NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

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Five Estuaries and North Falls Offshore Wind Farm Onshore Project Area

Updated Geoarchaeological Desk Based Assessment

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Summary

An updated Geoarchaeological Desk Based Assessment (GDBA) is presented for the Onshore Project Area of the Five Estuaries and North Falls Offshore Wind Farms ('the Scheme'). The GDBA outlines the sub-surface deposits underlying the Scheme, and provides an assessment of their geoarchaeological potential. It provides a suitable baseline within which to inform requirements for further targeted geoarchaeological works that may be needed to develop mitigation and/or management strategies to offset development impacts of the Scheme on the geoarchaeological resource.

Through a review of recent geoarchaeological investigations within the Onshore Project Area and updated deposit modelling, building on that presented in the previous GDBA (Wessex Archaeology 2022a), the updated GDBA has assessed the likely presence and lateral and horizontal extent of Quaternary deposits across the Scheme. The archaeological and paleoenvironmental potential of these deposits has been assessed, and the significance of any archaeological material they may contain considered in relation to national and regional research themes and priorities (EH 2008; EERRF 2021). The GDBA has identified areas where Quaternary deposits may be present which could contain significant archaeological evidence and/or deposits with palaeoenvironmental potential, as well as some areas where there is insufficient data to consider potential.

A Geoarchaeological Landscape Characterisation based on existing geoarchaeological data, BGS archive boreholes, mapping of superficial deposits and baseline character mapping is provided. The GLC defines 13 Geoarchaeological Character Zones based on variations in the geological characteristics of the deposits present, linked to the assessment of their archaeological and geoarchaeological potential.

Quaternary superficial deposits present within the Scheme include sediments of both Pleistocene and Holocene date. Pleistocene deposits are likely to be widely present across the Scheme, including Kesgrave Sands and Gravels and Head-Brickearth, with Alluvium and Peat of Holocene date, and Pleistocene fluvial deposits associated with the Holland Brook, located at the southern end of the Scheme. Pleistocene and/or Holocene slope deposits (Head/Colluvium), though unmapped, may be present on valley slopes or at the base of valleys in various parts of the Scheme. Towards the north of the Scheme at the OnSS, a gully feature incising the Kesgrave Sands and Gravels and infilled with Pleistocene deposits including Sands, Head-Gravel and Head-Brickearth was recorded, highlighting the potential for such features and deposits elsewhere within the Scheme.

The Kesgrave Sands and Gravels underlying much of the Scheme are likely to comprise deposits of the pre-Anglian (>MIS 12) Colchester Formation, equivalent to the Cooks Green/Wivenhoe (MIS 14-13) and Ardleigh (MIS 16-14) Gravels. On the basis of Palaeolithic finds within the study area, these deposits are of high archaeological potential. Towards the south of the Scheme post-Anglian fluvial deposits of the Holland Brook are present, which are likely to be of Late Pleistocene date. Such deposits have the potential to contain reworked artefacts derived from earlier gravel terraces, and can contain deposits of high palaeoenvironmental potential.

The Pleistocene fluvial sands and gravels in the area of the Scheme are overlain by a widespread unit of Pleistocene Head-Brickearth; these deposits are undated, but may include deposits of Late Devensian (MIS 2; 23-11.7 Ka) or older Pleistocene date. They are likely to be originally aeolian in origin, but may be substantially reworked by various processes. The geoarchaeological l potential of these deposits is unknown, and they warrant further investigation.

Towards the south of the Scheme in the lower valley of the Holland Brook, a thick (up to 9.0 m) sequence of Holocene Alluvium was recorded, including a peat deposit up to 1.5 m thick. These peat deposits are of high archaeological and palaeoenvironmental potential, and there is potential within

he alluvium for organic units or peat, including within any preserved palaeochannel features. Elsewhere within the Scheme there is the potential for Holocene alluvial sequences within the valley of the Holland Brook and its tributaries. In the absence of GI data for these areas the depth, thickness and character of these deposits is unknown, but they may contain peat or organic-rich units of high geoarchaeological potential.

Although parts of the Scheme have been the subject of more detailed evaluation, in most areas information on the geoarchaeological resource is currently insufficient to guide mitigation or management strategies to offset potential development impacts. To develop such strategies, targeted geoarchaeological field evaluation is required. Likely requirements for, and appropriate methods of geoarchaeological evaluation are provided for each GCZ of the GLC.

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Five Estuaries and North Falls Offshore Wind Farm Onshore Project Area

Updated Geoarchaeological Desk Based Assessment

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) were commissioned by Five Estuaries Offshore Wind Farm and Royal HaskoningDHV on behalf of North Falls Offshore Wind Farm Ltd (the 'Client') to update an existing Geoarchaeological Desk Based Assessment (GDBA) for the 'Onshore Project Area' of the Five Estuaries and North Falls Offshore Wind Farms (hereafter referred to as 'the Scheme'). The GDBA is required to inform the Preliminary Environmental Information Report (PEIR) submission as part of the Development Consent Order (DCO) application.

1.1.1 Five Estuaries Offshore Wind Farm (OWF) 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 Onshore Project Area is split into three areas:

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

1.1.2 The North Falls OWF is a similar project which will utilize the same or a very similar Onshore Project Area to VE. To avoid duplication of information and to ensure consistency of the baselines between the North Falls OWF and the Five Estuaries OWF, the data and results of the various works undertaken to date have been combined in the preparation of this assessment.

1.1.3 The GDBA has been undertaken on a revised footprint for the Onshore Project Area as it stands at the time of writing and as shown in **Figure 1**. The original GDBA prepared for the Onshore Project Area (reported in Wessex Archaeology 2022a) has been updated to include the results of a series of geoarchaeological investigations subsequently undertaken within the Onshore Project Area (individually reported in Wessex Archaeology 2022b; 2023a; 2023b; 2023c), the results of which are presented in this report.

1.1.4 The results of the updated GDBA provide further information on the archaeological potential of the Scheme, qualifying and quantifying the archaeological risks to the project represented by the superficial deposits, and facilitating an informed decision with regard to the requirement for, and methods of, any further archaeological and geoarchaeological works.

1.2 Site location and geology

1.2.1 The Onshore Project Area is located within the Tendring District of Essex, making landfall between Frinton-on-Sea and Clacton-on-Sea where the Scheme passes through Holland Haven Marshes SSSI and Holland Haven Local Nature Reserve.

1.2.2 The Scheme extends north-westwards from here over a distance of approximately 20 km, passing close to the villages of Thorpe-le-Soken, Tendring and Little Bromley before terminating to the east of Burnt Heath.

1.2.3 The bedrock geology in the area of the Scheme is mapped by the British Geological Survey (BGS) as clays, silts and sands of the Thames Group, formed in estuarine or marine environments during the Palaeogene period (47.8-56 Ma). In BGS archive boreholes in the area of the Scheme record that these deposits are mainly London Clay, described as a firm or stiff silty, in places sandy, clay.

1.2.4 Outcrops of the Red Crag Formation, of Pliocene or Early Pleistocene age (c. 3.3 to 2.5 Ma) are mapped by the BGS towards the north of the Scheme close to Lawford, and towards the centre of the Scheme at Beaumont. These are marine sands that are in places fossiliferous.

1.2.5 Quaternary superficial deposits are mapped in parts of the Scheme by the BGS, including both Pleistocene and Holocene deposits. Deposits likely to be of Pleistocene date include Coversand and sands and gravels of the Kesgrave Catchment Subgroup, with Alluvium of Holocene date, and potentially Pleistocene fluvial deposits, associated with the Holland Brook and its tributaries. These sediments and their geoarchaeological potential are considered in **Section 4**.

1.3 Scope of document

1.3.1 Assessment of the archaeological resource associated with Quaternary deposits is 'deposit-led', with the aim to provide lithostratigraphic and chronostratigraphic frameworks and to assess the archaeological and palaeoenvironmental records associated with different deposits. A multidisciplinary ‘geoarchaeological’ approach combining archaeological, geological, geophysical and palaeoenvironmental investigative techniques is required.

1.3.2 This updated GDBA outlines the sub-surface superficial deposits underlying the Onshore Project Area, and provides an assessment of their geoarchaeological potential. It provides a suitable baseline within which to inform a program of further geoarchaeological works (where appropriate).

1.3.3 In format and content, this document conforms to current best practice, including the guidance in *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record* (Historic England 2015a), *Management of Research Projects in the Historic Environment* (Historic England 2015b) and *Deposit modelling and archaeology: guidance for mapping buried deposits* (HE 2020).

1.3.4 The updated GDBA, building on the work presented in Wessex Archaeology (2022a), has been prepared with reference to wider regional and national guidance and research frameworks relevant to the Onshore Project Area, 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).

2 GEOARCHAEOLOGICAL BACKGROUND

2.1 Introduction

2.1.1 This section provides a summary of the known geoarchaeological record for the Scheme and the surrounding landscape.

2.1.2 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), 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 1**).

Table 1 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

2.2 Previous investigations

2.2.1 Essex County Council (ECC) have commissioned a number of recent investigations relevant to the geoarchaeological assessment of the Scheme. These include the National Mapping Programme for Essex (Essex County Council 2003), Tendring District Historic Environment Characterisation (Essex County Council 2008), the Tendring Geodiversity Characterisation Report (Essex County Council 2009) and Managing The Essex Pleistocene (O'Connor 2015). A summary of the information relevant to the geoarchaeological assessment of the Scheme is given below.

National Mapping Programme for Essex (Essex County Council 2003)

2.2.2 The National Mapping Programme (NMP) for Essex was undertaken as part of the National Mapping Programme of Archaeological Recording in England, with the aim of plotting all archaeological features visible on both oblique and vertical aerial photographs from early prehistory to 1945.

2.2.3 The NMP identified a number of geomorphological features, including those of glacial origin, ice polygons and former river channels, and whilst not mapped, the authors point out that such features can assist in assessing the archaeological potential of an area (Essex County Council (2003).

2.2.4 A number of features of prehistoric date were recorded, with the Tendring peninsula showing the highest concentration of sites of 'unknown prehistoric' date, including those associated with enclosures and linear features, some of which are located within or very close to the present Scheme. Essex County Council (2003) note that the distribution of prehistoric sites follows very distinct patterns, with a large proportion of sites located on alluvium and sands and gravels.

Tendring District Historic Environment Characterisation (Essex County Council 2008)

2.2.5 As part of the Tendring District Environment Characterisation, the area of Tendring District was broken down in to Historic Environment Character Areas (HECAs) and more detailed Historic Environment Character Zones (HCZs), building on knowledge of the historic environment resource and to inform the Local Development Framework within the District.

2.2.6 The majority of the present Scheme is located within HECAs 3 (Great Oakley area) and 6 (South East Tendring Plateau and the Sokens), with the northern end of the Scheme located within parts of HCAs 11 (St. Osyth and Great Bentley), 12 (Ardleigh) and 13 (Little Bentley area).

2.2.7 At the southern end of the Scheme the corridor passes through HECA 6, comprising a 'gently undulating agricultural plateau in the south east of Tendring, drained by the shallow valley of the Holland Brook with tidal marshes at its mouth' (ECC 2008). ECC (2008) note that although there are no specific records of Palaeolithic finds from the short section of coast between Holland and Frinton, this area along with much of the remaining Tendring coastline has potential for survival of Pleistocene deposits which may contain Palaeolithic material.

2.2.8 From south to north, the Scheme passes through HECZs 6.4 (Great Holland area), 6.3 (The Sokens) and 6.2 (Weeley area), all three of which are described as having good potential for below ground archaeological deposits. HECZ 6.4 is characterised by numerous stray finds ranging in date from the Palaeolithic to the post-medieval period recorded, along with evidence for medieval and earlier phases of settlement, possibly later prehistoric or Roman, and ring-ditch cemeteries of possible Bronze Age date (ECC 2008).

2.2.9 Although little fieldwork has been undertaken in both HECZs 6.2 and 6.3, a number of groups of cropmarks have been identified, many representing medieval or post-medieval field boundaries, but with some indicative of surviving earlier archaeological features, including a possible settlement site in HECZ 6.3 (ECC 2008). In HECZ 6.2 excavations in advance of the construction of the A133 revealed a series of sites dating from the Bronze Age onwards.

2.2.10 North of HECA 6, the Great Oakley area (HECA 3) comprises the gently undulating rural plateau in the north east of Tendring. ECC (2008) suggest that the area is likely to contain deposits related to widespread prehistoric activity and occupation. The corridor passes through HECZ 3.2 (Wix area), described as having good potential for below ground archaeological deposits and likely to contain deposits related to widespread prehistoric activity and occupation, including Prehistoric ring ditches and ring ditch cemeteries that are particularly characteristic of this zone (ECC 2008).

2.2.11 At its northern end the Scheme passes through HEZCs 13.2 (Bradfield Heath), 11.1 (Area to the north of Little Bentley) and 12.3 (Great Bromley). HECZ 13.2 is described as having extensive below ground deposits, with a high density of cropmarks throughout the zone indicating a long history of human occupation and activity, including prehistoric cemeteries and settlements, Roman settlements and roads and multi-period cropmarks.

2.2.12 HEZC 11.1 is described as having good potential for below ground archaeological deposits, with evidence for a number of cropmark complexes including ring-ditches of probable Bronze Age date, settlement enclosures and trackways of later prehistoric or Roman date (ECC 2008).

2.2.13 HEZC 12.3 is described as having high potential for below ground deposits, with multi-period archaeological deposits present throughout the zone including ring ditch cemeteries, probably of Bronze Age date, and other prehistoric monuments including a possible henge and settlement enclosures of both prehistoric and Roman date.

Tendring Geodiversity Characterisation Report (Essex County Council 2009)

2.2.14 The Geodiversity Characterisation project was undertaken in order to define the broad geological and geomorphological character of the Tendring area, to identify key natural systems (including fluvial and coastal) and to define the extent of internationally, national and locally designated sites, in order to inform he Local Development Framework. As part of this work, Tendring was divided in to Geodiversity Character Areas (GCAs), each of which has been subdivided in to Geodiversity Character Zones (GCZs).

2.2.15 The present Scheme lies within GCAs 1 (Tendring Plateau), 7 (Wivenhoe Gravels & Cooks Green Gravels), 13 (London Clay plateau) and 16 (Holland Brook valley). The southern part of the Scheme is located within GCA 16, comprising the valley of the Holland Brook, at a point where the valley widens to form a broad area of estuarine deposits at Holland Haven marshes.

2.2.16 ECC (2009) describe the alluvial deposits within the Holland Brook as increasing in thickness from 1.2 m in its upper reaches to more than 1.8 m at its downstream extent, with both freshwater and estuarine alluvium present at the coast. They describe the valley as asymmetric, with steeper south-western slopes falling from c. 25 to -5 m OD, with dry valleys on some of the steeper slopes. The narrow floodplains along the valley floor are flat and flanked by shallow slopes, and would have been unsuitable for settlement (ECC 2009).

2.2.17 The southern part of the Scheme crosses GCZ 16.2, representing estuarine alluvial deposits within the lower reaches of the Holland Brook and Holland Haven marsh. ECC (2009) point out that the alluvium within GCZ 16.2 has the potential for providing palaeoenvironmental evidence for Holocene sea-level and environmental change, particularly where organic-rich deposits have accumulated within the alluvium within the broad former estuary, now enclosed by a sea wall. North of here the Scheme crosses GCZ

16.3, described by ECC (2009) as comprising the steep valley sides of the Holland Brook, where bedrock London Clay is exposed at surface.

2.2.18 North of Holland Haven marshes the Scheme passes through parts of GCA 7, characterised by the Wivenhoe and Cooks Green Gravels, which belong to the third highest of the four Kesgrave Sand and Gravel terraces on the Tendring Plateau (ECC 2009). In GCZ 7.1 the Cooks Green Gravels, representing deposits at the confluence of the Thames and Medway Rivers, are recorded along the valley sides of the Holland Brook at heights of between 10-20 m OD. These deposits are contemporaneous with the Wivenhoe Gravels from which Palaeolithic flint artefacts have been recovered (ECC 2009).

2.2.19 North of here the Scheme passes through GCZ 7.4, characterised by deposits of the Cooks Green Gravel that are orientated west-east from Little Clacton to the coast at Frinton and where they rise to levels of c. 20-25 m OD. Further north the Scheme passes through GCZ 7.2, also characterised by the Cooks Green Gravel where they lie along the mid-valley slopes of the Holland Brook at heights of 15-25 m OD.

2.2.20 Palaeolithic findspots have been recorded within GCZ 7.2. Some uncertainty remains as to the age of the gravels in which they were found; if these were indeed Cooks Green Gravels then they would be of pre-Anglian (MIS 12) age, although recent investigation of some of the gravels suggests that they may be a post-Anglian deposit of the Holland Brook (ECC 2009).

2.2.21 Close to Thorpe Cross the Scheme passes through GCZ 1.5, where the Cooks Green Gravels are masked by a covering of brickearth (ECC 2009). These brickearth deposits are recorded widely across GCZ 1.5 on the lower levels of the Tendring Plateau, along the crest of the Holland Brook interfluve and the Oakley Ridge, generally at or above levels of c. 25 m OD (ECC 2009).

2.2.22 Although ECC (2209) suggest much of this Brickearth is Late Devensian (MIS 2; 23-11.7 Ka) age, deposited by aeolian (wind-blown) processes during the Devensian glacial stage, no investigation or dating of these deposits has been carried out and ECC (2009) point out that they may have been deposited during a number of periods of the Pleistocene.

2.2.23 Much of the centre of the Scheme crosses GCZs 13.1 and 13.2, where the London Clay is exposed on a plateau occupying a large area of the District at levels above 30 m OD near the Oakley Ridge and headwaters of the Holland Brook, and along the higher valley slopes down to levels of c. 10 m OD. ECC (2009) point out that a number of Palaeolithic artefacts have been recovered from cliffs in the area of Frinton (HER 3556, 3557 and 2813) within GCZ 13.1, but these are unrelated to the London Clay and are likely derive from Pleistocene fluvial deposits, which may belong to the sands and gravels of the Kesgrave Sands and Gravels.

2.2.24 In the northern part of the Scheme, the corridor crosses GCZs 1.2, 1.4, 1.7 and 1.8. GCZ 1.2 is characterised by brickearth deposits of the Tendring plateau at levels of c. 30-35 m OD, likely to broadly correlate to the Brickearth deposits described in GCZ 1.5. These deposits are recorded at levels of c. 25-35 m OD in GCZ 1.8 and rise to levels of c. 35-40 m OD in GCZs 1.4 and 1.7. Towards the north of the Scheme, in the area of GZCs 1.4 and 1.7, the brickearth may overlie deposits of the oldest Kesgrave Sands and Gravels within the Tendring Plateau, the Waldringfield Gravel, and the second oldest, the Ardleigh Gravels (ECC 2009).

Managing the Essex Pleistocene (O'Connor 2015)

2.2.25 The Managing the Essex Pleistocene project was undertaken with the aim of creating a predictive model of the archaeological and palaeoenvironmental potential of Pleistocene deposits in Essex. As part of this work O'Connor (2015) reviewed the Palaeolithic and palaeoenvironmental potential of the Colchester Formation of the Kesgrave sands and gravels, and the brickearth, forming the superficial deposits on which much of the Scheme is located.

2.2.26 O'Connor (2015) highlights that the deposits of the Colchester Formation represent a time period of 200-300 Ka prior to the onset of the Anglian glaciation, during which there was known to be periodic occupation of Britain. Rich archaeological sites such as the Caversham Ancient Channel (Berkshire), Pakefield (the Norfolk Coast), High Lodge, Culford, Warren Hill (Suffolk), Boxgrove (West Sussex) and Happisburgh (the Norfolk Coast) are contemporaneous with these sediments, and there is thus potential within the deposits for minimally disturbed evidence Lower Palaeolithic archaeology in fine-grained horizons or buried land surfaces, as well as fluvially-reworked archaeology from high energy fluvial sands and gravel.

2.2.27 O'Connor (2015) describes relatively abundant Palaeolithic findspots associated with the Colchester Formation, with 13 findspots that can be reasonably or definitively associated with the Kesgrave Sands and Gravels (see **Section 3**). O'Connor (2015) suggests that these deposits should be considered for Palaeolithic investigations when affected by development impacts.

2.2.28 The brickearth deposits of the Tendring plateau are described by O'Connor (2015) as thin (generally less than 2 m) and having a poor archaeological record, 'probably reflecting the relatively few brick-pits using the resource'.

Archaeological assessment of marine geophysical data (Wessex Archaeology 2022c)

2.2.29 An assessment of marine geophysical survey data comprising sub-bottom profiler, sidescan sonar, magnetometer and multibeam echosounder datasets was undertaken for the North Falls Offshore Wind Farm and Offshore Cable Corridor. A number of palaeogeographic features of archaeological potential were identified within the study area, including significant, potentially well-preserved palaeogeographic features identified within three of the four project areas:

- the offshore extension of the River Stour and its association with the Inner Gabbard Deeps in the northern array area;
- an extensive complex palaeochannel and possible delta, alongside a potential coastline and associated features in the southern array area;
- two channel complex areas, possibly the remains of the Thames-Medway river, and an area of channelling/possible preserved landscape deposits in the offshore cable corridor.

2.2.30 The main feature within the nearshore area is a distinct palaeochannel, located trending approximately northwest-southeast in the nearshore area of the Offshore Cable Corridor and a likely offshore extension of the Holland Brook. This is a distinct channel with two phases of fill; an earlier chaotic/unstructured fill, and a later layered fill. The second phase of fill also contains areas of acoustic blanking, interpreted as shallow gas, suggesting the preservation of organic material within the sediments of the second phase of fill.

2.2.31 This channel is also visible within the multibeam echosounder (MBES) data, suggesting it is underfilled, along with a much wider area of irregular surrounding seabed that could represent a preserved land surface at seabed. This wider area of seabed was not clearly identifiable in the sub-bottom profiler (SBP) data, suggesting deposits are restricted to outcrop at seabed and are not very thick, but they could be of archaeological potential.

2.2.32 The age of this channel feature is currently uncertain, but it likely dates from the post-Anglian to the early Holocene. This series of features is potentially important due to their location close to shore just along the coast from the known Lower Palaeolithic site at Clacton (see **Section 3**), which was also identified associated with a palaeochannel, and a preserved Mesolithic land surface/peat deposits at the foreshore in Jaywick. As such, these deposits are of high archaeological potential, and could contain both in situ and derived archaeology and preserved palaeoenvironmental material.

Monitoring of GI works at Frinton Golf Course (Wessex Archaeology 2022b)

2.2.33 Geoarchaeological monitoring of Ground Investigation (GI) works was undertaken close to the landfall of the onshore cable route for the Five Estuaries Offshore Windfarm (OWSF), approximately 1 km to the southwest of Frinton-on-Sea at Frinton Golf Course (within Geoarchaeological Character Zone (GCZ) 1 as defined in the initial GDBA (Wessex Archaeology 2022a); see **Section 6.3**).

2.2.34 The monitoring of the groundworks identified bedrock London Clay, overlain by a sequence of superficial deposits including Kesgrave Sands and Gravels and Holocene minerogenic alluvial deposits, representing sediment accumulated under the influence of rising post-glacial sea-levels and deposited within an estuarine environment. These sediments were in turn overlain by a modern soil profile.

2.2.35 The Holocene estuarine alluvium here was between 7.45 m and 8.7 m thick, and was composed of a tripartite sequence of lower alluvium, peat and upper alluvium overlain by up to 1.5 m of re-worked alluvial deposits. Peat deposits were recorded in all three of the boreholes monitored and are likely to have formed as result of periods of lower relative sea level rise. The upper elevation of the peat ranged in height from -2.0 m OD to -3.1 m OD.

Monitoring of GI works at Swan Road, Railway Crossing and Little Clacton Road (Wessex Archaeology 2023a)

2.2.36 Geoarchaeological monitoring of GI works and deposit modelling was undertaken for the Five Estuaries Offshore Windfarm onshore cable route located west (Little Clacton Road) and northwest of Great Holland (Railway Crossing) (within GCZ 3), and at farmsteads to the east of Tendring (Swan Road) within GCZ 4, as defined in the initial GDBA, respectively (see **Section 6.3**).

2.2.37 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. 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 were considered likely to be equivalent to the Cooks Green Gravel of MIS 13–14 date (563-478 Kya), and have potential to contain Lower Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential.

2.2.38 Brickearth was encountered at depths between 0.2 and 1.0 m bgl in five of the boreholes. The mode of deposition and age of these deposits was 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 the specific age of the Head-Brickearth, this deposit was considered to have the potential to contain Lower or Middle Palaeolithic archaeology and fossiliferous sediments of significant geoarchaeological potential.

Onshore substation (OnSS) Palaeolithic Archaeological Evaluation Phase 1 (Wessex Archaeology 2023b) and Phase 2 (Wessex Archaeology 2023c)

2.2.39 Palaeolithic geoarchaeological evaluation through a programme of test pitting was undertaken in two phases at the proposed location of the OnSS for the OWF projects, in tandem with an archaeological trial trench evaluation (Wessex Archaeology 2023d). The investigation was located north of Little Bromley Road, Little Bromley, within GCZ 9 as defined in the initial GDBA (see **Section 6.3**). An initial phase of evaluation (11 machine-dug test pits) was carried out in the north of the site and reported in Wessex Archaeology (2023b), followed by a second phase of evaluation (19 test pits) in the south-west and south of the Site.

2.2.40 The combined phases of evaluation demonstrated that the earliest Pleistocene deposits in the site belong to the Ardleigh Gravel of the Kesgrave Sands and Gravels (MIS 16-14; 676-524 Kya) of the River Thames. The upper c. 3.0 m of these deposits were evaluated and extensively sampled for artefacts, although no Palaeolithic archaeology was recovered. The palaeoenvironmental potential of these deposits was assessed as generally low, with the exception that finer-grained silts were locally present in the northern part of the site (see below) which had greater potential.

2.2.41 Across the site the Ardleigh Gravel was overlain by Pleistocene slope deposits comprising Head-Gravel and Head-Brickearth. The archaeological and palaeoenvironmental potential of these sediments has been assessed as generally low. In the northern part of the site (within GCZ 2 as defined in Wessex Archaeology 2023c) a gully incised into the top of the Ardleigh Gravel was infilled with a basal Sand and overlying Head-Gravel. Although no archaeology was recovered from these deposits, they have not previously been identified in the area, are poorly understood and are undated, and their Palaeolithic geoarchaeological potential and significance is unknown.

Onshore detailed gradiometer survey (Wessex Archaeology 2023e)

2.2.42 A detailed gradiometer survey for various parts of the Onshore Project Area was completed in November 2023 and is reported in Wessex Archaeology (2023e). The survey covered all GCZs as defined in the initial GDBA (Wessex Archaeology 2022a), and revealed a number of anomalies of archaeological origin including features of Romano-British and prehistoric date, as well as natural features associated with periglacial landforms and palaeochannels and alluvium of Pleistocene and/or Holocene date.

2.2.43 Features associated with possible former channels and potential alluvial deposits were highlighted in Area 5, Area 7, Area 9, Area 10, Tendring Green North, Area 12, East of Tendring, Little Clacton Road and Holland Haven North.

2.3 Superficial geology

2.3.1 Quaternary superficial deposits are mapped in parts of the Scheme by the BGS, including both Pleistocene and Holocene deposits. Deposits likely to be of Pleistocene date include Coversand and sands and gravels of the Kesgrave Catchment Subgroup, with Alluvium of Holocene date, and potentially Pleistocene fluvial deposits, associated with the Holland

Brook and its tributaries. These sediments and their geoarchaeological potential are considered below.

Kesgrave Sands and Gravels

2.3.2 The Kesgrave Sands and Gravels are the sediments of the pre-Anglian (MIS 12; 478-424 Ka) River Thames. 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).

2.3.3 Terraces associated with this river system were formed between c. 1.81 Ma and 460 Ka (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 underlying the Scheme as those of the Colchester Formation (c. 860-460 Ka; **Table 2**).

2.3.4 Buried soils (Kemp et al 1993; Read 1994 and Read et al 1996) and organic deposits have been recorded associated with various terraces of the Colchester Formation. In eastern Essex in particular, the terrace stratigraphy has been refined at a relatively high resolution based on the presence of organic temperate- and cold-climate sediments (Bridgland & Allen, 1996; Rose et al 1999). Here, organic deposits of the Colchester Formation containing evidence of diverse animal and plant assemblages have been identified at Little Oakley (e.g. Bridgland et al 1990), Ardleigh and Wivenhoe (e.g. Bridgland 1994; Bridgland and Allen 1996), largely forming in channels eroded into the cold climate sands and gravels (Rose et al 1999).

2.3.5 The gravel Members of the Colchester Formation underlying the Scheme are likely to comprise the Wivenhoe, Ardleigh and Waldringfield Gravels of the River Thames (Bridgland 1994; Bridgland and Allen 1996). Towards the southern end of the Scheme the deposits of the Cooks Green Gravel are encountered, equivalent in age to the Wivenhoe Gravel but deposited downstream of the Thames/Medway confluence.

2.3.6 The geoarchaeological potential of the terraces of the Colchester Formation is highlighted by the presence of temperate stage and arctic organic beds at Ardleigh (Bridgland and Allen 1996), temperate organic and fossiliferous silts and sands associated with the Little Oakley Channel (Bridgland et al. 1990), and organic beds in at Wivenhoe (Bridgland and Allen 1996).

2.3.7 Two different soil types have been recorded on the terrace surfaces of the Kesgrave Sands and Gravels, with those on the Colchester Formation tending to be less well developed (Rose et al 1999). These soils show signification variation in form and structure, and are likely to have developed over various lengths of time during the Early and Middle Pleistocene. They include a complex argillic soil known as the Valley Farm Soil (Kemp 1985), formed mainly in temperate climates, and an arctic soil known as the Barham Soil (Rose et al 1985), formed in a periglacial climate during the latter part of the Cromerian (MIS 19-13) and the early part of the Anglian (MIS 12) glacial Stage.

2.3.8 Palaeochannel deposits that date to the interglacial immediately following the Anglian glaciation (MIS 11) have been identified to the southwest of the Scheme at Clacton-on-Sea, first described by Brown (1838; 1840; 1841). These deposits, being richly fossiliferous as

well as containing an internationally important Palaeolithic assemblage, represent one of the most important Middle Pleistocene interglacial sites in Britain (Bridgland et al 1999).

2.3.9 Here, the Anglian (MIS 12) Holland Gravel are cut by the post-Thames diversion Clacton Channel Gravel and Clacton Channel deposits (MIS 11), which are post-dated and overlain by fluvial gravels of the Wigborough Gravel (post-diversion Thames Medway deposits correlated with the Boyn Hill Gravel in the Lower Thames).

Table 2 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)

Head-Gravel

2.3.0 Although not mapped by the BGS in the area of the Scheme, BGS boreholes from the region (BGS GeoIndex) record gravelly clays and silts overlying the Kesgrave Sands and Gravels, in particular in areas of steeper topography at the sides of and within dry or stream valleys.

These are likely to be deposits reworked down-slope by colluviation, solifluction and/or water run-off, and are often referred to by the BGS as Head deposits.

2.3.1 Head is defined as Pleistocene slope deposits containing sediments reworked downslope from earlier formations through colluvial and/or solifluction processes (alternate freeze thawing). Head deposits are therefore most widely recorded at the base of slopes and along river valleys.

2.3.2 These slope deposits may also include Holocene colluvium. Colluvium represents unconsolidated material which has been deposited downslope by either rainwash, sheetwash and/or slow continuous downslope creep during the Holocene. Colluviation is likely in areas of topographic relief where soil instability has been brought on by activities such as clearance of woodland, agricultural activity and soil degradation, leading to downslope movement of sediment.

2.3.3 Slope deposits can include archaeology reworked downslope within these sediments. More significantly they can also seal stratigraphy, including stable land surfaces and buried soil horizons associated with minimally disturbed/in situ archaeological layers, features and/or lithic scatters. The palaeoenvironmental potential of these slope deposits is generally low, except where calcareous units occur which can preserve evidence such as molluscs and vertebrate remains.

Head-Brickearth/Coversand

2.3.4 The BGS show deposits of clay, silt and sand overlying the overlying the Kesgrave Sands and Gravels in the area of the Scheme, described as Coversands. These form part of the sequence of 'Head-Brickearth' deposits that are widespread in this part of Essex, the mode of deposition and age of which is uncertain.

2.3.5 Head-Brickearth is a generic term used to describe Pleistocene sediments that have been deposited by a wider range of depositional processes, including aeolian (wind-blown), colluvial (slope) and alluvial (transported by water). The Head-Brickearth deposits in the area of the Scheme are likely to include an aeolian (coversand and loess) component, but may also include deposits formed through both colluvial and alluvial processes.

2.3.6 O'Connor (2015) describes the basal element of the Head-Brickearth throughout much of the Tendring District as a thin, fine sand (coversand). Overlying this 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 Head-Brickearth contains small stones worked upwards from the underlying gravels due to frost action (O'Connor 2015).

2.3.7 Coversands and loess are Pleistocene wind-blown sediment, predominantly transported in periglacial conditions close to the margins of ice sheets (Antoine et al 2003). Where dated, the majority of cover sands and loess in southern England are Late Devensian (MIS 2) between 18.8–14.6 Kya (e.g. Parks and Rendell 1992; Bateman 1998). Older deposits principally dated to MIS 6 and MIS 12 are known, however.

2.3.8 Primary coversands and loess are directly lain down as windblown sediment. These have often been 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. Calcareous Head-Brickearth sequences can preserve palaeoenvironmental evidence, including molluscs and vertebrates.

2.3.9 Fossiliferous Head-Brickearth deposits occur at Wrabness. Pleistocene faunal 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.

2.3.10 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 Ka).

2.3.11 The Wrabness Head-Brickearth is located south of the River Stour. On the opposite (northern) side of the Stour similar fossiliferous deposits have been identified in the cliffs between Stutton and Harksted in Holbrook Bay, Suffolk (Whittaker 1885, Evans 1897, Spencer 1958; 1962, 1979, Wymer 1985). The deposits here consist of Pleistocene sand and bedded silt (brickearth), with a basal gravel. The mammalian fauna from these deposits has been correlated that from the upper part pf the sequence at Aveley, which may indicate a later MIS 7 date (Schreve 1997).

2.3.12 Middle Palaeolithic Levallois material have been recovered from Holbrook Bay, mostly out of context, however one Levallois flake and a handaxe are recorded as from the Head-Brickearth. Levallois flakes have also been reported from the Wrabness Head-Brickearth (George 2010), although Wymer (1985) states that collections from Wrabness in the British Museum do not contain type such diagnostic material (Wymer 1985).

2.3.13 The evidence indicates that the Wrabness Head-Brickearth may be broadly contemporary with the Holbrook Bay deposits.

Alluvium

2.3.14 Alluvium is a generalised term covering unconsolidated sediment transported by water in a non-marine environment. Pleistocene river terrace deposits are technically alluvium, but the term here is applied to fine-grained deposits of Holocene date (11.7 Ka to present).

2.3.15 Deposits of alluvium associated with the floodplain of the Holland Brook and its tributaries are likely to be encountered in parts of the Scheme, and these may include both freshwater and estuarine deposits. Where the Alluvium has been investigated within the Holland Brook it has been recorded as a stoneless grey silty alluvium over thin sandy gravel, up to c. 1.2 m thick in the upper reaches of the valley and at least 1.8 m downstream (Essex County Council 2009).

2.3.16 The geoarchaeological potential of alluvium is generally low, although it has the potential to contain layers of peat or organic-rich alluvium of high potential (see below) and may also contain or seal archaeological remains.

2.3.17 Floodplain alluvium may also contain palaeochannels which are key contexts for understanding the physical evolution of the landscape and act as effective traps preserving both artefacts and ecofacts indicative of the surrounding environment, human activity and land-use.

Peat and organic-rich alluvium

2.3.18 Peat comprises partially decayed organic matter preserved within waterlogged anaerobic (oxygen-free) conditions. Peats and organic-rich alluvium are ideal contexts for the preservation of palaeoenvironmental remains (e.g. pollen, plant macrofossils, insects) that provide important data on past climate, vegetation, environment and land-use.

2.3.19 Peat deposits may form a component of Holocene alluvial sequences preserved within river valleys or preserved as discrete landform deposits (e.g. palaeochannels). However, mapping by the BGS is unlikely to fully resolve peat deposits within river valleys where they may simply be classified as alluvium.

2.3.20 Any peat deposits identified at the Scheme, interbedded in alluvium or preserved in palaeochannels, will be of high geoarchaeological potential.

2.4 Summary of geoarchaeological potential

2.4.1 A review of the available baseline data will provide important information on the likely age, depth and extent of superficial deposits at the Scheme, helping to inform on the archaeological risk and the future development proposals.

2.4.2 The key deposits and their associated geoarchaeological potential is summarised as follows:

- Pleistocene Kesgrave Sands and Gravels – potential for Lower Palaeolithic archaeology and faunal remains and fossiliferous horizons containing a range of palaeoenvironmental evidence;
- Pleistocene Brickearth – may contain or seal deposits containing Palaeolithic, including Middle Palaeolithic, archaeological and paleoenvironmental material, including mammalian fauna;
- Pleistocene Head and Holocene Colluvium - may include eroded and redeposited archaeology of Palaeolithic and/or later date. May seal underlying stratigraphy, including buried soil horizons, associated with minimally disturbed Palaeolithic archaeology, or bury Holocene archaeological features and/or layers of archaeological and geoarchaeological significance;
- Holocene Alluvium – potential to contain or partially mask Holocene archaeological features and/or layers, preserve palaeochannels and contain peat or richly-organic units of a high geoarchaeological potential;
- Holocene Peat – potential for peat units to be preserved in Holocene floodplain alluvium, including within palaeochannels. High geoarchaeological potential, preserving a range of palaeoenvironmental remains informing on past landscape, environment and land-use.

3 ARCHAEOLOGICAL BACKGROUND

3.1 Introduction

3.1.1 The principal potential of Quaternary deposits in the Scheme boundary is to contain geoarchaeological evidence of Palaeolithic and/or Mesolithic date. This section considers the Palaeolithic and Mesolithic archaeological resources from the area of Scheme. The

post-Mesolithic archaeological resource and potential for such archaeology within the Scheme is considered in a separate archaeological desk-based assessment prepared by Royal HaskoningDHV (2021).

3.1.2 Sources consulted include the Essex Historic Environment Record (HER) using a study area of 1km from the Scheme boundary, The English Rivers Project (TERPS; WA and Wymer 2009) and Palaeolithic and Mesolithic Lithic Artefact Database (PaMELA; WA and Jacobi 2014) using a 2km study area, and relevant published and unpublished literature and reports.

3.2 Lower Palaeolithic (Pre MIS 12 – Kesgrave Sands and Gravels)

3.2.1 The Kesgrave Sands and Gravels in Scheme boundary have undergone little research and their distribution and stratigraphy is uncertain. Nevertheless, they have been shown to contain Lower Palaeolithic archaeology that predates the diversion of the Thames further to the south during the Anglian glaciation (MIS 12; 478–424 Ka).

3.2.2 This is earliest archaeology from the region and some of the earliest archaeology from Britain. Units within the Kesgrave Sands and Gravels contain organic and other fossiliferous sediments, and therefore also have significant geoarchaeological potential. Consequently, these deposits have potential to contain Palaeolithic archaeological and geoarchaeological evidence that will contribute to national and regional research themes and priorities (EH 2008; EERRF 2021).

3.2.3 Lower Palaeolithic findspots with the study area are shown on **Figures 4-6** and relevant discoveries are summarised below.

Badley Hall, Great Bromley (TERPS 31986)

3.2.4 Potentially the earliest Lower Palaeolithic artefact from the study areas is a small broken handaxe from Badley Hall, Great Bromley. Although this artefact does not have a recorded context, its condition has been assessed as rolled and stained (Wymer 1985), indicating that it originates from Pleistocene fluvial deposits.

3.2.5 The Badley Hall findspot is within the valley of the Ten Penny Brook, which has incised through the Ardleigh Gravel in the area. The handaxe likely, therefore, originates from the Ardleigh Gravel, which would indicate a minimum age of MIS 16–14 (676–524 Ka). A second handaxe, a surface find, is recorded from 2.7 km to the south-west at Elmsted Market, where the Bromley Book, a tributary of the Ten Penny Brook, has similarly cut through the Ardleigh Gravel.

Daking's Pit, Weeley (TERPS 31918–31920)

3.2.6 The most significant collection of Lower Palaeolithic archaeology from the study area is from Daking's Pit, Weeley. Palaeolithic artefacts were first collected from this site, a disused gravel pit, by Warren in the 1930s (Warren 1933). Five handaxes, eight cores and 17 flakes from the site are in Warren's collection in the British Museum (Wymer 1985). Most are slightly fluvially abraded, though one handaxe is noted as in nearly mind condition.

3.2.7 A section through deposits in Daking's Pit was excavated and recorded by Wymer in 1970. This recorded sands overlying fluvially bedded sandy gravel (Wymer 1985). Wymer recovered 39 Palaeolithic artefacts when cutting this section, all from the lower bedded sandy gravel. These consisted of 37 flakes and spalls and one core. 27 of these artefacts are either unabraded or only slightly so.

3.2.8 Although the Daking's Pit material is in a range of condition states, it includes fresh and only slightly abraded pieces which are contemporary with the fluvial sandy gravels. This indicates that these artefacts are minimally disturbed and reflect activity in the immediate area that is contemporary with the deposition of the gravel.

3.2.9 The Pleistocene deposits in Daking's Pit are part of a spread of Pleistocene fluvial deposits which likely correlate with the Winvenhoe/Cooks Green Gravel. This indicates a MIS 14–13 age (563–478 Ka).

3.2.10 West of Daking's Pit, the Holland Brook has cut through these deposits. The Winvenhoe/Cooks Green Gravel west of the Holland Brook has also produced Palaeolithic artefacts. Warren recorded a flake from a temporary pit (British Museum register referenced in Wymer 1985), whilst Wymer reported on the discovery of two flakes from a small pit open in 1970 in this same area (Wymer 1985).

3.2.11 The Lower Palaeolithic archaeology from Daking's Pit is highly significant as it demonstrates that the Wivenhoe/Cooks Green Gravel contains minimally disturbed archaeology reflecting human activity during one of the earliest periods of the settlement history of Britain and of north-west Europe.

Bradley Hall Farm, Thorpe-Le-Soken (TERPS 31921/HER MEX6960 and TERPS 319222)

3.2.12 A Palaeolithic handaxe was found during ploughing at Bradley Hall Farm. The handaxe is described as in good condition but slightly abraded (HER MEX6960). Differential patination and staining were noted on the artefact (Wymer 1985), which may reflect having been from a context at the contact between two deposits and/or having been exposed on a Pleistocene land surface.

3.2.13 A second handaxe is recorded from an unidentified location at Thorpe-Le-Soken (Wymer 1985).

3.2.14 The original contexts of these artefacts are uncertain, but outcrops of the Cooks Green Gravel are mapped in the Thorpe-Le-Soken area. The Cooks Green Gravel is dated to MIS 14–13 (563–478 Ka). These add to the evidence from Daking's Pit, Weeley, that deposits of this age in the study area have potential to contain Lower Palaeolithic archaeology.

Holland Brook, Pig Street, Little Clacton (TERPS 31923)

3.2.15 A Palaeolithic handaxe and four flakes from unknown contexts are recorded from the valley side of the Holland Brook at Pig Street. The Holland Brook has incised a valley through Cooks Green Gravel in this area. This suggests that these artefacts may be from deposits broadly contemporary with those from Daking's Pit, Weeley. It is also possible that the valley contains unrecorded Pleistocene sediments deposited by the Holland Brook itself.

Frinton-on-Sea (TERPS 31953–31963)

3.2.16 Significant numbers of Palaeolithic artefacts are recorded from Frinton-on-Sea. Their context is uncertain; most were recovered out of context on the modern beach, whilst Pleistocene deposits are poorly characterised and mapped in this area.

3.2.17 Warren (1909) records Palaeolithic artefacts from an outcrop of gravel that has been mapped as belonging to the Cooks Green Gravel (Brigland and Allen 1996), but this material could not be identified in Warren's extant collection in the British Museum (Wymer 1985).

3.2.18 Palaeolithic artefacts recorded by Wymer (1985) from the modern beach at Frinton include a handaxe from Sandy Hook, four handaxes, four retouched flakes, 14 flakes and three miscellaneous pieces recorded from Stone Groin and a fresh handaxe from the 'base of crumbing cliffs'.

3.2.19 These beach finds may originate from pre-MIS 12 deposits (most likely the Crooks Green Gravel) exposed in cliff sections, or from unmapped post-Anglian sediments present either within the cliffs or in the intertidal/marine zone.

3.3 Lower/Middle Palaeolithic (Post MIS 12 – Thames-Medway deposits)

3.3.1 Pleistocene deposits of the Thames-Medway, which post-date the rerouting of the River Thames in the Anglian (MIS 12; 478-424 Ka), are recorded north-east and south-west of the study areas, along the modern coast. These include sediments of the Clacton Channel at Clacton-on-Sea, which contained nationally significant Lower Palaeolithic archaeology and palaeoenvironmental evidence. Such deposits may occur in area of the landfall of the cable corridor, and may be present in the offshore zone. Key locations in the area where such deposits have been identified are summarised below.

Clacton-on-Sea (TERPS 31940–31949)

3.3.2 Pleistocene deposits associated with the Clacton Channel have been recorded exposed on the modern shoreline in an area extending from Lion Point, Jaywick in the west to the West Cliff section, located south of Clacton prier, in the east.

3.3.3 Fossiliferous Pleistocene channel deposits were first discovered in the West Cliff in the late 1830s by Brown, who recovered mammal bones, marine and freshwater molluscs and plant remains (Brown 1828; 1840; 1841). The Clacton Channel deposits were subsequently investigated in detail in the first half of the 20th century by Warren (1911; 1912; 1922; 1923; 1924; 1933; 1940; 1951; 1955; 1958), who identified further outcrops of the deposits at Lion Point, Jaywick.

3.3.4 Warren recovered large numbers of Lower Palaoelithic artefacts and mammalian faunal remains during his studies. The artefacts consisted of cores and flakes, but no handaxes, which led to Warren identifying them as belonging to a distinct Lower Palaeolithic non-handaxe industry (Warren 1912), which he termed the Clactonian. Warren also recovered a wooden spear point from channel deposits (Warren 1911); this is earliest wooden artefact known from Britain.

3.3.5 Excavations of Clacton Channel deposits were carried out on a golf course near Jaywick Sands in 1934 by Oakley and Leakey and by Wymer between 1969 and 1970 (Singer et al. 1973). Further detailed work was undertaken during the redevelopment of Butlins Holiday Camp (Bridgland et al. 1999).

3.3.6 The Clacton Channel is dated to the MIS 11 interglacial and is associated with post-Anglian stratigraphy of the Thames/Medway. The deposits were originally dated based on the pollen record they preserved (West 1956, 1963), and subsequently through biostratigraphic correlations of molluscan faunas (Kerney 1971) and mammalian faunas (Schreve 1997), as well as amino acid geochronology (Miller et al. 1979; Bowen et al. 1989; Penkmen et al. 2010).

3.3.7 The composite Clacton Channel stratigraphy is summarised in **Table 3**. It consisted of clayey sands and gravel overlain by fresh water and estuarine clays and sands. The

freshwater and estuarine deposit have produced Palaeolithic archaeology, mammal bones, mollusc, ostracods and plant macro fossils.

3.3.8 The channel deposits were cut into London Clay Bedrock and sands and gravels attributed to the Lower Holland Gravel (MIS 12) and overlain in places by later fluvial sands and gravels of Wigborough Gravel.

Table 3 Clacton Channel composite stratigraphy; channel deposits highlighted (after Bridgland et al. 1999)

Deposits	Stratigraphy	Age
Bedded gravel	Wigborough Gravel	
Estuarine sand with shells, passing laterally into estuarine calcareous clay	Estuarine Beds	MIS 11
Estuarine laminated clay containing localized lens with freshwater fauna		MIS 11
Loamy sands and clays, with much channelling	Upper Freshwater Beds	MIS 11
Clayey gravel and sand	Lower Freshwater Beds/ Clacton Channel Gravel	MIS 11
Sand and gravel	Lower Holland Gravel	MIS 12
Clay	London Clay	

Holland-on-Sea (TERPS 31950)

3.3.9 A core and possible flake recorded as from the Holland Gravel, exposed in a cliff section at Holland-on-Sea, were collected by Warren (Wymer 1985). This would suggest at least an MIS 12 date.

Walton-on-the-Naze

3.3.10 Palaeolithic artefacts have been recovered from the foreshore at Stone Point, Walton-on-the Naze. The original contexts of these are unknown, but they are likely eroded from deposits either exposed in cliff faces or in the intertidal zone. Notably, material recovered from Stone Point include pieces potentially techno-typologically diagnostic of different periods of the Palaeolithic (Wymer 1985). These include Lower Palaeolithic handaxes, a Middle Palaeolithic Levallois core and a bout coupé handaxe (recorded by Roe 1968), which is regarded as late Middle Palaeolithic. This suggests potential for different deposits of multiple Pleistocene dates in the area.

3.3.11 Fossiliferous Pleistocene deposits also occur in the area. Wymer (1985) identifies that William Camden in 1610 quotes a passage from a 13th century monk, 'Ralph, the Monk of Coggeshall', who said '*two teeth of a certain Giant, of such bigness, that two such teeth as men have now a daies might be cut out of them*' were found on the seashore at 'Erdulplinesse', which is now Walton-on-the-Naze. These were most likely mammoth teeth.

3.3.12 Significant amounts of Pleistocene fauna were subsequently collected in the Walton-on-Naze area in the 19th century. A complete mammoth skeleton exposed on the foreshore is referred to by Warren (1918), whilst Whitaker (1877) provided a list of fauna from the area, which comprised lion, hyena, red deer and bear.

3.3.13 Pleistocene fauna from Walton-on-the-Naze occurs in several museum collections. Unfortunately these lack detailed contextual information. Wymer (1985) records the following species in collections in Colchester, Manchester and Saffron Waldon museums:

- Straight tusked elephant
- Mammoth
- Bos/bison
- Giant deer
- Hippopotamus
- Rhinoceros

3.3.14 Only limited more recent investigations have been carried out at Walton-on-the-Naze (Boatman 1973; Bowden et al. 1995; Bridgland 1995). These identified several Pleistocene channel fills which included one containing clayey silts that preserved a pollen record that may be indicative of a Hoxnian (MIS 11) date (Boatman 1973, Bowden et al. 1995), as well as a gravel whose lithology is indicative of a pre-Anglian (MIS 12) Thames-Medway origin, potentially belonging to the Cooks Green Gravel (Bridgland 1995).

3.3.15 The evidence suggests that significant Pleistocene deposits of both pre- and post-Anglian date occur in the Walton-on-the-Naze area, which are associated with Lower and Middle Palaeolithic archaeology, and which have potential to contain significant paleoenvironmental remains.

3.4 Upper Palaeolithic

3.4.1 Only one Upper Palaeolithic artefact is recorded from the study area. This consists of a late Upper Palaeolithic backed blade from an unknown context in Frinton-on-Sea (PaMELA 685).

3.5 Mesolithic

3.5.1 The PaMELA database records Mesolithic artefacts from across the study areas. These are mostly chance finds of tranchet axes and adze/axes. As such pieces are the largest and most easily identifiable Mesolithic artefacts, the presence of these across the study areas likely hints at a wider potential for Mesolithic lithic scatters.

3.5.2 The following Mesolithic tranchet axe and adze/axe findspots are recorded:

- Frinton-on-Sea (PaMELA 12303–12304) – Early Mesolithic tranchet axe and Mesolithic adze/axe;
- Tendring (PaMELA 12343) – Early Mesolithic tranchet axe/adze;
- Badley Hall, Great Bromley (PaMELA 123413/HER MEX6962) – Early Mesolithic tranchet axe/adze;
- Great Bromley (PaMELA 12311–12312) – two early Mesolithic tranchet axes/adzes, one provenanced to Cock Lane;

- Lawford Grange, Lawford (PaMELA 12352/HER MEX1040120) – two early Mesolithic tranchet axes/adzes, one provenanced to Cock Lane.

3.5.3 In addition to the Mesolithic axe and adze/axe findspots, two Mesolithic lithic scatters are recorded from the study area. These are a Mesolithic lithic assemblage from Holland Brook, Pig Street, Little Clacton (PaMELA 12344) that included obliquely backed points and partially backed pieces, and a lithic assemblage from Lawford containing patinated blades and flakes identified as Mesolithic (PaMELA 12340) and a separate find of a Mesolithic microlith from the same location (PaMELA 6654).

4 AIMS AND OBJECTIVES

4.1.1 The aims of the updated Geoarchaeological Desk Based Assessment were to:

- use available geoarchaeological and geotechnical data to characterise the principal superficial geological deposits present within the Onshore Project Area, including the results of recent geoarchaeological interventions undertaken by Wessex Archaeology (2022b, 2023a, 2023b, 2023c);
- assess the geoarchaeological potential of the superficial deposits underlying the Onshore Project Area;
- identify the extent of superficial deposits with geoarchaeological potential; and
- make suitable suggestions to guide a program of further geoarchaeological works, where appropriate.

4.1.2 These aims were addressed by achieving the following objectives:

- collation of relevant geoarchaeological and geotechnical data, updating the existing dataset to include data arising from Wessex Archaeology (2022b; 2023a; 2023b; 2023c);
- production of a series of outputs to model the vertical and lateral extent of deposits across the Onshore Project Area;
- interpretation of the sediments in their local and regional geoarchaeological context;
- assessment of the likely geoarchaeological potential of the deposits present;
- production of an updated characterisation for the Onshore Project Area, dividing it into different Geoarchaeological Characterisation Zones (GCZs) of varying sub-surface geoarchaeological potential; and
- provision of recommendations to guide a program of geoarchaeological l works (where appropriate).

5 METHODOLOGY

5.1 Introduction

5.1.1 The aims of the updated GDBA have been achieved through deposit modelling and a Geoarchaeological Landscape Characterisation (GLC) for the Onshore Project Area. These

techniques are important in providing a framework for more precisely determining the geoarchaeological potential of the Onshore Project Area at a scale which can most effectively inform future decision making, management and mitigation of impact to the buried geoarchaeological resource.

5.2 Review of lithostratigraphic data

5.2.1 A total of 59 British Geological Survey (BGS) archive boreholes in the area of the Scheme were initially reviewed, resulting in a total of 51 useable stratigraphic logs, in three clusters towards the north, centre and south of the Onshore Project Area (**Appendix 1** and **Figure 3**). Of these, 17 were located either within or very close to the Scheme boundary; the additional logs reviewed provide a wider landscape context to those deposits recorded within the Scheme itself.

5.2.2 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 data with existing BGS mapping and their topographic context. The results of this review were compiled in an Excel spreadsheet for deposit modelling purposes.

5.2.3 Following the results of a series of geoarchaeological works associated with Ground Investigation (GI) works and archaeological and geoarchaeological evaluation of the Onshore Project Area, an additional (Wessex Archaeology 2022b) 40 lithostratigraphic logs were reviewed for inclusion in the updated deposit model.

5.2.4 This included three monitored GI boreholes close to the landfall at Frinton Golf Course (Wessex Archaeology 2022b) and seven from Little Clacton Road and Swan Road (Wessex Archaeology 2023a), as well as 30 test pit logs from the OnSS (Wessex Archaeology 2023b, 2023c). This resulted in a total of 99 sedimentary logs in the updated deposit model for the Onshore Project Area (**Figure 3**).

5.3 Deposit modelling

5.3.1 The updated deposit model has provided a preliminary deposit model that can be used to map the lateral extent and depth of Quaternary deposits across parts of the Onshore Project Area. The preliminary models have been prepared on the basis of the currently available data set, which for large parts of the Scheme is limited to relatively few BGS archive boreholes located within or close to the Scheme (see **Figure 3**). However, the addition of lithostratigraphic logs associated with the geoarchaeological monitoring of GI works in the area of Little Clacton Road and the Railway Crossing (GCZ 3), Swan Road (GCZ4) and at Frinton Golf Course (GCZ 1), along with Palaeolithic test pitting at the OnSS (GCZ 9), has provided additional data for the deposit model in these areas. The updated deposit model has contributed data to the subsequent Geoarchaeological Landscape Characterisation (GLC; see below).

5.3.2 To create a deposit model of the potential lateral and horizontal extent of geoarchaeological deposits, lithological and stratigraphic data was entered into a digital (RockWorks 23) database.

5.3.3 The Rockworks data was utilised to map the lateral extent of key stratigraphic units and to produce representative stratigraphic profiles (transects) mapping the Quaternary stratigraphy beneath the relevant areas of the Onshore Project Area. These include west-east transects across the Scheme towards the north (Transect A; **Figure 7**) and south

(Transect B; **Figure 8**), and a north-south transect along the length of the Scheme (Transect C; **Figure 9**).

5.4 Geoarchaeological Landscape Characterisation (GLC)

5.4.1 The GLC works on the same principles as a Historic Landscape Characterisation (English Heritage 2004) and Landscape Character Assessment (Natural England 2014), but in this case largely considers the shallow buried and outcropping superficial geological elements of the landscape.

5.4.2 The GLC involves breaking down the Scheme into defined zones called Geoarchaeological Character Zones (GCZs). The GCZs are specific to the Onshore Project Area, and are based primarily on the expected variation in superficial geological characteristics and surface topography, linked to an assessment of the geoarchaeological potential of the deposits.

5.4.3 The process of generating the GCZs has been informed by the Character Zones defined in the National Mapping Programme for Essex (Essex County Council 2003), Tendring District Historic Environment Characterisation (Essex County Council 2008), the Tendring Geodiversity Characterisation Report (Essex County Council 2009) and Managing the Essex Pleistocene (O'Connor 2015).

6 RESULTS

6.1 Stratigraphy

6.1.1 The stratigraphy recorded in recent geoarchaeological investigations (Wessex Archaeology 2022b; 2023a; 2023b; 2023c) and BGS archive boreholes from across the Onshore Project Area is divided into ten main lithostratigraphic units, some of which are limited to localised areas of the Scheme:

- Topsoil (modern)
- Made ground (modern)
- Colluvium (Holocene)
- Alluvium (Holocene)
- Peat (Holocene)
- Head-Brickearth (Pleistocene)
- Head-Gravel (Pleistocene)
- Sands (Pleistocene)
- Fluvial Sands and Gravels (Pleistocene)
- Bedrock (Palaeogene)

Bedrock

6.1.2 Bedrock London Clay, generally described as a firm or stiff in places sandy or silty clay, was reached in 32 of the 59 BGS archive boreholes.

Fluvial Sands and Gravels

6.1.3 Deposits of fluvial sand and gravel, interpreted as the Kesgrave Sands and Gravels of the Colchester Formation and of pre-Anglian (MIS 12) date, were recorded in 29 of the 59 BGS archive boreholes, generally between 0.2 and 6.4 m thick but increasing to 9.2 m thick in TM02NE14/A and over 17 m thick towards the centre of the Scheme in the area of boreholes TM12NW13/B-E. No distinct fine-grained or organic units were recorded within the Sands and Gravels in the BGS archive boreholes. These fluvial sands and gravels are characteristic of high energy deposition in a braided river system, with occasional intervening sand banks and bars as represented by sandier units.

6.1.4 Similar deposits were encountered as the basal Quaternary stratigraphic unit during the geoarchaeological investigations at Frinton Golf Course (Wessex Archaeology 2022b), at Swan Road, the Railway Crossing and Little Clacton Road (Wessex Archaeology 2023a) and at the OnSS (Wessex Archaeology 2023b; 2023c). Where they rise to surface elevations of between 25 and 35 m OD towards the north of the Scheme, the Sands and Gravels are likely to be equivalent to the earlier Ardleigh or Waldringfield Gravels of the Thames (MIS 14–16; see **Table 2**).

6.1.5 The Sands and Gravels were generally recorded in the BGS archive boreholes at elevations between c. 25 and 35 m OD towards the north of the Onshore Project Area, falling to levels between c. 15 and 25 m OD towards the south (**Figure 9**). However, work at Frinton Golf Course (Wessex Archaeology 2022b) has shown that Sands and Gravels are present at significantly lower elevations at the landfall area of the Scheme (see **Figure 10**), and likely relate to post-Anglian aggradation within the valley of the Holland Brook (see below).

6.1.6 Towards the north of the Onshore Project Area at the OnSS, Sands and Gravels were recorded in all 30 test pits, with an upper surface at between 33.59 m OD (TP228) and 34.54m OD (TP224). These deposits were belonging to the Ardleigh Gravel (MIS 16-14) of the Kesgrave Sands and Gravels. Here these deposits were largely recorded as reddish-brown to yellowish-brown sandy gravels to sands. Gravel clasts were typically fine to coarse flint, predominantly subangular to subrounded, but occasionally low relative concentrations of rounded or angular clasts were present. Mudstone clasts, reworked from local Palaeogene bedrock, were rarely present within the gravels. These deposits were typically moderately well to moderately poorly sorted, with sub-horizontal fluvial bedding structures often observed.

6.1.7 In the northern part of the OnSS within the Phase 1 Evaluation Area, these Sands and Gravels have been eroded and incised into by a significant gully/valley form (c. 300 m in width) and most evident in TP203 and TP206 (see **Figures 11** and **12**).

6.1.8 Towards the centre of the Scheme the Sands and Gravels are recorded in BGS archive boreholes at a similar basal elevation to those of the south, but their surface elevation rises to c. 33 m OD. Fluvial Sands and Gravels were recorded during geoarchaeological monitoring of GI Works at Little Clacton Road (BHLC-1 and BHLC-3) and Swan Road (BHSR-3 and BHSR-4) (Wessex Archaeology 2023a). The deposits ranged in thickness from 0.90 m in BHSR-4 to 4.40 m in BHLC-3, and 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 here. The Sands and Gravels are considered likely to represent the Cooks Green Gravels (MIS 13–14; 563-478 Kya).

6.1.9 Towards the south of the Onshore Project Area where they are recorded at levels of c. 15–25 m OD the Sands and Gravels are likely to be equivalent to the Cooks Green Gravels (MIS 13–14), 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 and (ECC 2009).

6.1.10 A lack of BGS archive boreholes meant that it was not possible to confirm if pre-Anglian, Anglian or post Anglian Thames/Medway deposits, or Pleistocene deposits laid by the Holland Brook, were present towards the far south of the Onshore Project Area during the previous GDBA (Wessex Archaeology 2022a). However, during geoarchaeological monitoring of GI works at Frinton Golf Course (Wessex Archaeology 2022b) at the southern end of the Onshore Project Area, the Sands and Gravels underlying the Holocene alluvial sequence were encountered at -8.2 m OD in BH203, and were 2.3 m thick. These likely represent Fluvial Sands and Gravels of the Holland Brook that are of post-Anglian, potentially Devensian (MIS 5d-3) or Late Devensian (MIS 2) date.

Sands

6.1.11 At the northern end of the Onshore Project Area within the OnSS, a unit of fine-medium sands containing rare to very occasional fine to medium (<20mm) flint clasts was recorded overlying the Sands and Gravels. This unit was recorded in six test pits at the OnSS (TP201–TP206) at depths of between 0.90 m bgl (34.56m OD; TP204) and 3.20 m bgl (32.47m OD; TP203), present only within the gully incised into the Ardleigh Gravel in the north of the Site (within the Phase 1 area). The Sands were structureless and ranged from moderately well-sorted to well-sorted.

6.1.12 The mode of deposition of the Sands was considered uncertain, but may have been through low-energy water flow, potentially with a colluvial input (see Wessex Archaeology 2023a).

Head-Gravel

6.1.13 Deposits interpreted as Head-Gravel were recorded in three BGS archive boreholes (TM11NE45, TM11NE51 and TM12NW34), generally described as a gravelly sandy or silty clay. Here the Head-Gravel is distinguished from deposits of Head-Brickearth on the basis of their high gravel content and poor sorting.

6.1.14 In these boreholes the Head-Gravel was between 0.20 and 0.45 m thick. Although none of these boreholes were located within the Onshore Project Area, they demonstrate the potential for Head or Colluvium to be present on slopes or at the base of slopes within the wider area of the Scheme, as demonstrated at the OnSS (Wessex Archaeology 2023b). Here, deposits generally consisted of grey to reddish-brown clayey sandy gravels to clayey gravelly sands and interpreted as Head-Gravel were recorded overlying the Ardleigh Gravel and, where present the Sands, in all 30 test pits and varying in thickness between 0.12 m (TP218) and 2.17 m (TP206). The surface of these deposits was encountered at between 34.15 (TP218) to 35.05 m OD (TP219).

6.1.15 These deposits are characteristic of sediments that have been remobilised down-slope through colluviation and/or solifluction processes resulting from seasonal freeze-thaw processes in periglacial environments. Such deposits are often referred to as ‘Head’ (see **Section 2.3**) and are grouped here under Head-Gravel.

Head-Brickearth

6.1.16 Deposits collectively interpreted as Head-Brickearth were recorded in 33 of the 59 BGS archive boreholes reviewed during the previous GDBA (Wessex Archaeology 2022a). Similar deposits were also encountered at Little Clacton Road, the Railway Crossing and Swan Road (Wessex Archaeology 2023a), and were widespread across Phase 1 and 2 of the OnSS (Wessex Archaeology 2023b; 2023c).

6.1.17 These were generally described as a variably sandy silty clays, often with fine or medium sized gravel inclusions. The proportion of gravels was generally smaller, and the gravels finer, in these deposits compared to those interpreted as Head or Colluvium.

6.1.18 The Head-Brickearth was between 0.2 (TM11NE17, TM02NE14/A) and at least 2.75 m thick (TM12NW41) in the BGS archive boreholes, although they were not bottomed in nine BGS boreholes (including TM12NW41). In these boreholes, towards the north of the Scheme the Head-Brickearth was recorded at elevations between c. 33 and 36 m OD, whilst towards the south they were recorded at lower elevations between c. 20 and 25 m OD (**Figures 7-9**).

6.1.19 The Head-Brickearth was recorded in boreholes BHLC-1, BHLC-3 and BHSR-3 overlying Sands and Gravels at Little Clacton Road and Swan Road, and in BHR-N and BHR-S at the Railway Crossing overlying London Clay bedrock (Wessex Archaeology 2023a). Here these 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, but falling to between c. 11.0 and 15.0 m OD in BHR-S.

6.1.20 Towards the north of the Onshore Project Area at the OnSS, Head-Brickearth was recorded overlying Head-Gravel within all but a single test pit (TP208). The deposits here varied in thickness between 0.15 m (TP225) to 1.20 m (TP201), with their upper surface at depths ranging from 34.60 m OD (TP230) to 35.34 m OD (TP219).

6.1.21 These deposits are undated, but may include deposits of Late Devensian (MIS 2; 23-11.7 Ka) or older Pleistocene date (as highlighted in **Section 2.3**). They are likely to be originally aeolian in origin, but may be substantially reworked by various processes and may include an alluvial and colluvial component. Although sandier units were recorded in places in the logs, no distinct sand-rich unit was identified at the base of the Head-Brickearth that may be equivalent to the Coversands described at the base of the sequence in this area by O'Connor (2015).

6.1.22 The fine-grained component of these deposits is likely to have derived from wind-blown sediments (coversands or loess). At the OnSS these sediments showed a lack of structures indicative of primary aeolian deposition, and the frequent presence of gravel clasts more widely, suggests that these deposits consist of windblown sediments which have subsequently been remobilised through downslope processes such as solifluction, colluviation and/or water run-off (cf. 'Head-Brickearth'). As these deposits are therefore not actually windblown coversands, they are referred to here as Head-Brickearth (see **Section 2.3**).

Alluvium

6.1.23 Deposits of Alluvium were not recorded within the BGS archive boreholes, although none of these were located within mapped areas of Alluvium shown by the BGS. The presence of Alluvium was however confirmed during GI monitoring at Frinton Golf Course on the estuarine floodplain of the Holland Brook (see Wessex Archaeology 2022b).

6.1.24 Here, the sequence of Holocene estuarine alluvium was between 7.45 m and 8.7 m thick, and composed of a tripartite sequence of lower alluvium, peat (see below) and upper alluvium, recorded to levels between c. 0 and -1 m OD.

6.1.25 On the basis of BGS mapping, Alluvium is likely to be present more widely in the area of Holland Haven Marshes towards the south of the Onshore Project Area, on the floodplain of the Tendring Brook towards the centre of the Onshore Project Area (northeast of Tendring), and towards the north in the area of Holland Brook (close to Horsley Cross).

6.1.26 Depending on the preferred route, Alluvium may also be encountered in a stream valley located north of Thorpe-le-Soken, draining east towards Landermere Creek and Hamford Water. As outlined in **Section 2.3**, Alluvium may contain evidence for palaeochannels, peat and organic-rich deposits of high geoarchaeological potential, as demonstrated during GI monitoring at Frinton Golf Course (see below).

Peat

6.1.27 Peat was recorded within the Holocene alluvial sequence in all three monitored boreholes at Frinton Golf Course, ranging in thickness from 0.5 m in BH202 at -3.0 m OD, to 1.5 m at -3.1m OD in BH203 (see Wessex Archaeology 2022b). The peat was recorded as a single layer in BH202 and BH203, but in BH201 the peat was interbedded with a 1 m thick deposit of silty clay alluvium at -2.5 m OD.

6.1.28 The presence of peat at Frinton Golf Course highlights the potential of such deposits to be preserved within Holocene alluvial sequences encountered within the Onshore Project Area, in particular in the lower valley of the Holland Brook and Holland Haven Marshes.

Colluvium

6.1.29 Dark brown, structureless, slightly sandy silt and silty clays with rare to occasional subangular to subrounded flint clasts and heavy rooting were observed at the top of the Quaternary stratigraphic sequence in four test pits (TP201, TP203, TP207 and TP208) within Phase 1 of the investigations at the OnSS (see Wessex Archaeology 2023b).

6.1.30 These deposits were between 0.2 and 0.35 m thick, and were recorded only within a gully feature observed in this part of the OnSS. They were collectively interpreted as Holocene Colluvium, reflecting the downslope remobilisation of sediments resulting from landscape instability brought on by a lack of vegetation cover due to Holocene landscape-use and agricultural practices, and represent the final phase of infilling of the gully.

Made ground

6.1.31 A unit of modern made ground was recorded in 14 of the 59 BGS archive boreholes and in all seven GI boreholes at Little Clacton Road, the Railway Crossing and Swan Road (Wessex Archaeology 2023a).

6.1.32 The made ground was generally between 0.3 and 0.9 m thick in the BGS archive boreholes, increasing to 1.6 m in borehole TM11NE46. Up to 2.4 m of made ground was recorded at Swan Road, with between 0.2 and 0.6 m recorded at Little Clacton Road and the Railway Crossing. The composition of the Made Ground was variable, but in most cases it included fragments of modern brick and/or concrete.

Topsoil

6.1.33 A unit of modern topsoil was recorded in 30 of the 59 BGS archive boreholes, and was widespread across the OnSS (see Wessex Archaeology 2023b; 2023c) and at Frinton Golf Course (Wessex Archaeology 2022b). The topsoil was generally between 0.1 and 0.5 m thick, increasing to 0.76 m thick towards the north of the Onshore Project Area in borehole TM12NW35.

6.1.34 The topsoil was generally not described in detail in the geotechnical logs, but in most cases it was described as 'loam' (generally a sandy, silty clay). At Frinton Golf Course it was up to 0.5 m thick and described as a silty clay loam, while at the OnSS it was generally recorded as a gravelly loam up to 0.45 m thick, reflecting the different textures of the underlying parent material.

6.2 Deposit modelling

6.2.1 The deposit modelling comprised three stratigraphic profiles (transects) aligned broadly southwest-northeast across the north (Transect A; **Figure 7**) and south of the Scheme (Transect B; **Figure 8**) and north-south along the length of the Scheme (Transect C; **Figure 9**). The latter transect incorporates data from geoarchaeological works at Frinton Golf Course (Wessex Archaeology 2022b), the Railway Crossing, Little Clacton Road and Swan Road (Wessex Archaeology 2023a) and the OnSS (Wessex Archaeology 2023b, 2023c). Individual transects from works at Frinton Golf Course (Wessex Archaeology 2022b) and the OnSS (Wessex Archaeology 2023b, 2023c) are shown in **Figures 10** to **12**.

6.2.2 The cross-sections are composed of two-dimensional vertical visualisations of the stratigraphic records, along lines drawn through various sedimentary records within and close to the Onshore Project Area boundary. These transects model the possible make-up of the deposits between these individual deposit records, drawn as horizontal lines between the upper and lower surfaces of the stratigraphic units.

6.2.3 Data coverage within the Scheme is generally poor, with only 17 archive boreholes located within or very close to the Scheme boundary, although this data is supplemented by the results of geoarchaeological works in specific areas of the Onshore Project Area (including Frinton Golf Course, the Railway Crossing, Little Clacton Road and Swan Road, and the OnSS, where data coverage is good. It is anticipated that the deposit model will be developed further as archaeological evaluation and mitigation works across the Onshore Project Area are progressed.

6.2.4 The current deposit models provide a preliminary interpretation of the possible presence and distribution of Quaternary deposits across the wider Onshore Project Area, and a more detailed understanding of the deposits in specific areas.

Transect A

6.2.5 Transect A (**Figure 7**) is a west-east transect across the northern part of the Scheme. The transect demonstrates the height of the Kesgrave Sands and Gravels in this area of the Scheme (c. 30–35 m OD), where they are overlain by deposits of Head-Brickearth at elevations up to c. 37 m OD. At these elevations the Gravels are likely to be equivalent to either the Ardleigh or Waldringfield Gravels of the pre-Anglian Thames (MIS 14–16).

6.2.6 The Head-Brickearth deposits here are up to 2.75 m in thickness.

Transect B

6.2.7 Transect B (**Figure 8**) is a transect running northwest across the Onshore Project Area, from Clacton-on-Sea across the southern part of the Scheme to Mayfields Farm. Within the Onshore Project Area, the Kesgrave Sands and Gravels are recorded at elevations between c. 15 and 24 m OD, and are likely to be equivalent to the Cooks Green Gravels of MIS 13–14 date, deposited by the Rivers Thames and Medway downstream of their confluence.

6.2.8 The Gravels here are overlain by Head-Brickearth recorded at elevations of up to c. 24 m OD and up to c. 2 thick, but generally thinning towards the southwest to between c. 0.1 and 0.6 m in thickness.).

6.2.9 To the southwest of the Onshore Project Area the Brickearth and Kesgrave Sands and Gravels thin to absence in TM11NE1 and TM11NE2. Towards Clacton-on-Sea a separate gravel terrace is recorded at elevations between c. 4 and 7 m OD, where the deposits are possibly equivalent to the Holland Gravel (MIS 12).

Transect C

6.2.10 Transect C (**Figure 9**) is a north-south transect along the length of the Onshore Project Area. This transect has been updated to include the results of geoarchaeological investigations at Frinton Golf Course (Wessex Archaeology 2022b), the Railway Crossing, Little Clacton Road and Swan Road (Wessex Archaeology 2023a) and the OnSS (Wessex Archaeology 2023b, 2023c).

6.2.11 The transect illustrates the basal elevations of the different gravel terraces underlying the Onshore Project Area. At the southern end of the Project Area, the Sands and Gravels underlying the Holocene alluvial sequence were encountered at below -8.2 m OD. These likely represent fluvial sands and gravels of the Holland Brook that are of post-Anglian, potentially Devensian (MIS 5d-3) or Late Devensian (MIS 2) date.

6.2.12 Towards the centre of the Onshore Project Area in the area of Swan Road, the Railway Cutting and Little Clacton Road, the Gravels are recorded at elevations between c. 15 and 25 m OD, and are interpreted as the Cooks Green Gravels (MIS 13–14).

6.2.13 Towards the north of the Project area the Sands and Gravels are generally recorded at elevations between c. 25 and 35 m OD, consistent with the level of the deposits recorded at the OnSS (Wessex Archaeology 2023b, 2023c). Here they are interpreted as the Ardleigh Gravel (MIS 16-14) of the Kesgrave Sands and Gravels.

6.2.14 Deposits of Head-Brickearth are recorded overlying the Gravels across the Onshore Project Area, including in dry valleys or gully forms that incise the underlying Sands and Gravels. The Head-Brickearth is generally relatively thin towards the south and centre of the Scheme (where they are generally less than 1 m in thickness), although up to 4.0 m of Head-Brickearth was recorded at the Railway Crossing (Wessex Archaeology 2023a) and they increase in thickness to a minimum of 2.75 m towards the north of the Onshore Project Area. The potential for such deposits was highlighted at the OnSS (Wessex Archaeology 2023b, 2023c), where they were up to 1.2 m thick.

6.2.15 A thick sequence of Holocene Alluvium is present at the southern end of the Onshore Project Area in the lower valley of the Holland Brook. Here the alluvial sequence was recorded at up to 8.7 m in thickness, and it contained a peat unit up to 1.2 m thick (see Wessex Archaeology 2022b).

6.3 Geoarchaeological Landscape Characterisation

6.3.1 A total of nine Geoarchaeological Character Zones (GCZs) were defined for the Onshore Project Area in the previous GDBA (Wessex Archaeology 2022a) on the basis of a review of BGS archive boreholes, mapping of superficial deposits and baseline character mapping. These GCZs have been updated, and where necessary revised, on the basis of new data obtained from recent geoarchaeological monitoring of GI works (Wessex Archaeology 2022b; 2023a) and geoarchaeological investigations at the OnSS (Wessex Archaeology 2023b, 2023c).

6.3.2 As a result, the Onshore Project Area has been divided into a total of 13 GCZs as shown in **Figure 13**. These zones are summarised in **Table 4** and discussed in more detail below. For GCZ 2, no new lithostratigraphic information has been obtained, and the nature of the deposits and their geoarchaeological potential in this zone remains unknown.

Table 4 Geoarchaeological Character Zones GCZs) for the Onshore Project Area

GCZ	Principal Quaternary deposits	Geological period	Archaeological period	Approximate depth of deposits (m bgl)
1	Alluvium Peat Sands and Gravels	Holocene Holocene ?Late Pleistocene	Mesolithic to post-medieval Mesolithic to Iron Age ?Middle to Upper Palaeolithic	0.00-9.00 3.00-6.00 9.00-12.00
2	Unknown	Unknown	Unknown	Unknown
3	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown 0.20-4.50 0.50-6.00
3a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	?Middle to Late Pleistocene ?Early Middle Pleistocene	?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	0.20-2.00 1.20-5.60
3b	Head-Brickearth	?Middle to Late Pleistocene	?Middle to Upper Palaeolithic	0.30-4.50
4	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown
4a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	?Middle to Late Pleistocene ?Early Middle Pleistocene	?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	1.00-4.10 2.00-3.00
5	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Wivenhoe Gravel)	Holocene /Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown
6	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel, Wivenhoe Gravel)	Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown 0.20-3.00+ 0.50-3.50+

7	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Holocene Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown
8	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Holocene ?Middle to Late Pleistocene ?Early Middle Pleistocene	Mesolithic to post-medieval ?Middle to Upper Palaeolithic ?Lower to Middle Palaeolithic	Unknown 0.00-2.75 0.00-10.00
8a	Head-Brickearth Head-Gravel Sands Ardleigh Gravel	?Middle to Late Pleistocene ?Middle to Late Pleistocene ?Middle to Late Pleistocene Early Middle Pleistocene	?Lower to Middle Palaeolithic ?Lower to Middle Palaeolithic ?Lower to Middle Palaeolithic Lower Palaeolithic	0.30-1.70 0.60-2.55 0.90-3.20 1.60-3.30+
8b	Head-Brickearth Head-Gravel Ardleigh Gravel	?Middle to Late Pleistocene ?Middle to Late Pleistocene Early Middle Pleistocene	?Lower to Middle Palaeolithic ?Lower to Middle Palaeolithic Lower Palaeolithic	0.27-1.00 0.45-1.80 0.50-3.20+

GCZ 1

6.3.3 GCZ 1 is defined by the presence of Holocene Alluvium in the estuary of the Holland Brook, and the area of Holland Haven Marshes. GI monitoring at Frinton Golf Course (Wessex Archaeology 2022b) confirmed that the alluvial sequence here is up to 9.0 m thick, and contains peat at depths between c. 3.0 and 6.0 m bgl. The alluvial sequence is underlain by Fluvial Sands and Gravels associated with the Holland Brook; these are undated, but are likely to be of Late Pleistocene date and are present in thicknesses of up to a minimum of 3.0 m. These deposits are likely to extend into the intertidal and offshore zones.

GCZ 2

6.3.4 No sedimentary records are available for GCZ 2 and the extent of survival of any Quaternary deposits is unknown. BGS mapping indicates that no superficial deposits are present, although there is potential for unmapped Pleistocene deposits of the Holland Brook or Cooks Green Gravel, and Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium).

GCZ 3

6.3.5 Pleistocene deposits of Kesgrave Sands and Gravels, likely equivalent to the Cooks Green Gravel (MIS 14–13; 563-478 Kya), and Head-Brickearth are present in this zone. More widely, BGS archive borehole data indicates that Head-Brickearth of unknown date is present at depths between c. 0.20-1.00 m bgl, overlying fluvial sands and gravels of the Cooks Green Gravel at depths between 0.50 and at least 6.00 m bgl. There is potential for Head-Gravel and/or Holocene Colluvium on valley slopes in this zone.

GCZ 3a

6.3.6 Within GCZ 3, GI monitoring at Little Clacton Road (Wessex Archaeology 2023a) has confirmed the presence of Pleistocene Head-Brickearth at depths up to 2.0 m bgl, overlying Kesgrave Sands and Gravels (likely of the Cooks Green Gravel) at depths between c. 1.2 and 5.6 m bgl.

GCZ 3b

6.3.7 GI monitoring at the Railway Crossing (Wessex Archaeology 2023a), more broadly within GCZ 3, has confirmed the presence of Head-Brickearth, up to 5.6 m thick within GCZ 3b.

In the monitored boreholes in this zone the Head-Brickearth directly overlay London Clay bedrock, although there is the broad potential for Kesgrave Sands and Gravels (likely of the Cooks Green Gravel) to be locally present in this zone.

GCZ 4

6.3.8 No previous interventions have been carried out in GCZ 4 with the exception of the new monitored GI interventions in GCZ 4a (see below). As a result, the extent of survival of any Quaternary deposits is unknown more widely within GCZ 4. BGS mapping indicates that outcrops of the Pleistocene Kesgrave Sands and Gravels, likely equivalent to the Cooks Green/Wivenhoe Gravels (MIS 14–13; 563-478 Kya), are present within this zone, and there is potential for unmapped Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium) in valleys trending broadly southwest-northeast across the zone.

GCZ 4a

6.3.9 Geoarchaeological monitoring of GI works at Swan Road (Wessex Archaeology 2023a) has confirmed the presence of Head-Brickearth, up to 4.1 m thick, and localised deposits of the Kesgrave Sands and Gravels (likely equivalent to the Cooks Green Gravel) within GCZ 4a, towards the north of zone GCZ 4.

GCZ 5

6.3.10 GCZ 5 is defined by the potential presence of Holocene Alluvium associated with the Tendring Brook, a tributary of the Holland Brook. No previous interventions have been carried out in this zone and the extent, character and depth of any Alluvium is unknown. The Tendring Brook may have cut through Pleistocene deposits of the Cooks Green/Wivenhoe Gravel Gravels (MIS 14–13; 563-478 Kya), and Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium) may be present on the valley sides or at the base of the valley.

GCZ 6

6.3.11 BGS archive boreholes indicate that Pleistocene deposits of the Kesgrave Sands and Gravels, overlain by Head-Brickearth, are present in GCZ 6; the former may include deposits of the Ardleigh (MIS 16–14; 676-524 Kya) and/or Wivenhoe (MIS 14–13) Gravels. BGS archive boreholes indicate that Head-Brickearth, likely of Pleistocene date, is present at depths between c. 0.20 and at least 3.00 m bgl, with the underlying Sands and Gravels present at between c. 0.50 and at least 3.50 m bgl.

6.3.12 There is potential for Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium) on valley slopes within this zone.

GCZ 7

6.3.13 Zone 7 is characterised by the potential presence of Holocene Alluvium associated with the floodplain of the Holland Brook. No previous interventions have been carried out in this zone and the extent, character and depth of any Alluvium is unknown.

6.3.14 Pleistocene deposits of the Ardleigh Gravels (MIS 16–14; 676-524 Kya) of the Kesgrave Sands and Gravels may be present, whilst it is possible that Pleistocene sediments deposited by the Holland Brook may occur. Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium) may be present on the valley sides or at the base of the valley.

GCZ 8

6.3.15 More widely, BGS archive boreholes in GCZ 8 indicate that Pleistocene Head-Brickearth is present at depths between c. 0.00 and 2.75 m bgl, with fluvial sands and gravels (likely equivalent to the Ardleigh Gravel (MIS 16–14; 676-524 Kya) of the Kesgrave Sands and Gravels) present at between c. 0.0 and at least 10.0 m bgl. There is broad potential for Pleistocene and/or Holocene slope deposits (Head-Gravel, Head-Brickearth, Colluvium) on valley slopes within this zone. Geoarchaeological interventions at the OnSS (Wessex Archaeology 2023b; 2023c) have allowed a more detailed assessment of the deposits towards the north of GCZ 8 in zones GCZ 8a and GCZ 8b (see below).

GCZ 8a

6.3.16 GCZ 8a is in the north of the OnSS and is defined by a gully incised into the Ardleigh Gravel, and containing deposits infilling that gully (see Wessex Archaeology 2023b; 2023c). The earliest Pleistocene deposits identified in GCZ 8a consisted of high energy fluvial sands and gravels, belonging to the Ardleigh Gravel of the Kesgrave Sands and Gravels (MIS 16-14; 676-524 Kya) of the River Thames. Test pits evaluated the upper c. 3.0 m of these deposits.

6.3.17 Within GCZ 8a the surface of the Ardleigh Gravels has been truncated and incised into and the resulting gully is infilled with basal Sands, overlain by clayey, sandy gravels and clayey gravelly sands (Head-Gravel). The age of these sediments is uncertain, and they may post-date the Ardleigh Gravels by a considerate period.

6.3.18 The youngest Pleistocene sediments in GCZ 8a comprise Head-Brickearth. These deposits likely have a significant aeolian component, but have been reworked via colluviation and/or solifluction processes. Head-Brickearth deposits seal the Head-Gravel, and are therefore younger, but no chronology is currently available to date the Head-Brickearth. Within GCZ 8a, occasional occurrences of Holocene colluvium overlying the Head-Brickearth were recorded.

GCZ 8b

6.3.19 The deposits in this zone consist of Pleistocene deposits of the Ardleigh Gravel and overlying Head-Gravel and Head-Brickearth. The Head-Gravel and Head-Brickearth are widely distributed across GCZ 8b, and are analogous with those in GCZ 8a.

7 ASSESSMENT OF ARCHAEOLOGICAL AND GEOARCHAEOLOGICAL POTENTIAL

7.1 Introduction

7.1.1 This section provides an assessment of the geoarchaeological potential of the Quaternary deposit in each GCZ. It includes consideration of potential to contain geoarchaeological evidence (specifically archaeological remains and palaeoenvironmental data relevant for contextualising past settlement history) and its significance in relation to national (e.g., EH 2008) and regional (EERRF 2021) research themes and priorities. The assessment provides a framework for more precisely determining the geoarchaeological resource in each GCZ at a scale which can most effectively inform future decision making. This includes establishing where current data is insufficient to characterise the geoarchaeological resource and where field evaluation to inform future requirements for geoarchaeological mitigation and/or managements strategies may be required.

7.1.2 An archaeological and palaeoenvironmental '*potential*' rating has been assigned to deposits in each GCZ, representing a measure of probability. This has been determined via the

application of professional judgement, informed by the evidence from the study area and surrounding area. '*Potential*' is expressed on a four-point scale, assigned in accordance with the following criteria:

- **High** Situations where evidence is known or strongly suspected to be present within deposits and which are likely to be well preserved.
- **Moderate** Includes cases where there are grounds for believing that evidence may be present, but for which conclusive evidence is not currently available. This category is also applied in situations in which material are likely to be present, but also where their state of preservation may have been compromised.
- **Low** Circumstances where the available information indicates that evidence is unlikely to be present, or that their state of preservation is liable to be severely compromised.
- **Unknown** Cases where currently available information does not provide sufficient evidence on which to provide an informed assessment with regard to the potential for material to be present.

7.1.3 The relative '*Significance*' of known and potential archaeological assets has been determined in accordance with the criteria set out in **Table 5.** These criteria are related to national (EH 2008) and regional (EERRF 2021) research themes and priorities.

Table 5 Generic schema for classifying the significance of archaeological assets (based on HE 2015)

Significance	Categories
Very High	World Heritage Sites (including nominated sites) Assets of recognised international importance Assets that contribute to international research objectives
High	Scheduled Monuments Non-designated assets of national importance Assets that contribute to national research agendas
Moderate	Assets that contribute to regional research objectives
Low	Assets compromised by poor preservation and/or poor contextual associations Assets with importance to local interest groups
Negligible	Little or no archaeological or geoarchaeological interest
Unknown	The importance of the asset has not been ascertained from available evidence

7.2 Areas of archaeological and geoarchaeological potential

7.2.1 The archaeological and palaeoenvironmental potential of deposits in each GCZ is summarized in **Table 6**; consideration of the possible significance of any archaeological evidence present in relation to national (EH 2008) and regional (EERRF 2021) research themes and priorities is also provided.

Table 6 Updated GLC framework for the Onshore Project Area

GCZ	Principal Quaternary deposits	Archaeological potential of deposits	Paleoenvironmental potential of deposits	Geoarchaeological Significance
1	Alluvium Peat Fluvial Sands and Gravels (Late Pleistocene)	Low[1] High Unknown	Low[1] High Unknown	Low-Moderate Moderate-High Unknown
2	Unknown	Unknown	Unknown	Unknown
3	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Low Unknown Unknown	Low[2] Unknown Unknown	Low-Moderate Unknown Unknown
3a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	Unknown Unknown	Unknown Unknown	Unknown Unknown
3b	Head-Brickearth	Moderate	Low	Moderate
4	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Low Unknown Uknown	Low[2] Unknown Moderate	Low-Moderate Unknown Moderate-High
4a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	Unknown Unknown	Unknown Unknown	Unknown Unknown
5	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel/ Wivenhoe Gravel)	Low[1] Low Unknown Unknown	Low[1] Low[2] Unknown Unknown	Low-Moderate Low-Moderate Unknown Unknown
6	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel / Wivenhoe Gravel)	Low Unknown Unknown	Low[2] Unknown Unknown	Low-Moderate Unknown Unknown
7	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Low[1] Low Unknown Unknown	Low[1] Low[2] Unknown Unknown	Low-Moderate Low-Moderate Unknown Unknown
8	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Low Unknown Unknown	Low[2] Unknown Unknown	Low-Moderate Unknown Unknown

GCZ	Principal Quaternary deposits	Archaeological potential of deposits	Paleoenvironmental potential of deposits	Geoarchaeological Significance
8a	Head-Brickearth Head-Gravel Sands Kesgrave Sands and Gravels (Ardleigh Gravel)	Low Low-Moderate Low Low[3]	Low Low Unknown Low[3]	Moderate-Low Unknown Unknown High
8b	Head-Brickearth Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Low Low-Moderate Low[3]	Low Low Low-Moderate[3]	Moderate-Low Unknown High

[1]may contain organic-rich or peat units of high archaeological and palaeoenvironmental potential
[2]may contain calcareous units of moderate palaeoenvironmental potential
[3]potential of deposits below evaluated depth is unknown

GCZ 1

7.2.2 Recent archaeological monitoring of GI works (Wessex Archaeology 2022b) has confirmed the presence of a sequence of Holocene Alluvium including Peat, in zone GCZ 1.

7.2.3 Where the alluvium is composed of minerogenic sediments (e.g. sands, silts and clays), these deposits likely formed at a distance from dryland areas in an active floodplain environment, and is therefore considered to have limited archaeological potential. The palaeoenvironmental potential of such minerogenic sediments is similarly limited, although they may contain remains of diatoms, ostracods and forams that are important proxies for reconstructing changing conditions from freshwater to brackish water environments associated with changing estuarine influences, particularly where they are recorded at contacts with peat or organic muds.

7.2.4 Peat deposits have high potential for the preservation of waterlogged archaeology and palaeoenvironmental remains (e.g. pollen, plant macrofossils, insects) that provide important data on past climate, vegetation, environment and land-use. These deposits are therefore of high geoarchaeological potential.

7.2.5 The alluvial sequence is underlain in GCZ 1 by fluvial sands and gravels associated with the Holland Brook; these are undated, but are likely to be of Late Pleistocene date. These deposits have the potential to contain Middle and Upper Palaeolithic archaeology, and organic and other fossiliferous sediments of significant geoarchaeological potential. Where archaeological finds are reworked, such material would be of moderate potential in relation to national and regional research questions and priorities. If minimally disturbed/in situ, such archaeology would be of high significance.

GCZ 2

7.2.6 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-Brickearth and/or Holocene Colluvium.

7.2.7 As described in **Section 3**, the 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

7.2.8 Pleistocene deposits equivalent to the Cooks Green Gravel (MIS 14–13) and Head-Brickearth are likely to be widely present in this zone, and Head and/or Holocene Colluvium may be present on valley slopes. Recent GI monitoring in zones GCZ 3a and 3b (Wessex Archaeology 2023a) has confirmed the presence of variable thicknesses of the Cooks Green Gravel and Head-Brickearth within parts of GCZ 3.

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

7.2.10 Deposits of Pleistocene Head and/or Holocene Colluvium 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.

GCZ 4

7.2.11 With the exception of the area of GCZ 4a, 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 for the majority of GCZ 4. 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.

7.2.12 Geoarchaeological monitoring of GI works at Swan Road (Wessex Archaeology 2023a) has confirmed the presence of Head-Brickearth, up to 4.1 m thick, and localised deposits of the Kesgrave Sands and Gravels (likely the Cooks Green/Wivenhoe Gravels) in GCZ 4a.

7.2.13 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.

7.2.14 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.

GCZ 5

7.2.15 Holocene Alluvium may be present within this zone, although no stratigraphic data is available that would enable an assessment of the presence, character and thickness of these deposits. Where the alluvium is composed of minerogenic sediments (e.g. sands, silts and clays) it is considered to have limited archaeological and paleoenvironmental potential. Peat or organic-rich units within the Alluvium would have high palaeoenvironmental potential and high potential for Holocene archaeology.

7.2.16 Where Pleistocene deposits of Cooks Green/Wivenhoe Gravels are present in this zone, they 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 and colluvial sediments, such material would be of moderate potential. If minimally disturbed/in situ, such archaeology would be of high significance.

7.2.17 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.

GCZ 6

7.2.18 Deposits of the Ardleigh (MIS 16–14) and/or Wivenhoe (MIS 14-13) Gravels, overlain by Pleistocene Head-Brickearth, may be encountered in GCZ 6. The deposits of the Ardleigh/Wivenhoe Gravels and Head-Brickearth have the potential to contain Palaeolithic archaeology respectively, and organic and other fossiliferous sediments of significant geoarchaeological potential. One of the earliest Lower Palaeolithic artefacts from the study area, thought to derive from deposits of the Ardleigh Gravel (TERPS 31986; **Section 3**), highlights the potential of these deposits to contain significant Lower Palaeolithic archaeology.

7.2.19 Where archaeological finds are reworked within fluvial gravels and colluvial sediments, such material would be of moderate potential in relation to national and regional research questions and priorities. If minimally disturbed/in situ, such as within stable land surfaces in the Head-Brickearth, such archaeology would be of high significance.

7.2.20 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.

GCZ 7

7.2.21 Holocene Alluvium associated with the Holland Brook may be present within GCZ 7, potentially underlain by Ardleigh Gravels (MIS 16–14). Pleistocene Head and/or Holocene Colluvium may also be present on the valley sides or at the base of the valley. Holocene Alluvium has the potential to contain organic-rich units or peat of high palaeoenvironmental potential and may contain Holocene archaeology, whilst the deposits of the Ardleigh

Gravels may contain significant Lower Palaeolithic archaeology and organic/fossiliferous sediments.

7.2.22 Pleistocene Head and/or Holocene Colluvium which generally contain reworked archaeological finds of multiple periods, but are likely to be of low palaeoenvironmental potential except where calcareous units are identified.

GCZ 8

7.2.23 Zone 8 is likely to be underlain more widely by the Ardleigh Gravel (MIS 16–14) of the Kesgrave Sands and Gravels, overlain by deposits which could include Pleistocene Head-Brickearth and/or Pleistocene Head and Holocene Colluvium.

7.2.24 More broadly within GCZ 8, the Ardleigh Gravels have the potential to contain significant Lower Palaeolithic archaeology; where archaeological finds are reworked, such material would be of moderate significance, but if minimally disturbed or in situ, such archaeology would be of high significance.

7.2.25 The potential of any overlying Head-Brickearth is currently unknown. The significance of any Palaeolithic archaeology within Brickearth is dependent on its taphonomic history. If reworked Palaeolithic archaeology is present its significance is likely to be moderate, whilst if in situ, or only minimally disturbed, it is likely to be high. The palaeoenvironmental potential of these deposits is currently unknown.

7.2.26 The potential of Head/Colluvium in the zone is also unknown but are mostly likely to contain archaeology reworked by slope processes. Such reworked Palaeolithic material in Pleistocene Head is likely to be of moderate significance. Reworked material in Holocene colluvium is of low significance. Head/Colluvium can, however, these deposits could contain/bury stable land surfaces associated with archaeological layers, features and/or lithic scatters. The palaeoenvironmental potential of these deposits is likely to be low except if calcareous units are identified.

GCZ 8a and 8b

7.2.27 Recent geoarchaeological works at the OnSS, towards the north of GCZ 8 (Wessex Archaeology 2023b; 2023c) have enabled a more detailed assessment of the deposits in zones GCZ 8a and 8b. Here, a sequence of Fluvial Sands and Gravels likely equivalent to the Ardleigh Gravel and overlying Head-Gravel and Head Brickearth has been identified, which in GCZ 8a is incised by a gully infilled with Sands and Head-Gravel.

7.2.28 The works at the OnSS have investigated the archaeological potential of the Ardleigh Gravel through controlled artefact sieving. No clear artefacts have been identified, which indicates that the Palaeolithic archaeological potential of these deposits is low. However, any archaeology from these deposits would relate to the earliest period of Lower Palaeolithic human occupation of Britain, with the result that any archaeology may have high significance for regional and national Palaeolithic research themes and priorities.

7.2.29 The palaeoenvironmental potential of the coarse high-energy sand and gravel units of the Ardleigh Gravel is generally low. However, fine-grained deposits that were locally present within GCZ 8a are of moderate palaeoenvironmental potential, and may contain micropaleontological remains reflective of landscapes and environments. These may be of high significance for assessing the climatic and environmental context of Lower Palaeolithic activity in the wider region. The Ardleigh Gravel beneath c. 3.2m bgl could not be evaluated

and has been assessed as having an unknown archaeological and palaeoenvironmental potential (see Wessex Archaeology 2023b; 2023c).

7.2.30 Similarly, evaluation of the Sands and overlying Head-Gravel infilling the gully in GCZ 8a did not produce archaeology (although burnt, unworked flint was recovered). This suggests that their archaeological potential may be limited, whilst their palaeoenvironmental potential was similarly judged to be low. However, the fact that these deposits have not been recognised previously in the area and the lack of chronology for these deposits provides some uncertainty when judging geoarchaeological potential and significance. Based on this assessment, the archaeological potential of the Sands and Head-Gravel has been tentatively assessed as low and significance as unknown.

7.2.31 The Head-Brickearth was extensively evaluated across GCZ 8a and 8b and was shown to have low archaeological and palaeoenvironmental potential (see Wessex Archaeology 2023b; 2023c). The significance of any archaeology they do contain would be dependent on their age and the taphonomic history of the archaeology; *in situ*/minimally disturbed material would be of greater significance than archaeology reworked within the slope deposits, although the latter may be indicative of locations upslope where minimal disturbed material could occur.

7.2.32 The evaluation did not identify potential for buried stable surfaces that could preserve minimally disturbed/*in situ* archaeology. Overall, the Palaeolithic geoarchaeological potential of the Head-Brickearth was assessed as low, whilst the likely significance of any material is likely to be low or moderate.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

8.1.1 Updated deposit modelling, incorporating data from a review of recent geoarchaeological investigations and BGS archive boreholes, has enabled an assessment of the likely presence and lateral and horizontal extent of Quaternary deposits across the Onshore Project Area. The archaeological and paleoenvironmental potential of these deposits has also been assessed, and the significance of any archaeological material they may contain considered in relation to national and regional research themes and priorities (EH 2008; EERRF 2021).

8.1.2 The GDBA has identified areas where Quaternary deposits may be present which could contain significant archaeological evidence and/or deposits with palaeoenvironmental potential, as well as some areas where there is insufficient data to consider potential. Based on variations in geological characteristics of the deposits present, linked to the assessment of geoarchaeological potential of any Quaternary deposits, a GLC has been provided, which divides the Onshore Project Area into 13 GCZs. Although parts of the Scheme, namely the OnSS, have been the subject of more detailed evaluation, in the majority of areas information on the geoarchaeological resource present is currently insufficient to guide mitigation or management strategies to offset potential development impacts. To develop such strategies targeted geoarchaeological field evaluation is required.

8.2 Recommendations

8.2.1 Likely requirements for, and appropriate methods of geoarchaeological evaluation of deposits in each GCZ of the GLC are summarised in **Table 7**. These recommendations have been made assuming depths of impact of up to 1.5 m bgl across the majority of the

Onshore Project Area with the exception of the OnSS, where deeper impacts are expected which may include those from piling. The recommendations may require modification once detailed design proposals for the route are known.

8.2.2 Should any additional GI works be undertaken within the Onshore Project Area, monitoring of these GI works may address some aims of the evaluation proposed in **Table 7** and may negate the need for further purposive geoarchaeological evaluation. In addition, some of the evaluation proposed in **Table 7** could be undertake in tandem with any proposed archaeological trial trench evaluation. At the time of writing, further GI works, archaeological trial trench evaluation and targeted geoarchaeological test pitting are due to be undertaken across the Onshore Project Area, but the specific locations of these works are yet to be determined.

8.2.3 Recommendations for further works in GCZ 8a and 8b, following geoarchaeological evaluation at the OnSS follow those outlined in Wessex Archaeology (2023b; 2023c).

Table 7 Recommendations for archaeological and geoarchaeological evaluation

GCZ	Principal Quaternary deposits	Approximate depth of deposits (m bgl)	Recommended method of evaluation
1	Alluvium Peat Sands and Gravels	0.00-9.00 3.00-6.00 9.00-12.00	Targeted borehole survey to retain samples for palaeoenvironmental assessment
2	Unknown	Unknown	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
3	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Unknown 0.20-4.50 0.50-6.00	Test pits to determine whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
3a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	0.20-2.00 1.20-5.60	Targeted test pits with artefact sieving to assess Palaeolithic archaeological/geoarchaeological potential (max depth c. 4m bgl)
3b	Head-Brickearth	0.30-4.50	Targeted test pits with artefact sieving to assess Palaeolithic archaeological/geoarchaeological potential (max depth c. 4m bgl)
4	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Cooks Green Gravel)	Unknown	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
4a	Head-Brickearth Kesgrave Sands and Gravels (Cooks Green Gravel)	1.00-4.10 2.00-3.00	Targeted test pits with artefact sieving to assess Palaeolithic archaeological/geoarchaeological potential (max depth c. 4m bgl)

5	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Wivenhoe Gravel)	Unknown	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
6	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel, Wivenhoe Gravel)	Unknown 0.20-3.00+ 0.50-3.50+	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
7	Alluvium Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Unknown	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
8	Colluvium Head-Brickearth / Head-Gravel Kesgrave Sands and Gravels (Ardleigh Gravel)	Unknown 0.00-2.75 0.00-10.00	Test pits to assess whether Quaternary deposits are present and to assess archaeological/geoarchaeological potential (max depth c. 4m bgl)
8a	Head-Brickearth Head-Gravel Sands Ardleigh Gravel	0.30-1.70 0.60-2.55 0.90-3.20 1.60-3.30+	Targeted borehole survey / stepped test pit (see below)
8b	Head-Brickearth Head-Gravel Ardleigh Gravel	0.27-1.00 0.45-1.80 0.50-3.20+	Targeted borehole survey; palaeoenvironmental assessment of existing samples (see below)

GCZ 1

8.2.4 Holocene Alluvium, including peat, is present within GCZ 1 overlying fluvial sands and gravels of the Holland Brook. There is potential for the presence of peat deposits of high geoarchaeological potential within the alluvium and variable depths, potentially within the expected depth of impact from the Scheme (1.5 m bgl).

8.2.5 The most appropriate method of evaluating these deposits is through borehole survey. It is recommended that boreholes are distributed across the corridor of the Onshore Project Area to establish the lateral and vertical extent of Quaternary deposits, confirm the depositional processed associated with these deposits, recover suitable samples for palaeoenvironmental assessment and, if possible, recover material for dating.

8.2.6 The results of the borehole survey will enable assessment of whether targeted archaeological work (possibly test pits/trial trenches) will be required in any areas in order to offset any proposed development impacts.

GCZ 2

8.2.7 The extent of survival of Quaternary deposits in this zone is currently unknown. Machine dug test pits (with a maximum depth of c. 4.0 m bgl), distributed across the corridor of the Onshore Project Area in this zone, would be a suitable method of evaluation to assess the extent of survival of Quaternary sediments and to assess their geoarchaeological potential.

GCZ 3

8.2.8 Pleistocene deposits with Lower and Middle Palaeolithic archaeological potential are present in this zone. BGS archive borehole data indicates that Pleistocene Brickearth of unknown date is present at depths between c. 0.20-1.00 m bgl, overlying fluvial sands and gravels, likely equivalent to the Cooks Green Gravel, at depths between 0.50 and at least 6.00 m bgl. There is also potential for Head and/or Holocene Colluvium on valley slopes in this zone.

8.2.9 Machine dug test pits with associated artefact sieving and sampling for paleoenvironmental and dating evidence the most appropriate method of evaluation. These should target known areas of Pleistocene deposits of Head-Brickearth and fluvial sands and gravels, including where they have been identified within zones GCZ 3a and 3b, as well as providing a more widespread distribution across the corridor of the Onshore Project Area that assesses the presence of unrecorded sediments.

8.2.10 A programme of archaeological trial trench evaluation and targeted geoarchaeological test pitting is anticipated at Little Clacton Road, within GCZ 3a, the results of which will inform the Palaeolithic geoarchaeological potential of the deposits.

GCZ 4

8.2.11 The extent of survival of Quaternary deposits in this zone is currently unknown in all but GCZ 4a. Machine dug test pits (with a maximum depth of c. 4.0 m bgl), distributed across the zone, would be a suitable method of evaluation to assess the extent of survival of Quaternary sediments and to assess their archaeological and geoarchaeological potential.

8.2.12 In GCZ 4a a similar programme of targeted geoarchaeological test pitting with artefacts sieving is recommended targeting the deposits of Head-Brickearth and Kesgrave Sands and Gravels identified at Swan Road.

GCZ 5

8.2.13 No previous interventions have been undertaken in zone GCZ 5 and the extent of survival of Quaternary deposits in this zone is currently unknown. Holocene Alluvium may be present in GCZ 5, overlying Pleistocene deposits of the Cooks Green/Wivenhoe Gravels. Pleistocene Head and/or Holocene Colluvium may also be present on the valley sides or at the base of valleys.

8.2.14 Machine dug test pits (with a maximum depth of c. 4.0 m bgl), distributed across the corridor of the Onshore Project Area in these zones, would be a suitable method of evaluation to assess the extent of survival of Quaternary sediments and to assess their geoarchaeological potential.

GCZ 6

8.2.15 Pleistocene deposits of the Kesgrave Sands and Gravels, overlain by Head-Brickearth, are present in GCZ 7; the former likely to include deposits of the Ardleigh (MIS 16–14) and/or Wivenhoe (MIS 14–13) Gravels. BGS archive boreholes indicate that the Pleistocene Brickearth is present at depths between c. 0.20 and at least 3.00 m bgl, with the underlying Gravels present at between c. 0.50 and at least 3.50 m bgl. There is also potential for Pleistocene Head and/or Holocene Colluvium on valley slopes within GCZ 7.

8.2.16 Machine dug Palaeolithic test pits with associated artefact sieving and sampling for paleoenvironmental and dating evidence are the most appropriate method of evaluation.

These should target known areas of Pleistocene deposits of Head-Brickearth and fluvial sands and gravels, as well as providing a more widespread distribution across the corridor of the Onshore Project Area that assesses the presence of unidentified deposits.

GCZ 7

8.2.17 Holocene Alluvium may be present this zone, overlying Pleistocene deposits of the Ardleigh Gravels and or Head-Brickearth. Pleistocene Head and/or Holocene Colluvium may also be present on the valley sides or at the base of valleys.

8.2.18 Machine dug test pits (with a maximum depth of c. 4.0 m bgl), distributed across the corridor of the Onshore Project Area in this zone, would be a suitable method of evaluation to assess the extent of survival of Quaternary sediments and to assess their archaeological and geoarchaeological potential.

GCZ 8

8.2.19 BGS archive boreholes indicate that Pleistocene Head-Brickearth is present in GCZ 8 at depths between c. 0.00 and 2.75 m bgl, with fluvial sands and gravels (likely equivalent to the Ardleigh Gravel) present at between c. 0.0 and at least 10.0 m bgl. Pleistocene Head and/or Holocene Colluvium may also be present on valley slopes within this zone.

8.2.20 Machine dug Palaeolithic test pits with associated artefact sieving and sampling for paleoenvironmental and dating are recommended, alongside limited targeted boreholes to characterise the full Pleistocene sequences (up to 10m). These should target known areas of Pleistocene deposits of Brickearth and fluvial sands and gravels, as well as providing a more widespread distribution across the corridor of the Onshore Project Area that assesses the full lateral extent of these deposits.

GCZ 8a and 8b

8.2.21 Geoarchaeological evaluation within the OnSS in zones GCZ 8a and 8b has characterised much of the geoarchaeological resource in these zones and demonstrated generally low potential for significant geoarchaeological evidence. However, the evaluation has delimited selected Pleistocene deposits in the Site where data is insufficient to fully characterise the Palaeolithic geoarchaeological resource and, dependent on detailed development proposals, further investigations may be required to inform any requirements for mitigation and/or the production of a management strategy.

8.2.22 The Ardleigh Gravel and underlying sediments beneath 3.20 m bgl could not be evaluated, and their Palaeolithic geoarchaeological potential is uncertain. The principal Palaeolithic geoarchaeological potential is for the presence of fine-grained and organic deposits, which can occur at depth in the Ardleigh terrace. Should development proposals impact on deposits beneath 3.20 m bgl, assessment for the presence of such deposits through a borehole survey is recommended. This would also enable sampling to mitigate against any potential impacts. Should any Ground Investigation (GI) works (including boreholes) be carried out in this area of the Scheme, it is recommended that these are geoarchaeologically monitored to inform on the potential for finer-grained/organic deposits with geoarchaeological potential.

8.2.23 The evaluation has identified the localised presence of sediments with palaeoenvironmental potential in the top 3.00 m of the Ardleigh Gravel. These have been sampled as part of the evaluation undertaken at the OnSS (Wessex Archaeology 2023b). It is recommended that that these samples are assessed to establish their potential for analysis. Given the localised

nature of these deposits, the samples taken and a program of assessment and analysis are considered sufficient to mitigate against any development impacts. Specific recommendations for assessment are provided in **Table 8**.

Table 8 Recommendations for palaeoenvironmental assessment

Sample number	Description	Recommendations
091	Fine sandy clayey silt within fluvial sands and gravels. TP225. 2.75m bgl. Contact between fine-grained deposits and overlying sands. 1 litre sample.	Foraminifera, ostracods
092	Fine sandy clayey silt within fluvial sands and gravels. TP225. 2.75m bgl. Contact between fine-grained deposits and overlying sands. 1 litre sample.	Diatoms, pollen
093	Fine sandy clayey silt within fluvial sands and gravels. 20 litre bulk samples.	Diatoms, foraminifera, ostracods, pollen

8.2.24 There is some uncertainty regarding the geoarchaeological resource that may be associated with deposits within a gully cut into the Ardleigh Gravel in GCZ 8a, particularly the basal Sands. In order to mitigate against development impacts on these sediments, a stepped geoarchaeological test pit in this area is recommended to record in detail and geoarchaeologically sample the deposits and to facilitate a program of geoarchaeological sample assessment and dating.

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APPENDIX

Appendix 1 Review of BGS archive boreholes

Name	Total Depth (m)	Easting	Northing	Elevation (m OD)	Notes
TM11NE2	10.70	619230	218870	13.10	Elevation acquired from lidar
TM11NE1	9.80	619160	218950	15.00	Elevation acquired from lidar
TM22SW17	6.10	620220	220140	22.50	Elevation acquired from lidar
TM22SW12	12.19	620200	220160	22.40	Elevation acquired from lidar
TM22SW21	3.05	620340	220200	23.60	Elevation acquired from lidar
TM22SW13	6.10	620240	220210	22.90	Elevation acquired from lidar
TM22SW20	12.19	620310	220230	23.20	Elevation acquired from lidar
TM22SW19	6.10	620320	220240	23.20	Elevation acquired from lidar
TM22SW18	6.10	620300	220250	23.20	Elevation acquired from lidar
TM22SW14	6.10	620320	220280	24.00	Elevation acquired from lidar
TM22SW16	12.50	620390	220300	24.00	Elevation acquired from lidar
TM22SW15	6.10	620360	220320	24.00	Elevation acquired from lidar
TM22SW5	121.92	620750	220620	23.47	
TM22SW31	5.50	621180	220780	N/A	No stratigraphy data
TM11NE20	10.00	618460	216230	9.20	Elevation acquired from lidar
TM11NE18	10.00	618410	216250	7.70	Elevation acquired from lidar
TM11NE16	10.00	618370	216300	6.70	Elevation acquired from lidar
TM11NE17	10.00	618460	216300	6.20	Elevation acquired from lidar
TM11NE42	3.00	618380	216470	7.45	
TM11NE43	1.10	618410	216490	5.81	
TM11NE41	10.00	618390	216500	6.77	
TM11NE50	3.00	618370	216500	7.10	
TM11NE44	1.10	618410	216510	5.55	
TM11NE45	3.00	618390	216520	6.15	
TM11NE40	10.00	618370	216530	6.75	
TM11NE49	3.00	618350	216530	7.60	
TM11NE46	2.00	618410	216550	4.64	
TM11NE48	1.10	618370	216550	6.55	
TM11NE51	1.10	618400	216550	5.45	
TM11NE47	3.00	618410	216550	4.64	
TM11NE19	10.00	618360	216230	7.70	Elevation acquired from lidar
TM12NW34	1.83	611949	227199	27.76	
TM12NW35	3.35	612089	227264	34.81	
TM12NW36	1.83	612233	227315	35.97	
TM12NW37	1.83	612382	227351	36.64	
TM12NW53	10.00	612350	227480	36.58	
TM12NW54	20.11	613050	227500	N/A	Insufficient detail
TM12NW52	8.53	612320	227510	N/A	Insufficient detail

Name	Total Depth (m)	Easting	Northing	Elevation (m OD)	Notes
TM12NW55	3.20	612360	227520	36.65	
TM12NW38	1.83	613249	227592	37.19	
TM12NW39	1.83	613394	227642	36.85	
TM12NW40	2.74	613542	227690	37.03	
TM12NW41	3.05	613687	227734	36.85	
TM12NW42	3.05	613835	227772	36.33	
TM12NW43	2.44	613983	227807	35.02	
TM02NE14/B	7.62	608350	229220	35.40	
TM02NE14/A	17.37	608360	229220	35.40	
TM02NE15	10.10	608430	228550	34.40	
TM02NE193	10.00	608600	228500	N/A	No stratigraphy data
TM02NE164	Unknown	609100	228000	N/A	No stratigraphy data
TM02NE165	Unknown	609100	227900	N/A	No stratigraphy data
TM02NE21	6.40	609410	227770	33.20	
TM02NE174	7.92	607960	228400	35.05	
TM02NE175	8.07	608000	228360	N/A	No stratigraphy data
TM12NW13/E	4.87	613520	226350	33.52	
TM12NW13/D	152.40	613510	226410	33.52	
TM12NW13/B	103.63	613750	226460	35.36	
TM12NW13/A	152.40	613420	226530	N/A	No superficial recorded (well on to bedrock)
TM12NW13/C	4.87	613420	226530	33.53	

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605000
610000
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Dedham
Cattawade
Manningtree
Lamb Corner
Dedham Heath
Lawford
Bradfield
Wrabness
Parkeston
A120
Ramsey
Foxash Estate
Bradfield Heath
Ardleigh
Little Oakley
Wix
Wix Green
A137
Burnt Heath
Little Bromley
Bromley Cross
Great Oakley
Crockleford Heath
Stones Green
Great Bromley
Little Bentley
Tendring Green
Beaumont
Elmstead Market
Tendring
Frating Green
A133
Frating
Weeley
Thorpe-le-Soken
Kirby-le-Soken
Wivenhoe
Great Bentley
Alresford
Weeley Heath
Kirby Cross
High Park Corner
Thorrington
Aingers Green
Frinton-on-Sea
Great Holland
Little Clacton
Brightlingsea
St Osyth
Point Clear
Clacton-on-Sea
East Mersea
Jaywick
Seawick

Onshore project area

BGS Bedrock Geology

- Thames Group - Clay, Silt and Sand
- Red Crag Formation - Sand
- Thanet Formation and Lambeth Group (Undifferentiated) - Clay, Silt and Sand

0 2 km

Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW
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Figure 1: Location of the Onshore Project Area showing BGS bedrock geology

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605000 610000 615000 620000 625000

230000 225000 220000 215000

Dedham Cattawade Manningtree Lamb Corner Dedham Heath Lawford Bradfield Wrabness Parkeston Ramsey Foxash Estate Bradfield Heath Ardleigh Little Oakley Wix Wix Green Little Bromley Burnt Heath Bromley Cross Great Oakley Crockleford Heath Great Bromley Stones Green Little Bentley Tendring Green Beaumont Elmstead Market Tendring Frating Green Thorpe Green Frating Weeley Thorpe-le-Soken Kirby-le-Soken Wivenhoe Great Bentley Alresford Weeley Heath Kirby Cross High Park Corner Thorrington Aingers Green Frinton-on-Sea Great Holland Little Clacton Brightlingsea St Osyth Point Clear Clacton-on-Sea East Mersea Jaywick Seawick

A133

Onshore project area

BGS Superficial Geology

- Interglacial Deposits - Clay and Silt
- Storm Beach Deposits; River Terrace Deposits, 2 and 3 - Sand and Gravel
- Kesgrave Catchment Subgroup - Sand and Gravel
- Cover Sand - Clay, Silt and Sand
- Head - Silt
- Lowestoft Formation - Sand and Gravel
- Alluvium; Intertidal Deposits (Undifferentiated) - Clay and Silt

0 2 km

Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW
Scale: 1:75,000 at A3	Revision: 0

Figure 2: Location of the Onshore Project Area showing BGS superficial geology

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See Figure 3.2

See Figure 3.3

See Figure 3.4

Onshore project area
Recent geoarchaeological works
BGS archive boreholes
Transect A
Transect B
Transect C

0 2 km

Date: 02/01/2024 | Created by: AW

Scale: 1:75,000 at A3 | Revision: 0

Figure 3.1: Location of BGS archive boreholes and recent geoarchaeological works, showing Transects A-C

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606000
608000
610000
230000
228000
226000

Hunter's Chase
Coggeshall Rd
Harwich Road
A137
Foxash Estate
Hungerdown La
Home Farm La
Ardleigh
B1029
Grange Rd
Dead La
Bromley Rd
Chequers Rd
Burnt Heath
Little Bromley
Great Bromley
Cowey Green
Badley Hall Rd
Hillards Rd
Parsley's
Bentley
Harwich Rd
Rectory Rd
Monkey Street
A120

TM02NE19
TM02NE20
TM02NE21
TM02NE15
TM02NE174
TM02NE14/B
TM02NE14/A

TP201 TP202 TP203 TP204 TP205 TP206 TP207 TP208 TP209 TP210 TP211 TP212 TP213 TP214 TP215 TP216 TP217 TP218 TP219 TP220 TP221 TP222 TP223 TP224 TP225 TP226 TP228 TP229 TP230 TP231

Norman's Farm
Cattsgreen Farm

Scale 1:10,000

Onshore project area
BGS archive boreholes
Recent geoarchaeological works
Transect C

0 1 km

Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024 | Created by: AW
Scale: 1:20,000 at A3 | Revision: 0

Figure 3.2: Location of BGS archive boreholes and recent geoarchaeological works, showing Transects A-C

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612000
614000
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226000
224000

Horsleycross Street
Wix Green
A120
Colchester Rd
Goose Green
Horsley Cross
Tendring Heath
Stones Green
Wix Rd
B1035
Little Bentley
Mill Green
Rectory Rd
Tendring Green
Goose Green
Beaumont
Chapel Rd
Swan Rd
Church Rd
Crown La
Grow La
Hillhouse La
Whitehall La
A133

TM12NW43
TM12NW41
TM12NW42
TM12NW39
TM12NW40
TM12NW38
TM12NW55
TM12NW53
TM12NW36
TM12NW35
TM12NW37
TM12NW34
TM12NW13/C
TM12NW13/B
TM12NW13/D
TM12NW13/E
BHSR-1
BHSR-3
BHSR-4

Onshore project area
BGS archive boreholes
Recent geoarchaeological works
Transect A
Transect C

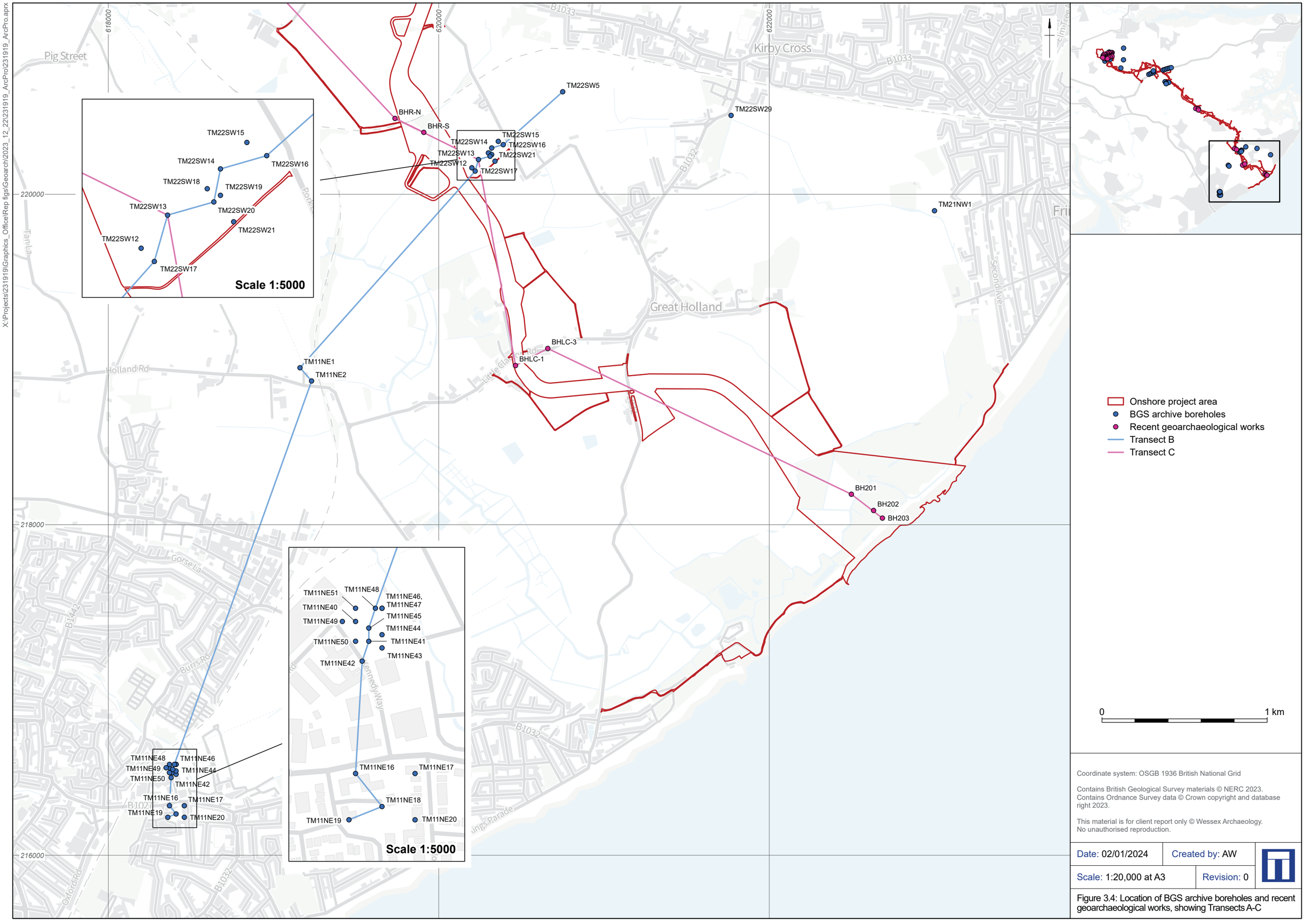
0
1 km

Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024 | Created by: AW
Scale: 1:20,000 at A3 | Revision: 0

Figure 3.3: Location of BGS archive boreholes and recent geoarchaeological works, showing Transects A-C

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22\231919_ArcPro\231919_ArcPro.aprx



Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	
Scale: 1:20,000 at A3	Revision: 0	

Figure 3.4: Location of BGS archive boreholes and recent geoarchaeological works, showing Transects A-C

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22\231919_ArcPro\231919_ArcPro.aprx

MEX1045541
MEX1045309
MEX8356
MEX6962
MEX6960

Onshore project area
1 km buffer
HER Data (Points)
Palaeolithic
Mesolithic

0 2 km

Date: 02/01/2024 | Created by: AW

Scale: 1:75,000 at A3 | Revision: 0

Figure 4: HER Palaeolithic and Mesolithic from within 1 km of site boundary

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22\231919_ArcPro\231919_ArcPro.aprx

605000 610000 615000 620000 625000

230000 225000 220000 215000

Dedham
Cattawade
Manningtree
Lamb Corner
Dedham Heath
Lawford
Bradfield
Wrabness
Parkeston
A120
Ramsey
Foxash Estate
Bradfield Heath
Ardleigh
A137
Wix
Wix Green
Little Oakley
Little Bromley
Burnt Heath
Bromley Cross
Great Oakley
Stones Green
Crockleford Heath
Great Bromley
Little Bentley
Tendring Green
Beaumont
Elmstead Market
Tendring
Frating Green
Frating
A133
Weeley
Wivenhoe
Great Bentley
Alresford
Kirby-le-Soken
Walton-on-the-
Weeley Heath
Kirby Cross
High Park Corner
Thorrington
Aingers Green
Frinton-on-Sea
Great Holland
Little Clacton
Brightlingsea
St Osyth
Point Clear
Clacton-on-Sea
East Mersea
Jaywick
Seawick

31986
31918 to 31920
31921
31922
31923, 31924
31958 to 31964
31953

Onshore project area
2 km buffer
TERPS findspots

0 2 km

Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024 | Created by: AW

Scale: 1:75,000 at A3 | Revision: 0

Figure 5: TERPS findspots within 2 km of site boundary

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22\231919_ArcPro\231919_ArcPro.aprx

605000 610000 615000 620000 625000

230000 225000 220000 215000

Dedham
Cattawade
Manningtree
Lamb Corner
Dedham Heath
Lawford
Bradfield
Wrabness
Parkeston
A120
Ramsey
Foxash Estate
Bradfield Heath
Ardleigh
A137
Wix
Wix Green
Little Oakley
Little Bromley
Burnt Heath
Bromley Cross
Great Oakley
A120
Crockleford Heath
Stones Green
Great Bromley
Little Bentley
Tendring Green
Beaumont
Elmstead Market
Tendring
Frating Green
A133
Thorpe Green
Frating
Weeley
Thorpe-le-Soken
Kirby-le-Soken
Wivenhoe
Alresford
Great Bentley
A133
Weeley Heath
Kirby Cross
High Park Corner
Thorrington
Aingers Green
Frinton-on-Sea
Great Holland
Little Clacton
Brightlingsea
St Osyth
Point Clear
Clacton-on-Sea
East Mersea
Jaywick
Seawick

6654 12340 12352
12313
12312 12311
12233
12344
685 12303
12304

Onshore project area
2 km buffer
PaMELA findspots

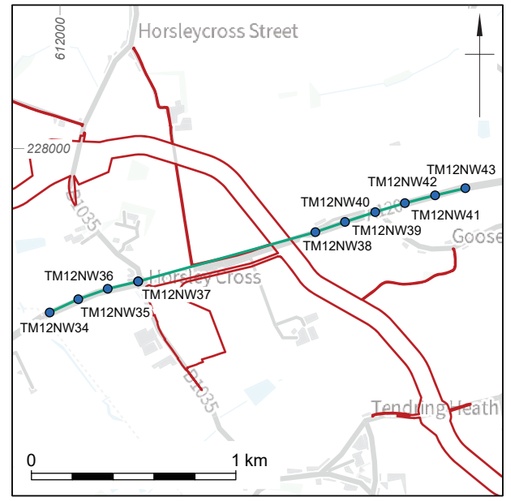
0 2 km

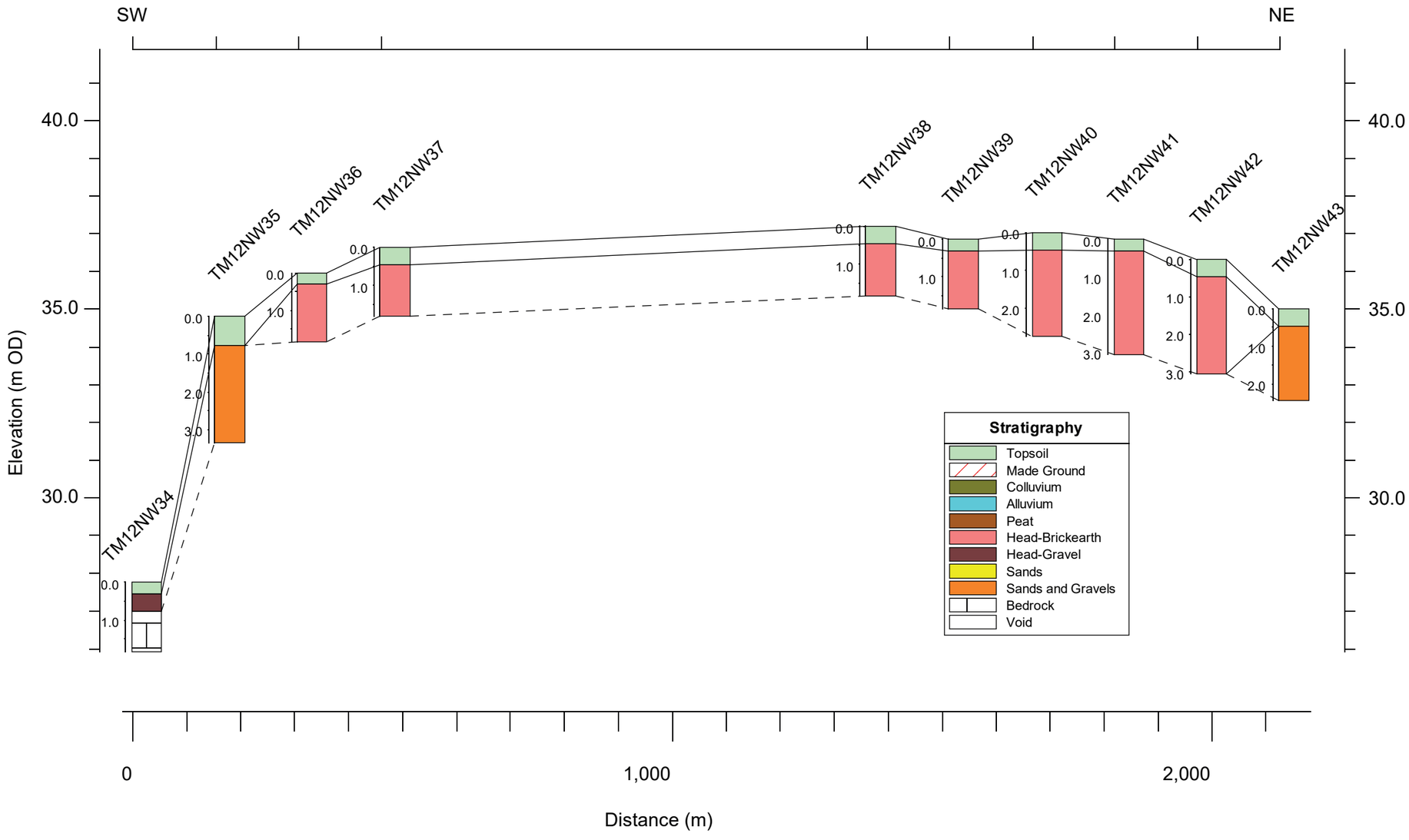
Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	
Scale: 1:75,000 at A3	Revision: 0	

Figure 6: PaMELA findspots within 2 km of site boundary

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22



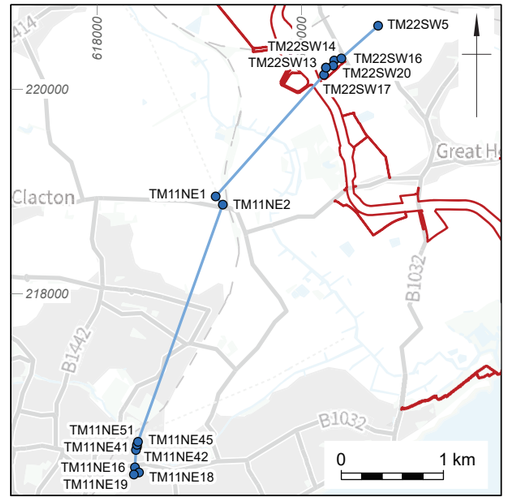


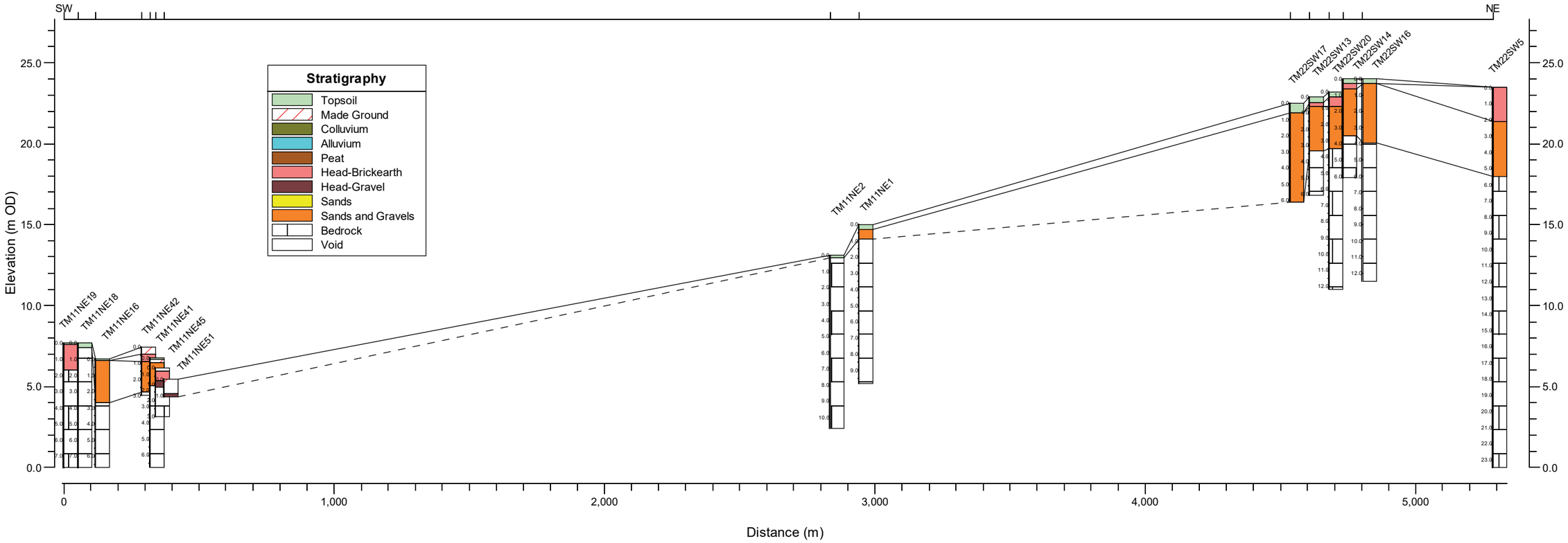
Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:30,000 at A3

Figure 7: Transect A

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22

Onshore project area
BGS archive boreholes
Transect B

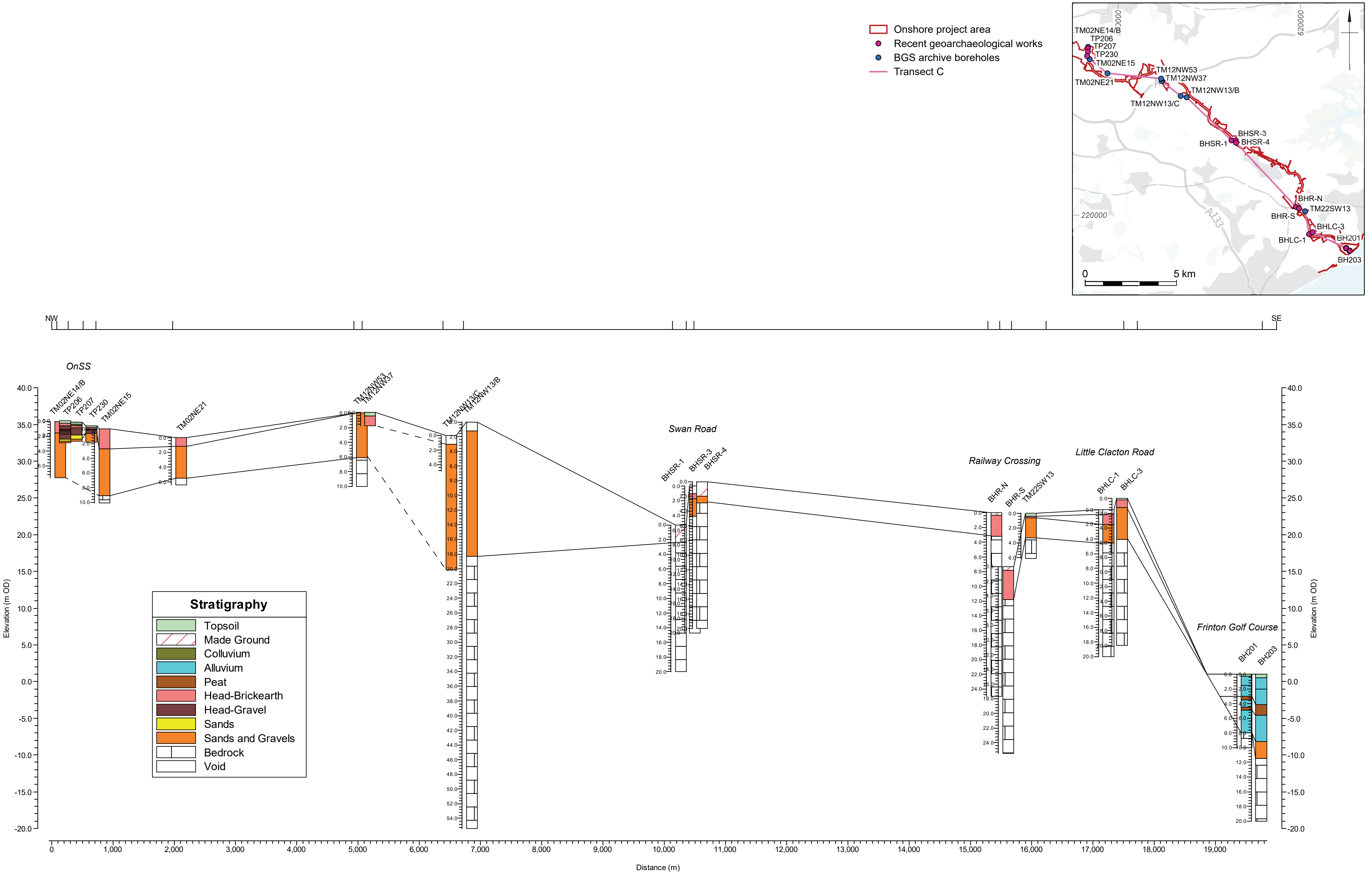




Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:60,000 at A3

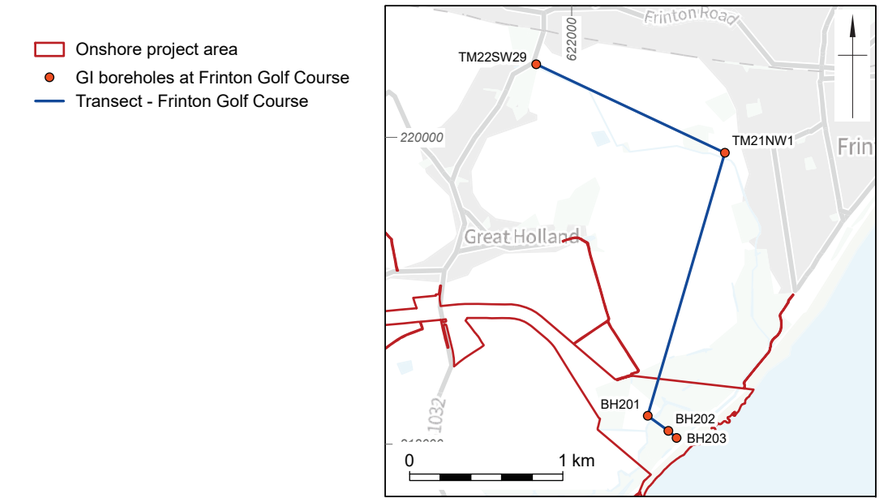
Figure 8: Transect B

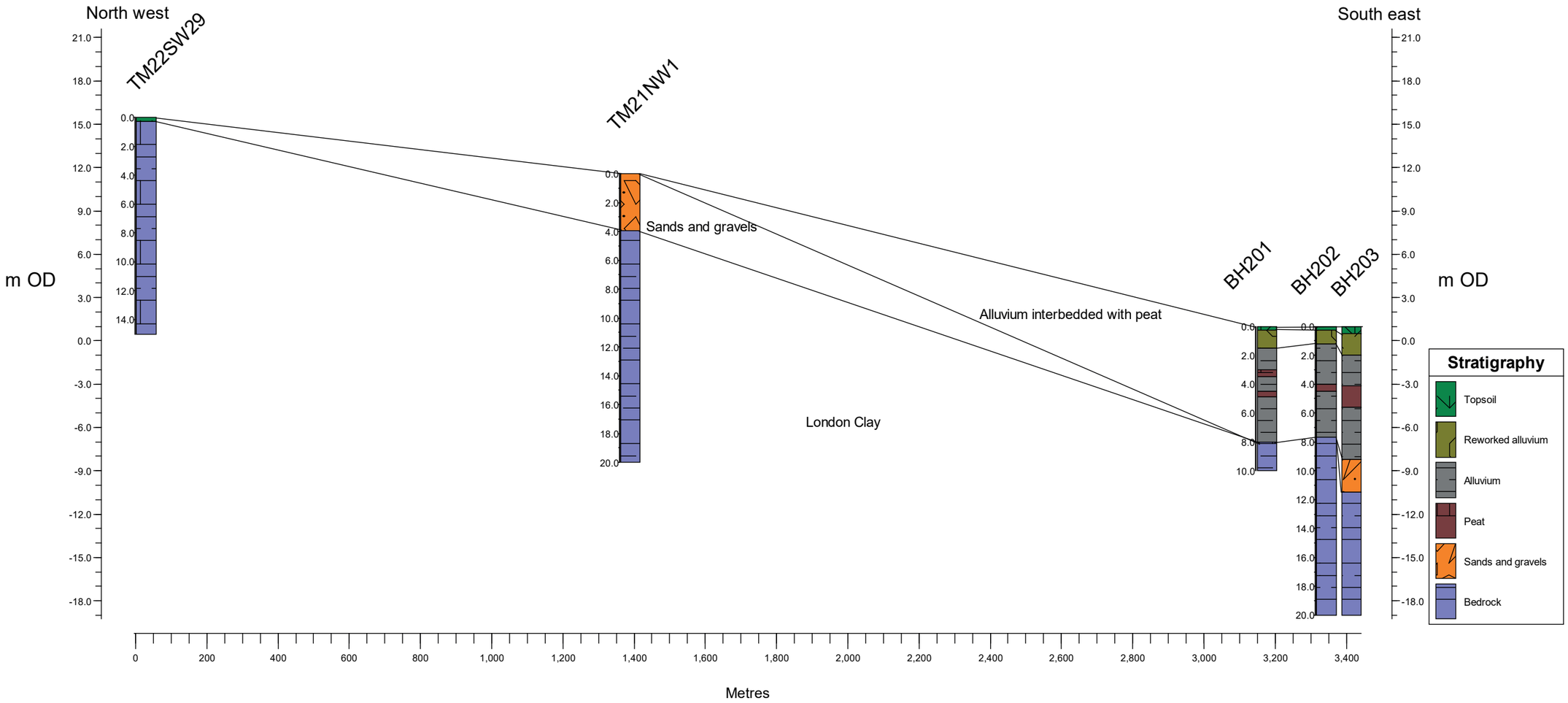


Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:200,000 at A3

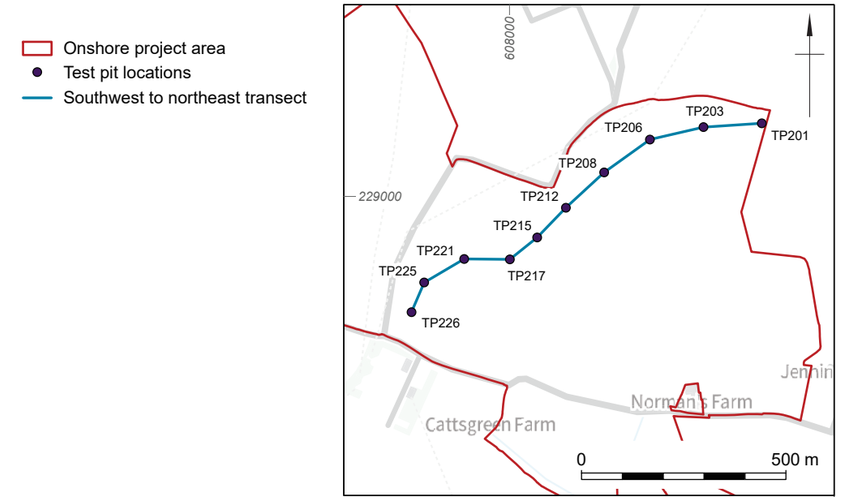
Figure 9: Transect C

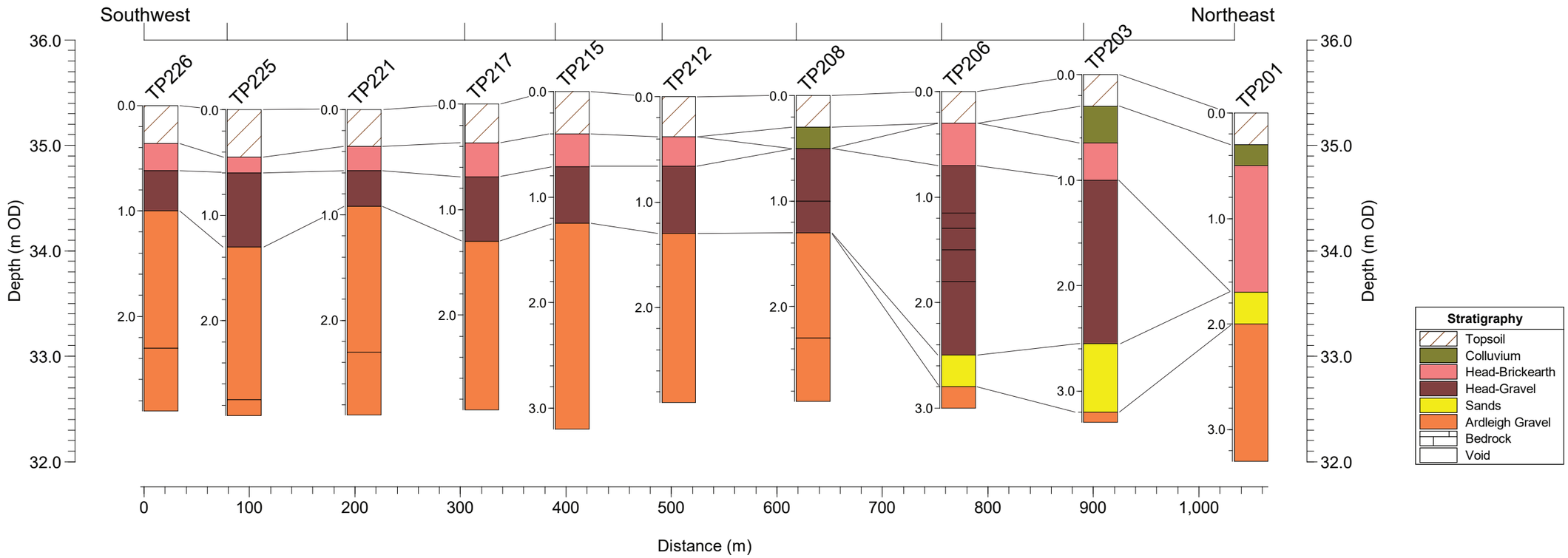




Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:40,000 at A3

Figure 10: Transect of GI boreholes at Frinton Golf Course reproduced from Wessex Archaeology (2022b)

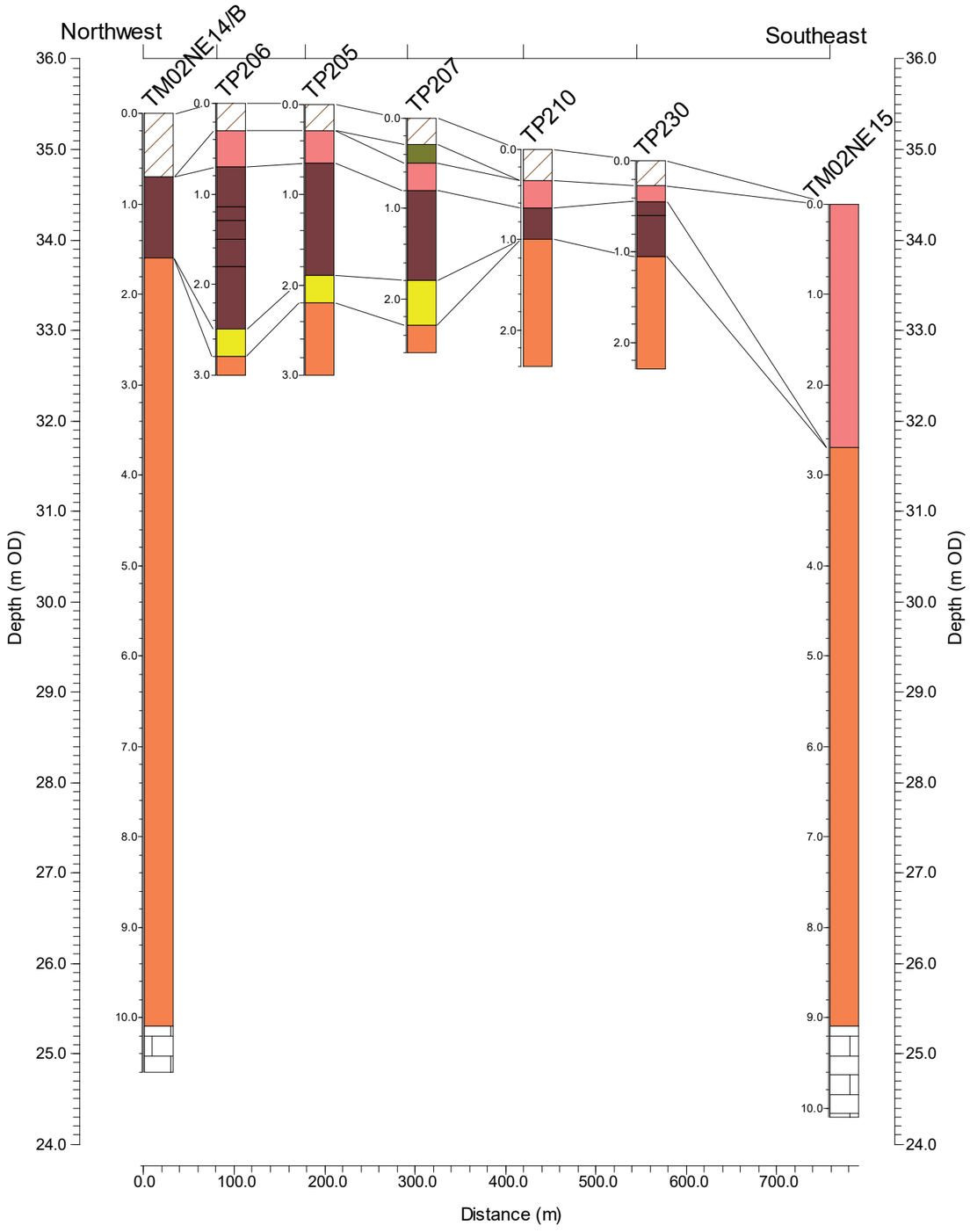


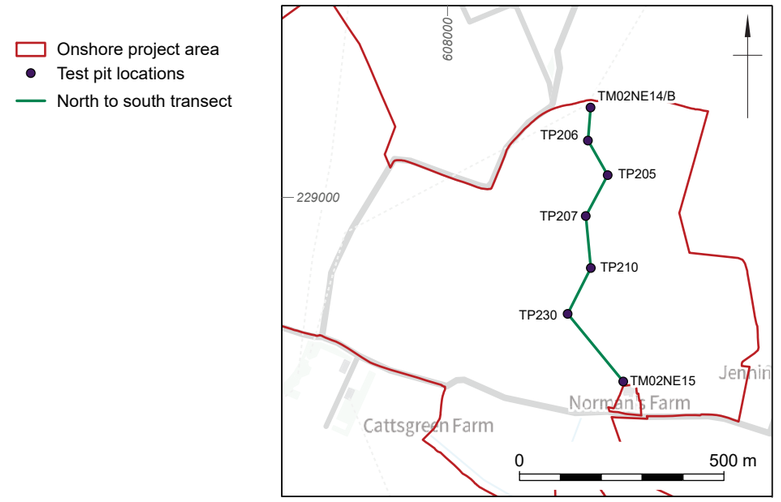


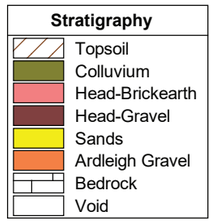
Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:15,000 at A3

Figure 11: Southwest to northeast transect of test pits at the OnSS (reproduced from Wessex Archaeology 2023c)







Coordinate system: OSGB 1936 British National Grid

Date: 02/01/2024	Created by: AW	Revision: 0	Scale: Inset 1:15,000 at A3

Figure 12: North to south transect of test pits at the OnSS (reproduced from Wessex Archaeology 2023c)

X:\Projects\231919\Graphics_Office\Rep figs\Geoarch\2023_12_22\231919_ArcPro\231919_ArcPro.aprx

GCZ 8a
GCZ 8
GCZ 8b
GCZ 8
GCZ 7
GCZ 6
GCZ 5
GCZ 4
GCZ 4a
GCZ 4
GCZ 3
GCZ 3b
GCZ 3
GCZ 3a
GCZ 2
GCZ 3
GCZ 1

Onshore project area
Geoarchaeological character zones

0 2 km

Coordinate system: OSGB 1936 British National Grid

Date: 05/01/2024 | Created by: AW

Scale: 1:60,000 at A3 | Revision: 0

Figure 13: Revised Geoarchaeological Character Zones (GCZs)

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NORTH FALLS

Offshore Wind Farm

sse Renewables | RWE

HARNESSING THE POWER OF NORTH SEA WIND

North Falls Offshore Wind Farm Limited

A joint venture company owned equally by SSE Renewables and RWE.

To contact please email contact@northfallsoffshore.com

North Falls Offshore Wind Farm Limited Registered Address: Windmill Hill Business Park, Whitehill Way, Swindon, Wiltshire, SN5 6PB, United Kingdom

Registered in England and Wales Company Number: 12435947