Cooks Green Gravels (MIS 13–14; 563-478 Kya), representing gravels deposited at the confluence of the Thames and Medway Rivers, generally orientated west-east in this area from Little Clacton to the coast at Frinton (ECC 2009).

Brickearth

5.2.7 An orangish brown sandy clay with occasional flint clasts was recorded in boreholes BHLC-1, BHLC-3 and BHSR-3 overlying Sands and Gravels, and in BHR-N and BHR-S overlying London Clay bedrock. The deposits ranged in thickness from 0.70 m in BHSR-3 to 4.0 m in

BHR-S, generally ranging in elevation between c. 20.0 and 25.0 m OD. However, in BHR-S these deposits are significantly deeper, recorded at elevations between c. 11.0 and 15.0 m OD.

5.2.8 These deposits are interpreted as Brickearth, forming part of a sequence that is widespread in this part of Essex, the mode of deposition and age of which is currently uncertain. They are likely to include a significant aeolian (loess) component, but may also include deposits formed through both colluvial and alluvial processes. Here the deposits are predominantly sandy, though they include a significant clay component and occasional flint clasts. These deposits are post-Anglian (<MIS 12) in date, but their specific age range is uncertain and they may include deposits formed in various stages of the Pleistocene, and could potentially include deposits of Holocene date (e.g. more recent colluvium).

Topsoil/Made Ground

5.2.9 Present in all boreholes, this was the uppermost unit composed of gravel, sandy clay, and redeposited soil with anthropogenic inclusions such as brick. This ranged in thickness from 0.20 m in BHLC-3 to 2.0 m in BHLC-1 and BHSR-4. These deposits were predominantly formed through ploughing associated with modern agricultural activity in the area of the boreholes.

6 DISCUSSION

6.1 Introduction

6.1.1 A programme of geoarchaeological monitoring of GI works and deposit modelling was undertaken at the monitoring locations, building on work carried out during a previous GDBA (Wessex Archaeology 2022b). The GI locations were in Geoarchaeological Character Zones (GCZs) 2 to 4 as assigned in the previous GDBA (see Wessex Archaeology 2022b).

6.1.2 The principal aims of the geoarchaeological monitoring and subsequent deposit modelling were focused on refining understanding of the nature and distribution of superficial sediments in these areas of the Scheme, to assess the geoarchaeological potential of those deposits, and to inform on the requirements for any further archaeological investigations.

6.1.3 A total of seven boreholes were monitored, supported by a programme of deposit modelling. These investigations have revealed a consistent sequence across the evaluation areas, comprising London Clay bedrock, Kesgrave Sands and Gravels, Brickearth, and Topsoil and Made Ground.

6.1.4 No significant archaeology was identified during the monitoring. The discussion presented here is focused on the archaeological potential of the Quaternary deposits encountered.

6.2 Sedimentary Sequences and depositional environment

6.2.1 The basal superficial deposits recorded across the area of the GI works, specifically in four of the seven boreholes (BHLC-1, BHLC-3, BHSR-3 and BHSR-4), are the Kesgrave Sands and Gravels, forming fluvial deposits of the pre-Anglian River Thames (MIS 12; 478-424 Kya). At the time of their deposition this river system flowed south-eastwards from Wales and the West Midlands, eastwards through the middle Thames valley, north-eastwards into East Anglia, then progressively eastwards to a contemporaneous shoreline in Suffolk and Essex (Rose et al. 1999).

6.2.2 The Sands and Gravels recorded in the GI boreholes are present at elevations between c. 19 and 24 m OD towards the south, and between c. 23 and 25 m OD towards the north, consistent with the Cooks Green Gravels (MIS 13-14; 563-478 Kya, see **Table 3**). These Gravels were deposited at the confluence of the Rivers Thames and Medway, generally orientated west-east in this area from Little Clacton to the coast at Frinton and (ECC 2009).

6.2.3 The deposits of the Cooks Green Gravel have the potential to contain Lower Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential. Where archaeological finds are reworked within fluvial gravels such material would be of moderate significance with regards to regional and national research agendas and priorities (EERRF 2021, English Heritage 2008). If minimally disturbed/in situ, such as within finer grained fluvial sediments or associated with stable land surfaces within the Gravels, such archaeology would be of high significance.

6.2.4 No evidence for fine-grained units or stable land surface was encountered within the present boreholes, though such deposits may be encountered elsewhere within these deposits. Archaeological and palaeoenvironmental (including scientific dating) potential would be high where such deposits are encountered.

6.2.5 Brickearth was recorded overlying the Kesgrave Sands and Gravels in boreholes BHLC-1, BHLC-3 and BHSR-3, and overlying London Clay bedrock in BHR-N and BHR-S. these deposits were generally present at elevations between c. 20.0 and 25.0 m OD, although in BHR-S they were present within a dry valley at elevations between c. 11.0 and 15.0 m OD.

6.2.6 The mode of deposition and age of these deposits is currently uncertain. As outlined in **Section 5.2** they are likely to include a significant aeolian (loess) component, but may also include deposits formed through both colluvial and alluvial processes. Here the deposits are predominantly sandy, though they include a significant clay component and occasional flint clasts. These deposits are post-Anglian (<MIS 12) in date, but their specific age range is uncertain, and could potentially include deposits of Holocene date (e.g. more recent colluvium).

6.2.7 As outlined in **Section 2.3**, O'Connor (2015) describes the basal element of the Brickearth throughout much of the Tendring District as a thin, fine sand, likely to have an aeolian origin and equivalent to the Coversand described by the BGS. Resting on top of the Coversand is a predominantly silty deposit (loess), usually less than 0.75 m thick but reaching over 1.0 m in thickness at Walton (O'Connor 2015). In places the Brickearth contains small stones worked upwards from the underlying gravels due to frost action (O'Connor 2015). The Brickearth described here is predominantly sandy, indicating that these deposits may have a similar depositional origin, though the clay component may indicate some alluvial reworking of the sediments.

6.2.8 Dependant on date, the Brickearth deposits have the potential to contain Lower and Middle Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential. Where archaeological finds are reworked within colluvial sediments, such material would be of moderate significance. If minimally disturbed/in situ, such as where they are associated with stable land surfaces within the Brickearth, such archaeology would be of high significance.

6.2.9 Where deposits of Pleistocene Head and/or Holocene Colluvium are present, these may contain reworked archaeological finds, potentially of multiple periods; the significance of such material is likely to be low-moderate. However, if they include stable land surfaces,

these could be associated with archaeological layers, features and/or lithic scatters. The palaeoenvironmental potential of these deposits is likely to be low, except where calcareous units are identified.

6.2.10 The Brickearth at the monitoring locations is overlain by a modern ploughsoil described here as Made Ground. This deposit is of negligible archaeological potential.

7 CONCLUSION AND RECOMMENDATIONS

7.1 Summary

7.1.1 Geoarchaeological monitoring of GI works was undertaken on a total of seven boreholes and associated hand-dug test pits, followed by a programme of geoarchaeological deposit modelling for the Site building on the work of a previous GDBA (Wessex Archaeology 2022b) and work undertaken at the landfall (Wessex Archaeology 2022c). No archaeology was identified in the hand-dug starter pits or boreholes, but Quaternary deposits with archaeological potential were identified.

7.1.2 The key results of the geoarchaeological monitoring, and the archaeological potential of the revealed deposits, are summarised below:

- Kesgrave Sands and Gravels were encountered in four boreholes at depths between 1.2 and 2.0 m bgl, directly overlying London Clay bedrock. These deposits are considered likely to be equivalent to the Cooks Green Gravel of MIS 13–14 date (563-478 Kya), and have the potential to contain Lower and Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential.

- Brickearth was encountered at depths between 0.2 and 1.0 m bgl in five boreholes. The mode of deposition and age of these deposits is currently uncertain, though they may include a significant aeolian (loess) component and deposits formed through both colluvial and alluvial processes. They may include deposits formed in various stages of the Pleistocene and, dependent on date, have the potential to contain Lower and Middle Palaeolithic archaeology and organic and other fossiliferous sediments of significant geoarchaeological potential.

7.2 Recommendations

7.2.1 The scope of any further archaeological evaluation and mitigation will need to be considered when the construction impact of the proposed development is known, as this will have a direct impact on the requirement for and extent of any further evaluation. Although no archaeological finds or features were identified during the monitoring, Quaternary superficial deposits with archaeological potential were identified.

7.2.1 Recommendations for targeted geoarchaeological evaluation of appropriate deposits will be made in an updated GDBA. This GDBA will incorporate data on various phases of geoarchaeological monitoring and evaluation undertaken on the proposed route, and an assessment of design proposals and expected below ground impacts.

7.2.2 The requirements for, and appropriate methods of evaluation will be made based on expected impacts and variations in geological characteristics of the deposits present, linked to the assessment of the archaeological potential of the Quaternary superficial deposits. Appropriate methods of evaluation may include machine-dug test pits with associated artefact sieving and sampling for paleoenvironmental and dating evidence, and where

deeper deposits are identified, boreholes. Where appropriate opportunities arise during any subsequent GI works on the project, the opportunity to monitor these for geoarchaeological purposes should also be considered.

REFERENCES

Antoine P, Catt J, Lautridou J-P and Sommé J 2003 The loess and coversands of northern France and southern England. *Journal of Quaternary Science* 18, 309-318.

Bateman M 1998 Geochronology, in Murton, J.B., Whiteman, C.A., Bates, M.R., Bridgland, D.R., Long, A.J., Roberts, M.B., and Waller, M.P (Eds.) *The Quaternary of Kent and Sussex field guide*. London: Quaternary Research Association.

Bridgland DR, Gibbard PL and Preece RC 1990 The geology and significance of interglacial sediments at Little Oakley, Essex. *Philosophical Transactions of the Royal Society of London* B328: 307-339.

Bridgland DR 1994 *The Quaternary of the Thames*. Geological Conservation Review Series No.7. Chapman & Hall, London.

Bridgland DR and Allen P 1996 A revised model for terrace formation and its significance for the early Middle Pleistocene terrace aggradations of northeast Essex, England. In (Turner, c.; ed.) *The Early Middle Pleistocene in Europe*. Balkema, Rotterdam, 121-134.

Bridgland D, Field MH, Holmes J, McNabb J, Preece RC, Selby I, Wymer JJ, Boreham S, Irving BG, Parfitt SA and Stuart AJ 1999 Middle Pleistocene interglacial Thames–Medway deposits at Clacton-on-Sea, England: Reconsideration of the biostratigraphical and environmental context of the type Clactonian Palaeolithic industry. *Quaternary Science Reviews* 18: 109-146.

Brown J 1838 Discovery of a large pair of fossil horns in Essex. *Magazine of Natural History*, Ser. 2, 2, 163-164.

Brown J 1840 Notice of a fluvio-marine deposit containing mammalian-remains occurring in the parish of Little Clacton on the Essex coast. *Magazine of Natural History*, Ser. 2, 4, 197-201.

Brown J 1841 A list of the fossil shells found in a fluvio-marine deposit at Clacton in Essex. *Annals and Magazine of Natural History*, Ser. 1, 7, 427-429.

Chartered Institute for Archaeologists [CIfA] 2020a *Standard and Guidance for Archaeological Field Evaluation*. Reading, CIfA

Christy M 1907 *Victoria History of the County of Essex. Vol. 2* (industries).

English Heritage 2008 *Research and Conservation Framework for the British Palaeolithic*. The Prehistoric Society/English Heritage, April 2008.

Essex County Council 2008 *Tendring District Historic Environment Characterisation Project*. Tendring District Council/Essex County Council, 2008.

Essex County Council 2009 *Tendring Geodiversity Characterisation Report*. Tendring District Council/Essex County Council, 2009.

Gascoyne A and Medlycott M 2014 *Essex Historic Grazing Marsh Project*. Essex County Council, February 2014.

English Heritage 2004 *Using historic landscape characterisation*. English Heritage and Lancashire Country Council.

Historic England 2015a *Management of Research Projects in the Historic Environment: The MoRPHE project managers' guide*. Swindon: Historic England.

Historic England 2015b *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record.* Swindon, Historic England

Historic England 2020 *Deposit Modelling and Archaeology. Guidance for Mapping Buried Deposits*. Swindon. Historic England.

Ingle C and Saunders H 2003 *Essex NMP Project Management Report*. Essex County Council/English Heritage, November 2003.

Kemp RA 1985 The Valley Farm Soil in southern East Anglia. In (Boardman, J.; ed.) *Soils and Quaternary Landform Evolution*. Wiley, Chichester: 179-196.

Kemp RA, Whiteman CA and Rose J 1993 Palaeoenvironmental and stratigraphic significance of the Valley Farm and Barham Soils in eastern England. *Quaternary Science Reviews* 12: 833-848.

Natural England 2014. *An approach to landscape character assessment*. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/396192/landscape-character-assessment.pdf

O'Connor T 2015 *Managing The Essex Pleistocene*. Essex County Council, September 2015.

Parks DA and Rendell HM 1992 Thermoluminescence dating and geochemistry of loessic deposits in south-east England. *Journal of Quaternary Science* 7: 99-107.

Pilcher WS, Shearman DJ and Pugh DC 1954 The loess of Pegwell Bay and its associated frost soils. *Geological magazine* 91, 308-314.

Read G 1994 *Buried Pleistocene Soils in Essex and Suffolk, U.K.* PhD thesis, University of London.

Read G, Kemp RA and Rose J 1996 Development of a feldspar weathering index and its application to a buried soil chronosequence in southeastern England. *Geoderma* 74: 267-280.

Rose J, Kemp RA, Whiteman CA and Owen N 1985 The Early Anglian Barham Soil of eastern England. In (Boardman, J.; ed.) *Soils and Quaternary Landscape Evolution*. Wiley, Chichester: 197-230.

Rose J, Whiteman CA, Allen P and Kemp RA 1999 The Kesgrave Sands and Gravels: 'pre-glacial' Quaternary deposits of the River Thames in East Anglia and the Thames valley. *Proceedings of the Geologists' Association* 110 (2): 93-116.

Royal HaskoningDHV 2022 North Falls Offshore Wind Farm: Scope of Works for Geoarchaeological Desk-Based Assessment. Confidential Specification, May 2022.

West RG 1980 *The pre-glacial Pleistocene of the Norfolk and Suffolk coasts*. Cambridge University Press, Cambridge.

Westaway, R. (2014) Quaternary uplift revealed by terrace deposits of the Lower Thames system. In: Bridgland, D.R., Allen, P. and White, T.S. (eds.) *The Quaternary of the Lower Thames and Eastern Essex: Field Guide*. The Quaternary Research Association: London, pp. 39-55.

Whiteman CA 1992 The palaeogeography and correlation of pre-Anglian Glaciation terraces of the River Thames in Essex and the London Basin. *Proceedings of the Geologists' Association* 103: 37-56.

Wessex Archaeology and Wymer J 2009 TERPS - The English Rivers Project [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1000063

Wessex Archaeology and Jacobi RM 2014 Palaeolithic and Mesolithic Lithic Artefact (PaMELA) database [data-set]. York: Archaeology Data Service [distributor] https://doi.org/10.5284/1028201.

Wessex Archaeology 2022a Five Estuaries Offshore Wind Farm Onshore Project Area, Essex Archaeological Desk-Based Assessment. Report ref.: 231910.01, December 2022.

Wessex Archaeology 2022b. *North Falls Offshore Wind Farm – Onshore Project Area Geoarchaeological Desk Based Assessment*. Report Ref: 265330, September 2022.

Wessex Archaeology 2022c. Five Estuaries OSWF Onshore cable route Archaeological and Geoarchaeological Monitoring of Ground Investigation works. Report Ref: 231912.2, December 2022.

Wessex Archaeology 2023a Onshore Geophysics Five Estuaries, Essex Detailed Gradiometer Survey Report. Report Ref.: 231911.03, February 2023.

Wessex Archaeology 2023b. *Five Estuaries Onshore Cable Route Written Scheme of Investigation for Archaeological and Geoarchaeological Monitoring of Ground Investigation Works.* Report Ref: 231912, March 2023.

Wymer, J.J. 1985. Palaeolithic Sites of East Anglia. Geo Books, Norwich.

APPENDIX

Appendix 1 Sediment description logs

Site Code: 231914	Site Name: Five Estuaries	Borehole ID: WA-01/BHR-N
Coordinates (NGR) X: 619734.90	Coordinates (NGR) Y: 220458.70	Level (top): 22.98 m OD
Length:	Width:	Depth: 25 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
101	Brown sandy clay soil with rootlets onto orangish brown clay-still contains rootlets.	Topsoil	0.00 - 0.30	22.98 - 22.68	
102	Orangish brown with occasional grey mottles clayey fine sand. Some angular flint gravel. Pockets of finer sand.	Brickearth	0.30 - 3.20	22.68 - 19.78	
103	Stiff grey brown clay.	London Clay bedrock	3.20 - 25.00	19.78 - -2.03	

Site Code: 231914	Site Name: Five Estuaries	Borehole ID: WA-02/BHR-S
Coordinates (NGR) X: 619909.17	Coordinates (NGR) Y: 220374.42	Level (top): 15.66 m OD
Length:	Width:	Depth: 25.45 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
201	Sandy clayey brown soil with rootlets. Some angular flint.	Topsoil	0.00 - 0.50	15.66 - 15.16	
202	Orangish brown sandy clay with rare rootlets/plants. Rare subangular flint gravel. Lenses of silty clay.	Brickearth	0.50 - 4.50	15.16 - 11.16	
203	Stiff grey brown clay.	London Clay bedrock	4.50 - 25.45	11.16 - -9.79	

Site Code: 231914	Site Name: Five Estuaries	Borehole ID: WA-03/BHSR-1
Coordinates (NGR) X: 616440.15	Coordinates (NGR) Y: 224098.11	Level (top): 21.331 m OD
Length:	Width:	Depth: 20 m

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
301	Silty clay with frequent roots. Gravel is fine flint. Rare small bits of brick.	Topsoil	0.00 - 0.30	21.33 - 21.03	
302	Slightly sandy orangish brown clay. Some plant material. Small pieces of brick present. Sand is medium to coarse.	Made ground/levelling layer for field	0.30 - 2.40	21.03 - 18.93	

303	Stiff dark grey clay.	London Clay	2.40 - 20.00	18.93 - 1.33	

Site Code: 231914	**Site Name: Five Estuaries**	**Borehole ID: WA-05/BHSR-3**
Coordinates (NGR) X: 616440.15	**Coordinates (NGR) Y: 220458.70**	**Level (top): 26.62 m OD**
Length:	**Width:**	**Depth: 25.45 m**

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
501	Clayey orangey brown soil. Subangular flints.	Topsoil	0.00 - 1.00	26.62 - 25.62	
502	Orangish brown clayey sands. Rare roots throughout, occasional subangular flint gravel. From 1.70 onwards becomes coarser.	Brickearth	1.00 - 4.10	25.62 - 22.52	
503	Stiff grey brown clay.	London Clay Bedrock	4.10 - base	22.52	

Site Code: 231914	**Site Name: Five Estuaries**	**Borehole ID: WA-06/BHSR-4**
Coordinates (NGR) X: 616454.56	**Coordinates (NGR) Y: 223967.40**	**Level (top): 27.22 m OD**
Length:	**Width:**	**Depth: 20 m**

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
601	Sandy and slightly gravelly clay with frequent rootlets. Sand is fine, gravel is angular to subrounded flint. Occasional brick inclusions.	Topsoil/made ground	0.00-2.00	27.22 - 25.22	
602	Orangish brown clayey sand with angular to subangular fine to medium flint.	Kesgrave Sands and Gravels	2.00-2.90	25.22 - 24.32	
603	Stiff greyish brown clay.	London Clay Formation	2.90-20.00	24.32 - 7.22	

Site Code: 231914	**Site Name: Five Estuaries**	**Borehole ID: WS7/BHLC-1**
Coordinates (NGR) X: 620464.39	**Coordinates (NGR) Y: 218963.39**	**Level (top): 23.40 m OD**
Length:	**Width:**	**Depth: 20 m**

Context Number	Description	Interpretation	Depth m bgl	Depth m OD	Samples
701	Clayey orangey brown soil. Subangular flints. Ploughed farm soil.	Topsoil	0.00-0.60m	23.40 - 22.80	
702	Orangish brown slightly sandy clay sand with rare angular to subangular fine to medium flint.	Brickearth	0.60-2.00m	22.80 – 21.40	

703	Very coarse brownish orange sands. Subangular flints. Clayey at top.	Kesgrave Sands and Gravels	2.00-4.50m	21.40 - 18.90	
704	London Clay	London Clay Bedrock	4.50-20.00	18.90 - 3.40	

Site Code: 231914	**Site Name: Five Estuaries**	**Borehole ID: WA9/BHLC-3**
Coordinates (NGR) X: 620659.52	**Coordinates (NGR) Y: 219066.72**	**Level (top): 24.93 m OD**
Length:	**Width:**	**Depth: 20 m**

Context Number	**Description**	**Interpretation**	**Depth m bgl**	**Depth m OD**	**Samples**
901	Sandy clay with roots and plants. Rare flint gravel.	Topsoil	0.00 - 0.20	24.93 - 24.73	
902	Orangish brown sandy clay with pockets of fine sand. Subrounded fine to medium flint gravel.	Brickearth	0.20 - 1.20	24.73 - 23.73	
903	Orangish yellow clayey coarse sand with subangular to subrounded fine to medium flint gravel.	Kesgrave Sands and Gravels	1.20 - 5.60	23.73 - 19.33	
904	Stiff grey brown clay.	London Clay Bedrock	5.60 - 20.00	19.33 - 4.93	

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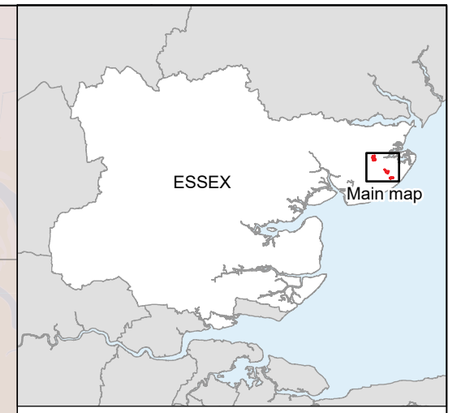
220000

RED CRAG FORMATION - SAND

THAMES GROUP - CLAY, SILT AND SAND

BEAUMONT
NEWLANDS
ELM FARM
LOWER BARN FARM
BARKER'S FARM
YEWTREE FARM
BARKER'S HALL COTTAGES
MILL HOUSE
HOLLYWOOD FARM
WHITE HOUSE
BRADLEY HALL FARM
CYPRUS COTTAGE
HIELAND HOUSE
HILLHOUSE FARM
ANKERDENE HOUSE
VALLEY FARM
LANDERMERE
PARKERS FARM
SCENEFELDA FARM
LANDERMERE COTTAGE
KENTSHILL FARM
MARSH HOUSE
BIRCH HALL
BIRCHOU
THORPE GREEN
FAR THORPE GREEN
LANE END
THORPE-LE-SOKEN
BARNARD'S FARM
KING'S FARM
GRANGE FARM
LIFEHOUSE
THORPE CROSS
HALL FARM
LODGE FARM
LEYS FARM
WEELEY HEATH
PIG'S TREET
BROOK COTTAGE
BIRCH HOE FARM
MAYFIELDS FARM
BOTANY FARM
RECTORY LODGE
LITTLE CLACTON LODGE
ROW HEATH
DRAGON'S DEN
GROVE HOUSE
THE MILL HOUSE
GREAT HOLLAND
PARKGATE FARM
REEDLAND'S FARM
COOK'S GREEN FARM
AL FRESCO
BRIDGE COTTAGES
GREAT HOLLAND LODGE
LITTLE CLACTON
SLADBURYS COTTAGES



Site boundary

0 1 km

Coordinate system: OSGB 1936 British National Grid

Date: 29/06/2023	Created by: KJF
Scale: 1:25,000 at A3	Revision: 0

Figure 1: Site location and BGS mapping of bedrock geology

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616000
618000
620000
622000
224000
222000
220000

BEAUMONT
NEWLANDS
ELM FARM
LOWER BARN FARM
BARKER'S FARM
YEWTREE FARM
BARKERS HALL COTTAGES
MILL HOUSE
HOLLYWOOD FARM
WHITE HOUSE
BRADLEY HALL FARM
CYPRUS COTTAGE
HIELAND HOUSE
HILLHOUSE FARM
ANKERDENE HOUSE
VALLEY FARM
LANDERMERE
PARKERS FARM
SCENEFIELDA FARM
LANDERMERE COTTAGE
KENTSHILL FARM
MARSH HOUSE
BIRCH HALL
BIRCHOU
THORPE GREEN
FAR THORPE GREEN
LANE END
THORPE-LE-SOKEN
BARNARD'S FARM
KINGS FARM
GRANGE FARM
LIFEHOUSE
THORPE CROSS
HALL FARM
LODGE FARM
LEYS FARM
WEELEY HEATH
PIG STREET
BROOK COTTAGE
BIRCH HOE FARM
MAYFIELDS FARM
BOTANY FARM
RECTORY LODGE
LITTLE CLACTON LODGE
ROW HEATH
GROVE HOUSE
DRAGON'S DEN
PARKGATE FARM
THE MILL HOUSE
GREAT HOLLAND
REEDLAND'S FARM
COOK'S GREEN FARM
AL FRESCO
BRIDGE COTTAGES
LITTLE CLACTON
GREAT HOLLAND LODGE
SLADBURYS COTTAGES

HEAD - SILT

INTERTIDAL DEPOSITS (UNDIFFERENTIATED) - CLAY AND SILT

KESGRAVE CATCHMENT SUBGROUP - SAND AND GRAVEL

COVER SAND - CLAY, SILT AND SAND

ALLUVIUM - CLAY AND SILT

Site boundary

0 1 km

Coordinate system: OSGB 1936 British National Grid

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Figure 2: Site location and BGS mapping of superficial deposits

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616000
618000
620000
622000
224000
222000
220000

BEAUMONT
ELM FARM
NEWLANDS
LOWER BARN FARM
BARKER'S FARM
YEWTREE FARM
BHSR-1
BHSR-3
BHSR-4
MILL HOUSE
HOLLYWOOD FARM
WHITE HOUSE
BRADLEY HALL FARM
HIELAND HOUSE
HILL HOUSE FARM
ANKERDENE HOUSE
VALLEY FARM
LANDERMERE
PARKERS FARM
SCENESELDA FARM
LANDERMERE COTTAGE
KENTSHILL FARM
MARSH HOUSE
BIRCH HALL
BIRCHOU
FAR THORPE GREEN
LANE END
WEELEY
BARNARD'S FARM
KING'S FARM
GRANGE FARM
LIFEHOUSE
THORPE CROSS
HALL FARM
LODGE FARM
LEYS FARM
WEELEY HEATH
BIG'S STREET
BROOK COTTAGE
TM22SW31
TM22SW5
BIRCH HOE FARM
BHR-N
BHR-S
TM22SW15
TM22SW16
TM22SW14
TM22SW18
TM22SW20
TM22SW19
TM22SW13
TM22SW21
TM22SW12
TM22SW17
BOTANY FARM
RECTORY LODGE
LITTLE CLACTON LODGE
ROW HEATH
DRAGON'S DEN
GROVE HOUSE
PARKGATE FARM
GREAT HOLLAND
BHLC-3
BHLC-1
TM11NE1
TM11NE2
REEDLAND'S FARM
COOK'S GREEN FARM
AL FRESCO
BRIDGE COTTAGES
LITTLE CLACTON
GREAT HOLLAND LODGE
SLADBURYS COTTAGES

Site boundary
GI boreholes
BGS boreholes
Transect location

0 1 km

Coordinate system: OSGB 1936 British National Grid

Date: 29/06/2023	Created by: KJF
Scale: 1:25,000 at A3	Revision: 0

Figure 3: Site location and borehole transect

N

S

BHSR-3

BHSR-4

BHSR-1

BHR-N

TM22SW12

BHLC-1

BHLC-3

BHR-S

Depth (m OD)

28.0 27.0 26.0 25.0 24.0 23.0 22.0 21.0 20.0 19.0 18.0 17.0 16.0 15.0 14.0 13.0 12.0 11.0 10.0

0 1,000 2,000 3,000 4,000 5,000 6,000 7,000

Distance (m)

Stratigraphy

- Made Ground
- Topsoil
- Brickearth
- Sands and Gravels
- Bedrock

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Figure 4: Borehole transect

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