Lower Thames Crossing

# 6.3 Environmental Statement Appendices
# Appendix 6.6 – Lower Thames Crossing: Standalone Palaeolithic Archaeological Assessment and Research Framework (SPAA-&-RF)

APFP Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

Volume 6

**DATE: October 2022**

Planning Inspectorate Scheme Ref: TR010032
Application Document Ref: TR010032/APP/6.3

**VERSION**: 1.0

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# 6.3 Environmental Statement Appendices
# Appendix 6.6 – Lower Thames Crossing: Standalone Palaeolithic Archaeological Assessment and Research Framework (SPAA-&-RF)

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# 1 Executive summary

1.1.1 This report (SPAA-&-RF) was commissioned as a stand-alone complement to the separate *Palaeolithic and Quaternary Deposit Model* (PQDM). It was envisaged as an appendix within the cultural heritage section of the Environmental Statement that would form part of the overall application for a Development Consent Order for the new Lower Thames Crossing.

1.1.2 This SPAA-&-RF duplicates some of the content of the PQDM, but goes significantly beyond it in several areas. The PQDM has more detail on the methods, principles, and data that were used to develop a sub-surface Quaternary deposit model for the Project footprint, and on the Holocene archaeological potential associated with the various Quaternary deposits across the Project - predominantly Holocene colluvium infilling dry valleys, and Holocene alluvium associated with the Thames floodplain and some tributaries.

1.1.3 Both reports provide the same information on (a) a review of nearly 100 known Palaeolithic sites within, and near to, a 3km buffer around the LTC footprint, and (b) the division of the Project's footprint into 29 different Palaeolithic/Quaternary deposit character areas (forming 34 PQ zones, since some zones of identical character are not contiguous). The sites review confirmed the Project as taking place within a key area for the Palaeolithic in Britain. Presaging the more-detailed characterisation into PQ zones, it highlighted four aspects of the Palaeolithic for which the LTC is likely to affect nationally important remains:

a. *Boyn Hill Gravel (and equivalent deposits)*. Deposits in Essex dating to *c.* 400,000-380,000 BP [years Before Present] with rich remains of stone tools, and sometimes also with mammalian fossils and other palaeo-environmental remains;

b. *Lynch Hill Terrace (and equivalent deposits)*. Deposits in Essex dating to *c.* 340,000-300,000 BP, with very rich mammalian and other palaeo-environmental remains, and likely to include palaeo-landsurfaces with minimally-disturbed stone tool evidence of human activity;

c. *Middle Palaeolithic (British Mousterian) sites*. Deposits under Holocene alluvium on both sides of the Thames, dating to between 115,000 and 40,000 BP, and containing nationally rare evidence from the middle part of the Devensian Glacial, representing late Neanderthal incursions into Britain from the European continental landmass;

d. *Final Upper Palaeolithic Long Blade sites*. Deposits under Holocene alluvium on both sides of the Thames, and also under Holocene colluvium in dry valleys above the south side of the Thames, dating *c.* 14,000-10,000 BP, and representing early modern human presence and re-settlement at the end of the Last Glacial and the start of the Holocene.

1.1.4 The Project's footprint is divided into 34 distinct Palaeolithic and Quaternary (PQ) character zones: PQ1-11, 12a-b, 13-19, 20a-c, 21, 22a-b, 23a-b and 24-29. Each zone was assessed to one of three categories of Palaeolithic and geo-archaeological potential: UNCERTAIN (n=7), LOW-MODERATE (n=20) and MODERATE-HIGH (n=7) (Section 9, Table 9.1).

1.1.5 This SPAA-&-RF report builds on the PQDM in several ways. Firstly, it includes results from the walk-over survey (Section 7). Secondly, it establishes a LTC-specific Palaeolithic Research Framework (Section 8). This defines key Palaeolithic research themes and priorities for the LTC archaeological programme, and provides a unified context within which to assess the importance of Palaeolithic remains encountered during the project, and against which to prioritise resources. And thirdly, the SPAA-&-RF has divided the project area into seven broad landscape zones (LZ1 - LZ7, Section 3.2), and identified for each landscape zone a series of Research Objectives, relating to themes and priorities of the LTC Palaeolithic research framework (Section 8.3). These will thus feed into the phased mitigation programme that follows from the assessment reported here.

# 2 Introduction

## 2.1 The Lower Thames Crossing (LTC)

2.1.1 A new road crossing is proposed across the Lower Thames (Highways England project 540039). This major Project - the Lower Thames Crossing (LTC) - will involve a double-bore motorway tunnel under the Thames between Gravesend and Thurrock (passing *c.* 10km to the east of the existing Dartford crossing), as well as overland link roads between the south and north tunnel portals, and the A2 and M25 respectively (Figure 1). The overall length of the route is *c.* 27km and the impact footprint of the road and associated development is a little over 2630ha (based on the Statutory Consultation footprint, version of January 2020).

## 2.2 Planning background and cultural heritage impact

2.2.1 In accordance with the requirements of the *National Planning Policy Framework* (initially issued in 2012, but updated in 2019) and those specifically for large national infrastructure projects such as this (*National Policy Statement for National Networks* 2014), various processes are being followed to ensure that the development takes place in a sustainable manner and with due consideration to avoid (and if necessary, mitigate) impact upon cultural heritage. In summary, as a Nationally Significant Infrastructure Project (NSIP), authority to proceed with the project will be granted as a Development Consent Order (DCO) by the Secretary of State. The application for the DCO must be supported by various documentation, including an Environmental Statement (ES) that covers the impact of the proposed Project upon cultural heritage. And the cultural heritage content of the ES follows from substantial investigations, including desk-based reviews and a certain amount of field investigation.

2.2.2 Following from initial identification of the preferred route, an *Environmental Impact Assessment* (EIA) *Scoping Report* was issued (Highways England 2017). This outlined (in Chapter 7, Cultural Heritage) the general approach that would be taken to assessing the cultural heritage impact of the proposed new crossing. It identified:

a. national and regional bodies for consultation, such as Historic England and Local Authority planning archaeologists

b. relevant heritage datasets, such as nationally important heritage lists and, for non-designated heritage assets, local Historic Environment Records

c. major research projects recently carried out in the area, such as the *Medway Valley Palaeolithic Project* (Wenban-Smith *et al.* 2007a, b) and the *Thames Estuary Survey of Mineral Extraction Sites* (Essex and Kent County Councils, 2004)

d. work that would be undertaken to contribute to an Environmental Statement (ES) to be submitted as part of the process for gaining formal government planning consent to proceed with the Project, such as a desk-based

assessment (DBA) of cultural affects and field evaluation of areas with insufficient desk-based information for the impact of the Project to be adequately predicted

e. parameters and criteria for assessing the significance of heritage assets, and the magnitude of impact relating to the proposed new crossing

2.2.3 The initial scoping report was followed by a more-detailed *Preliminary Environmental Information Report* (PEIR) in September 2018 (Highways England 2018a). This reiterated the requirements of the Environmental Statement (ES) for the DCO application, and the proposed approach to addressing these requirements. In relation to cultural heritage (Chapter 7 of the PEIR), these included:

a. a detailed and up-to-date Desk-based Assessment (DBA) of heritage assets (designated and undesignated) affected by the proposed new crossing, with an assessment of their significance, to be included as an appendix to the ES

b. for assets of uncertain significance, methodologies for field evaluation that will be agreed with heritage stakeholders, and included as appendices to the ES

c. for key areas of greatest uncertainty, suitable preliminary (stage 1) field evaluation will be carried out to investigate the nature and significance of any unrecognised or poorly-known heritage assets, and the results taken account of in the ES chapter and the DBA appendix, as appropriate

d. the assessment of heritage assets will include a consideration of the level of impact on them from the proposed development, and in particular whether there is a risk of substantial harm or total loss of significance

e. an outline of mitigation measures to record, and advance understanding of, any heritage assets that will have their significance diminished by the project, proportionate to their significance and the impact

f. to identify areas with the greatest potential for new discoveries of heritage assets during the project, and specification of measures to identify and suitably investigate any such new discoveries

2.2.4 Both the EIA Scoping Report and the PEIR specified that the principles of the "Rochdale envelope" should be followed (PEIR para 2.1.14-2.1.16, pp6-7). This specifies that the parameters of a project design may not be fixed at the stage of ES production. Therefore, worst-case variations should be considered in the ES and accompanying technical documents, to ensure that likely significant environmental effects of a project are properly assessed. From a cultural heritage perspective, this means that (a) worst-case impacts of project design will be considered, and (b) worst-case possibilities for harm to the historic

environment will be considered, where there is uncertainty over the nature/importance of remains.

2.2.5 Thus, the scope and content of the ES should be sufficient for the Secretary of State to make an informed decision for the project to proceed with confidence that the impact upon any cultural heritage assets is well-understood and will be suitably mitigated. Some pre-DCO field investigations that complement desk-based assessment have taken place during the Archaeological Trial Trenching and inform the ES, but the bulk of archaeological fieldwork (comprising phased post-assessment mitigation) typically follows granting of the DCO.

2.2.6 This document has been prepared by Francis Wenban-Smith (University of Southampton) as part of the specialist Palaeolithic and geo-archaeological work package. A glossary of acronyms and technical terms relating (a) to Palaeolithic archaeology and Quaternary geo-archaeology, and (b) the Lower Thames Crossing project, is included as an annex (Annex A).

## 2.3 Specialist Palaeolithic and geo-archaeological assessments: rationale and scope

2.3.1 The PEIR also provided substantially more detail than the EIA Scoping Report on details of the cultural heritage assets already known, sources of heritage data, and research frameworks for the project area (see below, Section 3.4; and Annex B). Many of the research frameworks draw attention to the international importance of the Lower Thames valley for the rare survival of a suite of Quaternary deposits spanning the last 1,000,000 years. These contain evidence of Stone Age (Palaeolithic) hunter-gatherer ancestors spanning the time from the earliest occupation of Britain *c.* 800,000 BP [years Before Present] through to the end of the last ice age *c.* 11,700 BP, as well as later prehistoric presence (Mesolithic, Neolithic and Bronze Age) through the earlier part of the post-Last-Glacial Holocene period up to *c.* 2,700 BP, and even evidence of the Roman and Saxon periods buried in higher-level floodplain alluvial sediments.

2.3.2 Although no designated Palaeolithic assets are present, it was already identified in the EIA Scoping Report (Sec 7.6: 82-83) that the LTC footprint had high potential for unknown Palaeolithic remains in the Pleistocene gravel terraces either side of the new crossing. It was also recognised in the EIA Scoping Report that further consideration of the numerous undesignated archaeological assets affected by the LTC project would be required to identify and assess their value. The absence of designated Palaeolithic assets reflects the statutory difficulty of giving Palaeolithic assets this level of recognition, rather than the lack of presence of nationally significant Palaeolithic assets, of which some (or many) may be present in the project area.

2.3.3 The PEIR reviewed known heritage assets within the LTC development footprint and within a 1km buffer of it. The primary sources of information were the Historic Environment Records (HERs) of the three Local Authorities affected by the LTC project - Thurrock (Essex), Gravesham (Kent), and Havering (Greater London) - and also the separate national heritage list recently developed and populated by Historic England.

2.3.4 The problem with this latter source is that it duplicates much of the information in Local Authority HERs, which themselves include many duplicate records for the same archaeological asset. There is, therefore, a risk of over-estimating the quantity of heritage assets affected by a development if the data from all these sources is combined without careful consideration. Conversely, for the Palaeolithic, many important known assets are not included in any of these primary sources; so, even when combined, there is the risk of under-recognition of the potential Palaeolithic impact of a project unless a specialist contribution is sought that investigates a wider range of sources.

2.3.5 Based on the regional HERs and the national list, the PEIR identified 41 records for Palaeolithic remains (PEIR, Appendix E.5), in amongst >1000 post-Palaeolithic cultural heritage records. However, the PEIR did not review data from several major sources such as the *Southern Rivers Palaeolithic Project* (Wessex Archaeology 1993), the *English Rivers Palaeolithic Project* (Wessex Archaeology 1996), and various other specialist reviews and publications with important Palaeolithic records from the project area (see below, Section 5.2; and Annex C). This initial Palaeolithic listing was, therefore, (a) not-at-all exhaustive (and nor was it intended to be so, rather it can be taken as initially indicative), and (b) included several duplicate records from the Historic England list. Nonetheless, the Palaeolithic assets listed in the PEIR include a Palaeolithic occupation and flint working site at Upminster (Havering), as well as numerous instances of handaxes, flakes and flake-tools having been found *in situ* in deposits in gravel pits and other works in the vicinity of the project footprint.

2.3.6 Based on these Palaeolithic site records, the main text of the PEIR (Sec 7.4: 140) drew attention to the potential impact of the project upon Palaeolithic remains in terrace gravel deposits north and south of the Thames, in particular possibly associated with the tunnel portals. However, it did not otherwise seek to identify zones of greater or lesser Palaeolithic importance across the project area. Nor did it seek to consider the varying value of the various HER-derived records listed in the PEIR Appendix E.5.

2.3.7 Building on this initial review, the heritage stakeholder consultees further emphasised the potential importance of Palaeolithic assets likely to be affected by the project, and identified suitable approaches to addressing their potential for the DCO. In particular, comments from Historic England (East of England office, provided by D. Priddy on 18th December 2018, ref PL-0021 762) included:

a. it is likely that the greatest impact of the project (numerically and in terms of significance) may arise from the disturbance of buried remains (designated, undesignated and as-yet-unidentified). It is essential that the ES, as well as listing sites and assessing the impact upon them of the Project, gives consideration to their significance on a landscape scale and in the context of national and regional research frameworks.

b. deposit models have a valuable role to play in the DBA for the ES (para 5.6); Palaeolithic and Geo-archaeological specialists should be consulted to help determine the potential for buried archaeological remains, using

existing information (including that from separate geological and soils work areas) to develop an initial deposit model, and then to enhance this using new data from ground investigations done for the project.

c. the route should be divided into zones of varying character and potential, illustrating depths and deposits of interest on a schematic section; this initial model should be included in the DBA and ES, and should inform the design of preliminary investigative fieldwork, and should be iteratively updated as new information becomes available.

d. several key Palaeolithic and Pleistocene geo-archaeological sources have not yet been taken account of for data gathering, such as the Southern Rivers Project, the English Rivers Project, and relevant Quaternary Research Association Field Guides.

e. the Palaeolithic sections of relevant regional research frameworks should be included in the baseline assessment, and several nationally significant sites in the close vicinity of the project (Purfleet, Aveley, Swanscombe and Tilbury) are not considered in the PEIR, but their relevance to deposits affected by the project needs to be considered.

f. the DBA and ES should include a more detailed discussion of the archaeological potential of the alluvial and peat sequences at Tilbury, and also nearby gravel terrace deposits, than is provided in the PEIR.

2.3.8 Complementing these post-PEIR comments, other Historic England comments from the earlier consultation on the project (collated in the Tender Specification for the provision of Palaeolithic archaeological advice - Highways England 2018b), included:

a. Thames deposits are an important archive of human occupation in northwest Europe. Gravel terraces and fine-grained interglacial and estuarine deposits laid down over the last 400,000 years contain regionally, nationally and internationally significant archaeological finds complemented by palaeo-environmental remains. Several key sites in Kent and Essex have been designated as nationally important Sites of Special Scientific Interest (SSSIs) and Local Geological Sites (LGSs) due to their significance for Palaeolithic archaeology and Quaternary geology. There is a high likelihood that significant or highly significant Palaeolithic archaeology will be encountered during the project.

b. Thames gravel terrace deposits occur on both the Kent and Essex sides of the Thames, although are more abundant on the Essex side. Any intrusive development on these deposits is likely to encounter Palaeolithic archaeology.

c. significant Palaeolithic archaeology may be more likely to be encountered at interfaces between different gravel terraces, and between Chalk bedrock and gravel terraces. Particular deposits where an impact is projected and where Palaeolithic archaeology is likely include Corbets Tey and Mucking gravels near the southern tunnel portal in Kent, and Orsett Heath gravels at the junction with the A13 in Essex.

d. specialists in Palaeolithic archaeology and Quaternary geology should be engaged early in the development process to understanding the impact risks, to develop tailored approaches to determine the best evaluation strategy, and ultimately to minimise risk to the Project and develop the best mitigation strategy.

e. the assessment of Palaeolithic sites and potential should take a deposit-led approach (considering evidence from deposits in conjunction with their depositional process), and include consideration of finds from relevant analogue deposits that may be several km from the project area

2.3.9 Generally, it was clear from the prior scoping work and the ensuing stakeholder comments that the project passes through an area of high Palaeolithic significance, and that the DBA and ES (as well as complementary and subsequent field investigations) would benefit from specialist Palaeolithic and Quaternary geo-archaeological input.

2.3.10 Therefore, suitably qualified specialists (Francis Wenban-Smith of University of Southampton for Palaeolithic archaeology, and Martin Bates of University of Wales for Quaternary geo-archaeology) were commissioned by LTC to deliver the following material as part of the ES for the DCO:

a. *Palaeolithic and Quaternary Deposit Model* (PQDM). The initial version of this was issued in February 2020 (Wenban-Smith & Bates 2020). It used a combination of desk-based data and new data from LTC-related Ground Investigations to develop a Quaternary sub-surface deposit model for the project footprint. It took a deposit-led approach, and divided the project footprint into zones of varying Palaeolithic and Quaternary archaeological potential based on sub-surface deposit character and known Palaeolithic finds. Three categories of potential were recognised: MODERATE-HIGH, LOW-MODERATE, and UNCERTAIN. More details of the PQDM, and how it complements the SPAA, are given below (Sections 2.4 and 3.5).

b. *Stand-alone Palaeolithic Archaeological Assessment* (SPAA) [**this report**]. This separate report, which includes an LTC-specific Palaeolithic Research Framework, is intended to build on, and complement, the PQDM. Its content and scope in relation to the PQDM are reviewed below (Section 2.4).

2.3.11 This specialist material complements, and informs, the wider post-Palaeolithic cultural heritage contribution to the ES. It may also be submitted, in extract or in its entirety, as part of the ES.

## 2.4 Scope of this document: Stand-alone Palaeolithic Archaeological Assessment and Research Framework (SPAA-&-RF)

2.4.1 This document comprises the *Stand-alone Palaeolithic Archaeological Assessment and Research Framework* (SPAA-&-RF). It provides a general background to the Palaeolithic for the benefit of less-specialist readers, and an overview of varying Quaternary deposit character and known Palaeolithic finds along the route of the project. Current national and relevant regional Palaeolithic research priorities are reviewed, and collated into a single *LTC Palaeolithic Research Framework*. These desk-based data then inform assessment of the project footprint into zones ("PQ zones") of different Palaeolithic/Quaternary archaeological potential, based on their importance in relation to the research priorities defined in the accompanying *LTC Palaeolithic Research Framework*. These PQ zones are presented in this SPAA-&-RF report, with an overview of their potential contribution to the defined LTC Palaeolithic research priorities, and with an outline of suitable approaches to field investigation. Thus the goal of this report is to demonstrate that the Palaeolithic impact of the Project has been fully assessed, areas of greatest importance have been recognised, and that there is a clear framework for mitigating investigation. The SPAA-&-RF follows Chartered Institute for Archaeologists (CIfA) standards for Desk-based Assessment (CIfA 2017) and also has been carried out following the KCC standard specifications for Palaeolithic assessments, available from KCC Heritage Conservation on request.

2.4.2 Some of the content of this SPAA-&-RF report duplicates that of the PQDM. It reiterates the same 34 zones of varying deposit character and Palaeolithic potential that were identified in the PQDM (see below, Sections 3.5 and 9), although without the sub-surface deposit transects that informed their development.

2.4.3 This SPAA-&-RF builds on the PQDM in the following ways:

a. it provides a report of the walk-over/drive-by survey of the project area, and results from this feed into assessments of PQ zones

b. it provides more detail on the known Palaeolithic finds from the project footprint and its environs

c. it reviews the themes and priorities of the national Palaeolithic research framework, and those for the regional areas affected by the LTC project (Greater London, Essex, Kent and the Thames Estuary)

d. it integrates the themes and priorities of the national and various relevant regional research frameworks into a single new project-specific LTC Palaeolithic Research Framework, which can serve as a baseline for assessing the importance and potential of different areas of the LTC footprint, and for Palaeolithic remains encountered in course of the project

e. it provides additional information for each PQ zone, relating to: (a) relevance to the LTC Palaeolithic research framework priorities, (b) priority objectives for the first stage of mitigation, and (c) outline fieldwork methods

2.4.4 The SPAA-&-RF provides a full stand-alone desk-based assessment of the known Palaeolithic resource affected by the LTC project, complementing the Quaternary deposit model of the PQDM. It also provides an outline of priorities and approaches for Palaeolithic field evaluation, signposting the content of the Written Schemes of Investigation (WSIs) for the phased Palaeolithic mitigation programme.

# 3 Background

## 3.1 The Palaeolithic and Pleistocene: general introduction

3.1.1 The Palaeolithic (or Stone Age) represents the earliest phases of human occupation of Britain, as evidenced by the stone tools that survive in ancient deposits attributable to various dates between *c.* 800,000 BP [years Before Present] and the end of the last ice age *c.* 12,000 BP (Table 3.1). Britain was not continuously occupied through the Palaeolithic, due to climatic oscillations which made it periodically too cold to survive. The British Palaeolithic has been subdivided into different stages (Lower, Middle and Upper) based on changes in stone tool types and manufacturing techniques through this period (Table 3.1). The Lower and Middle Palaeolithic periods (lasting from *c.* 800,000 to 40,000 BP) are associated with early forms of human (*Homo heidelbergensis*, and their Neanderthal descendants). This lineage became extinct between 40,000 and 30,000 BP, and was replaced *c.* 35,000 BP by anatomically modern humans, who are associated with the Upper Palaeolithic (*c.* 35,000 BP to 12,000 BP).

3.1.2 The Palaeolithic (in Britain) is associated with the second half (Middle and Late stages) of the Pleistocene geological epoch, which began *c.* 2 million years ago. This was a time when the earth's climate oscillated over the course of millennia between cold ice ages (glacials) and warm periods (interglacials) (Lowe & Walker 2015). The end of the Pleistocene is defined by the end of the last ice age *c.* 12,000 BP, and the subsequent warm phase (which continues to the present day) is known as the Holocene. It is probably no coincidence that the changes in lithic material culture that define the end of the Palaeolithic (and the start of the subsequent Mesolithic period) coincide with the climatic transition that defines the boundary between the end of the Pleistocene and the start of the Holocene.

3.1.3 The term "Quaternary" represents the time period that encompasses both the Pleistocene and Holocene epochs. In practice, the terms Pleistocene and Quaternary are often used synonymously, since they have such a substantial overlap. The Pleistocene is also often incorrectly described as a "period" rather than an "epoch". It is useful to note the correct definitions, and to be aware of the slight technical differences when the terms are used correctly. From a Palaeolithic point of view, Palaeolithic remains are mostly associated with Pleistocene deposits. However, archaeological remains from the very end of the Palaeolithic are often buried by, or incorporated in the basal part of, early Holocene deposits (typically alluvium or colluvium). Therefore, it is usually correct to regard Quaternary deposits as providing the all-embracing potential source of Palaeolithic remains; although in practice, investigations will mostly be focused on Pleistocene deposits, which are much more varied and represent a far greater timespan.

3.1.4 Pleistocene deposits are generally dated with reference to numbered marine isotope stages (MIS). These are derived from analysis of changing proportions of oxygen isotopes ($O^{18}$ and $O^{16}$) in the continuous deep-sea sedimentary record that reflect the global climatic oscillations. Even-numbered MIS stages

(2,4 *etc.*) represent cold glacial troughs in the continuous sequence, and odd-numbered stages (5, 7 *etc.*) represent warm interglacial peaks. These numbered stages have been dated by various means (primarily radiometric), and thus the continuous deep-sea record provides a reference framework (Figure 2) against which the discontinuous terrestrial record can be related.

3.1.5 Key reference stages for the purposes of this report are MIS 12 (the Anglian glaciation, which lasted between c. 475,000 and 425,000 BP), MIS 5e (the Ipswichian interglacial, which lasted between c. 130,000 and 115,000 BP), and MIS 2 which represents the coldest part (Last Glacial Maximum) of the last glacial period (the Devensian) between *c.* 24,000 and 16,000 BP. MIS 2 was followed by some relatively short cold and warm oscillations, before the significant warming trend at 11,700 BP that defines the end of MIS 2, and the start of MIS 1 (the present warm Holocene epoch).

3.1.6 Terrestrial deposits can themselves often be directly dated, or can be dated in relation to other deposits on the basis of their contained faunal evidence or their stratigraphic relationships. Therefore, following almost 2 centuries of work, we have quite a good idea of the Pleistocene framework for southern England, and the important well-dated framework of fluvially-lain terrace deposits in the Lower Thames valley (Bridgland 1994).

**Table 3.1 Overview of the British Palaeolithic and Pleistocene framework**

| Traditional Palaeolithic stage | Updated stage | Human species | Lithic artefacts and other material culture | MI Stage | Date (BP) | UK geo stage |
|---|---|---|---|---|---|---|
| Upper Palaeolithic | Upper Palaeolithic | Anatomically modern humans (Homo sapiens sapiens) | Dominance of blade technology and standardised tools made on blade blanks; personal adornment, cave art, bone/antler points and needles | 2-3 | 10,000-35,000 | Late Devensian |
| Middle Palaeolithic | British Mousterian | Neanderthals (Homo neanderthalensis) | The appearance of bout coupé handaxes; discoidal flake/core reduction strategies | 3-5d | 35,000-115,000 | Early/Middle Devensian |
| | - | - | Britain uninhabited | 5e | 115,000-125,000 | Ipswichian |

| Traditional Palaeolithic stage | Updated stage | Human species | Lithic artefacts and other material culture | MI Stage | Date (BP) | UK geo stage |
|---|---|---|---|---|---|---|
| | Lower/Middle Palaeolithic | Early pre-Neanderthals, evolving into Homo neanderthalensis | Still some handaxe-dominated sites, but growth of more standardised (Levalloisian) flake and blade production techniques (e.g. Crayford) | 6-9 | 125,000-425,000 | Saalian complex and Hoxnian |
| Lower Palaeolithic | | | Handaxe-dominated (Eg. Swanscombe; Cuxton), but appearance of more standardised flake and blade production techniques (Levalloisian); occasional industries without handaxes (Clactonian) | 8-11 | | |
| | - | - | Britain uninhabited | 12 | 425,000-480,000 | Anglian |
| | Lower Palaeolithic | Homo cf heidelbergensis | Handaxe-dominated (Eg. Boxgrove), with occasional unstandardised flake core production techniques and simple unstandardised flake-tools; occasional unifacial flake-tool industries without handaxes (High Lodge) | 13 | 480,000-500,000 | Cromerian Complex IV |
| | | Homo ergaster | Simple flake/core industries with no standardised flake-tools (Pakefield; Happisburgh) | 13-21 | 500,000-850,000 | Cromerian Complex I-III |

## 3.2 Geology and landscape context

3.2.1 The Solid bedrock geology in the area of the LTC project is mostly formed of London Clay filling a synclinal basin which widens eastward from the London area across the southern part of Eastern England towards the North Sea. The north side of an anticlinal Chalk dome forms high ground (the North Downs) to

the south side of this basin, and the current Lower Thames runs eastward in the base of a minor ripple in the Chalk bedrock structure where the London Clay basin abuts the northern dip-slope of the North Downs.

3.2.2 Chalk outcrops on the Thames valley slope to the south of the southern LTC portal, which rises further south to the Shorne plateau where the high ground is capped by Thanet Sand and younger Tertiary deposits (Lambeth Group, Harwich Group and London Clay). These same deposits appear in a limited east-west band on the higher ground on the north side of the Thames, although their northward dip means that London Clay outcrops north of an east-west line along the route of the A13 and A 1013. The solid bedrock is overlain in the LTC footprint by complex and varied Superficial, or Quaternary, deposits.

3.2.3 As outlined above (Section 2.3), the Project is in an area in which extensive spreads of Quaternary sediments are preserved. The Thames valley contains an internationally important archive of deposits spanning the last 1,000,000 years (the later Lower Pleistocene, the Middle Pleistocene and the Late Pleistocene) (Bridgland 1994; Gibbard 1994). The recent geological development of the Lower Thames area and the establishment of the modern topography, including the Thames estuary, have been a result of major drainage basin modifications during the Quaternary, and in particular events during the last 500,000 years. The early Middle Pleistocene course of the river Thames has been identified to the north of the modern channel, draining eastward through the Vale of St. Albans and into eastern Essex (Gibbard 1977, 1985). During this time the river Medway would have been a south-bank tributary of this ancestral Thames, draining northward across the present-day mouth of the Thames (passing across what is now the Hoo peninsula, east of the LTC footprint) to converge with the ancestral Thames in eastern Essex (Bridgland 1983, 1994, 1999 and 2003). During this time drainage across the LTC area would similarly have been from southwest to northeast, with the river (maybe an ancestral Cray, Darent or even Ebbsfleet) forming another more-westerly south-bank tributary of the then-more-northern course of the river Thames.

3.2.4 Elements of this ancestral drainage network are only likely to be preserved on the Kent site of the LTC, on the higher ground at the southern boundary of the study area. The creation of the modern Thames valley downstream of Reading and through the LTC area, by channel disruption in the Thames basin associated with the major Anglian glaciation (Gibbard 1977, 1985), has removed all traces of prior fluvial activity associated with what would have been south-bank tributaries of the ancestral Thames. Thus, almost all deposits in the LTC area - including on the southern bank of the Thames in Kent, on the northern side of the Thames in Essex, and further to the northwest where the LTC route heads towards the M25 - represent sediments that have accumulated since the major late Anglian re-arrangement of river systems in southeast Britain, dating from approx. 500,000 BP.

3.2.5 Thus, in the present-day Lower Thames valley, to the east of London and in the area of the new crossing where the Thames is tidal and begins to widen into a major estuary between Kent and Essex, the dominant deposits (Figures 3-6) relate to the late Anglian and post-Anglian period Middle and Late Pleistocene (representing an alternating series of cold glacial episodes and warm

interglacial episodes over the last 500,000 years). These occur as a "staircase" of terrace deposits down both sides of the Thames valley, with progressively younger deposits occurring at lower elevations down the valley side, as the river course eroded down throughout the Pleistocene towards its present level in the base of the valley (see below, Section 5.3).

3.2.6 Although many well-known Palaeolithic sites containing both archaeological and palaeoenvironmental remains are documented in the lower Thames, many of these are west of the project route corridor (see below, Section 6). Relatively little detailed work has been undertaken on Pleistocene deposits in the area of Project impact. Nonetheless, based on geological mapping and extrapolating from the known information a short distance to the west of the project area, it is to be anticipated that:

a. interglacial sediments, including both riverine and estuarine, may be preserved within the study area

b. the interglacial sediments are likely to rest on older, cold stage, fluvial sediments

c. these fluvial/estuarine sequences may often be buried by slopewash and solifluction (cold climate mass movement deposits) sequences

d. younger parts of the Pleistocene terrace succession are likely to be buried beneath Holocene alluvium, especially on the Thames floodplain; older parts of the terrace succession are likely to be present at shallow depths below the ground surface away from the river (although the sequences themselves may be of considerable thickness)

e. both the Holocene and Pleistocene parts of the record are often rich in palaeoenvironmental remains that include large and small mammals, molluscs and microfossils (including pollen, ostracods, diatoms and foraminifera); these remains not only provide a record of changing environmental conditions but may also aid in constructing chronological frameworks for the sequences.

3.2.7 Varying bedrock, topography and Quaternary geology are the major factors behind the division of the LTC project area into different deposit character areas for the PQDM (see below, Sections 3.5, 5.4 and 9). At a broader level, and working from south to north, the route can be divided into seven broad landscape zones (LZ1-7) based on topography and geological character areas (Figure 7):

a. LZ1 - Tertiary deposits capping Chalk forming higher ground at Shorne Country Park, with Pleistocene and Holocene colluvial deposits infilling depressions and surrounding dry valley networks

b. LZ2 - Chalk valley-side slope on the south side of the Thames floodplain, with north-draining minor dry valleys, and with small patches of Thanet

Sand and Pleistocene terrace outcrops at the base of the slope, at elevations of between 5m and 25m OD

c. LZ3 - the Thames floodplain, with deep Holocene alluvium overlying late Devensian fluvial gravels and isolated fluvial channel-fill deposits from the late Middle and Late Pleistocene, partly cut through by the current water-filled Thames channel

d. LZ4 - Pleistocene terrace deposits on the north side of the Thames floodplain, overlying Tertiary deposits (Thanet Sand and Lambeth Group), and ranging in age from early post-Anglian (Black Park Gravel) down to early-mid Devensian (Taplow Gravel)

e. LZ5 - the Mar Dyke basin, mostly London Clay bedrock, with its lower-lying parts filled with Holocene alluvium and with marginal dry valleys containing colluvial deposits (that may be of mixed Pleistocene/Holocene age), which merge and interdigitate with the lower-lying alluvial deposits

f. LZ6 - Thames terrace deposits on the west side of the Mar Dyke basin, west of North Ockenden, ranging in age from early post-Anglian (MIS 12, Black Park Gravel) down to MIS 9 (Lynch Hill Gravel);

g. LZ7 - higher ground at the northern side of the Mar Dyke basin, east of Upminster, where depressions in an undulating landscape of London Clay are infilled with Head deposits (that may be of mixed Pleistocene/Holocene age); and where the London Clay is in places capped by higher Tertiary deposits (Bracklesham Group) which are in turn overlain by the Pliocene or Early Pleistocene Stanmore Gravel; there are also occasional minor outcrops of Lowestoft Till from the Anglian glaciation (MIS 12) and Black Park Gravel.

## 3.3 Palaeolithic background of the LTC area

3.3.1 The Middle and Late Pleistocene Thames terrace deposits in the vicinity of the project contain abundant Palaeolithic archaeological remains (mostly flint artefacts) as well as vertebrate fossils and other palaeo-environmental remains (such as molluscs, ostracods, plant macro-remains, insects and pollen). Some of the mammalian fossils have cut marks and other signs of damage that relate directly to hominin behaviour, but mostly these are of significance for the additional information they provide on climate, local environment and dating. The contained Palaeolithic archaeological evidence (including artefacts, and faunal and other palaeo-environmental remains) is a major factor in the international importance of this part of the Thames terrace archive.

3.3.2 During this time Britain was at the northern edge of the hominin-inhabited world, and was periodically colonised from continental Europe during periods of warmer climate when these early hominins were able to survive, but hominins became locally extinct during the coldest glacial episodes (see **Figure 2**). Thus,

the Thames valley is an important laboratory for investigating the behaviour and survival capability of early hominins at this time, which mostly represents a period when one of Europe's early colonisers (*Homo heidelbergensis*) was evolving into Neanderthals. This settlement history and evolutionary transition is reflected in changing types of lithic artefacts through the Middle and Late Pleistocene deposits of the project area; however, the absence of skeletal material (apart from one early skull from deposits at Swanscombe that seems to show a transitional form between *H. heidelbergensis* and Neanderthal) means that attempts to link specific tool-types and manufacturing practices with this evolutionary transition remain speculative.

3.3.3 There are also likely to be terminal Pleistocene (Late Upper Palaeolithic) archaeological remains associated with the alluvium of the Thames and its tributaries. Remains of this period may be found at the base of the Holocene alluvium. They may be buried at depths ranging from less than 1m to the full depth of the alluvial sequences (>35m in some places). Remains from a range of late Prehistoric archaeologies and historic archaeology may also be found below, and within the Holocene alluvium. Site types might vary from isolated finds associated with hunting activities through to major concentrations reflecting occupation and activity foci. Preservation in these circumstances, where full waterlogging is likely, might be exceptionally high quality.

3.3.4 The proposed footprint of works for the new crossing passes broadly SSE-NNW across the Lower Thames valley, intersecting the terrace staircase on both sides of the Thames and cutting through major spreads of Holocene alluvium flanking the current river channel. As outlined in the PEIR and reviewed in more detail below (Section 6; Annex D) numerous Palaeolithic and later prehistoric sites are known from deposits that will be impacted by the project. It is therefore necessary to carry out this systematic deposit-led desk-based assessment of the project area, supplemented initially by field evaluation and later where necessary by mitigating excavations, to ensure that the project is carried out with due regard for heritage impact, and maximises its potential to promote appreciation and increase understanding of our shared past and the wide span of European and British history and prehistory that is represented in deposits of the Lower Thames valley in Kent and Essex.

## 3.4 Planning background: Palaeolithic Research Frameworks and Guidance

### Research frameworks and heritage asset significance

3.4.1 As discussed above (Section 2.2), the information provided in the DCO application needs to provide an assessment of the significance of heritage assets (designated and undesignated) affected by the Project. This assessment will initially be based on desk-based research, and this is part of the role of this SPAA report.

3.4.2 A key aspect of this work is, therefore, the definition and recognition of grades of significance. Various approaches have been historically adopted for assigning significance to heritage assets, for instance (e.g. in the EIA Scoping Report, p87, Table 7-3) based on attribution to grades of significance such as international (very high), national (high), regional (medium) or local (low), and

often based on statutory designation to identify the higher levels. More recently, it has become established that the notion of significance can also be related to the potential contribution to current research priorities. Thus, there has been a general development over recent decades of national and regional research frameworks, usually with period-specific sections. These define current research priorities, and provide a benchmark against which to judge the significance of heritage assets. These have also been supported by period-specific and topic-specific Guidance documents.

3.4.3 The Project is wholly within England, but encompasses parts of three regional areas: Greater London (Borough of Havering), Eastern England (county of Essex, Boroughs of Brentwood and Thurrock) and the South-East (county of Kent, Borough of Gravesham). Each of these regions has its own regionally-focused historic environment research framework; for the East of England the initial framework was produced by Brown & Glazebrook (2000), later revised by Medlycott (2011), and for the South-East a series of period-specific and topic-focused reports are held on-line (https://www.kent.gov.uk/leisure-and-community/history-and-heritage/south-east-research-framework). And then both Kent and Essex have their own county-specific projects to facilitate pre-development curatorial decision-making. In Essex there was the project *Managing the Essex Pleistocene* (Essex County Council 2015); and in Kent there is an ongoing project to develop Archaeological Notification Areas, which covers all periods but has a specific Palaeolithic element. And cross-cutting these areas, the Thames Estuary has been recognised as a distinctive geographic and historically distinct area, and has attracted its own research framework (Williams & Brown 1999), then updated (Essex County Council 2010).

3.4.4 For the LTC, rather than try and relate the Palaeolithic remains to all of these distinct research frameworks, it has been decided to develop a single new project-specific *LTC Palaeolithic Research Framework*. The national and various regional research frameworks have significant overlaps, but some important projects or priorities are only referenced in one (or a few) of them. Therefore, the *LTC Palaeolithic Research Framework* will collate the best and most-relevant parts of the national and various regional research frameworks into a single framework. The significance of any remains and areas identified in the Project will then be assessed in relation to the themes and research priorities of the LTC-specific research framework.

3.4.5 The national and various relevant regional research framework documents for area affected by the Project are collated as an annex (Annex B), and summarised below, along with key National Guidance relating to the identification and protection of Palaeolithic remains. And then the key elements are collated into the new *LTC Palaeolithic Research Framework* further below (Section 8).

## National Palaeolithic research framework

3.4.6 Well-defined research priorities, and statements defining significance, provide the basis for assessment of significance as part of the planning process. Following from PPG 16 (Dept. of Environment 1990) and the integration into the planning process of the requirement for archaeological work to be undertaken in

conjunction with development, English Heritage initiated a broad framework of national research priorities in *Exploring our Past* (1991). Three main themes were identified for the Palaeolithic in this initial framework: physical evolution; cultural development; and global colonisation. The research framework for the Palaeolithic has subsequently been kept under review and periodically updated (English Heritage 1999 & 2008).

3.4.7 The current national framework (English Heritage 2008) identifies four Primary Research Themes and eight cross-cutting Strategic Research and Conservation Themes.

3.4.8 Primary themes are:

a. hominin environments and climate drivers

b. hominin demographies: the palaeoecology of hominin colonisation and the settlement process

c. how we became human: social, cultural and economic change

d. sharing human origins, developing new audiences

3.4.9 Strategic research and conservation themes are:

a. areas

b. understanding the record

c. dating frameworks

d. curation and conservation

e. dealing with development

f. professional training

g. education

h. collections and records enhancement

3.4.10 Several specific questions/issues are then presented as priorities under the umbrella of each of these themes. These latter are, however, indicative rather than restrictive or exclusive; it is expected that other specific questions can arise in relation to the primary themes. Specific priorities that are mentioned and that relate to the LTC area are integrated into the project-specific *LTC Palaeolithic Research Framework* below (Section 8).

## Greater London research frameworks

3.4.11 A Resource Assessment and then an accompanying Research Framework were prepared for the Greater London area early in the new millennium (MoLAS 2000, and then MoL 2002 respectively). These documents have been supplemented relatively recently by a new overarching Strategy for Researching the Historic Environment of Greater London (MoL 2015).

3.4.12 Even though the earlier two reports are in principle superseded by the latter, it is useful to recap them all, since the latter is a substantial revolution from the former two, and is best understood in their context. The overlap of the LTC footprint with the Greater London area is relatively small, but the Resource Assessment (MoLAS 2000) identified four Palaeolithic findspots in the part of Havering within a 3km buffer of the LTC project footprint, in amongst the far greater number of Palaeolithic findspots across the whole Greater London area; these are incorporated within the desk-based review of Palaeolithic sites (Section 6). The Research Framework (MoL 2002) was grouped into five main periods - Prehistory, Roman, Saxon, Medieval and post-1500 - and then within the “Prehistory” section (Chapter 3) the Palaeolithic was covered under the first three sub-sections: landscape and environment, “Early scavengers” (for the Lower/Middle Palaeolithic), and “Later hunters” (for the Upper Palaeolithic).

3.4.13 A list of framework objectives was put forward for each Prehistory sub-section, and thus the Palaeolithic was covered under three sets of framework objectives P1-P3, with each list having several specified subsidiary objectives.

3.4.14 P1 framework objectives (landscape and environment) most relevant to the Palaeolithic included:

a. establishing a firm regional chronology for Pleistocene deposits (especially terrace deposits) of the London region, and relating this to a national chronological framework

b. understanding the development of the Thames since the Anglian glaciation (MIS 12)

c. palaeoecological reconstruction, and understanding the animal presence and human interaction with it

d. understanding environmental and climatic change through the Palaeolithic, and its effect on hominin behaviour

3.4.15 P2 framework objectives (“Early scavengers”: Lower/Middle Palaeolithic) included:

a. establish sound chronologies using approaches such as biostratigraphy and litho-stratigraphy, together with use and testing of chronometric dating methods (such as OSL)

b. palaeo-environmental investigations and reconstruction of conditions, modelling of ecosystems and hominin palaeoecology

c. local and regional analysis of landscapes and sequences

d. extending the analysis of lithic technology and typology, and going beyond culture-historical explanations to consider behavioural and cognitive factors

3.4.16 P3 framework objectives (“Later hunters”: Upper Palaeolithic) included:

a. geomorphological modelling of the late Last Glacial and early Holocene landscape associated with this period, using topographical and borehole data and geophysical methods, focusing on identifying and predicting palaeo-landsurfaces that might contain undisturbed remains, which maybe deeply buried

b. investigating and understanding the continuity and change of subsistence strategies through the Upper Palaeolithic and from the Late Upper Palaeolithic into the Mesolithic

3.4.17 The period-based sets of framework objectives were then organised into an overall Research Agenda (MoL 2002, Chapter 8) with five major thematic areas, supplementing and cross-cutting the period-based framework objectives. Twenty-seven subsidiary framework objective areas were divided across the major thematic areas, and then each subsidiary framework objective area had up to nine further specific research priorities listed.

3.4.18 The five major thematic areas were: Topography and Landscape (Framework Objectives TL1-TL4), Development (Framework Objectives TD1-TD7), Economy (Framework Objectives TE1-TE4), People and Society (Framework Objectives TS1-TS8), and Continuity and Change (Framework Objectives TC1-TC4). In total, 120 specific research priorities were listed under these thematic headings and their subsidiary framework objective areas. Besides those repeated from the period-based framework objective groups P1-P3 and listed above, those that are most relevant to the Palaeolithic are:

a. TL1 (Topography and Landscape: ecology and geomorphology) - division of the Greater London area into eight landscape study areas, including tributary valleys, wetlands, gravels (and brickearths), high-level terraces (pre-MIS12), claylands, and chalk;

b. TL3 (Topography and Landscape: cognitive landscapes) - the relationship between landscape character, topography and settlement pattern;

c. TD7 (Development: material culture studies), and also TS8 (People and Society, material culture studies) - material cultural studies to investigate the social role of material culture [although probably not intended as such, these framework objectives are very relevant to the analysis and interpretation of Palaeolithic lithic material];

d. TE4 (Economy: material culture studies) - inter- and intra- regional comparisons of material culture assemblage types;

e. TS5 (People and Society: demography) - investigating changing population size through time;

f. TC1 (Continuity and Change: chronologies) - dating all prehistoric sites, developing/testing dating techniques, and using chronometric and

biostratigraphic dating techniques in combination to establish robust control frameworks for non-absolute techniques;

g. TC2 (Continuity and Change: transition periods) - here, nothing Palaeolithic is specified, but there are important transitions within the Palaeolithic that merit focus, such as: the development within the Hoxnian from Clactonian to Acheulian, the transition from Neanderthal to modern human, and the transition from Late Upper Palaeolithic to Mesolithic at the start of the Holocene;

h. TC3 (Continuity and Change: catastrophe and upheaval) - here again, nothing Palaeolithic is specified, but there are important catastrophes and upheavals within the Palaeolithic that merit focus, such as the periodic inhabitability caused by climate change and glaciation in, for instance: the Anglian glaciation (MIS 12), MIS 6, the Last Glacial Maximum (MIS 2) and the final cold episode at the end of the Last Glacial (the Younger Dryas);

3.4.19 Following from this 2002 Research Framework, a new *Greater London Historic Environment Research Strategy* (GLHERS) was produced more than 10 years later (MoL 2015). This report - which was produced in the context of national policy statements and guidance, such as PPS5 (DCLGE 2010), NHPP (English Heritage 2011, rev 2013) and then the NPPF (MHCLG 2012, rev 2019) - aimed to help researchers navigate through "the forest of competing priorities" (*ibid.* ix). It expanded its terms of reference to include the built historic environment, although was restricted in its stated remit to "the totality of the physical evidence for past human activity" (*ibid.*). Thus it formally sidelines the important context to past human behaviour provided by the landscape and palaeo-environmental evidence apart from where associated with human activity, and the important contribution of sediment sequences and palaeo-environmental remains to understanding the chronological and palaeo-climatic framework of past human presence. It set out a 5-year Action Plan of strategic actions to develop a suitable research culture for the wider historic environment, and it also re-defined a new set of Research Priorities to guide research activity and pre-development investigation.

3.4.20 A key innovation in the GLHERS was to re-position understanding of the physical evidence of the historic environment within six over-arching "Structural Elements" (SE1-6):

a. SE1 - a city in its hinterland and world context;

b. SE2 - inhabiting the pre-urban landscape;

c. SE3 - evolving urban settlement;

d. SE4 - identifying places and communities;

e. SE5 - buildings for living and working;

f. SE6 - artefacts: manufacture and consumption.

3.4.21 Thirty-two London-focused Research Priorities were then defined. These were mapped against these Structural Elements, as well as against an unlabelled element covering “Theoretical and methodological issues” (MoL 2015, Section 7.3). The Research Priorities and Structural Elements were also referenced back to NHPP measures and to English Heritage’s thematic research strategies (TRS), of which the only one relevant to the Palaeolithic is that for Prehistory (“TRSP” - English Heritage 2010). Only two of the Structural Elements - SE2 and SE6 - have relevance for the Palaeolithic, as also does the theme of “Theoretical and methodological issues”.

3.4.22 Relevant Research Priorities under the unlabelled theme “Theoretical and methodological issues” included:

a. RP1 - Key period transitions and prehistoric chronologies [= TRSP PR4];

b. RP2 - Scientific techniques, to use them to their full potential and in particular dating techniques [= TRSP PR5];

c. RP3 - Synthesis and publication of substantial archives from pre-development work, that could identify new research areas and provide new information to improve understanding of the significance of the historic environment to aid curatorial decision-making.

3.4.23 Relevant Research Priorities under SE2 included:

a. RP6 - archaeology of palaeo-landsurfaces [= NHPP aim 4G2 and various TRSP critical priorities, such as CP2 “Setting prehistoric sites in context”” and CP 3 “Understanding sites without structures”];

b. RP7 - prehistoric settlement [= NHPP aims 4F and 4G; and TRSP PR2];

c. RP8 - understanding prehistoric society, with areas of interest identified as including chronological frameworks, settlement patterns, landscape history, material culture studies and regionality [= NHPP aims 4G; and TRSP PR3 and PR6];

d. RP9 - Pleistocene and Early Holocene activity [= NHPP aim 4G1; and various TRSP themes, including PR1, PR3 and PR4];

e. RP10 - wetland, riverine and waterlogged evidence, most-applicable to Late Upper Palaeolithic remains from below Holocene alluvium [= NHPP aim 4G; and TRSP PR1];

f. RP11 - climate change and sea-level rise, using long-term records from the Pleistocene and the Holocene [=TRSP themes PR6 and PR7].

3.4.24 Research Priorities under SE6 comprised RP31 and RP32 as detailed below, although neither have much to offer to establishment of a framework by which to assess the value of Palaeolithic remains affected by the LTC. However, the study of artefacts (and in particular lithic artefacts) has much to contribute to

investigation of the Palaeolithic, and this is recognised in other research frameworks (this section) and in the new *LTC Palaeolithic Research Framework* (**Section 7**). Research Priorities under SE6 were:

a. RP31 - comparison of finds assemblages from the central London area with those from the wider outskirts of Greater London, investigating the scale of regionality [= NHPP aim 4F];

b. RP32 - artefact studies at the London Archaeological Archive and Research Centre (LAARC), using the existing archive of catalogued and well-provenanced artefacts for academic research, education and public engagement.

## East of England research framework and the Essex Pleistocene predictive Palaeolithic model

3.4.25 Essex is one of the counties within the "East of England" region. The initial East of England research framework - under the regional umbrella of "Eastern Counties" - was issued in two parts. Firstly, there was a *Resource Assessment* (Glazebrook 1997), and this was followed shortly after by a combined *Research Agenda and Strategy* (Brown & Glazebrook 2000). Both these reports were mainly structured on a period-by-period basis, and included period-specific sections on the Palaeolithic (Austin 1997, & 2000).

3.4.26 These reports were then reviewed a little more than a decade later, and an updated research framework issued for the East of England as a single report (Medlycott 2011). This new report emphasised that it was not intended to replace the previous Eastern Counties research framework reports, but to augment them. In particular, and again on a period-by-period basis, it (a) reviewed key projects undertaken since issue of the *Research Agenda and Strategy* in 2000, (b) examined progress on the research priorities proposed in the latter report, and (c) reconsidered priorities for future work.

3.4.27 Austin's 1997 Palaeolithic resource assessment highlighted the importance of the Lowestoft Till (mapped as Boulder Clay) from the Anglian glaciation, representing the most southerly advance of glacial ice-sheets during the repeated climatic oscillations through the Palaeolithic, as providing a key stratigraphic tie-point across the eastern region. The Hornchurch rail cutting at Upminster, just to the west of the LTC footprint, is an important example of this, providing a direct relationship between the Anglian Boulder Clay and the Lower Thames terrace sequence (Bridgland 1994: 176-185). She characterised the Lower and Middle Palaeolithic resource (see above, Section 3.1, Table 3.1) as mostly comprising lithic flakes and tools from river gravels, with a small number of undisturbed sites from palaeo-landsurfaces. Sites from throughout the British Lower/Middle Palaeolithic are present in the Eastern region, including pre-Anglian sites such as High Lodge, post-Anglian sites such as Hoxne, and Last glacial Devensian sites at Ipswich.

3.4.28 She drew attention to the importance of using palaeo-environmental information to help construct an overall regional chronological and palaeo-climatic framework for the Palaeolithic, and to the important contribution of sites without artefactual remains, as well as those where lithic artefacts are present. Her

overall conclusion was that the Lower/Middle Palaeolithic resource of Eastern England, including Essex, is of national and international importance.

3.4.29 For the Upper Palaeolithic, the resource in eastern England is sparse, as for most of the country. The period is mostly represented by stray lithic finds of uncertain provenance. There are a few stratified sites with evidence of the final Late Upper Palaeolithic “Long Blade” industry, for instance Titchfield in Norfolk, Sproughton in Suffolk and Carrow Road in Norwich. Despite the paucity of known sites, the region has good potential for the survival of final Upper Palaeolithic sites, at the base of Holocene peat and alluvium in the fens and along river valleys. In general, the Upper Palaeolithic is poorly understood in Eastern England, and the national rarity of sites increases the importance of any that are found.

3.4.30 The subsequent Palaeolithic research agenda and strategy (Austin 2000) identified several broad topics as priorities for future work in the region. These included:

a. development and testing of new methodologies to understand the potential of the Palaeolithic resource, and enable deposit modelling and the development of predictive landscape models

b. linking sequences from different sites to improve understanding of Quaternary chronological frameworks;

c. investigating palaeo-environmental remains to study palaeo-environments;

d. investigating undisturbed sites to provide detailed information on early hominin behaviour;

e. investigating less well-preserved evidence to gain understanding of broader patterns of early hominin activity, and its relationship to the landscape;

f. investigation of sites with faunal remains representing diet and tool manufacture.

3.4.31 Some areas of Eastern England were identified as of high potential, and with potential to address a range of research priorities. These included:

a. ancient Thames deposits, both preserved as terrace deposits in the southern part of the region, and also earlier deposits represented by remnant sand/gravel bodies (the Ingham/Bytham river, and the Kesgrave Sands and Gravels) preserved under the Boulder Clay from the Anglian glaciation that covers much of the region

b. post-Anglian lacustrine deposits, including those already known at Hoxne and Marks Tey

c. non-Thames river valleys, where the chronology and Palaeolithic archaeological content of mapped terrace deposits should be more

thoroughly investigated, such as the Colne, the Waveney, the Gipping, the Stour and the Blackwater

3.4.32 The research strategy for the Eastern Counties (Wade & Brown 2000) was not laid down on a period-by-period basis initially, but established general principles. It recognised that development-led work had an important contribution to make, and indicated that the research framework should assist in providing a research focus for such work, and in particular that work should be prioritised that addresses the aims put forward in the period-specific research agendas. It also put forward the principle that for heritage impacted by development, it was important to collect data that would otherwise be lost, even if it sometimes wasn't clear how all the data contributed to current research priorities. It was recognised that research questions and priorities would continue to evolve, so that it would be important to archive data that would potentially be relevant in the future, even if present-day analysis focused upon a subset of the overall data collected that was relevant to presently-recognised research questions.

3.4.33 This initial research framework was reviewed and revised a little over ten years later, in the report *Research and Archaeology Revisited: a Revised Framework for the East of England* (Medlycott 2011, ed.). This report emphasised that it augmented, rather than replaced, the two previous research framework reports (Glazebrook 1997, ed.; and Brown & Glazebrook 2000, eds). It reviewed key projects that had been undertaken over the decade since the initial research framework agenda and strategy was issued. It considered what progress had been made towards addressing the research priorities previously put forward. And it provided additional indications for future research projects and priorities.

3.4.34 For the Palaeolithic (Medlycott 2011: 3-8), the revised research framework reiterated that the East of England has enormous research potential, with the region's unique geographical situation and landscape history putting it at the forefront of Palaeolithic studies in Britain - as exemplified by work such as that at Pakefield (Parfitt *et al.* 2005), Happisburgh (Parfitt *et al.* 2010) and Linford (Boismier *et al.* 2012), and by research and resource review projects in the region such as the *Thames Estuary Survey of Mineral Extraction Sites* (Essex County Council and Kent County Council, 2004) and the *Medway Valley Palaeolithic Project* (Wenban-Smith *et al.* 2007a,b). It was thought that there had been greater progress in improving understanding of the Lower and Middle Palaeolithic, and less progress for the Upper Palaeolithic (and Mesolithic). Various suggestions for possible future research projects and priorities were put forward, broadly following those indicated in the *Medway Valley Palaeolithic Project* (*ibid.*) with some additions:

a. a structured programme of fieldwalking to collect surface finds that might provide new indications of sub-surface deposits with Palaeolithic potential

b. targeted investigations of sites from which Palaeolithic remains are known, but without good information on their provenance

c. intensive study of artefact-bearing terrace gravel deposits, to investigate and understand the extent to which artefacts are clustered as concentrations and associated with specific horizons

d. recovery of larger and well-provenanced artefact assemblages from terrace deposits

e. increased attention to the Upper Palaeolithic of the region, and in particular to identify the evidence of the Final Upper Palaeolithic Long Blade industry, and to model the evidence of human activity of this period in the region, which probably represents early Holocene colonisation after the final cold snap of the Last Glacial, and presages the transition to the Early Mesolithic

f. understanding the Quaternary chronological framework

g. promoting wider community and public engagement with, and understanding and appreciation of, the Palaeolithic and the “Ice Age”

h. increased attention to the Palaeolithic and Quaternary in pre-development investigations

3.4.35 Medlycott’s general all-period review has since been supplemented for the Palaeolithic and Pleistocene by the Palaeolithic predictive model for Essex put forward in the report *Managing the Essex Pleistocene* (MEP) (Essex County Council 2015). The general approach of this model was to review how the known Palaeolithic sites and find-spots across Essex (as represented in the county Historic Environment Record) mapped onto broad types of Pleistocene deposits. This was then taken as a model for the wider potential of these deposit types. Thus, for instance, if the deposit type “river terrace gravel” had produced abundant Palaeolithic finds in one part of the county, then the resulting model indicated that similar finds were likely to be encountered in similar terrace gravels in other parts of the county even in areas where no finds were known.

3.4.36 The report identified 14 major Pleistocene deposit types or “Lithological Units” (LUs) across Essex (Table 3.2). An algorithm was then used to attribute deposits of each Lithological Unit to one of six categories of Palaeolithic potential, based on factors such as the prevalence of previous finds and the presumed degree of depositional disturbance (Table 3.3). Precautionary buffers were added around polygons in areas where the extent of important deposits was thought uncertain. Therefore, while LU type follows directly from geological mapping, and while there is a close correspondence between LU type and the assessed category of Palaeolithic potential, one cannot rely directly on geological mapping to indicate Palaeolithic potential. The resulting county-wide model has been issued as a report with the predictive model illustrated for each borough (Essex County Council 2015, Section 5.4: 118-130), as well as incorporated as a GIS layer within Essex Place Services’ computer system.

3.4.37 The LTC corridor passes through the Essex borough of Thurrock and into the southern part of Brentwood. Based on the MEP predictive model (Figure 8), the corridor affects areas of varying importance to a varied degree as follows:

a. Very high. None;

b. High. The corridor skirts, and slightly impacts, areas of high potential corresponding with LU 9 (mapped Thames terrace deposits) near Chadwell St. Mary and Orsett Heath;

c. Moderate. The corridor substantially impacts areas of moderate potential corresponding with LU 9 (mapped Thames terrace deposits) north/northwest of Orsett Heath, in South Ockendon and towards Upminster;

d. Low. The corridor substantially impacts areas of low potential corresponding with LU 14 (Holocene alluvium) on the north side of the Thames at Tilbury, and with areas mapped as Head (unassigned to a LU) or without mapped Quaternary deposits towards Upminster;

e. Zero. None;

f. - Uncertain. A small area in Brentwood at the north end of the LTC corridor corresponding with an outcrop of LU 1 (Stanmore Gravel).

3.4.38 These initial predictive assessments have been substantially rethought and revised in the PQDM and this SPAA-&-RF (see below, Section 9). However, they do usefully indicate *a priori* that the project has a substantial impact on areas that are likely to be of Moderate-High Palaeolithic importance. The MEP predictive model thus serves a vital function in highlighting in advance the need for specialist Palaeolithic and Quaternary geo-archaeological input, as has been the case here for LTC as represented in the PQDM and this SPAA-&-RF report.

**Table 3.2 Lithological Units defined in the Managing the Essex Pleistocene Palaeolithic predictive model**

| Age * | Marine Isotope Stage * | Lithological Unit - central/south-western Essex | Lithological Unit - southern/eastern Essex |
|---|---|---|---|
| Holocene | 1 | LU 14 - Tufa; and Alluvium | |
| Devensian (peak) | 2 | LU 13 - Shepperton Gravel, and various brickearth deposits (presumed aeolian) | |
| Devensian (early) | 5d-2 | LU 12 - Grays and Ilford brickearths | LU 10 - low-level East Essex Thames-Medway gravels (eg. Barling, Southchurch, |
| Ipswichian | 5e | | |

| Age * | Marine Isotope Stage * | Lithological Unit - central/south-western Essex | Lithological Unit - southern/eastern Essex |
|---|---|---|---|
| Saalian Complex | 10-6 | LU 11 - Terrace deposits (East Essex rivers: Colne, Blackwater, Chelmer)<br>LU 9 - Lower Thames terrace gravels (eg. Orsett Heath, Corbets Tey, Mucking and Kempton Park)<br>LU 8 - interglacial lacustrine deposits (Hoxnian) in the Blackwater Valley (Rivenhall End) and at Marks Tey | Asheldham) and buried channels<br>LU 4 - Post-Anglian interglacial channel-fills |
| Hoxnian | 11 | | |
| Anglian | 12 | LU 8 - glacial lacustrine silts<br>LU 7 - Lowestoft Formation: glacial and fluvio-glacial deposits | |
| Comerian Complex, and prior uncertain attributions | 20-13 | LU 5 - Woodford Gravel<br>LU 3 - Colchester Formation<br>LU 2 - Sudbury Formation | LU 4 - Colchester Formation (interglacial horizons)<br>LU 6 - high-level East Essex Medway gravels (eg. Oakwood, Canewdon, Chalkwell and Lower Holland) |
| Even earlier uncertain attributions | Up-to-and-including 21 | LU 1 - Stanmore Gravel | - |

*(Essex County Council 2015)*

** see Section 2.1, Table 1 and Figure 2*

**Table 3.3 Categories of Palaeolithic potential defined in the *Managing the Essex Pleistocene* Palaeolithic predictive model**

| Palaeolithic potential | Primary criteria | Additional criteria |
|---|---|---|
| Very High | • Proven association in well-provenanced horizons of artefacts and/or palaeo-environmental remains | • Deposits laid down under conditions suitable for human occupation<br>• Deposits known to be suitable for good preservation and survival of artefacts and/or palaeo-environmental remains |
| High | • Confident association of deposits with artefacts and/or palaeo-environmental remains<br>• Adjacent to deposits that are categorised as “Very High” | • Direct borehole or other evidence of deposit presence<br>• Deposits laid down under conditions suitable for human occupation<br>• Deposits likely to be suitable for reasonable preservation and survival of artefacts and/or palaeo-environmental remains |
| Moderate | • Possible presence of deposits with artefacts and/or palaeo-environmental remains<br>• Adjacent to deposits that are categorised as “High” | • Deposits with occasional Palaeolithic findspots of uncertain provenance, probably from different Quaternary deposits than are mapped<br>• Holocene or pre-Quaternary deposits that have produced Palaeolithic finds, and therefore may contain unmapped Quaternary deposits with Palaeolithic potential |
| Low | • Quaternary deposits contemporary with known hominin occupation, but without any known Palaeolithic or palaeo-environmental remains<br>• Deposits adjacent to areas of higher potential | • Areas of pre-Quaternary bedrock without any known Palaeolithic finds<br>• Deposits laid down under conditions prohibitive to human occupation<br>• Areas where potentially relevant Quaternary sediments are known to have been mostly extracted or otherwise substantially removed by development |
| Zero | • No association with any known Palaeolithic or palaeo-environmental remains | • Areas where potentially relevant Quaternary sediments are known to have been completely extracted or otherwise entirely removed by development<br>• Pre-Quaternary bedrock that shares no boundaries with Quaternary deposits of any Palaeolithic potential |

| Palaeolithic potential | Primary criteria | Additional criteria |
|---|---|---|
| Uncertain | • Insufficient data to reach any conclusions as to the nature/period of any deposits, or their Palaeolithic potential | - |

*(Essex County Council 2015: 31-37)*

## South-East Research Framework (SERF) and Kent Archaeological Notification Areas (ANAs)

3.4.39 The South-East Research Framework (SERF) is available on-line as a series of period-specific documents (https://www.kent.gov.uk/leisure-and-community/history-and-heritage/south-east-research-framework), including one for the Lower/Middle Palaeolithic (Wenban-Smith *et al.* 2010, rev 2019) and a separate one for Upper Palaeolithic and Mesolithic (Pope *et al.* 2011, rev 2019). The SERF Palaeolithic research frameworks focus on research priorities from an up-to-date academic viewpoint, to help guide curatorial decision-making and prioritise research efforts in the South-East, in order to contribute most effectively to increasing our understanding of the Palaeolithic. For the earlier Palaeolithic (including the Lower and Middle Palaeolithic) the SERF framework follows a similar structure to the national framework (English Heritage 2008), with some differences of detail and emphasis.

3.4.40 The SERF framework develops three broad *Primary Research Themes*, complemented by three *Framework Priorities* that are still general in nature, and which cross-cut the primary themes. Following from this framework, a number of specific research objectives are put forward, focusing upon the resource in the South-East, and which have the most immediate benefits for addressing the wider themes and framework priorities. Several specific projects were also suggested of immediate relevance to this cascade of primary themes, framework priorities and regional objectives.

3.4.41 The three primary earlier Palaeolithic themes for SERF are:

a. *The Ice Age*. This theme goes beyond the national framework in directly asserting the importance of the Pleistocene, not just as an adjunct to hominin-focused questions, but as a theme of interest and relevance in its own right. It embraces the environmental and chrono-stratigraphic framework issues that are directly relevant to Palaeolithic archaeological research. It also engages with the development history of the present-day physical landscape, and the previous presence in the UK of exotic mammals such as cave bear, rhinoceros, sabre-tooth cat and woolly mammoth.

b. *Colonisation and Demography*. This theme covers the same ground as theme two of the national framework. It covers both the facts of hominin presence, including both intra-regional distribution of settlement and presence/absence of occupation at the national/regional scale, and debate over the processes and ecology of colonisation (and its converse, when populations ceased to exist, whether by migration or local extinction)

c. *Becoming Human*. This theme likewise follows the national framework, covering behavioural and material cultural aspects of Palaeolithic adaptation more directly. It is this theme that covers the fundamental archaeological task (somewhat marginalised in the national framework) of documenting and explaining the changing technological and typological details of lithic material culture through the Early Palaeolithic, as well as consideration of less tangible social and behavioural aspects such as speech, ritual, social organisation and logistic planning.

3.4.42 Complementing these primary research themes, three SERF Early Palaeolithic framework priorities were identified:

a. *Understanding the Record*. This is fundamental to interpretation of any archaeological remains that are found, addressing site formation processes, post-depositional disturbance, preservation bias and taphonomy. These are particularly important issues for the Early Palaeolithic record, with the wide range of depositional environments represented in surviving Pleistocene deposits, and debate over the potential importance of lithic remains from fluvial gravel contexts.

b. *Dating Frameworks*. This is likewise self-evidently a critical theme for Early Palaeolithic studies, providing the basic chronological order for events, allowing us to examine both changes within and between regions, and at wider scales, between countries and climatic/geographic zones.

c. *Curating the Resource*. This recognizes the importance of carrying out specific projects/programmes that help curators to manage the Palaeolithic/Pleistocene resource effectively.

3.4.43 Following from these Early Palaeolithic primary themes and framework priorities, several more-specific subsidiary research objectives were identified, focusing upon the resource in the South-East. These are not reiterated here, but are incorporated below in the LTC-specific Palaeolithic research framework, so far as they are relevant to it (**Section 7**).

3.4.44 For the Upper Palaeolithic, the SERF identifies five primary research themes (A-E) with numerous more-specific subsidiary aims and priority projects. These mostly relate specifically to the Mesolithic and Holocene, but a selection of Palaeolithic-relevant subsidiary aims and priorities under these themes are tabulated below (Table 3.4), and are incorporated within the new *LTC Palaeolithic Research Framework* (**Section 7**).

**Table 3.4 SERF Upper Palaeolithic research themes and priorities**

| Primary themes | Subsidiary aims |
|---|---|
| A - Data management (n=7, A1-A7) | A1 - integration of existing data-sets<br>A4 - collation of evidence |
| B - Environmental studies (n=19, B1-B19) | B6 - address the lack of UP faunal and other palaeo-environmental data<br>B18 - how do the region's palaeoenvironmental records relate to the landscape archaeological record?<br>B19 - what evidence is there for hunting strategy/technology? |
| C - Site prospection and distribution of evidence (n=13, C1-C13) | C2 - investigate and explain the distribution of EUP, Aurignacian and Gravettian finds in the region<br>C3-C5 - investigate and explain the distribution of later UP presence in the region<br>C8.1 - investigate mobility by flint provenance studies |
| D - Specific research questions (n=13, D1-D13) | D1 - improve characterisation of LUP techno-complexes<br>D2, D5 - investigate the regional distribution of final LUP Long Blade industries, and the possible relationship with landscape, substrate and habitat<br>D6-D7 - investigate LUP presence and mobility patterns in the English Channel area and its margins, and the extent to which these were seasonal<br>D13.1 - investigate funerary practices<br>D13.2 - investigate links of British LUP populations with Channel and Continental populations |
| E - Dating (n=7, E1-E7) | E4 - refine and construct dated sequences of technological change |

3.4.45 More recently (since November 2018), zones of key Palaeolithic potential have been identified across Kent as part of the ongoing Kent County Council *Archaeological Notification Areas* project. For this project, zones of higher Palaeolithic potential were defined, and flagged up as requiring a greater degree of curatorial scrutiny in the event of a development application, on a scale of 2 (default, no particular Palaeolithic potential) through to 5 (maximum national/international Palaeolithic significance). For the most important areas (level 5), scrutiny would be applied to any application. For progressively less-important areas (levels 4 and 3), the degree of scrutiny would be graded accorded to whether there were groundworks and the size of the proposed development. And for the default level 2, scrutiny would only take place for "Major applications". Zones assessed as levels 3 through 5 were accompanied by notes on the site-specific historic environment factors that should inform curatorial decision-making.

3.4.46 The LTC footprint overlaps with two zones - ANAP_0259 and ANAP_0267 (Figure 9) - that were assessed as level 3, requiring scrutiny for "Medium applications involving groundworks". Clearly this planning input is superseded by the separate process for a large-scale project such as LTC. However the

factors to inform curatorial decision-making for this ANAP zone are reproduced below, and give some indications of key questions for these areas (Table 3.5).

**Table 3.5 Kent Archaeological Notification Areas (Palaeolithic): curatorial considerations for zones ANAP_0259 and ANAP_0267**

| ANA zone | General Palaeolithic considerations | Priority curatorial issues | Possible evaluation methods | Additional comments |
|---|---|---|---|---|
| ANAP_0259 | • are the various mapped terrace outcrops fluvially deposited, and if so how do they fit into the key Lower Thames terrace staircase framework?<br>• are there unmapped terrace outcrops?<br>• are any of the mapped Head outcrops terrace deposits? [and if so, how do they fit into the key Lower Thames terrace staircase framework?] | • sub-surface deposit model, based on ground-truth data?<br>• presence/depth of terrace deposits (gravel, or fine-grained: clay/silt/sand)?<br>• presence/depth of mapped Coombe Deposits outcrop, and if present, what formation process?<br>• presence/abundance of Palaeolithic artefacts, and/or faunal remains and other palaeo-environmental evidence?<br>• in footprint of previous quarrying, and if so, confidence on presence/absence of surviving patches of unquarried deposits? | Machine-dug test pits | An interesting and poorly-understood area, suggest that a Pleistocene geological specialist may be needed, with expertise in Lower Thames fluvial deposits. May contain both post-Anglian Thames deposits passing to west of Hoo peninsula, and also Anglian/pre-Anglian deposits passing across its "neck", heading towards vicinity of Higham and Mockbeggar. |
| ANAP_0267 | • are there unmapped high-level Quaternary deposits (rather than Eocene), and if so of what age?<br>• are any Palaeolithic artefacts in these deposits (and thus of great antiquity), rather than on them (and thus of almost any age, including post-Palaeolithic)? | • sub-surface deposit model, based on ground-truth data?<br>• presence/depth of Quaternary deposits, and how formed?<br>• presence/abundance of Palaeolithic artefacts, and/or faunal remains and other palaeo-environmental evidence?<br>• sealed stratigraphic context for any lithic artefacts?<br>• lithic artefacts distinctly Palaeolithic, or multi-period? | Machine-dug test pits | - |

## Greater Thames Estuary Historic Environment Research Framework (GTEHERF)

3.4.47 An initial framework for the Greater Thames Estuary was issued in 1999 (Williams & Brown 1999); this was subsequently revised and re-issued in 2010 (Essex County Council 2010). The revised Greater Thames Estuary research framework identifies 8 broad themes, and certain specific objectives and areas of research are suggested as priorities under these themes.

3.4.48 The 8 broad themes of the revised Greater Thames Estuary research framework are:

a. Development and palaeo-environment of the Thames Estuary

b. Maritime heritage

c. Intertidal and related archaeology

d. Land-use and occupation

e. Historic built environment

f. Historic defences and other military installations

g. Industry and transport

h. Methodology, management and promotion

3.4.49 The Palaeolithic is covered under the first of these themes "Development and palaeo-environment of the Thames Estuary", for which four framework objectives were defined (GTEHERF Section 2.6: 18-21):

a. 1A - to increase understanding of the physical evolution of the Thames Estuary during the Pleistocene and of the social and cultural strategies of early human populations in relation to changes in environment and climate

b. 1B - to develop a better understanding of the Upper Palaeolithic and Mesolithic around the estuary, which has been identified as a ‘gap’ in the record

c. 1C - to increase understanding of the physical evolution of the Thames Estuary and associated climatic and environmental change and their relationship with human activity during the Holocene

d. 1D - to advance our understanding of the Palaeolithic Medway valley, building on the recommendations of the MVVP which identified a number of research priorities for that study area

3.4.50 Complementing the seven subject-specific themes, the revised *Greater Thames Estuary Historic Environment Research Framework* included an 8th cross-disciplinary theme of “Methodology, management and promotion” (GTEHERF

Chapter 9). Two framework objectives were defined (GTEHERF Section 9.4: 93-94):

a. 8A - to exploit the potential of the Thames Estuary as a study area for methodological innovation relating to the detection, recording, monitoring and management of estuarine sediments and sites

b. 8B - to promote understanding of the archaeology of the Greater Thames region, and to utilise the resource for general educational purposes and informed tourism, alongside academic study and primary/secondary level education, so as to broaden understanding and appreciation of the region's past

3.4.51 All of these framework objectives are supplemented by numerous suggestions for specific objectives and areas of research that could take them forward. These are not reproduced here, but reference is made back to them below, when relevant to the new *LTC Palaeolithic Research Framework* (Section 8).

3.4.52 The revised *Greater Thames Estuary Historic Environment Research Framework* concludes with an updated Research Strategy (GTEHERF Chapter 10), which also identifies a selection of key objectives and initiatives to pursue. The importance of these objectives in providing a framework for pre-development investigations is noted, although it is also noted that these should be complemented by funded research projects targeted at the inevitable gaps left by ad hoc pre-development work. The general benefits of multi-disciplinary co-operation for large projects are emphasised, and the use of deposit modelling involving the geotechnical data typically collected in conjunction with development.

3.4.53 The importance of dissemination was emphasised, and the potential to use newer web-based outputs and platforms to complement (although not replace) more-traditional heavyweight printed volumes and journal papers, and thus reach a wider audience than the academic specialists who are the main consumers of the latter.

3.4.54 For the Palaeolithic-related theme "Development and palaeo-environment of the Thames Estuary", two of these initiatives that have particular relevance to the LTC project are (GTEHERF Section 10.3: 100):

a. the need for work on various scales, both wide-scale data collation and modelling, and field investigations of specific sites to address questions arising from regional studies;

b. the need for initiatives to address the lack of progress in improving understanding of the Upper Palaeolithic and Mesolithic in the region, for which there is a particular gap in knowledge, but for which the region is thought to have significant potential.

3.4.55 For the more-general cross-disciplinary theme "Methodology, management and promotion", initiatives that have particular relevance to the LTC project include (GTEHERF Section 10.4: 103):

a. improving understanding of the significance and value of non-designated assets, making use of appropriate specialists, to inform curatorial decision-making and planning policies

b. build on the distinctive identity of the Thames Estuary region, engaging local communities and boosting cultural regeneration and informed tourism

c. be sure not to overlook the resource in the inter-tidal zone

d. follow the numerous developments in methodological and management good practice over the last ten years, as specified in various good practices guidance and guidelines, including use of deep sequence geo-archaeological investigation, sub-surface deposit modelling and integration of Ground Investigation data and monitoring into the cultural heritage assessment and mitigation process

e. promoting understanding and appreciation of the Greater Thames historic environment to the local communities of the region, and making greater use of knowledge about the region's historic environment in primary, secondary and higher education

## National Guidance: identifying and protecting Palaeolithic remains

3.4.56 English Heritage (1998) have produced a Guidance note for planning authorities and developers, to aid in the identification and protection of Palaeolithic remains. Although now more than 20 years old, and under current revision, this document reinforces several important principles and provides some useful guidance for the recognition of important remains.

3.4.57 Key principles include:

a. development proposals should take account of Palaeolithic remains (as well as those of later periods) so that they may be located, protected or investigated as appropriate to their significance

b. information on Palaeolithic remains may be acquired from desk-based assessment, but it may be necessary to obtain further information from a field evaluation

c. where development proposals could affect important Palaeolithic sites, the full extent of impact must be assessed in advance of a planning decision

d. sites are of varying importance and it is necessary to assess their level of significance before deciding what levels of protection, management or recording are appropriate

3.4.58 As outlined above (*Section 2.4.1*), significance can be assessed on the basis of potential to contribute to current research themes and priorities. Although it is often clear how certain data contribute to the main questions of the period, it is sometimes less clear, and then it can become the role of the specialist to explain how certain apparently-less-significant data can contribute to major objectives. However, it is also possible to spell out a less-contingent set of criteria that are generally agreed as reflecting high importance for a Palaeolithic site, and the inevitability of it being able to make a major contribution to research.

3.4.59 The English Heritage Guidance (1998) includes a list of criteria for the identification of remains that can be regarded as of national importance (Table 3.6). An important aspect of these criteria is that *any one* of them is specified as sufficient for a site to be regarded as of national importance, so a site that matches several of these criteria is clearly of national or international importance.

**Table 3.6 Criteria for national Palaeolithic importance**

| English Heritage criteria | Comments |
|---|---|
| Human bone | • The full total of Lower/Middle Palaeolithic bone from England comprises one part-skull from Swanscombe (Kent), and a part-tibia and two incisor teeth from Boxgrove (West Sussex); Upper Palaeolithic material is more common, but still very rare and usually found in caves/rock-shelters<br>• any context with bone preservation has the potential to produce human remains |
| Primary undisturbed context | • almost no sites are totally undisturbed; however minimally-disturbed sites are more common than one might think, and can be found in a range of contexts, including river terrace gravels |
| Period/area rare | • very contextual to region; generally Palaeolithic remains are rarer north of London and northwest of the A12 due to the landscape effect of repeated glaciations |
| Organic artefacts | • even rarer than human remains<br>• only liable to be found where suitable conditions for preservation |
| Well-preserved associated bio-evidence | • often a discussion to be had about whether bio-evidence is behaviourally-related to co-occurring lithic remains, or just in the same deposit as them<br>• but in either case, the evidence is important |
| Evidence of lifestyle | • can include various types of evidence, such as cut-marked bones, or intra-site patterning of artefacts or faunal remains |
| Stratigraphic relationships between different archaeological horizons | • a very important factor that enhances the importance of a site, even if the separate horizons do not in themselves have evidence of high importance |

| English Heritage criteria | Comments |
|---|---|
| Artistic evidence | • - another very rare category, can be a portable artefact such as a carved/painted stone or bone, or fixed such as cave-art |
| Evidence of hearths or structures | • - hard to confirm in the field without thorough investigation, and would be an adjunct to an undisturbed site |
| Resource exploitation | • - could relate to the landscape situation of a site, in relation to resources such as flint raw material, a notable feature such as a gully, or to the presence of a resource such as a spring or water-course |
| Artefacts are particularly abundant | • - some sites/horizons are particularly rich, and we still don't know why these few sites were such a focus of activity<br>• - key angles of investigation for these sites are: whether this richness represents Palaeolithic behaviour or relates to natural site formation processes, and what is the spatial/vertical extent of the artefact concentration |

*(English Heritage 1998)*

## 3.5 The LTC Palaeolithic and Quaternary Deposit Model (PQDM)

3.5.1 The initial version of this (Wenban-Smith & Bates 2020) was issued in February 2020. Using geological mapping, geological borehole logs and new data from LTC Ground Investigations, it developed a sub-surface deposit model for the area of the LTC project footprint. Then, in conjunction with a desk-based review of known Palaeolithic sites and find-spots, it divided the project area into 34 zones attributed to one of three categories of Palaeolithic/Quaternary potential: UNCERTAIN (n=7), LOW-MODERATE (n=19) and MODERATE-HIGH (n=8). These same zones are presented in this SPAA report (see below, Section 9), although one of them (PQ-17) has had its potential downgraded from MODERATE-HIGH to LOW-MODERATE following the walk-over survey that has now taken place (see below, Sections 5.5 and 6).

3.5.2 It is anticipated that the PQDM will periodically be revised throughout the LTC project, as new data become available (such as stage 3 GI data, archaeological trial trenching data, and observations during groundworks and archaeological mitigation), and in response to stakeholder review. However, a precautionary approach to the presence of Palaeolithic remains has been taken and provides a robust assessment which will be refined for mitigation purposes. The current version (v2) of the PQDM was updated in September 2020 and incorporates the results of the walk-over survey (see below, Sections 5.5 and 6) and stakeholder feedback from April 2020.

# 4 Aims and objectives

## 4.1 General aims

4.1.1 The general aims of the SPAA-&-RF are:

a. to provide a general introduction for the non-specialist to the Palaeolithic, and to the Quaternary geological deposits that contain evidence of the period

b. to provide a background introduction to the Palaeolithic remains and Quaternary deposits of the LTC project area

c. to review known Palaeolithic finds from the LTC footprint and a surrounding buffer, so as to inform understanding of remains likely to be affected by the LTC project

d. to review national and regional research frameworks, and to derive from these a project-specific LTC Palaeolithic Research Framework

e. to assess the Palaeolithic potential of the LTC project area in relation to c national and regional research framework priorities, as collated in the new LTC Palaeolithic Research Framework

f. to provide an outline of appropriate mitigation approaches following from the assessment results of the SPAA-&-RF

g. to present these results as a stand-alone report supported by suitable figures and appendices, that builds on and complements the PQDM, to contribute to the ES for the DCO application

## 4.2 Specific objectives

4.2.1 Specific objectives of the SPAA-&-RF are:

a. to provide a detailed desk-based review of all Palaeolithic finds and other important Quaternary locations (such as findspots of important palaeo-environmental remains, or locations of key geological sequences) in the project footprint and a surrounding buffer zone

b. to identify and remove duplicate desk-based records from the various available HER sources, and to incorporate new site data from other sources and primary publications, so as to provide a definitive list of known sites, accurately located, which will be provided to HER owners in an accessible format

c. to provide a brief report on, and key results from, the walk-over/drive-by survey of the project footprint

d. to provide a Palaeolithic and Quaternary characterisation for the project footprint, dividing it into different areas ("PQ zones") of varying sub-surface geology and Quaternary archaeological potential, referenced against research priorities as collated in the *LTC Palaeolithic Research Framework*

e. to present a series of maps showing the locations of the PQ zones, colour-coded according to their Palaeolithic potential, and overlain against the LTC project footprint and geological mapping

f. to provide an outline of appropriate mitigation approaches following from the assessment results of the SPAA-&-RF in each PQ zone, in relation to the newly-defined research themes and priorities of the LTC-specific Palaeolithic Research Framework (see below, Section 8).

# 5 Methods and approaches

## 5.1 Palaeolithic assessment: deposit-centred approach

5.1.1 Although artefact finds are the most direct evidence of Palaeolithic human activity, research into, and understanding of, the period depends almost more upon understanding the depositional processes of the sediment in which they were found and any post-depositional disturbance that may have affected any artefacts recovered, and on analysis of any associated palaeo-environmental evidence. Therefore, in accordance with Historic England best practice, and as also preferred by Essex County Council (2015) and Kent County Council, the approach taken here to assessing Palaeolithic potential is “deposit-centred”, following the principles established in the Solent-Thames (Wenban-Smith *et al.* 2014) and South-East regional research frameworks (Wenban-Smith *et al.* 2010, revised in 2017 and 2019).

5.1.2 Therefore the starting point for this Palaeolithic desk-based assessment is to review the variety and distribution of Pleistocene deposits in the LTC project corridor, and to consider how they formed, what palaeo-environmental remains they contain, and what are the implications of their formation and post-depositional processes for interpretation of any contained Palaeolithic remains.

5.1.3 This deposit-centred starting point is then supplemented by a detailed review of all known Palaeolithic findspots within a 3km buffer of the project footprint (Figure 1). This is a wider buffer than for post-Palaeolithic cultural heritage assessment as Palaeolithic finds are rare, and often dependent upon where large-scale deposit impact (such as quarrying) has taken place and where people have chosen to look for finds. Therefore, it is important to take a wide buffer around the Project since finds from a particular deposit type in one area, may reflect potential of that same deposit type in another area without any finds. A 3km buffer is recognised by Kent County Council, Essex County Council and Historic England as suitable for Palaeolithic desk-based assessments. This provides an initial indication of where Palaeolithic remains are already known, and how they contribute (or have the potential to contribute) to current regional, national and international research framework priorities.

## 5.2 Desk-based data collection and sources

### Quaternary sequence data

5.2.1 A sub-surface deposit model has been constructed and issued in the PQDM (Wenban-Smith & Bates 2020). This was mostly based on pre-existing desk-based data, although supplemented by some new data from LTC Ground Investigations. The model may be periodically refined during the lifespan of the project if relevant new data become available, for instance from geotechnical investigations, engineering groundwork, or purposive geoarchaeological and archaeological field programs. However, revision would not affect the robustness of the desk-based assessment; rather it would address the ongoing national and regional research priority to achieve the best possible understanding of sub-surface Quaternary geology, of the LTC area and beyond.

5.2.2 Primary sources for the construction of the model included:

a. published academic papers, grey literature reports and any existing published works

b. borehole data from the British Geological Survey archive

c. mapped geological data from the British Geological Survey.

d. archive data from extant phase of ground investigation for the project

e. information from archives held by organisations and individuals

f. other forms of ground investigation data including results of geological geophysical surveys, Lidar, and remote sensing

## Palaeolithic site data

5.2.3 The primary resources for Palaeolithic site data were the Historic Environment Records for Kent and Essex, within which the project footprint is located. However previous work on the Kent HER (for instance for the Stour Basin Palaeolithic Project, Kent County Council 2015) has indicated that county HERs may have substantial omissions and inaccuracies for Palaeolithic data when compared with key primary sources such as the pioneering national synthesis of Evans in the late 19th century (Evans 1872 and 1897) and the more-recent syntheses of Roe (1968) and the Southern and English Rivers Projects (Wessex Archaeology 1993 and 1996 being the relevant reports for this project area). Previous research has also shown that important Palaeolithic archaeological data can be found in primarily geological sources such as early 20th century sheet memoirs, and in series such as the regular Field Guides produced by the Quaternary Research Association for annual visits to various parts of Britain (the area of this project was visited in 1995 and 2014, reflecting its high Quaternary importance - Bridgland *et al.* 1995, and Bridgland *et al.* 2014).

5.2.4 Therefore, while the Kent and Essex HERs were the starting point for collation of Palaeolithic find records, these were supplemented by a systematic review of (a) key sources that have already collated Palaeolithic site information for the project area, and (b) primary published sources for each site. The primary data were then checked against and cross-referenced with the HER data, to arrive at an overall optimum collation of the location and characteristics of known Palaeolithic sites in and near the project area. These were collated into an annex (Annex D), and shown on maps in conjunction with geological mapping and landscape topography (Figures 3-6) to aid in identification of zones of different Palaeolithic and Quaternary character and potential.

5.2.5 The full list of sources that were consulted are given as an annex (Annex C). And the full list of primary sources for individual sites are included as a separate section within the annex listing all the Palaeolithic sites identified in and around the project footprint (Annex D, Section D.3). Geological sequence data from Palaeolithic sites were, when recorded, collated and included in the geo-archaeological model.

5.2.6 In accordance with best practice and the principles of the deposit-led approach (Wenban-Smith *et al.* 2010 and 2014) advocated by Historic England and the planning archaeologists of both Kent and Essex local authorities (eg. Kent County Council 2016), the area to be investigated for this desk-based PQDM included a substantial buffer zone beyond the immediate impact footprint of the project. The EIA Scoping Report and PEIR both specified a 1km before zone as being appropriate. However, as explained above (Section 5.1), best practice for Palaeolithic desk-based assessment is to take a wider 3km buffer since Palaeolithic remains, and relevant geological outcrops, can be rare in the landscape. Therefore, to ensure that the best information was obtained to ensure a robust assessment for the ES, the PQDM collated Palaeolithic site information from within a 3km buffer zone around the project footprint, covering an overall area of *c.* 270km$^2$, as well as from several nearby nationally important sites that are not quite within the 3km buffer, but which nonetheless are informative about the potential of deposits within the buffer and the development footprint.

5.2.7 Palaeolithic site data was collated in a systematic framework, and the data recorded for each site are listed below (Table 5.1). Sites identified in the initial investigation of published site lists, grey literature and primary sources were then cross-referenced against information in the Kent and Essex HERs. This led to recognition of numerous duplications, omissions and inconsistencies. Many HER records included information on more than one Palaeolithic site, and conversely, many sites in the HER were represented by more than entry. Furthermore, many sites in the primary literature were not listed in the HER, although conversely the HER did provide the only information on a few sites, particularly those originating from relatively-recent fieldwork and the Portable Antiquities Scheme (PAS).

5.2.8 Overall, all the information on Palaeolithic sites was conflated into a single site list (Annex D, Section D.2), with each site allocated a unique number from the overall LTC cultural effects list. Information was cross-circulated within the LTC team on which sites in the final conflated Palaeolithic list were valid Palaeolithic HER records with LTC numbers, and which ones needed deleting as unnecessary duplicates. A block of new LTC site-numbers was allocated for use for new Palaeolithic sites that were not already in the LTC list, which was based on HER records. Of these 59 have been used to-date (4000-4058, inclusive).

**Table 5.1 Data recorded for Palaeolithic sites [listed in Annex D, Section D.2]**

| Site data | Explanation |
|---|---|
| LTC list no. | Unique LTC identifier for cultural effects across whole Lower Thames Crossing heritage work |
| Site name | Site name, and summary information |
| HER MonUID | Unique identifier for previous finds within Kent/Essex HERs, if applicable |

| Site data | Explanation |
|---|---|
| SR/ER PP, map.site | Site identification (if applicable) within the two national Palaeolithic surveys of (a) the Southern Rivers Project (Wessex Archaeology 1993) for the Kent side of the LTC, and (b) the English Rivers Survey for the Essex side (Wessex Archaeology 1996) |
| Rec-Type | Record type, one of:<br>• Mon - flint artefact/s well-provenanced to a known context<br>• Mon/PE - flint artefact/s well-provenanced to a known context, in association with faunal or other palaeoenvironmental remains<br>• F-spot - location of flint artefact find/s, with less-reliable info on its/their provenance<br>• PEFS (Pleistocene environmental find-spot) - site with faunal or other palaeoenvironmental remains<br>• Geo - a significant geological sequence or feature, but lacking artefactual or palaeoenvironmental remains |
| NGR-E | OS grid easting, to nearest metre |
| NGR-N | OS grid northing, to nearest metre |
| Acc | Accuracy of OS grid location, one of:<br>• A (Accurate) - site is accurately located based on reliable primary sources<br>• E (Estimated) - site location can be estimated with reasonable confidence based on primary sources<br>• G (General) - sites and finds from a general area, lacking good information on location and provenance |
| Artefacts | Information on the quantity and variety of artefactual remains found |
| Palaeo-environmental remains | Information on the quantity and variety of faunal and other palaeo-environmental remains found |
| Geo attribution | Interpretation of likely geological context for Palaeolithic finds (see Annex D, Section D.1, Table D-2, for details, and their interpreted depositional and post-depositional history |
| Primary sources | Key primary source references (listed in Annex D, Section D.3) |

## 5.3 Pleistocene terraces: mapping and interpretation

5.3.1 Pleistocene terraces are a key element of the Quaternary deposits in the LTC project area, and are the principal source of the most significant Palaeolithic remains. Therefore, a basic understanding of their mapping and interpretation, and various related problems and disputes, is a necessary aspect of this Palaeolithic review. These matters are fully covered in the PQDM (Wenban-Smith & Bates: Section 4.4), so are only briefly reviewed here.

5.3.2 Models describing the geological succession and landscape evolution of the Lower Thames have most recently been described by Bridgland (2006). His

model (**Figures 10**, **11**) forms the basis for our current understanding of the Quaternary geology of the route corridor. However, other workers, including some dating back to the early 20th century, have provided important details, while researchers such as Gibbard (1994), have provided alternative interpretations for some sequences, for instance for the earliest post-diversion Thames deposits at Dartford Heath in Kent, see discussion by Bridgland (2006: 287).

5.3.3 In the lower Thames (as is common elsewhere in the geological record), ancient river deposits have been attributed to distinct terrace bodies based on early geological and geomorphological mapping, and named after historical type sites. However, these frameworks are often inconsistently applied, even in adjacent areas. The LTC project area is a good example of an area where numerous and complex suites of Pleistocene deposits have been given different nomenclature by different workers (Table 5.2).

**Table 5.2 Stratigraphic nomenclature for Pleistocene terrace mapping of the Lower Thames, in vicinity of Lower Thames Crossing footprint**

| **British Geological Survey (BGS)** | | | | **Other specialists** | |
|---|---|---|---|---|---|
| **London *; Romford and Dartford **** | **South London, 1981 ***** | **Southend **** | **Chatham **** | **Gibbard (1994)** | **Bridgland (2006)** |
| Alluvium | | | | Tilbury Deposits | |
| | | | | Shepperton Gravel | |
| Kempton Park Gravel | Terrace 1 | Not seen - below alluvium | | East Tilbury Marshes Gravel | East Tilbury Marshes Gravel |
| Taplow Gravel | Terrace 2 | River Terrace Deposits 2 | River Terrace Deposits 1 | Mucking Gravel/West Thurrock Gravel | Mucking Gravel |
| Hackney Gravel | Terrace 3a (River Lea) | | | Hackney Gravel | |
| Lynch Hill Gravel | Terrace 3b | River Terrace Deposits 3 | River Terrace Deposits 2 | Corbets Tey Gravel | Corbets Tey Gravel |
| Finsbury Gravel | | | | | |
| Boyn Hill Gravel | Terrace 4 | | | Orsett Heath Gravel | Orsett Heath Gravel |
| Black Park Gravel | | | | Dartford Heath Gravel | |

*[* Ellison et al., 2004; ** on-line 2020; *** based on BGS revision survey of the South London district in 1981]*

5.3.4 Following Bridgland's model (**Figure 11**), terrace sediments are thought to typically represent a sandwich of fluvial environments with a central "filling" of gently-deposited fine sediments laid down under warm interglacial conditions topped and bottomed by coarse-grained sediments laid down by high energy waterflow during either cold/warming or cool/cooling conditions (**Figure 10**). The terrace deposits in the lower Thames area can be traced both upstream and downstream and often contain faunal remains as well as Palaeolithic stone tool industries. Analyses of the faunal remains, in conjunction with clast lithological correlation and amino acid dating of molluscan remains, have led to a reasonably robust correlation of the Lower Thames terrace sequence with the global Marine Isotope Record (**Figure 12**) (Bridgland 2006 & 2014). Of relevance to the LTC corridor the following key points are noted:

a. Five main bodies of sediment are present at differing elevations in the lower Thames valley (**Figure 10**) (Table 5.2).

b. Four of these aggradations are associated with interglacial sediments containing faunal/floral remains.

c. Type sites for each stage are identified as Swanscombe (Boyn Hill/Orsett Heath Gravel), Purfleet (Lynch Hill/Corbets Tey Gravel), Aveley (Taplow/Mucking Gravel) and Trafalgar Square (Kempton Park/East Tilbury Marshes Gravel).

d. Each interglacial sequence is associated with an odd numbered marine isotope stage (MIS) (**Figure 12**), and the most recent aggradation (the Shepperton Gravel) is overlain by the Holocene Thames estuary sequences.

e. No sediments older than MIS 12 exist within the Lower Thames valley because the valley was only created as part of the rearrangement of the fluvial systems in southern Britain associated with glaciation in MIS 12 (the Anglian) (Gibbard, 1985).

f. Palaeolithic archaeological material (artefacts, mammalian fossils and other faunal/palaeoenvironmental remains) may be associated with many of the gravel bodies.

5.3.5 Despite the widespread adoption of Bridgland's model (terrace stratigraphic framework) a number of issues emerge when the model is applied to individual sites and sequence, and other interpretations have been developed for several deposits bodies in the LTC area. Several issues and inconsistencies, listed below, need to be considered when discussing the Quaternary geology and associated Palaeolithic archaeology of the route corridor.

a. It is often hard to relate specific horizons from deep sequences to the wider model.

b. Nomenclature and terminology used within the study area varies. In this report, the predominant nomenclature followed is that of British Geological Survey mapping (although this itself has inconsistencies across the 4 sheets covering the study area: Sheets 257, 258-259, 271 and 272). Table 5.2 shows how this nomenclature corresponds with Bridgland's (2006) terrace framework for the area, and some specific inconsistencies are listed below.

c. Differences in the interpretation of mapped bodies of sediment. For example, because Bridgland does not recognise the Black Park Gravel in the Lower Thames area; he maps as Orsett Heath Gravel sediments mapped by the British Geological Survey as Black Park Gravel. Furthermore, the British Geological Survey have identified an additional deposit (the Hackney Gravel Member) in the Romford area that Bridgland argues cannot be distinguished from the Lynch Hill Gravel (Bridgland, 2014).

d. Differences in the geomorphological interpretation of deposits and of fundamental landscape evolution. For example, when considering the geomorphology of the river during the Boyn Hill/Orsett Heath times, Dines and Edmunds (1925: 35,) state "The position of the Boyn Hill terrace shows that, in Boyn Hill times, the Thames crossed the anticline of the Chalk between Purfleet and Grays". They go on to state "The change of conditions at the close of the Boyn Hill period resulted in the lowering, by about 50ft, of the river-level. This brought the Thames against the Chalk barrier behind which its water ponded". By contrast Bridgland (2006) clearly suggests in his mapping that the river depositing the Boyn Hill/Orsett Heath Gravel swung south-westwards to the north of the Chalk anticline at Purfleet in the so-called Ockendon Loop, then forming another sharp loop back on itself to resume its eastward drainage via Dartford and Swanscombe.

## 5.4 Quaternary deposit model: principles and construction

### Geo-archaeological principles

5.4.1 Understanding of the Quaternary geology of the route corridor is based on the understanding of the background data (primarily geological mapping), coupled with extant borehole and excavation data from the area of the route corridor articulated within the context of the geology of the wider Lower Thames region. Additionally, information on bedrock geology and local geomorphology is utilised. Consequently, a number of considerations are made:

a. What is the nature of the bedrock geology and how is that likely to have an impact on the nature and content of the overlying Quaternary sequences?

b. What evidence do we have for the nature of sequences in the study area?

c. Where are we missing data for the study area?

d. What types of sequences do we anticipate finding in the area?

e. What does the local geomorphology and sedimentary sequences imply for any archaeological or palaeoenvironmental finds in the area?

## Sediment types

5.4.2 Base on the known geology, and the likely range of sedimentary units we would expect in the study area, the following groups of deposits are noted:

a. High energy fluvial gravels. These are likely to consist of coarse to fine gravels that may be well stratified or lack any clear bedding. Laterally they may grade into homogenous or bedded sand units and typically (although not always) are devoid of fossil material. They represent cold stage river environments in which braided channels dominated. They belong to Bridgland's Phase 2 and Phase 5 stages (Figure 11). Artefacts present in the sediments are typically likely to be reworked.

b. Low energy fluvial sands and silts. These may be structured or massive. Under the right circumstances they may be carbonate rich, and locally rich in tufa, elsewhere they may contain organic content or peats. They represent warm stage rivers where meandering river systems dominate. Locally higher energy gravels may exist. They are often faunal rich and belong to Bridgland's Phase 3 (Figure 11).

c. Low energy well-stratified sands and silts. These are often very well bedded with a variety of being structures. They may be carbonate rich in places. They represent low energy intertidal, mudflat or saltmarsh environments in the mid interglacial phase. They can be faunal rich and belong to the Phase II/III of the brackish model described above.

d. Variable sand, silts and gravels. These deposits are often associated with slopes and valley sides and represent colluvium and head deposits moving under gravity downslope. Often deposited in cold climate conditions these deposits typically bury underlying fluvial sediments. In places palaeosols may be developed in these deposits.

e. Finally, a group of sediments belonging to the true estuary environments are likely to exist (certainly in the Holocene sequences but also perhaps in the East Tilbury Marshes Gravel). These consist of homogenous to very well laminated sands and silts, sometimes interbedded with peat deposits of variable thickness.

### Construction and iterative revision

5.4.3 The sub-surface deposit ground model was initially constructed using Rockworks 16 and Surfer 12 software to archive, manipulate and export the data. Data from extant sources was examined, logged and integrated into the software systems by the two specialists (FWS and MRB). Project sub-contractors were responsible for data recording from geoarchaeological field programs undertaken by them.

5.4.4 The model has utilised extant borehole data in the British Geological Survey Geology of Britain repository coupled with geotechnical data from the GI Phase 1 investigations for the Lower Thames Crossing. Additionally published and unpublished data from archaeological and geological investigations in the Lower Thames have been consulted. The approach adopted was first to construct transects through the landscape (where data is sufficient) in order to characterise the nature, thickness and distribution of Quaternary deposits across the LTC project footprint (PQDM, Figures 21-30). These transects were then used in conjunction with current geological mapping and landscape topography to designate a series of Palaeolithic and Quaternary (PQ) character zones (see below, Sections 5.7 and 9).

5.4.5 The deposit model (PQDM v2, September 2020) should not be thought of as static through the lifetime of the project. The model may be refined if relevant additional information becomes available from further geotechnical and engineering groundwork, and from archaeological and geo-archaeological work. The seven transects that have been constructed were chosen to exemplify the character of the route corridor. However, some stretches of the corridor were short on primary data, and the precise locations of boundaries between zones of different character and potential have had to be estimated. However, due to the precautionary approach revision would not affect the robustness of this desk-based assessment, or the resulting pathway to phased and targeted mitigation; rather it would itself form part of refining the mitigation programme, and address the ongoing national and regional research priority to achieve the best possible understanding of sub-surface Quaternary geology, of the LTC area and beyond.

## 5.5 Walk-over survey

5.5.1 A short walk-over survey was conducted jointly by the Palaeolithic and Quaternary geo-archaeological specialists. Site walk-overs are standard best practice to complement desk-based archaeological assessments (CIfA 2017). Despite their intrinsic limitations when compared to targeted excavation, they provide an important adjunct to purely desk-based work, allowing engagement with the general landscape topography - of particular relevance for the Palaeolithic and Quaternary - and providing an opportunity to observe exposures and site conditions across a project area, which enhance the robustness of the assessment.

5.5.2 Due to the size of the LTC project area (>2600ha), it was not practical to literally walk over it all. In practice, two days were taken during which the whole of the LTC project area was driven through, in conjunction with frequent on-foot walk-overs of key areas. The general topography and landscape was observed, and

key areas were visited on foot to look for, and take notes on, topographic features and exposures that would help in the Palaeolithic and Quaternary assessment. Numerous photographs were taken, and attention was also paid to identifying current land usage, and potential and constraints for future field investigation. All work was done from publicly accessible paths and spaces; no access was made or requested to private land.

5.5.3 The walk-over survey was conducted after the PQ zones had been defined from desk-based work, so it provided the opportunity to investigate some zones where the desk-based data was more limited, and to look more closely at areas identified as of greater interest. The following areas were identified beforehand as meriting particular attention during the walkover investigation:

a. WO1 - visible landforms, and possible Pleistocene terraces (a) in zone PQ-7 on the south side of the Thames, in the vicinity of the proposed southern portal east of Gravesend (NGR 568000 173000), and (b) in zones PQ- 11, 12a and 13, on the north side of the alluvial floodplain, between Chadwell St. Mary and East Tilbury (vicinity of NGR 566500 178500).

b. WO2 - zone PQ-17 (the area just to the southeast of the Mar Dyke: Cuckoo Lane, NGR 560800 180200) where some impact is proposed at the southeast valley-side edge of the spread of Lynch Hill terrace gravel, and in an area that might have been favoured for Palaeolithic occupation due to the proximity of Chalk bedrock that could have provided flint raw material for tool manufacture.

c. WO3 - NGR 563500 180000 - the small quarry (LTC 4018, on the southeast side of the A1013, Stanford Road) in zone PQ-13 where Palaeolithic finds were made in the 19$^{th}$ century in Boyn Hill terrace deposits, where no development seems to have taken place since, other than slight re-routing of the road, and which is within the impact footprint of the Project.

d. WO4 - areas where mapped Boyn Hill outcrops are adjacent to higher-level outcrops mapped as Black Park Gravel: (a) between Orsett Heath and Southfields (zones PQ-13 and PQ-14, NGR 565000 180500), and (b) vicinity of North Ockenden (zones PQ-25 and PQ-26, NGR 559000 185000).

e. WO5 - zone PQ-19, where LTC project impacts high potential Lynch Hill terrace deposits; investigate for exposures, observe landscape and topography, and consider current ground conditions/use in relation to potential/constraints for field evaluation.

f. WO6 - the higher northern part of the LTC project footprint (zone PQ-28, NGR 557500 190000) where it encroaches into an area with glacio-fluvial sediments and outcrops of the Stanmore Gravel.

g. WO7 - to generally observe the topography, landforms and landscape along the project corridor, and to take note of any exposures that revealed sub-surface deposits.

5.5.4 The walkover survey was carried out 10th-11th March 2020, and its results are summarised below (Section 7).

## 5.6 LTC Palaeolithic Research Framework

5.6.1 The new LTC Palaeolithic research framework (see below, Section 8) will draw from the existing national and regional research frameworks (see above, Section 3.4) to extract a unified series of primary themes and framework objectives for Palaeolithic archaeology in relation to the LTC project. These will be supplemented by a number of more-specific research priorities, related to the seven broad geological character zones identified above (see above, end paras of Section 3.2). This framework will then provide a context against which to consider the value of Palaeolithic remains, and to decide appropriate steps for their safeguarding, or for mitigating investigations and subsequent reporting and other dissemination.

## 5.7 Palaeolithic and Quaternary (PQ) zones: identification and assessment

5.7.1 Based on the desk-based information outlined above (Section 5.2), and in conjunction with geological mapping, preliminary Ground Investigation data from LTC, and the Quaternary deposit model (Section 5.4), the LTC project footprint was divided into 29 character areas. These are represented in the landscape as 34 actual Palaeolithic and Quaternary (PQ) zones (PQ 1-11, 12a-b, 13-19, 20a-c, 21, 22a-b, 23a-b and 24-29, see Figures 13-15) since several areas of similar character are not directly contiguous (full details below, Section 9).

5.7.2 Each zone was defined as a unique polygon in a GIS project, overlain on the LTC project footprint so as that every part of the project footprint was attributed as part of a PQ zone. A range of key information was systematically collated for each zone (Table 5.3), and an initial assessment was made of its Palaeolithic and geo-archaeological potential. This latter was assessed as one of three broad categories, as outlined below (Table 5.4), and this assessment then guides the pathway for archaeological mitigation.

**Table 5.3 Information collated for PQ zones.**

| Zone | PQ-no. | Name of PQ zone |
|---|---|---|
| • Topography/geomorphology<br>• Bedrock geology | • Summary description of topography (including ground surface elevation) and geomorphology<br>• Solid (pre-Quaternary) bedrock geology | |
| Sediment sequences | Summary description of Quaternary sediment sequences | |

| Zone | PQ-no. | Name of PQ zone |
|---|---|---|
| Geological interpretation | Current geological interpretation, including presumed depositional process and stratigraphic attribution (for instance to a particular Lower Thames terrace or gravel body) | |
| Palaeoenvironmental potential | Review of palaeo-environmental potential, so far as known | |
| Palaeolithic remains | Review of Palaeolithic artefact finds from zone, and potential based on recoveries from similar deposits, with specific sites referenced to LTC cultural effects list (Annex D) | |
| Landscape-zone Research Objectives | LTC Palaeolithic landscape-zone evaluation Research Objectives (**Table 13**) | |
| Pal./geo-arch. assessment | One of three categories: UNCERTAIN, MODERATE-HIGH, or LOW-MODERATE (see criteria below, **Table 10)** | |
| Stage 1 fieldwork:<br>• Priorities | Key priorities to address in stage 1 Palaeolithic/geo-archaeological fieldwork | |
| • Outline approach | Overview of strategic approach to stage 1 fieldwork | |
| Stage 2 fieldwork:<br>• Priorities | Tbc in light of stage 1 results | |
| • Outline approach | Tbc in light of stage 1 results | |
| Key reference/s | Most important sources for up-to-date information on zone | |

**Table 5.4 Categories of Palaeolithic/geo-archaeological assessment for PQ zones, and staged mitigation pathway.**

| Pal./geo-arch. assessment | Criteria, explanation |
|---|---|
| Uncertain | Too little primary information on Quaternary sequence for mitigation programme to be determined; requires stage 1 Palaeolithic/geo-archaeological fieldwork, with further stages of mitigation contingent upon results of stage 1 |
| Moderate-high | Likely to contain sites with Medium-Very High Palaeolithic potential (see **Annex E** for criteria for Palaeolithic potential); requires stage 1 mitigation fieldwork to clarify distribution and potential of key deposits, followed by further mitigation work in stages 2 and 3, scope to be determined in light of the stage 1 and 2 results respectively |
| Low-moderate | Likely to contain sites with Negligible-Medium Palaeolithic potential (see **Annex E** for criteria for Palaeolithic potential); scope of stage 1 mitigation to be specified zone-by-zone, and then scope of further work in stage 2 tbc in light of stage 1 results |

## 5.8 Staffing and Health-and-Safety

5.8.1 This SPAA-&-RF has been prepared by the Palaeolithic specialist Francis Wenban-Smith (University of Southampton). It incorporates results of the walk-over survey carried out jointly with Martin Bates (University of Wales), and also includes substantial material from the previously-issued PQDM prepared jointly by Francis Wenban-Smith and Martin Bates. The two specialists worked as part of the LTC team under direction of the CASCADE JV. GIS support was provided by Tim Sly (University of Southampton).

5.8.2 Most of the work was desk-based, and was carried out at the places of employment of the respective specialists and the GIS support worker. There was some travel to examine records at various libraries and at institutions such as the British Geological Survey, and for LTC meetings and specialist liaison. All of these activities were at institutions with well-developed Health and Safety protocols, or were carried out as part of normal day-to-day activity. Thus a separate specific Risk Assessment was deemed unnecessary for this desk-based phase of work. Existing practices and protocols in these workplaces were adhered to, and normal care was taken when travelling and going about business away from these work premises.

5.8.3 The only activities that required further measures were the site visit to observe OCA trial trenches for the stage 1 trial trenching in Land Parcel 5 (Brooks Farm) on February 11th 2020, and the walk-over/drive-by survey of 10th-11th March 2020. The former was done under the site-visit protocol, under which up to ten site visits can be made, as long as the visitors are escorted and undergo an initial briefing. This was the first such visit for the two specialists involved (Francis Wenban-Smith and Martin Bates). The latter was done under a standard University of Southampton Risk Assessment for off-campus travel and non-fieldwork visits.

# 6 Palaeolithic overview and potential

6.1.1 In total, having investigated all the desk-based sources and removed duplicate entries, 99 separate Palaeolithic sites were identified within, and near, a 3km buffer around the LTC project footprint. These are collated as an annex (Annex D), and their locations are shown in relation to the LTC footprint and geological mapping (Figures 4-6).

6.1.2 The general abundance of Palaeolithic sites confirms the Project as taking place within a key area for the Palaeolithic in Britain, and the site list includes several iconic British sites such as the HS1 elephant (LTC 4043), the Belhus Park Cutting (LTC 4020-4021), the Purfleet pits (LTC 4008-4010) and the Baker's Hole Levallois site (LTC 4058).

6.1.3 In terms of LTC project impact, 17 known sites (two of them only generally located) are directly affected by the development footprint, and a further 11 (one of which only generally located) have their locations very near to it (Table 6.1, below). However, this cannot be taken as a direct prediction of impact by the works. The historic discovery of Palaeolithic sites can be a very haphazard affair, strongly influenced by areas of previous deep quarrying (or other infrastructural works) and by whether or not avid local collectors were active in an area. Rather, historic patterns of discovery can be used to model likely potential on the basis of the similarity of deposits in an area of interest to those that have previously produced material in the same general region. This is why the desk-based review has collated information up to (and in some cases, slightly beyond) a 3km buffer around the Project's impact footprint.

6.1.4 The distribution of specific sites in relation to defined Palaeolithic-and-Quaternary zones of the Project's footprint is discussed further below (Section 9). Pending that, the sites identified in the desk-based review highlight the following general themes of interest for the Palaeolithic in and around the LTC footprint:

6.1.5 *Boyn Hill Gravel, and equivalent deposits*. These deposits are extensive across the LTC footprint in Essex. They have produced numerous Palaeolithic finds, especially in the area of Orsett and Chadwell St Mary. Slightly further afield, on the south side of the Thames, deposits of this age have also produced abundant and important remains, including the HS1 elephant site (LTC 4043) and at Barnfield Pit, Swanscombe (not listed here in the LTC site list, but another iconic British Lower Palaeolithic site of the Lower Thames - Ovey et al 1964; Bridgland 1994: 193-218, Conway et al. 1996). It remains possible that the local geography on the south side of the Thames (in particular the abundant local availability of flint from nearby Chalk bedrock, and possibly also a slightly different fluvial depositional regime) has meant that Palaeolithic occupation was focused there, and/or sites are more likely to be preserved there with less disturbance. However, unless/until there is robust evidence to confirm the relative absence of important Palaeolithic remains in other parts of Boyn Hill Gravel (and equivalent deposits) it has to be presumed that they may contain similar remains in nearby as-yet-uninvestigated areas.

6.1.6 *Lynch Hill Terrace (and equivalent deposits)*. These deposits are likewise extensive near to the LTC footprint in Essex. The greatest spread occurs mostly to the west of the LTC footprint, although the eastern side of this spread is directly affected by Project in several places These deposits have also produced numerous Palaeolithic finds, especially at the Belhus Park Cutting (LTC 4020-4021) between M25 junctions 29 and 30 where minimally-disturbed lithic remains have been found associated with a deep sequence of deposits very rich in diverse botanical, molluscan and vertebrate remains. Slightly further to the west, and a little beyond the 3km buffer, similar and rich remains have been found at the Purfleet pit complex (LTC 4008-4010). In contrast to the situation for the Boyn Hill Terrace (see para 6.1.5) here there is every likelihood that similar remains to those of the Belhus Cutting will be affected by the LTC work, since the same deposit body extends into the LTC footprint (see below, Section 9, zones PQ-18 and PQ-19).

6.1.7 *Middle Palaeolithic (British Mousterian) sites*. Sites of this period (from the middle part of the Devensian Glacial, representing late Neanderthal incursions into Britain from continental Europe) are rare in Britain. However, there is at least one characteristic handaxe (described as a fine *bout coupé*) from Tilbury dockyard (LTC 4028); and two other handaxes likely to be of the same age are known from the same area, one of them reported as having been recovered during extension of the dock in 1913 (LTC 4029). It therefore seems likely that the wide spread of alluvium representing the Thames floodplain on the north side of the current river channel may seal deposits with remains of this period, and possibly palaeo-landsurfaces.

6.1.8 *Final Upper Palaeolithic Long Blade sites*. Sites of this period are also generally rare in Britain, but those that we do know about seem to be concentrated in the Southeast, and especially in the Thames basin. This may relate to use of the Thames valley as a primary access route into southern Britain from the North Sea area. In particular, relatively numerous sites and find-spots, including two instances of concentrated scatters with refitting material representing minimally-disturbed material (LTC 2370 and 4045) and a third instance that probably also represents undisturbed material (LTC 3406) have been found on the south side of the Thames, in the vicinity of the Ebbsfleet valley. Two of these sites (LTC 2370 and 3406) were found under Holocene alluvium, as were many isolated findspots of Long Blade material in the Swanscombe area (not in the LTC site list). However, one site (LTC 4045) was found away from the alluvial floodplain, in a dry valley infilled with fine-grained colluvium dating to the Last Glacial maximum. A palaeo-landsurface had formed on the surface of the Last Glacial colluvium, and this preserved a dense scatter of undisturbed lithic remains, which was then buried by subsequent Early Holocene slopewash deposition. This highlights the potential of similar remains to be found in other analogous landscape situations in the LTC footprint, especially on the southern side of the Thames, where the more-chalky landscape would have led to a more abundant supply of fresher flint raw material, essential for the large-scale blade production associated with the Final Upper Palaeolithic Long Blade industry.

**Table 6.1 Known Palaeolithic sites affected by, or near to, the LTC footprint.**

| | In LTC footprint | | | | Near LTC footprint | | | |
|---|---|---|---|---|---|---|---|---|
| **Site-type** | **Acc.** | **Est.** | **Gen** | **Key sites [by LTC list no.]** | **Acc.** | **Est.** | **Gen** | **Key sites [by LTC list no.]** |
| Mon | 4 | 1 | - | **468** - Gun Hill Pit<br>**1661** - handaxe found *in situ* under colluvium during HS1 evaluation, southeast of Tollgate, ARC TGS 97<br>**4018** - pit NE of Hangman's Wood | 1 | 1 | - | **3452** - handaxe from brickearth bank, TP 25<br>4053 - gravel pits east of Higham |
| Mon/PE | - | - | - | - | 1 | - | - | **4043** - the HS1 Ebbsfleet elephant butchery site |
| F-spot | 4 | 3 | 1 | **4049** - handaxe and debitage from brickearth bank, north of HS1 elephant site<br>**4007** - sharp cordate at South Ockendon windmill | 4 | 3 | 1 | **503**, **2021**, **2143** and **4017** - handaxe finds from Chadwell St. Mary<br>**4028**, **4029** - handaxes (including *bout coupé*) from Tilbury docks |
| PEFS | 2 | - | - | **4046**-**4047** - ostracods and molluscs from Hoxnian lake sediments at Ebbsfleet, east of HS1 elephant site | - | - | - | - |
| Geo | 1 | 1 | - | **173** - Boyn Hill Terrace at M25 Ockenden Cutting | - | - | - | - |
| **Totals** | **11** | **5** | **1** | | **6** | **4** | **1** | |

# 7 Walk-over survey: results

## 7.1 General overview

7.1.1 The walk-over survey was carried out on 10th-11th March 2020 by the LTC Palaeolithic and Pleistocene specialists (Francis Wenban-Smith and Martin Bates) in accordance with the methods and objectives outlined above (Section 5.5). Seven specific objectives were identified in advance - WO1 through to WO7 - and the outcomes in relation to these objectives are reviewed below (Section 6.2). A selection of relevant photos from the survey are given as an annex (Annex G). These are referenced below as “photo G-nn”, with “nn” representing the numeric order in Annex G.

7.1.2 The general progression of the survey was from south to north. The first area that was visited on day 1 was the south side of the Thames, to the east of Chalk in the general area of the south portal (zone PQ-7). Here, the surface of the Holocene alluvium of the Thames was clearly identifiable as a flat plain stretching north from Lower Higham Road, and abutting the 1st terrace (photo G-1a). The ground to the south of Lower Higham Road was a ploughed field, with the caps of LTC boreholes clearly visible (photo G-1b). The surface of the field was slightly undulating, and rising steadily to the south. Although there were some slightly higher areas, terrace flats were not clearly visible.

7.1.3 The next area visited was the high ground of Shorne Woods Country Park. The areas due for LTC impact were not easily accessible, but we drove around some back lanes to get an idea of the general lie of the land. This high point is significant as the interfluve between the Thames and Medway systems. In particular, the slope and dry valley system on the north side of the plateau (photo G-1c) were examined, and the incised dry valley on the southeast side of the plateau (photo G-1d), where work is planned in the area of J1 of the M2. There is in principle some possibility of remnant fluvial terraces associated with the latter, but no sign of these was detected on the visit.

7.1.4 The survey then progressed to the north side of the Thames, where various terrace outcrops abut the floodplain between Chadwell St Mary and Coalhouse Fort at East Tilbury. The higher ground of the Black Park Gravel outcrop at Southfields and Linford was clearly recognisable, and some gravel quarries were active. The bluff of the Lynch Hill (=Corbets Tey) outcrop (PQ-11) to the northwest of Coalhouse Fort was clearly visible (photo G-1e), and the clean nature of this gravel and its fluvial bedding was clearly visible in an exposure near Barvills Farm (photo G-1f), in an area where substantial works are planned (NGR 568000 177500).

7.1.5 Further west, the bluff between the Thames floodplain and the Pleistocene terrace system is very pronounced (photo G-2a), with the Middle Pleistocene Boyn Hill (=Orsett Heath) terrace directly abutting the floodplain. The Boyn Hill gravel has been quarried at various locations, including Gun Hill Pit a short distance to the north on the west side of Turnpike Lane, where several Palaeolithic handaxes were found (Annex D, site LTC 468). Here, the pit has not been backfilled and gravel exposures remain clearly visible in the degrading quarry faces (photo G-2b).

7.1.6 The northwest continuation of the Boyn Hill terrace is substantially occupied by the built-up area of Chadwell St Mary. Several handaxe finds are known from previous gravel pits and construction work here (LTC 503, 2143, 4017, 4030 and 4031), although no current exposures were located. The pit west of Greyhound Lane (LTC 423) that previously produced four handaxes and which will be skirted by LTC works (vicinity of NGR 564000 179800) has been backfilled, and is now an open green space. Likewise, the small pit at NGR 563530 179980 which is within the LTC footprint, and for which there is a good record of *in situ* Palaeolithic finds (LTC 4018), is fully backfilled and re-turfed, and there is no visible sign of its previous existence. The current A1013 was re-routed in the 1980s and passes directly across the northwest area of this pit.

7.1.7 The final part of the first day of the survey involved a walk-over of the Sockett's Heath area of this wide expanse of Boyn Hill terrace, where finds had been made from previous gravel pits at Dene Holes roundabout (LTC 414) and at Sockett's Heath pit a little further west (LTC 4026). There were no visible exposures, but the edge of the previously-quarried area was clearly visible on the south side of the Dene Holes roundabout (photo G-2c). The Sockett's Heath pit has been fully filled in, and is now occupied by residential housing.

7.1.8 The second day of the survey started with scouting out the high ground at the north end of the project corridor. A vantage point at Warley Street (NGR 559500 188200) allowed a view back towards the project corridor across the Mar Dyke basin (photo G-2d), and a ditch cutting in the floor of the basin near Blankets Farm, NGR 562000 185800, (photo G-2e) showed the loamy/peaty alluvium at this point. We then crossed the M25 by the road bridge, and observed The cutting (LTC 173) through the Boyn Hill deposits near North Ockenden (photo G-2f), where substantial work is planned (vicinity of NGR 558300 185000), was observed from the road bridge here across the M25.

7.1.9 The survey then focused on ground to the west of the M25, mostly mapped as Lynch Hill (=Corbets Tey) terrace (zone PQ-19). This is an area of high Palaeolithic potential, likely to include organic-rich sediments, and with good potential for minimally-disturbed Palaeolithic activity areas where the LTC footprint impacts its eastern valley-side edge. A typical part of this area is the field to the NE of Dennises Cottages (NGR 558120 184250), which seems easily accessible for archaeological fieldwork (photo G-3a). The stretch along Dennis Road to Little Belhus Country Park via West Road was then walked over, which route follows a substantial linear part of the LTC project footprint. The surface of the unquarried Lynch Hill terrace was plainly visible in a ploughed field to the east of Dennis Road (photos G-3b,3c), and appeared to be flat and dipping slightly eastward.

7.1.10 After this, zone PQ-17 (Cuckoo Lane) was examined, initially thought to be an area of high potential, where Lynch Hill deposits might occur in an area favourable for human activity due to the proximity of Chalk bedrock as a flint source. However, contra prior expectations, the area of LTC impact around the roundabout at NGR 560765 180295 was substantially formed of built-up ground (photo G-3d). The Palaeolithic potential of this zone was therefore downgraded to LOW-MODERATE. It was not possible to access Mederbridge Road (zone PQ-18, a very small zone of 0.37 Ha, where the Lynch Hill terrace is also likely

to be affected by the LTC work) as this is a private access road for a working pit and/or waste amenity site.

7.1.11 The final part of the survey involved investigation of the “Mar Dyke narrows” (zone PQ-21). Here, the Mar Dyke forms a narrow channel as it passes southwest along the north side of the Purfleet chalk anticline, cutting through Lynch Hill terrace deposits which are preserved on both sides. Nothing of interpretive relevance was seen, although photos were taken of the general landform (photos G-3e, 3f).

## 7.2 Key outcomes

7.2.1 In relation to the issues identified at the outset of the survey (see above, Section 5.5, WO1-WO7):

a. WO1a - Pleistocene terraces near the south portal (PQ-7). Some minor undulations were present in the ploughed field that sloped steadily up to the south in zone PQ-7, in the vicinity of the south portal; however, these were not clearly recognisable as terrace surfaces. This will be investigated in stage 1 of fieldwork.

b. WO1b - Pleistocene terraces on the north side of the Thames (PQ- 11, 12a and 13). Here, the landscape morphology clearly reflects the geological terrace mapping; the artefactual and palaeo-environmental content of the terrace deposits will be investigated in fieldwork stages 1 and 2, leading to a full stage 3 mitigation programme where required. Key objectives of the mitigation programme will be to clarify their date, and their correlations with the wider Thames terrace framework and the global MIS framework.

c. WO2 - zone PQ-17. The walkover visit established that the area impacted by the LTC project appears to be built-up ground, and thus the Palaeolithic potential of this zone has been assessed as LOW-MODERATE.

d. WO3 - old pit with Palaeolithic finds, LTC 4018. This pit wasn’t visible. Its location was level and turfed over. It seems to have been backfilled when the A1013 was improved and moved slightly southeast, probably in the early 1980s. However, its footprint is accurately mapped, so it should be straightforward to target stage 1 mitigation test pits to locate its edge and investigate for Palaeolithic remains.

e. WO4a - Boyn Hill and Black Park terraces, between Orsett Heath and Southfields. The outcrops were clearly visible, and there remain several working quarries, indicating the presence of sand/gravel. The artefactual and palaeo-environmental content of the terrace deposits will be investigated in mitigation stages 1 and 2, leading to a full stage 3 mitigation programme where required. The results of this programme may lead to reconsideration of their date, and their correlations with the wider Thames terrace framework and the global MIS framework.

f. WO4b - Boyn Hill and Black Park terraces in vicinity of North Ockenden. The outcrops were clearly visible, but there was no current quarrying, and no exposures were visible. The artefactual and palaeo-environmental content of the terrace deposits will be investigated in mitigation stages 1 and 2, leading to a full stage 3 mitigation programme where required. The results of this programme may lead to reconsideration of their date, and their correlations with the wider Thames terrace framework and the global MIS framework.

g. WO5 - Lynch Hill terrace, zone PQ-19. Various old gravel pits in this area have either been backfilled, or are lakes used for fishing or water-sports. Otherwise, much of the ground is arable fields, showing a flat terrace surface sloping shallowly down to the west. Nothing was seen to change the initial assessment of this zone as MODERATE-HIGH. Subject to landowner permission, many areas also seemed reasonably straightforward for fieldwork access, and without obvious constraints.

h. WO6 - higher northern part of the project corridor (zone PQ-28). The general landscape was noted, but no exposures were located, and the project impact is limited to a narrow corridor along the current route of the M25. Nothing was seen to change the initial assessment of this area from LOW-MODERATE, requiring minimal stage 1 fieldwork.

i. WO7 - general observation of topography, landforms, and landscape. This took place along the project route, particularly for the Shorne Woods plateau at its southern end, and the Mark Dyke basin. No exposures were seen that had any interpretive value, although one exposure of a freshly-cut drainage ditch in the base of the Mar Dyke basin confirmed the clayey sediment here, and the need for drainage management to avoid waterlogging.

# 8 LTC Palaeolithic Research Framework

## 8.1 Introduction to the LTC Palaeolithic Research Framework

8.1.1 Clearly-defined research priorities, and statements defining significance, provide the basis for: (a) assessment of importance as part of the pre-development planning consent process; and (b) targeting of resources for pre-development investigations and subsequent reporting. As reviewed above (Section 3.4), the LTC project is beholden to numerous research frameworks. Firstly, the project area is wholly within England, and thus comes within the remit of the national research and conservation framework for the Palaeolithic (English Heritage 2008). Secondly, different parts of the project area come within the compass of three regional areas (Greater London, Eastern England, and the South-East), all of which have their own research frameworks and sets of research priorities. And thirdly, there are at least three further subsidiary research framework or Palaeolithic asset management exercises that have been carried out (the *Greater Thames Estuary Historic Environment Research Framework*, *Managing the Essex Pleistocene*, and *Kent Archaeological Notification Areas*) that should inform archaeological thinking for the LTC project.

8.1.2 Bearing in mind this plethora of research frameworks, the only practical approach is to collate them into a single project-specific LTC Palaeolithic Research Framework. Rather than just adding them together, which would produce an unwieldy framework of very numerous (and often very similar) themes and priorities, key recurring themes and research priorities have here been extracted into a unified LTC list. Most themes and priorities relate to academic research issues; however, there are also themes relating to dissemination, engagement and archive curation, all of which are important aspects of heritage curation.

8.1.3 These are then complemented by some LTC-specific research objectives for evaluation of the seven broad geological character landscape-zones identified above (see above, the end paras of Section 3.2), and in light of the results of the desk-based review of Palaeolithic assets (Section 6) and the walk-over survey (Section 7). Addressing these objectives in the evaluation process will clarify the potential of each zone to contribute to national and regional research priorities, as conflated in the LTC Palaeolithic Research Framework, and guide subsequent targeting of resources for mitigation and reporting in the event of unavoidable impact.

## 8.2 LTC Palaeolithic Themes and Research Priorities

8.2.1 Seven broad primary themes have been identified for the Palaeolithic Table 8.1), building on the existing national and regional research framework themes. Some more-specific research priorities are listed alongside these themes, illustrating the type of topics covered under these themes. However, these are by no means either exclusive or complete; many other research issues have relevance, and many issues have crossover relevance between themes.

8.2.2 Theme 1, **The Ice Age**, directly recognises the importance of the Pleistocene, not just as an adjunct to hominin-focused questions, but as a theme of interest and relevance in its own right. This theme embraces the palaeo-environmental and chrono-stratigraphic framework issues that are directly relevant to Palaeolithic archaeological research. It also engages with the development of the physical landscape in the present day, the history of part-glaciation, and the past presence in the UK of exotic mammals such as cave bear, sabre-toothed cat, hippopotamus, rhinoceros and woolly mammoth.

8.2.3 Theme 2, **Colonisation and Demography**, covers the same ground as the similarly-titled theme two of the national framework. It covers the facts of hominin presence, including both intra-regional distribution of settlement and presence/absence of occupation at the national/regional scale, and debate over the processes and ecology of colonisation (and its converse, when populations ceased to exist, whether by migration or local extinction).

8.2.4 Theme 3, **Becoming Human**, likewise follows the national framework, covering behavioural and material cultural aspects of Archaic adaptation more directly. It is this theme that covers the basic area of documenting and explaining technological and typological details of lithic material culture through the Early Palaeolithic, as well as consideration of less-tangible social and behavioural aspects such as speech, ritual, social organisation and logistic planning.

8.2.5 Theme 4, **Understanding the Record**, is fundamental to interpretation of any archaeological remains that are found, addressing site formation processes, post-depositional disturbance, preservation bias and taphonomy. These are particularly important issues for the Palaeolithic record, with the wide range of depositional environments represented in surviving Pleistocene deposits, and debate over the potential importance of lithic remains from fluvial gravel contexts.

8.2.6 Theme 5, **Dating Frameworks**, is likewise self-evidently a critical theme for Palaeolithic studies, providing the basic chronological order for events, allowing us to examine both changes within and between regions, and at wider scales, between countries and climatic/geographic zones. Great progress has been made in chronometric dating over the last decade with increased use of optically stimulated luminescence (OSL) and significant technical advances in amino acid racemisation (AAR). Further attention is needed, however, to both refine the precision of these techniques, and to expand their range. There is also further work to be done refining the bio-stratigraphic framework for the British Pleistocene which, although often very useful as presently understood, is also often somewhat circular, and insufficiently-founded on independent chronometric and lithostratigraphic foundations.

8.2.7 Theme 6, **Curating the Resource and Archiving**, recognizes the importance of carrying out work, and delivering its results, in ways that help curators to manage the Palaeolithic/Pleistocene resource effectively. It is also important to wrap up project archives and ensure that all records - project reports, finds, paper records, digital data, photographs, *etc.* - are curated and archived in an organised fashion, and with metadata ensuring that potentially-important data that could be relevant to future research is easily identifiable and accessible.

8.2.8 And Theme 7, **Reporting, Engagement and Education**, addresses the need that the results of all work done should be properly reported and widely disseminated. This should go beyond academic reporting, which generally only reaches a small and specialist audience. There should be a targeted effort to reach a wider general audience with the Palaeolithic results arising from the LTC archaeological programme, and in particular to engage with the community in and around the LTC footprint, and with existing cultural organisations and societies that are active in the area. Likewise, an effort should be made to look at how the Palaeolithic results from the LTC programme relate to different aspects of the national curriculum, and how this can be brought to the attention of the educational community, particularly in the regions directly affected by the project, and integrated in their work.

**Table 8.1 Primary Themes and Research Priorities for the LTC Palaeolithic archaeological programme.**

| Primary Theme | Research Priorities |
|---|---|
| 1. The Ice Age | 1.1 - Improving understanding and dating of regional Pleistocene environmental, climatic and litho-stratigraphic frameworks |
| | 1.2 - How did Pleistocene climate and sedimentary processes contribute to development of present-day landscapes? |
| | 1.3 - Conversely, what stories of Pleistocene climate and depositional process are reflected in today's landscapes? |
| | 1.4 - What faunal communities, including extinct tropical and cold-adapted species, previously were present? And what are the climatic and palaeo-environmental implications of recovered fossil communities? |
| | 1.5 - What effect did Pleistocene climate change have on British environments and faunal communities? |
| 2. Colonisation and demography | 2.1 - Patterns of colonisation, settlement and abandonment through the Pleistocene — were there significant periods when the South-East was deserted? How densely were landscapes settled? And how were activities and occupation organised within landscapes? |
| | 2.2 - What was the climatic and environmental context of Archaic settlement, and the relationship between climate/environment and colonisation? |
| | 2.3 - Dating of artefact-bearing deposits within regional, national and international Quaternary frameworks |
| | 2.4 - What were the biological relationships between British and continental populations? |
| | 2.5 - When occupation ceased, did the hominins migrate, or did they die out *in situ*? |
| | 2.6 - What factors constrained/influenced the expansion and viability of hominin populations? |

| Primary Theme | Research Priorities |
|---|---|
| | 2.7 - How did Upper Palaeolithic occupation of Britain relate to the prevailing climate, to what extent was it episodic, and what were the links between British and continental populations? Or could they be construed as a single highly-mobile population, and if so, was this seasonal, and with what pattern? |
| 3. Becoming human | 3.1 - Documentation and explanation of diachronic and synchronic patterns of material cultural variability |
| | 3.2 - Behaviour of Archaic *and* anatomically modern (= “Modern”) hominins: (a) at specific sites; and (b) across the wider landscape |
| | 3.3 - Extent of contrasts in Archaic and anatomically modern human behaviour and adaptations, and in fundamental cognitive capacities such as speech and forward planning |
| | 3.4 - Improved documentation and understanding of hominin physiological evolution |
| | 3.5 - Investigation of the relationship between evolutionary, behavioural and material cultural change |
| | 3.6 - Models for cultural transmission and learning, especially in pre-Modern Archaic populations |
| | 3.7 - Social organisation, behaviour and belief systems |
| | 3.8 - Funerary practices, in both Archaic and Modern populations, and contrasts between them |
| 4. Understanding the Record | 4.1 - Improving models of Palaeolithic site formation and post-depositional modification |
| | 4.2 - Lithic provenancing studies |
| | 4.3 - Modeling of raw material distribution |
| | 4.4 - Experimental investigations of raw material suitability for tool manufacture |
| 5. Dating Frameworks | 5.1 - Improving understanding and dating of regional Pleistocene environmental, climatic and litho-stratigraphic frameworks |
| | 5.2 - Development of improved techniques of AAR and OSL dating, to improve accuracy and expand range |
| | 5.3 - Expanding use of OSL dating through deep sediment sequences, especially where there are independent dating controls, to get better dating results and at the same time validate the technique |
| | 5.4 - Refining biostratigraphic frameworks through: more detailed anatomical studies; improved chronometric dating; and better litho-stratigraphic controls |

| Primary Theme | Research Priorities |
|---|---|
| 6. Curating the Resource and Archiving | 6.1 - Improved mapping/modeling of Pleistocene deposits |
| | 6.2 - Expanding Quaternary/Palaeolithic awareness in the curatorial community |
| | 6.3 - Refining/expanding HER databases of Palaeolithic and Quaternary records |
| | 6.4 - Creating consistent project archive structures and metadata indexing |
| | 6.5 - Ensuring archives and project reports are deposited so as to remain accessible to researchers |
| 7. Reporting, Engagement and Education | 7.1 - Engaging with heritage cultural organisations and societies in regions affected by LTC; programmes of visits, talks, possibly including while fieldwork is ongoing |
| | 7.2 - Engaging with educational community in regions affected by LTC; programmes of visits, talks, possibly including while fieldwork is ongoing, and discussions on relevance of LTC work to, and incorporation within, national curriculum |

## 8.3 Specific LTC landscape-zone Research Objectives

8.3.1 Specific Research Objectives for stage 1 of the mitigation programme of the seven landscape-zones LZ1-LZ7 (see above, Section 3.2) are given below (Table 8.2). These are cross-referenced against their relevance to the wider LTC Palaeolithic Themes and Priorities framework (see above, Table 8.1).

**Table 8.2 Landscape-zone Research Objectives for the LTC Palaeolithic archaeological programme.**

| Landscape zone | Research Objectives | LTC Themes, Priorities |
|---|---|---|
| LZ1 - Shorne Country Park, and surrounds | RO 1.1 - Any residual Palaeolithic evidence capping the high ground? | 2.1, 3.1, 3.2 |
| | RO 1.2 - Any Palaeolithic evidence within, or under, Head deposits in dry valleys surrounding the plateau? | 2.1, 3.1, 3.2 |
| | RO 1.3 - What is age, nature and formation process of any Quaternary sediments? | 1.1-1.3, 4.1, 5.1 |
| LZ2 - Thames valley-side south, Chalk | RO 2.1 - What is age, nature and formation process of dry valley fill sediments, and is there a palaeo-landsurface between colluvium from the Last Glacial Maximum and Holocene slopewash? And if so, any evidence of Late Upper Palaeolithic activity? | 1.1-1.3, 2.7, 5.1, 5.3 |

| Landscape zone | Research Objectives | LTC Themes, Priorities |
|---|---|---|
| | RO 2.2 - Are there any Palaeolithic remains associated with Head/Colluvium infilling dry valley valleys (especially Late Upper Palaeolithic where dry valleys cut through Chalk and Bullhead flint bed)? | 2.1, 2.7, 3.2 |
| | RO 2.3 - What is the distribution and date of Thames terrace deposits above the south bank of the Thames, how many terraces are represented, and what Palaeolithic artefactual/palaeo-environmental remains are associated? | 1.1-1.4, 2.1-2.3, 4.1, 5.1 |
| LZ3 - Thames floodplain | RO 3.1 - Upper Palaeolithic remains at the base of the Holocene alluvium, especially in association with organic/palaeo-environmental remains? | 2.1, 2.7, 3.2 |
| | RO 3.2 - Buried Thames terrace/channel-fill deposits, other than the main Late Devensian gravels (Shepperton Gravel): distribution, differentiation, dating, palaeo-environmental remains and artefactual remains? | 1.1, 1.4, 5.1 |
| LZ4 - Thames valley-side north, Chadwell St. Mary | RO 4.1 - Thames terrace deposits, in particular Black Park, Lynch Hill and Boyn Hill deposits: distribution, differentiation, dating, palaeo-environmental remains and artefactual remains? | 1.1-1.4, 2.1-2.3, 3.1-3.2, 4.1, 5.1 |
| | RO 4.2 - Colluvial deposits: distribution, depth, dating, presence/prevalence of palaeo-environmental/artefactual remains, and buried fluvial sediments from previous drainage patterns? | 1.1-1.3, 2.3 |
| LZ5 - Mar Dyke basin | RO 5.1 - Distribution, dating and formation process of any Quaternary sediments? | 1.1-1.3, 5.1 |
| | RO 5.2 - Any evidence of Palaeolithic presence in Quaternary sediments, and if so of what age, and with any organic preservation? | 2.1-2.2, 3.2 |
| | RO 5.3 - Any buried Pleistocene terrace deposits, and if so, differentiation, dating, palaeo-environmental remains and artefactual remains? | 1.1-1.3, 2.1-2.3, 5.1 |
| | RO 5.4 - is there evidence of a palaeo-drainage channel south-eastward direct to the Thames, and if so at what date? | 1.1-1.3, 5.1 |
| LZ6 - West side of Mar Dyke, North Ockenden | RO 6.1 - Thames terrace deposits, in particular Black Park, Lynch Hill and Boyn Hill deposits: distribution, differentiation, dating, palaeo-environmental remains and artefactual remains? | 1.1-1.3, 2.1-2.3, 3.1-3.2, 4.1 |
| | RO 6.2 - For Thames terrace deposits, what was the course of the Thames in relation to the Chalk high ground (now quarried away) at West Thurrock? | 1.1-1.3 |

| Landscape zone | Research Objectives | LTC Themes, Priorities |
|---|---|---|
| | RO 6.3 - For Lynch Hill deposits in particular: identification of the Belhus Park organic channel, palaeo-environmental investigation, investigation of artefactual content and palaeo-landsurfaces, and correlation with the key Purfleet Bluelands/Greenlands sequence | 1.1-1.3, 2.1-2.3, 3.1-3.2 |
| LZ7 - North of Mar Dyke basin, eastern Upminster | RO 7.1 - Distribution of terrace deposits and Anglian till deposits, and sequence logs showing their relationship | 1.1-1.3 |
| | RO 7.2 - For terrace deposits, normal questions on differentiation, dating, palaeo-environmental remains and artefactual remains - but also: whether mainstream Thames, or its north bank Ingrebourne tributary? | 1.1-1.3, 2.1-2.3, 3.1-3.2 |
| | RO 7.3 - Identification of older Stanmore Gravel deposits, investigation for any artefactual and palaeo-environmental content, and studies (mineralogical?) that might help in dating and regional correlations | 1.1-1.3, 2.1-2.2 |

# 9 Palaeolithic and Quaternary (PQ) zones: desk-based assessments

9.1.1 Based on the information and approaches outlined above (Section 5), the LTC project footprint was divided into 29 character areas. These are represented in the landscape (Figures 13-15) as 34 actual Palaeolithic and Quaternary (PQ) zones (PQ 1-11, 12a-b, 13-19, 20a-c, 21, 22a-b, 23a-b and 24-29) since several areas of similar character are not directly contiguous. These zones supersede the preliminary model developed by Wessex Archaeology (AECOM 2019b), which placed greater reliance on the accuracy of current geological mapping and Bridgland's interpretive framework for Pleistocene terrace deposits in the LTC area.

9.1.2 An assessment was made for each zone of its Palaeolithic and geo-archaeological potential, attributed to one of three categories (UNCERTAIN, MODERATE-HIGH, or LOW-MODERATE) on the basis of the rationale outlined above (Section 5.7). Staged field mitigation approaches are recommended for each zone according to its assessment, as also previously described (Table 5.4).

9.1.3 A zone-by-zone summary of the Palaeolithic assessments is provided below (Table 9.1). Full details of each PQ zone are provided as an annex (Annex F), and a series of larger-scale maps are also provided, showing each zone in relation to known Palaeolithic sites, geological mapping, topography and previous quarrying (Figures 16-29).

**Table 9.1 PQ zones: Palaeolithic assessments**

| PQ zone | Name - summary description | Ha | Pal./geo-arch. assessment |
|---|---|---|---|
| PQ-1 | Ebbsfleet International car park - asphalt surface over deep thickness of made/backfilled ground onto Chalk, previously Chalk quarry | 11.03 | LOW-MODERATE |
| PQ-2 | Ebbsfleet Valley (unquarried southwest part) - northward continuation of similar deposits to those at the HS1 Ebbsfleet Elephant site | 3.46 | UNCERTAIN |
| PQ-3 | Ebbsfleet Valley upland catchment - Chalk and Thanet Sand bedrock, with Head infilling dry valleys and as intermittent spreads/patches on valley sides and less-sloping areas | 23.97 | UNCERTAIN |
| PQ-4 | Shorne Woods Plateau - high-ground interfluve between Thames and Medway, formed of outcrop of Lambeth and Thames Group bedrock | 42.00 | LOW-MODERATE |

| PQ zone | Name - summary description | Ha | Pal./geo-arch. assessment |
|---|---|---|---|
| PQ-5 | Jeskyns shelf - broadly-level high-ground interfluve between Thames and Medway to southwest of, and slightly lower than, PQ-4; Thanet Sand with wide spreads of Head and possibly small outcrops of high “plateau gravels” | 71.68 | UNCERTAIN |
| PQ-6 | Thong Lane, dip slope of North Downs - Chalk and Thanet Sand bedrock with Head in dry valleys and intermittently across bedrock sides and plateau surface | 419.94 | LOW-MODERATE |
| PQ-7 | Filborough - Thames terraces (Lynch Hill and Taplow) lying on Chalk bedrock at foot of dip slope above south bank of Thames | 6.87 | MODERATE-HIGH |
| PQ-8 | Thames, southern floodplain edge - Holocene alluvium overlying potential buried Pleistocene terrace deposits | 8.88 | MODERATE-HIGH |
| PQ-9 | Thames, main floodplain - Holocene alluvium overlying Late Pleistocene gravel (Shepperton) | 301.53 | LOW-MODERATE |
| PQ-10 | Thames, northern floodplain edge - Holocene alluvium overlying potential buried Pleistocene terrace deposits | 84.37 | MODERATE-HIGH |
| PQ-11 | Goshems Farm - outcrop of Lynch Hill Gravel surrounded by apron of Head deposits | 58.83 | LOW-MODERATE |
| PQ-12a,b | Shearwater Avenue (PQ-12a) and Sutton’s Farm (PQ-12b) - Mucking/Taplow Gravel spread with possible Lynch Hill outcrop at northwest edge of PQ-12a | 132.91 | LOW-MODERATE |
| PQ-13 | Chadwell Saint Mary - wide spread of Orsett Heath/Boyn Hill gravel | 280.33 | MODERATE-HIGH |
| PQ-14 | Southfields - local high, Black Park Gravel (mapped as Orsett Heath Gravel by Bridgland) | 64.38 | LOW-MODERATE |
| PQ-15 | Brook Farm Channel - Head-filled channel-like feature between Mar Dyke Basin and main Thames estuary | 102.01 | UNCERTAIN |
| PQ-16 | Loft Hall Farm - Bedrock-dominated zone (Lambeth Group) on southwest side of Mar Dyke basin | 53.53 | LOW-MODERATE |
| PQ-17 | Cuckoo Lane - small outcrop of Lynch Hill/Corbets Tey Gravel on southern side of Mar Dyke, with Head infilling minor dry valley | 3.95 | LOW-MODERATE |
| PQ-18 | Mederbridge Road - southeast margin of wide spread of Lynch Hill Gravel on northwest side of Mar Dyke | 0.37 | MODERATE-HIGH |
| PQ-19 | Kemps Farm, Dennis Road and Manor Farm - wide spread of Lynch Hill Gravel (including the Belhus Organic Channel) to west and north of the curving course of the Mar Dyke | 54.65 | MODERATE-HIGH |

| PQ zone | Name - summary description | Ha | Pal./geo-arch. assessment |
|---|---|---|---|
| PQ-20a,b,c | East side of Mar Dyke basin (PQ-20a - Green Lane; PQ-20b - Castles Grove; PQ-20c - Bulphan) - Head with patches of London Clay bedrock | 170.93 | LOW-MODERATE |
| PQ-21 | Mar Dyke narrows - narrowing channel of Mar Dyke as it passes south-westward towards the north side of the Purfleet anticline, infilled with Holocene alluvium | 2.35 | UNCERTAIN |
| PQ-22a,b | Mar Dyke basin (PQ-22a - main part, Fen Farm; PQ-22b - northwest part, Puddle Dock) - Holocene alluvium (thin?) over Head or bedrock | 161.25 | UNCERTAIN |
| PQ-23a,b | Mar Dyke, eastern margins (PQ-23a - Orsett Fen, Hobletts; PQ-23b - Stringcock Fen) - Head outcrops at edge of Mar Dyke basin, interspersed with spreads of presumed Holocene alluvium | 28.21 | LOW-MODERATE |
| PQ-24 | Mar Dyke basin, west side - Head on western edge of Mar Dyke, with occasional outcrops of London Clay bedrock | 163.88 | LOW-MODERATE |
| PQ-25 | Hall Farm - major spread of Orsett Heath/Boyn Hill Gravels, overlain in places by Head-filled depressions or minor channels | 141.54 | MODERATE-HIGH |
| PQ-26 | White Post Farm - local high ground, Black Park Gravel outcrops | 0.48 | LOW-MODERATE |
| PQ-27 | Mar Dyke, northern edge - Head on edge of Mar Dyke (possible glacial till of Lowestoft Formation and glacio-fluvial outwash present beneath Head) | 137.98 | LOW-MODERATE |
| PQ-28 | Foxburrow Wood - Mainly Eocene bedrock (London Clay, Claygate Member, and Bagshot Formation) with occasional patches of Head | 23.33 | LOW-MODERATE |
| PQ-29 | Park Pale - South Downs (Medway basin), chalk downs with Palaeocene outcrops (Thanet Sand, Lambeth Group) dissected by Head-filled dry valleys | 75.94 | LOW-MODERATE |

# 10 Discussion and conclusions

10.1.1 This *Stand-alone Palaeolithic Archaeological Assessment and Research Framework* (SPAA-&-RF) has repeated some of the content of the previously-issued *Palaeolithic and Quaternary Deposit Model* (PQDM). However, it has built on the PQDM and gone significantly beyond it in some areas.

10.1.2 Mostly using pre-LTC desk-based data – although also using some data from new LTC Ground Investigation work – the PQDM provides a sub-surface deposit model for Quaternary sediments in the LTC corridor. It also identifies 29 different deposit character zones (PQ zones); these were represented by 34 different polygons (Figures 13-15 and 16-29), since some zones of similar character were not directly contiguous. And the PQ zones were assessed to one of three categories of Palaeolithic potential: LOW-MODERATE, MODERATE-HIGH and UNCERTAIN.

10.1.3 This report builds on the PQDM in several ways. Firstly, it includes results from the walk-over survey (Section 7), which changed our understanding of one zone (PQ-17) and provided much useful background information on the general landscape of the project corridor, and evaluation constraints/potential in some zones. Secondly, it establishes an LTC-specific Palaeolithic Research Framework (see above, Section 8). This conflates the themes and priorities for the national Palaeolithic Research Framework with the various themes and priorities for the different regions affected by the LTC project (see above, Section 3.4). The LTC-specific framework provides a unified context within which to assess the importance of Palaeolithic remains encountered during the project, allowing suitable prioritisation of resources.

10.1.4 Thirdly, this SPAA-&-RF has also characterised the project area into seven broad landscape zones (LZ1 - LZ7, Section 3.2), and identified for each landscape zone a series of Landscape Zone Research Objectives, in relation to the Palaeolithic research themes and priorities (Section 8.2). These Research Objectives will inform the mitigation programme in each of the 34 PQ zones, summarised in the zone overview annex (Annex F).

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# Figures

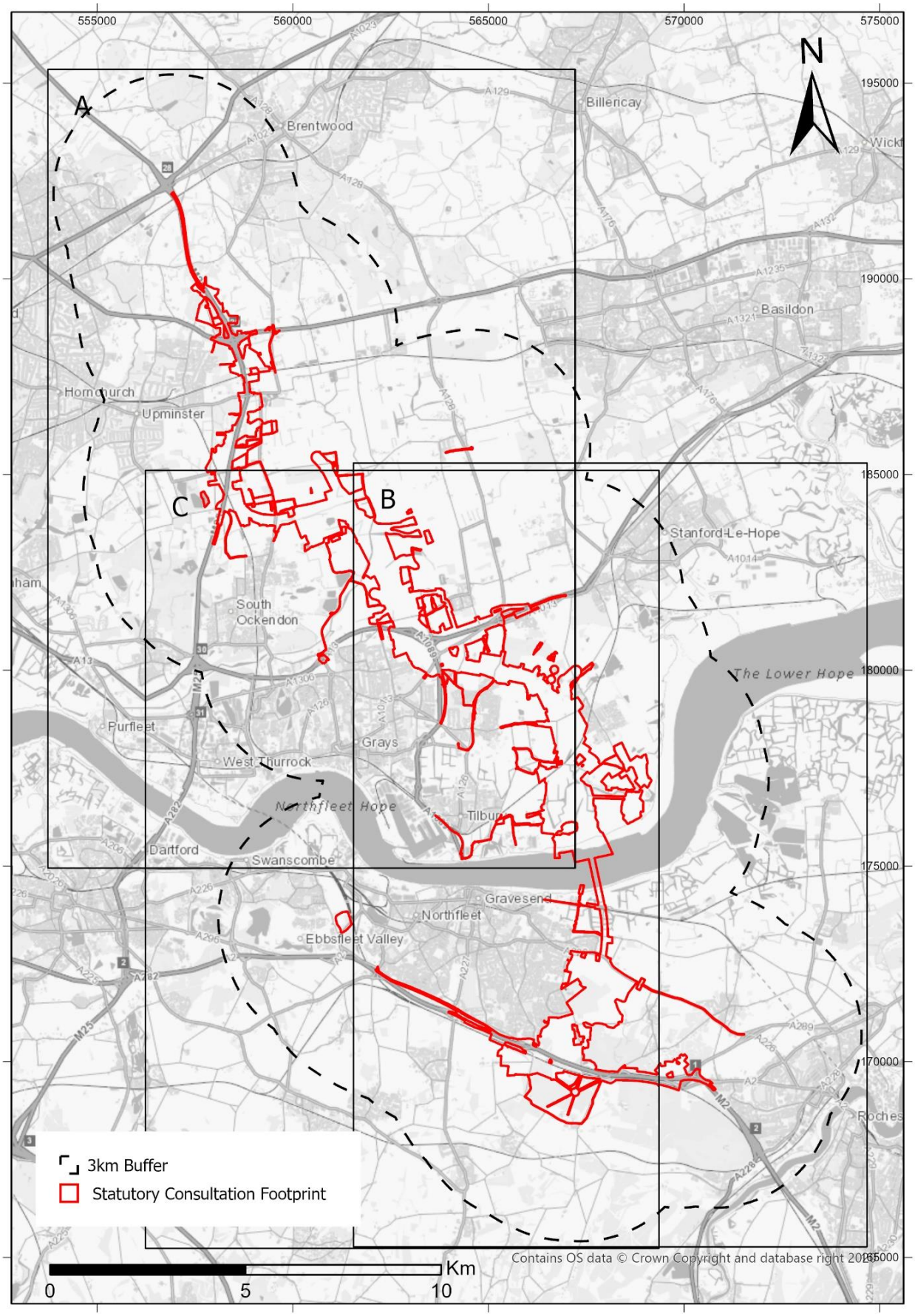


**Figure 1.** Lower Thames Crossing, whole project area: statutory consultation footprint (as revised in January 2020) with 3km buffer. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

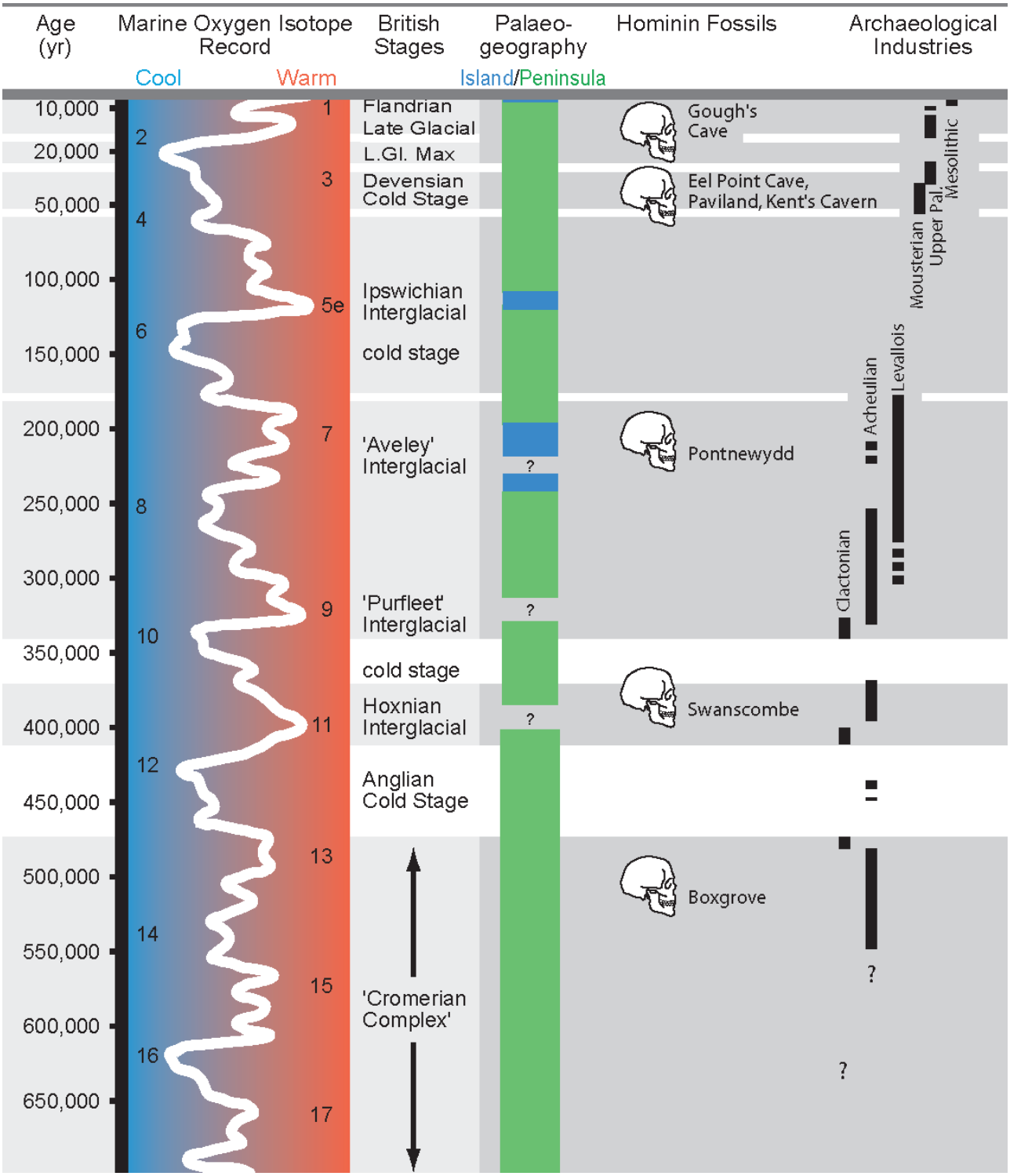


**Figure 2.** Pleistocene framework for the British Palaeolithic.


**Figure 3.** Geological mapping key, and legend for other data. [Geological mapping data reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

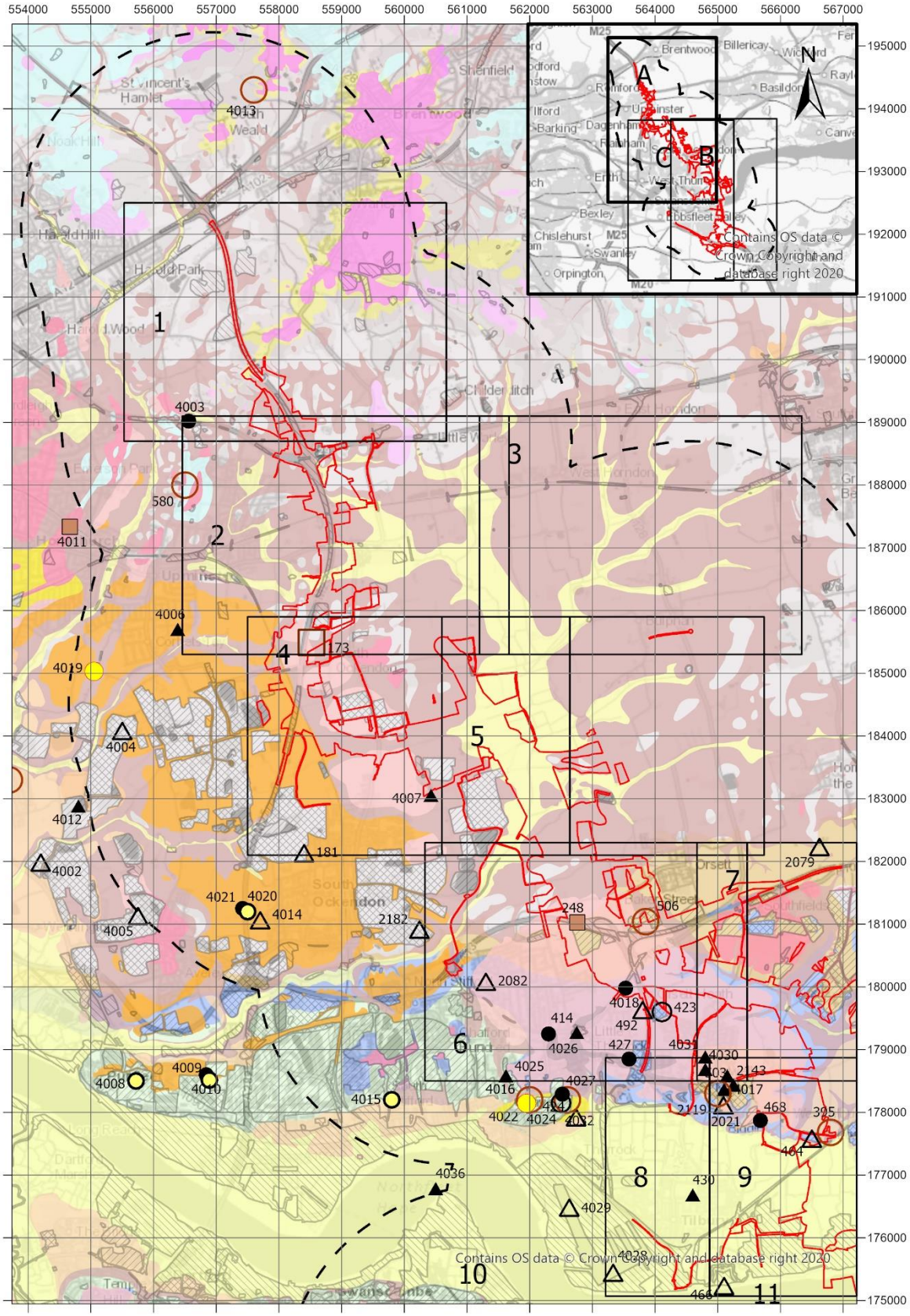


**Figure 4.** Lower Thames Crossing (north - Map A): statutory consultation footprint (January 2020) with 3km buffer, Quaternary transects and Palaeolithic sites [see **Figure 3** for geological key]. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

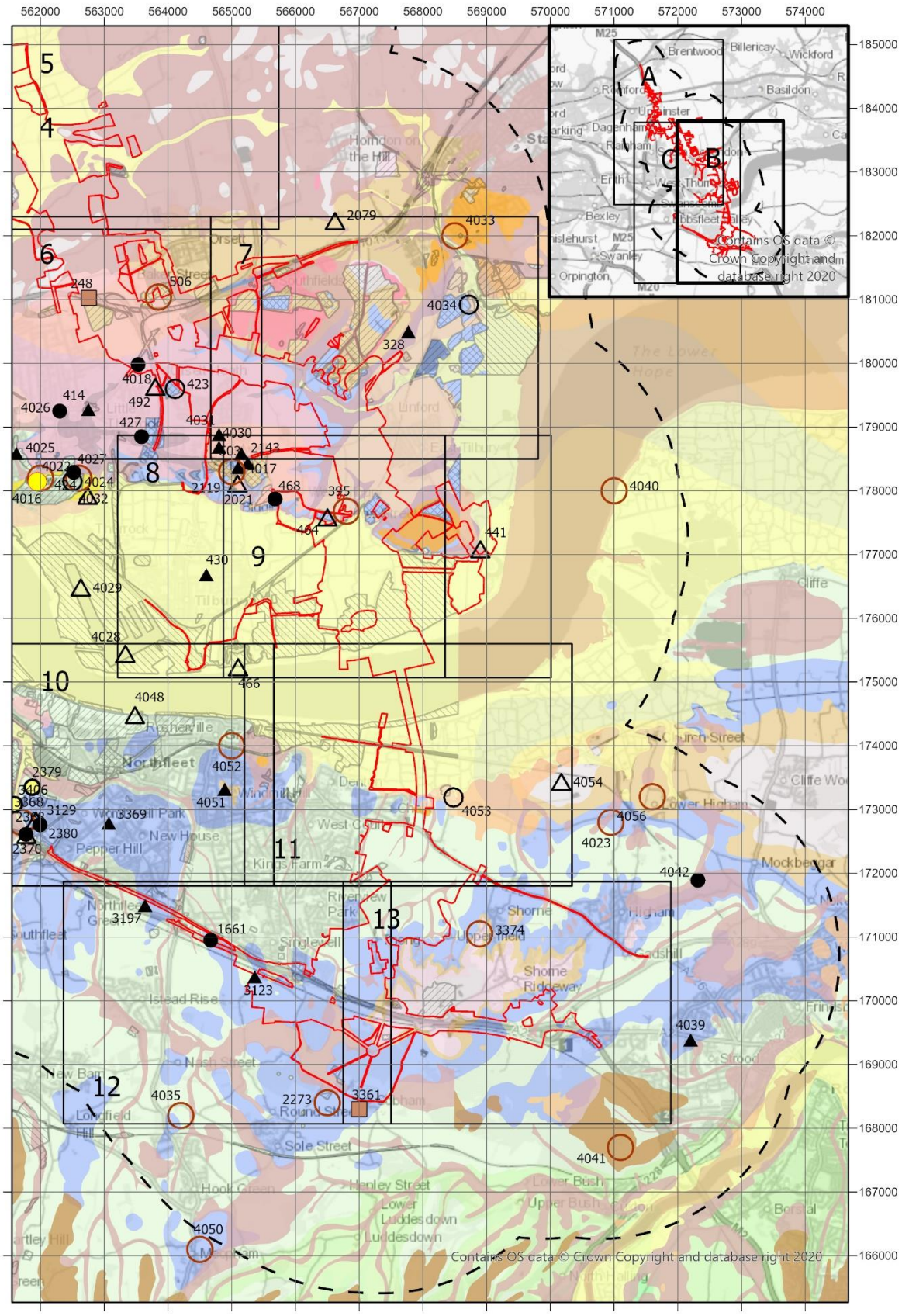


**Figure 5.** Lower Thames Crossing (southeast - Map B): statutory consultation footprint (January 2020) with 3km buffer, Quaternary transects and Palaeolithic sites. [see **Figure 3** for geological key]. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

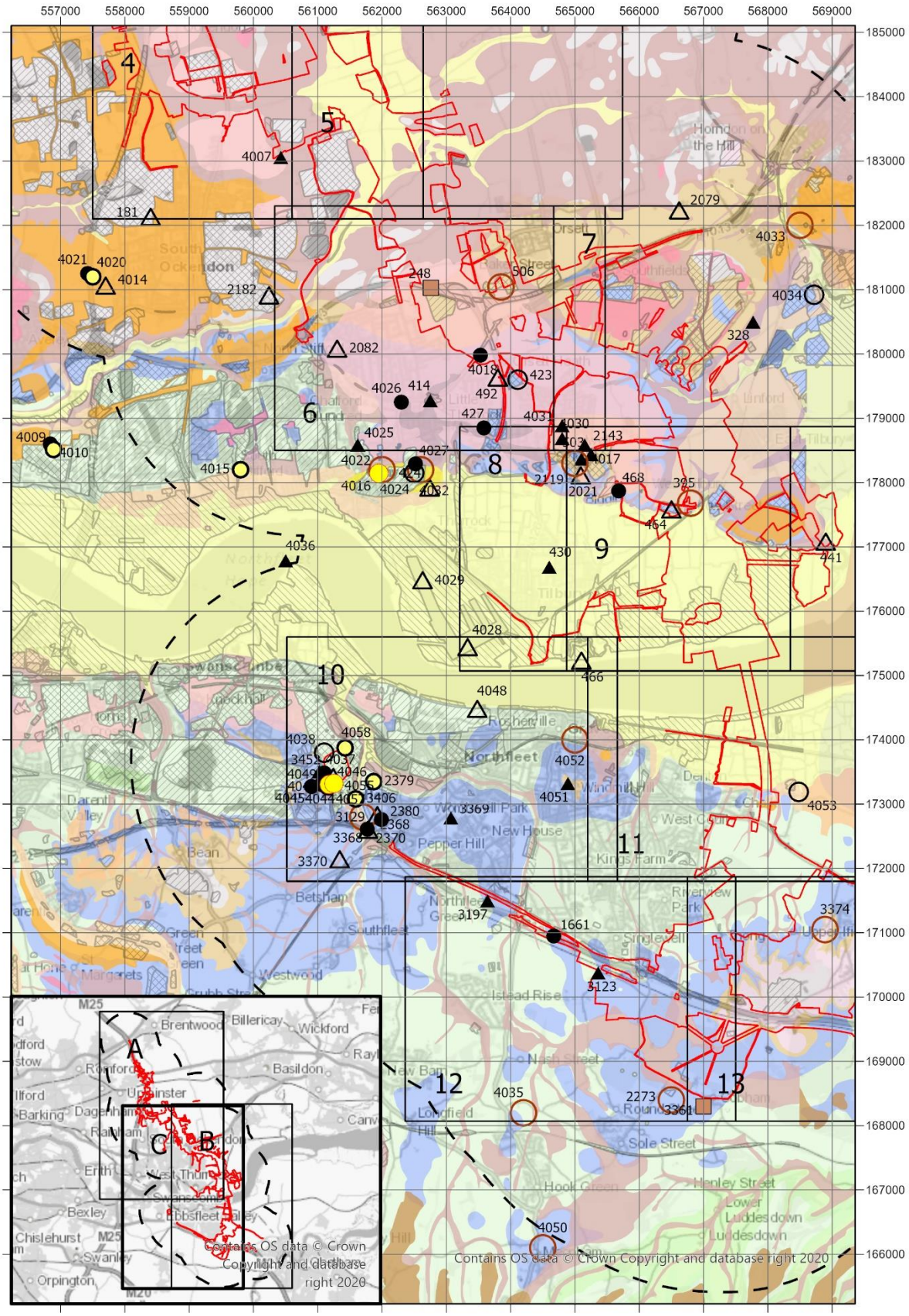


**Figure 6.** Lower Thames Crossing (southwest - Map C): statutory consultation footprint (January 2020) with 3km buffer, Quaternary transects and Palaeolithic sites. [see **Figure 3** for geological key]. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

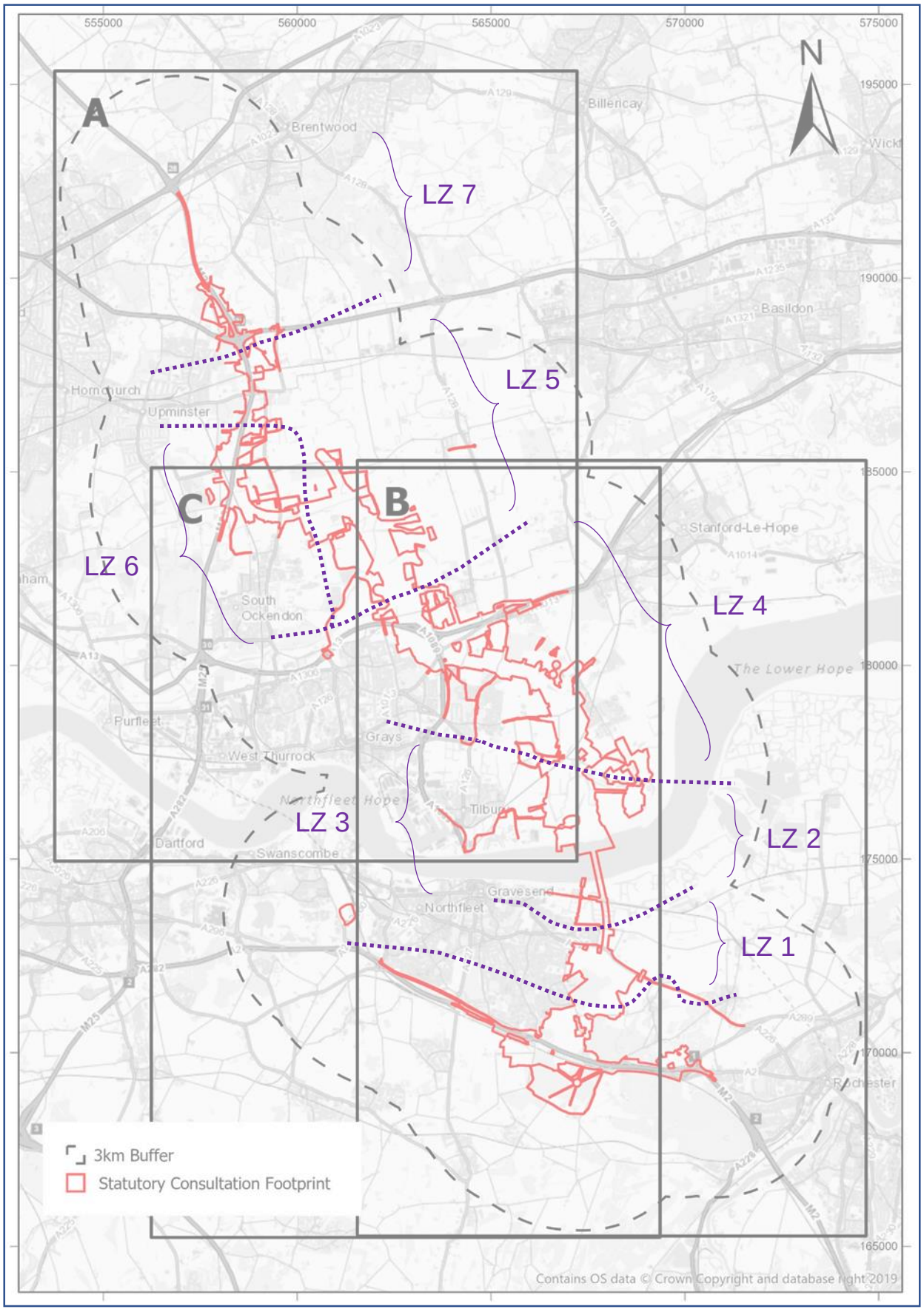


**Figure 7.** LTC geomorphological landscape zones, LZ1-7.

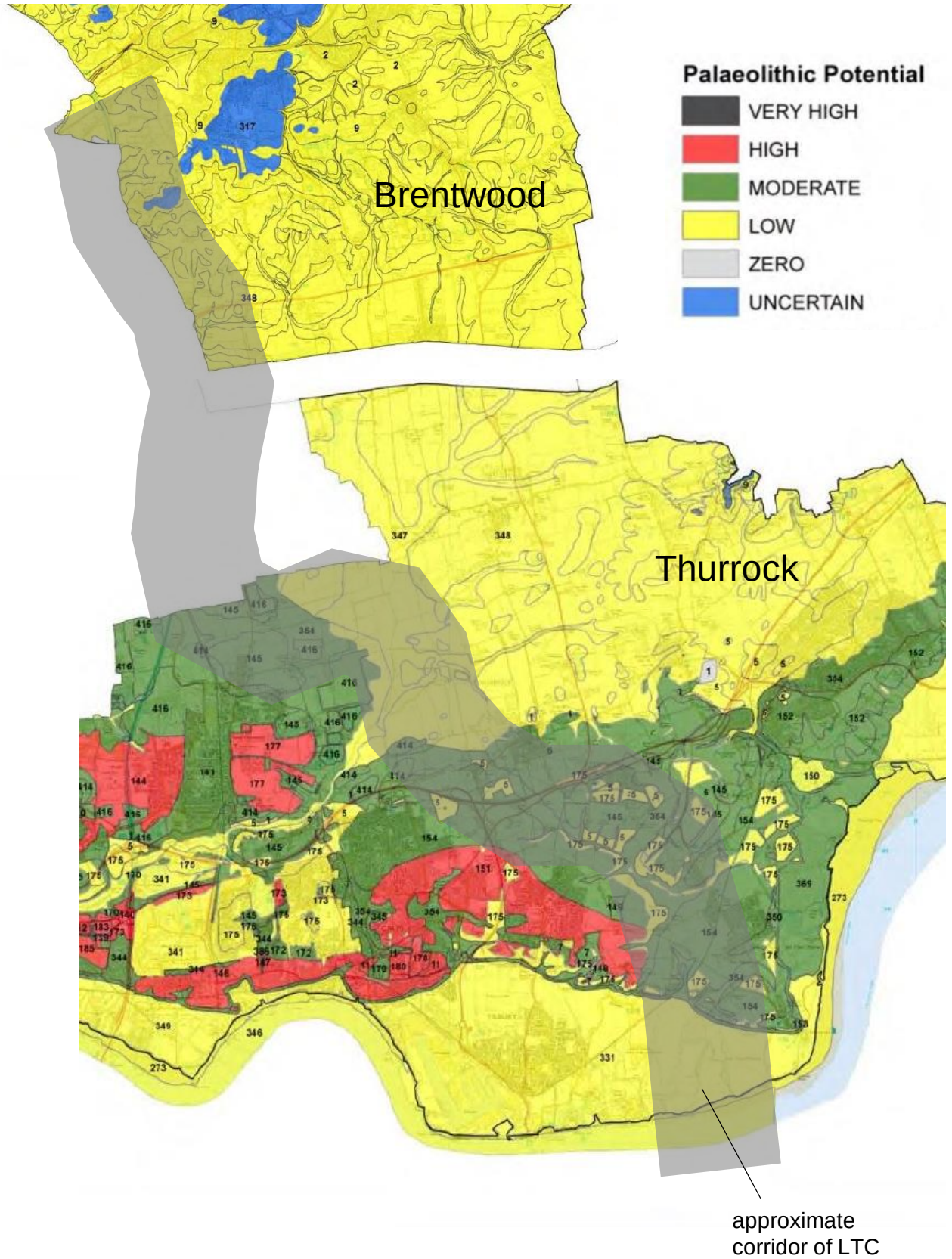


**Figure 8.** LTC corridor in relation to the *Managing the Essex Pleistocene* predictive model of Palaeolithic potential.

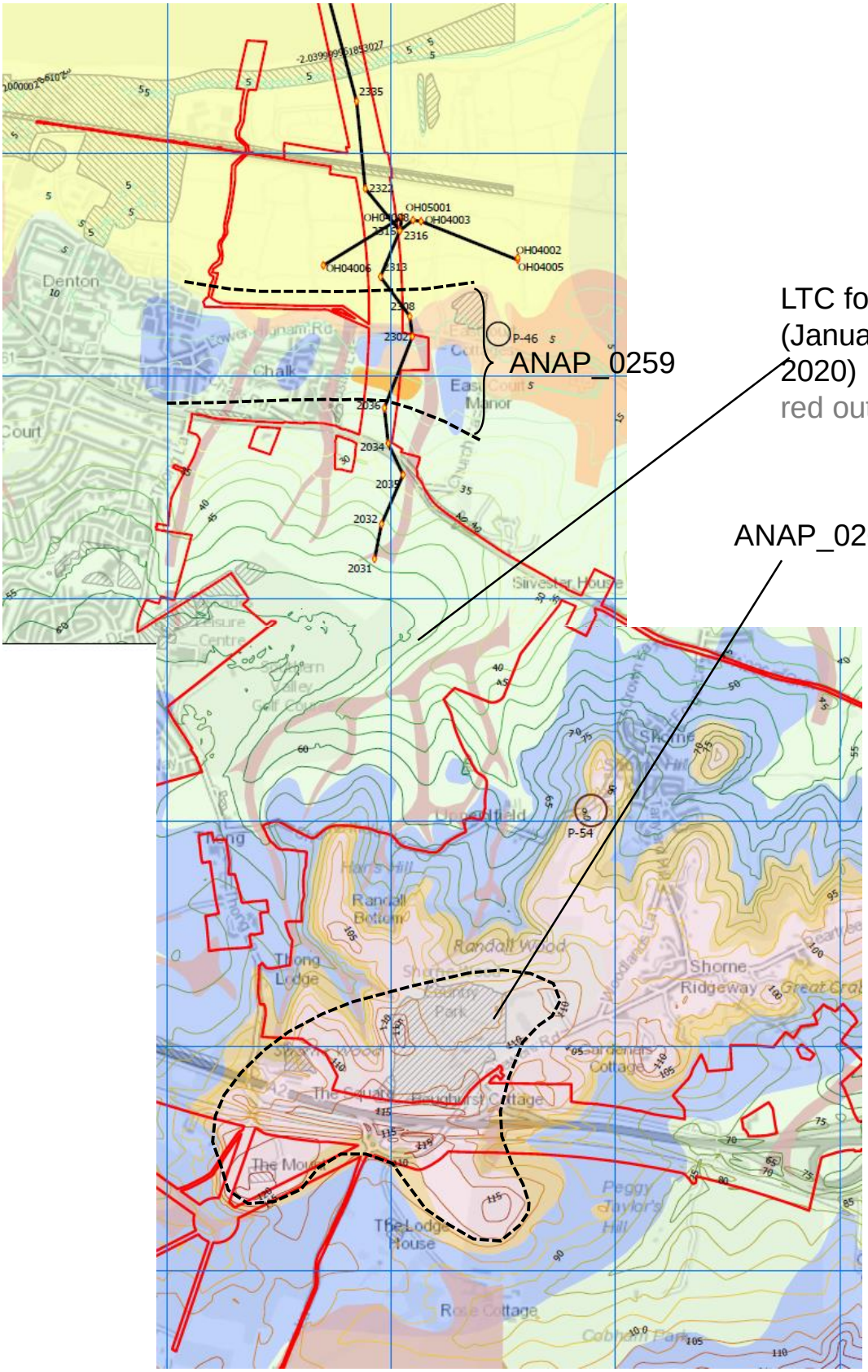


**Figure 9.** Kent Archaeological Notification Areas (Palaeolithic): ANAP_0259 and ANAP_0267.

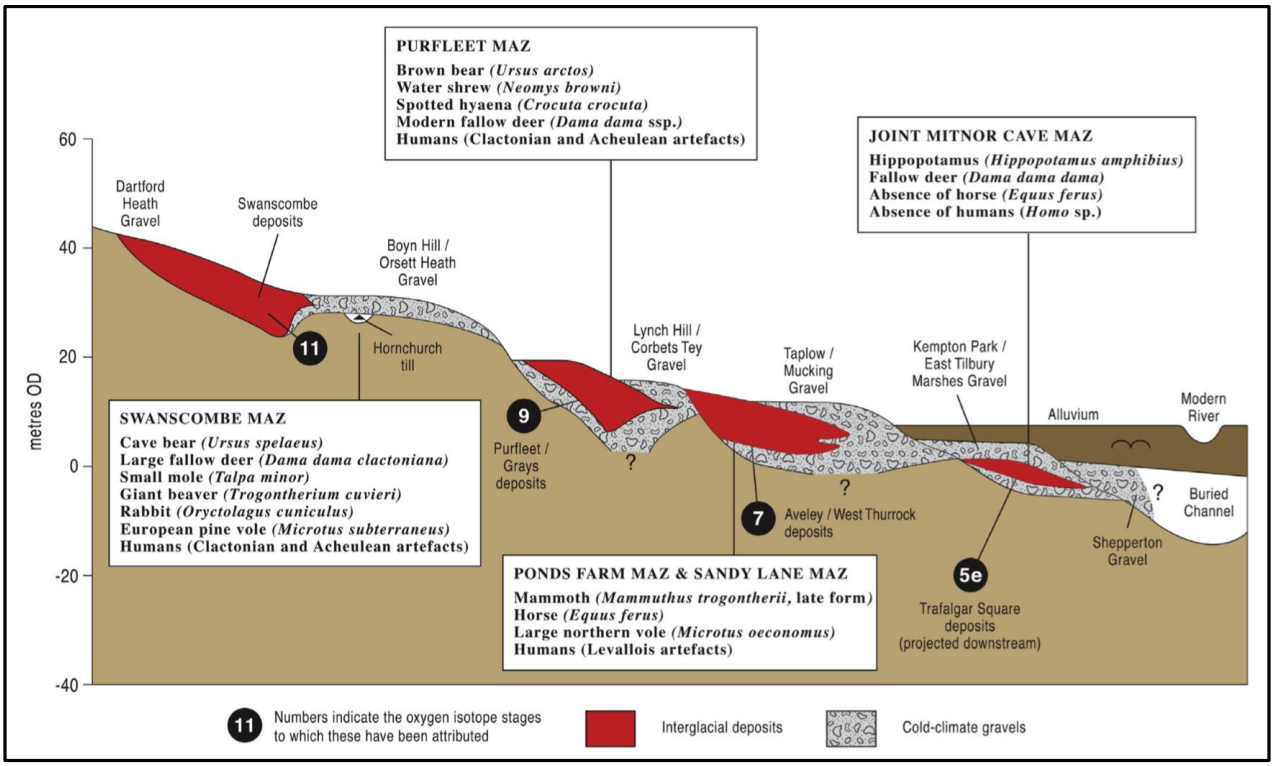


**Figure 10.** Idealised transverse section through the Thames terrace staircase with features of the Mammalian Assemblage-Zones (MAZ); correlation with the marine oxygen isotope record indicated (from White *et al.* 2018).

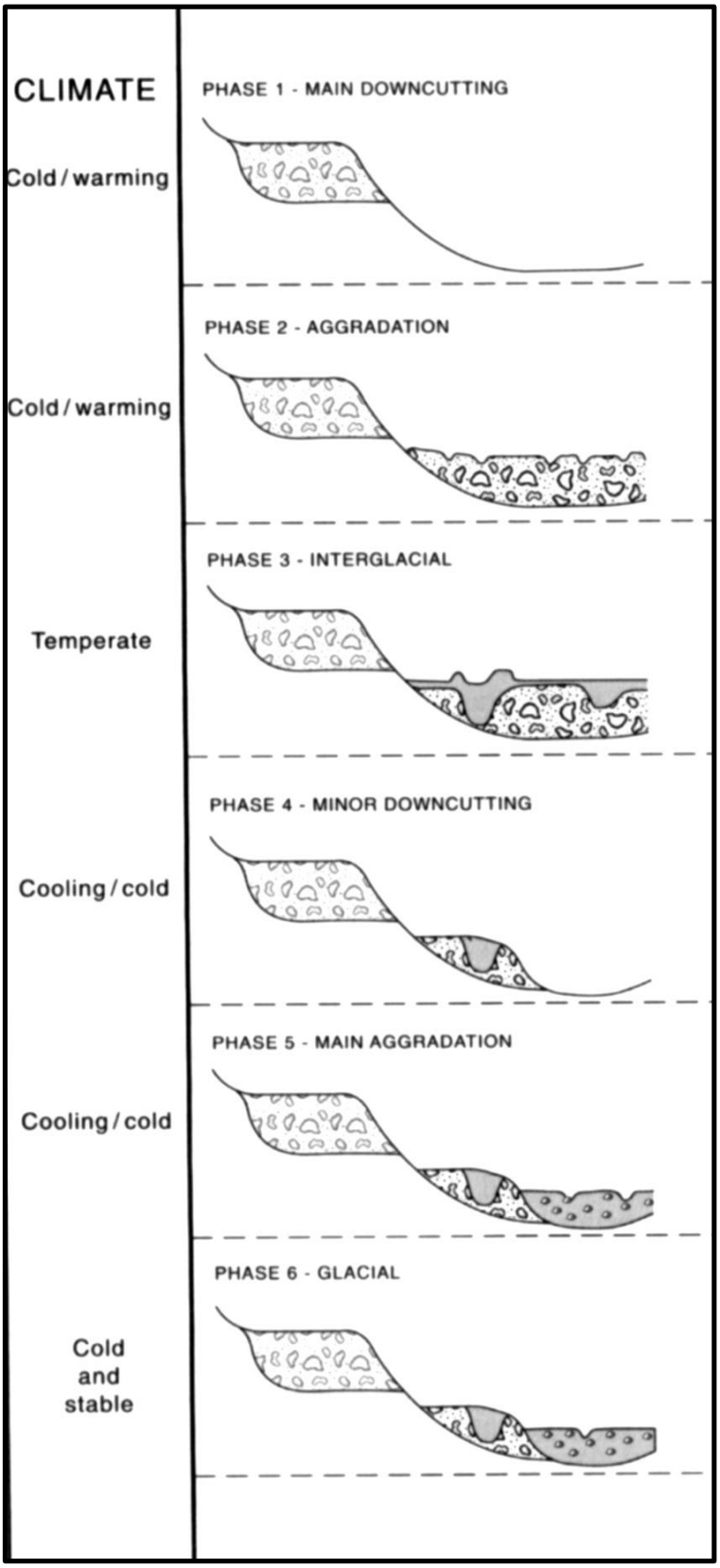


**Figure 11.** Formation of river terraces in synchrony with Quaternary climate change based on evidence from the Lower Thames (Bridgland 2006).

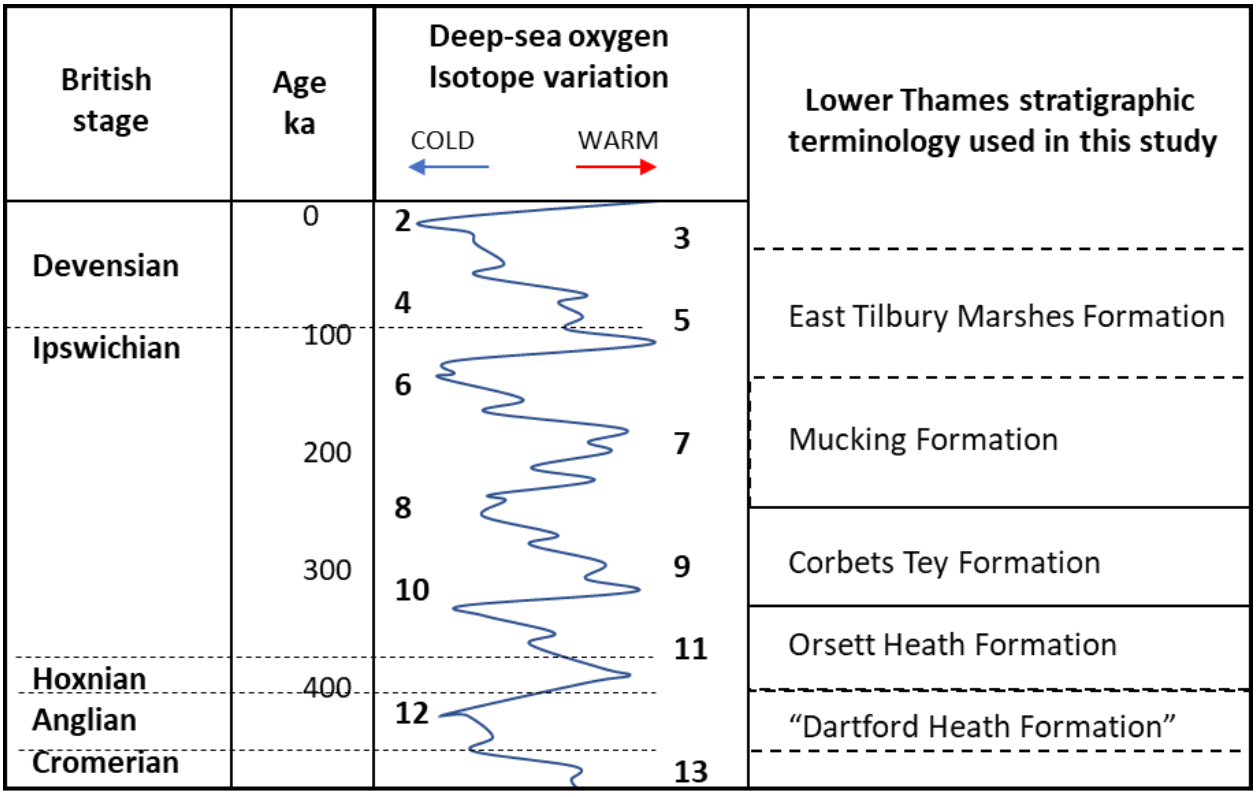


**Figure 12.** British Stage names, ages and marine isotope stages for the key stratigraphic units recognised in the Lower Thames Valley.

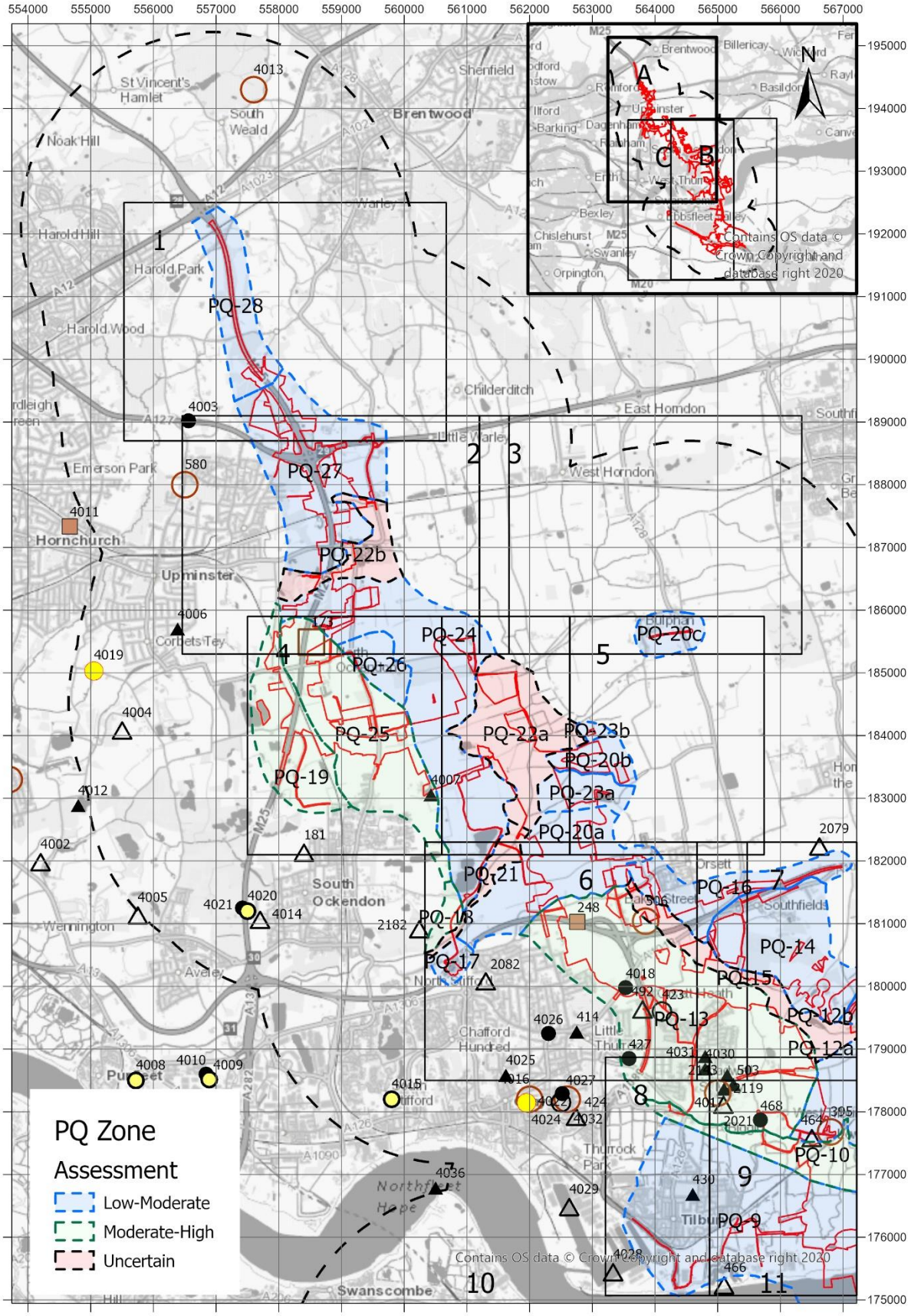


**Figure 13.** PQ zones overview (north), Map A. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

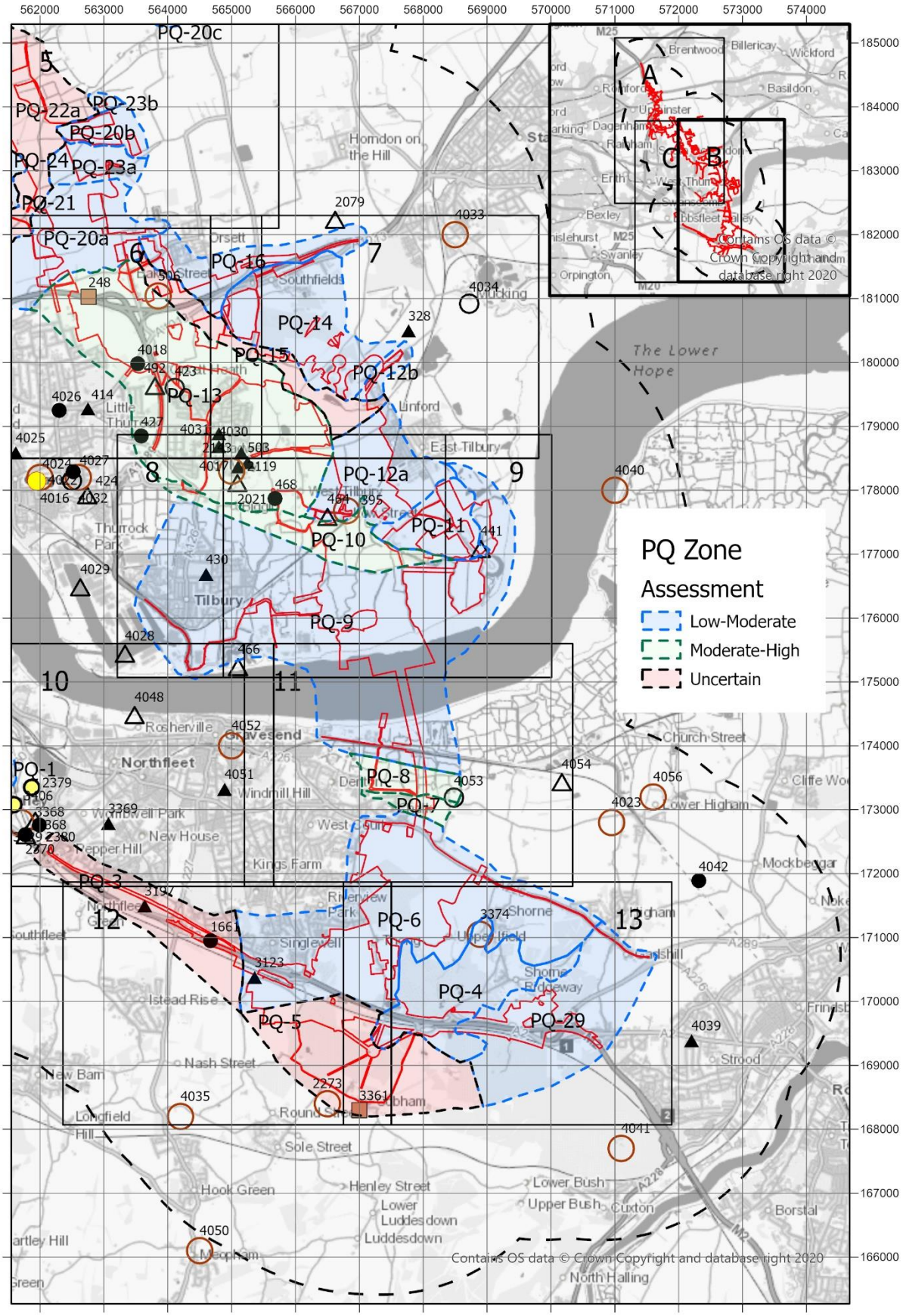


**Figure 14.** PQ zones overview (southeast), Map B. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

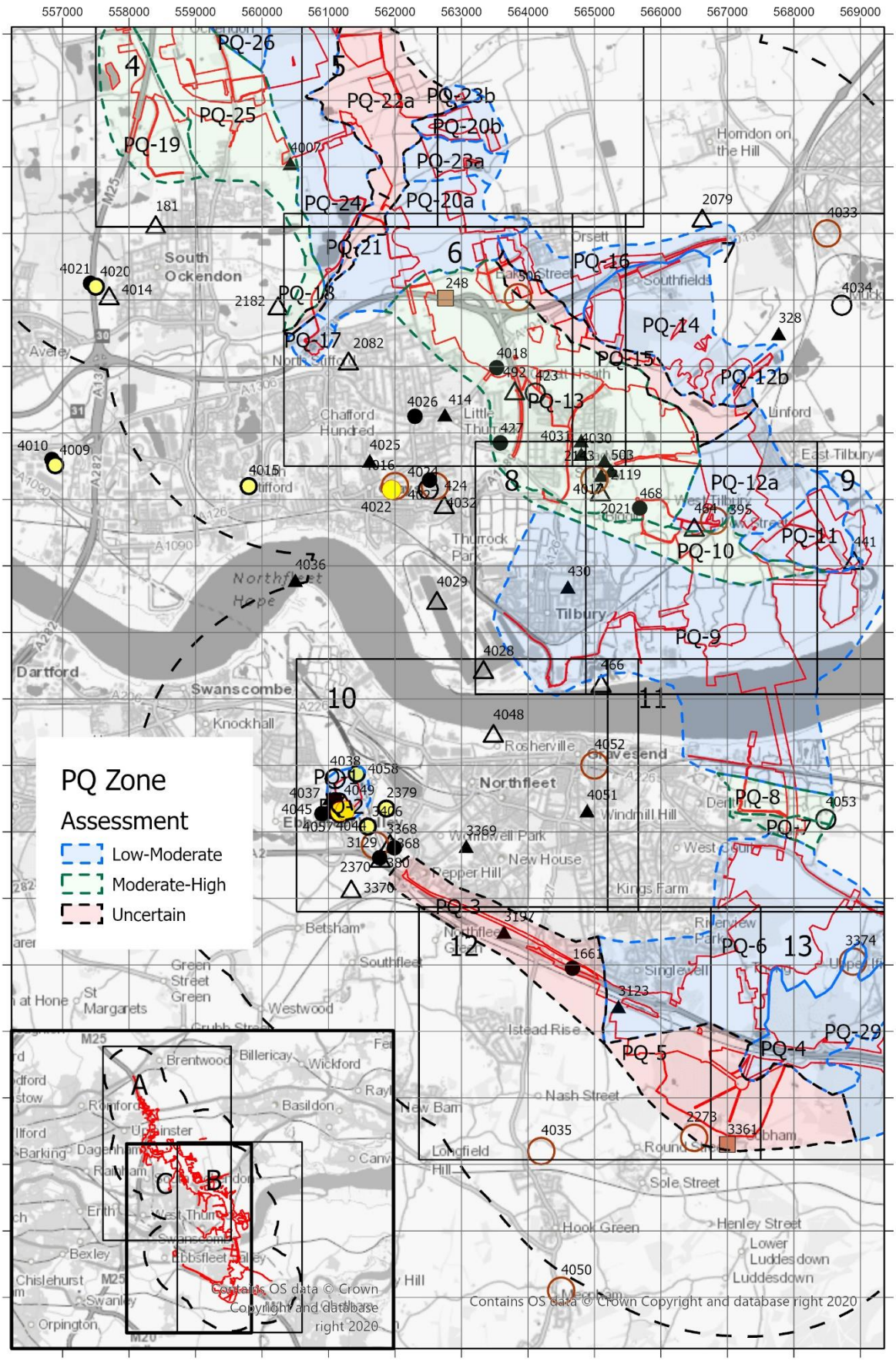


**Figure 15.** PQ zones overview (southwest), Map C. [Crown copyright OS mapping data reproduced under HE Licence 100030649]

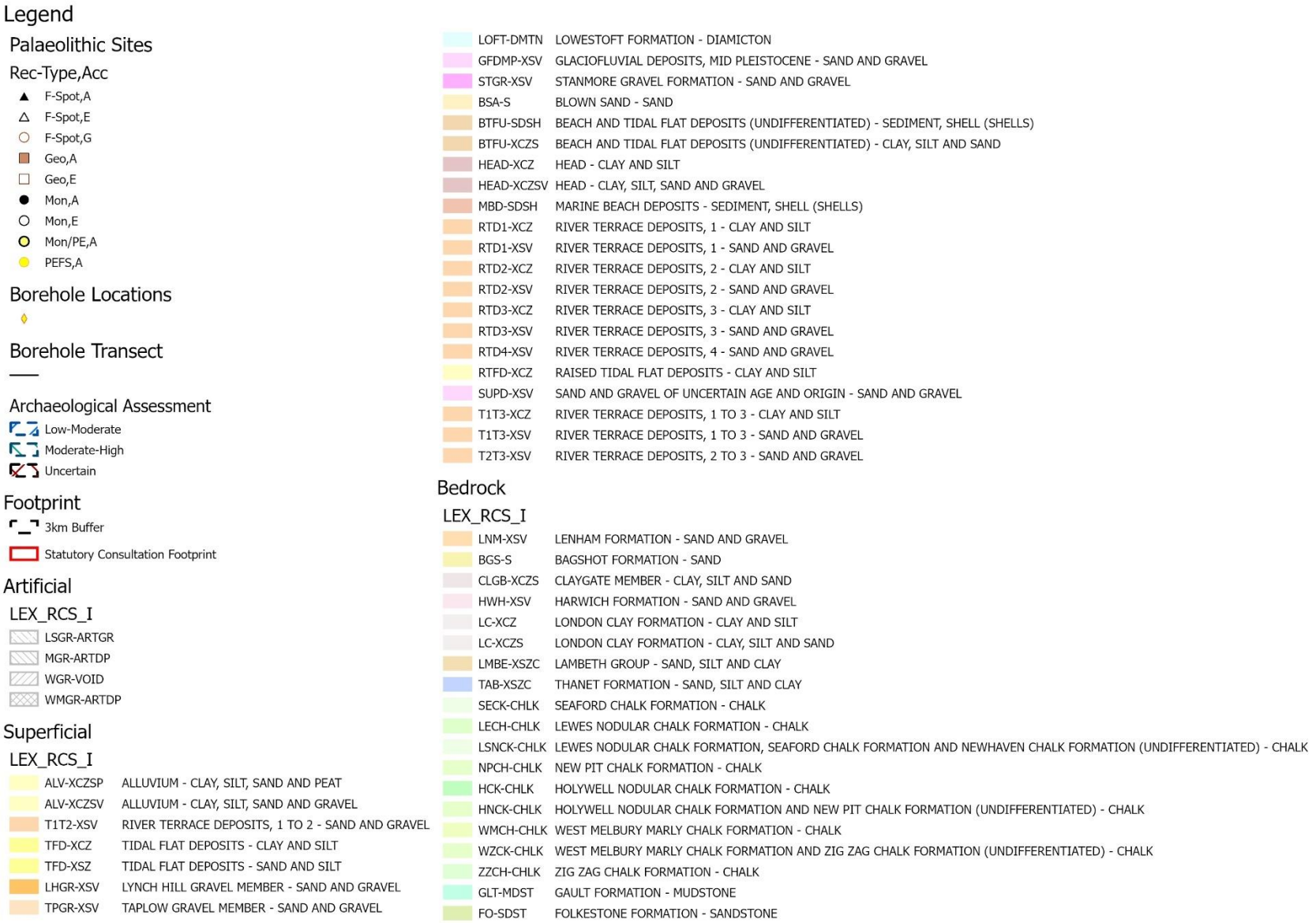


**Figure 16.** Geological mapping key, and legend for other data. [Geological mapping data reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

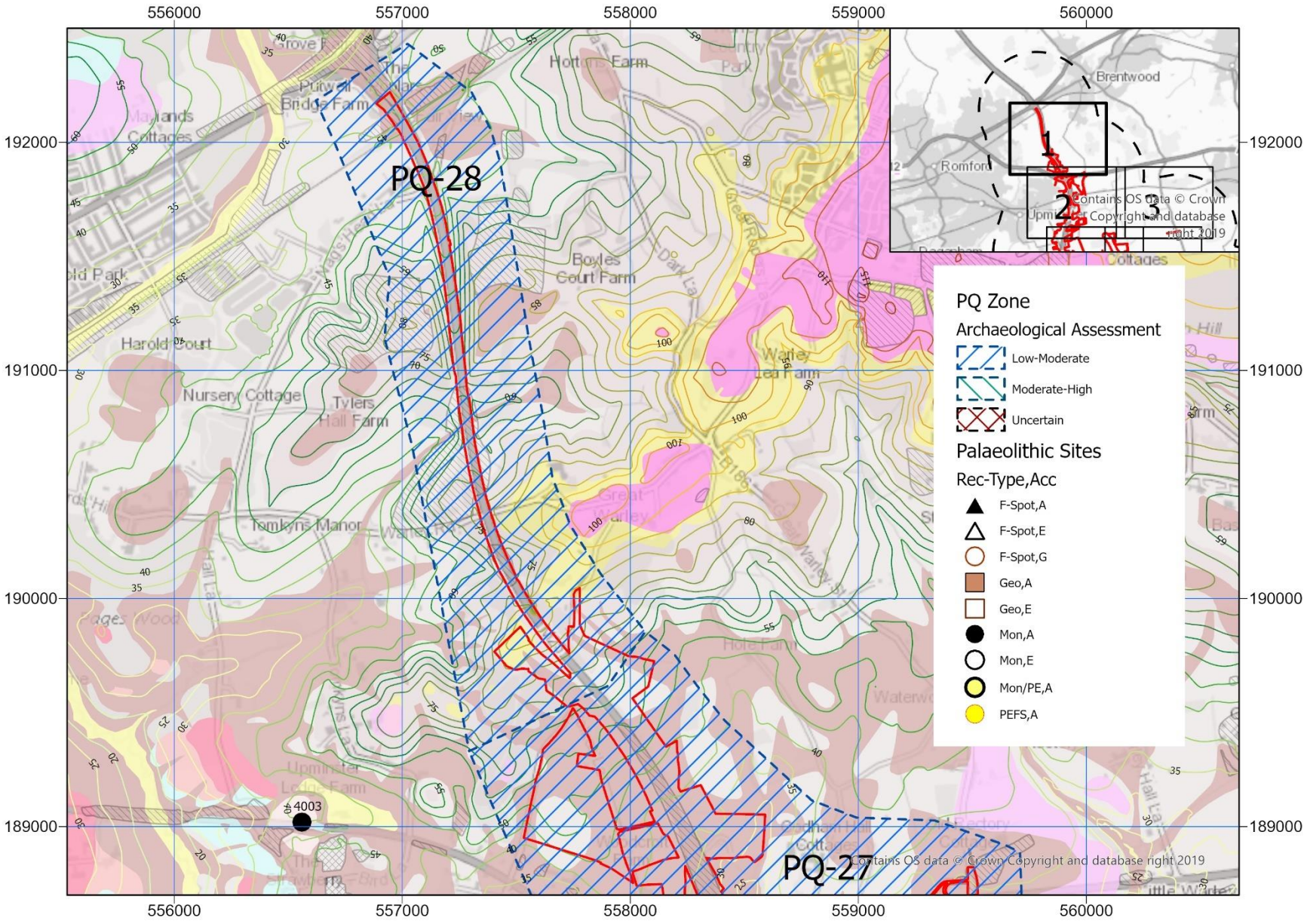


**Figure 17.** PQ zones, Map 1. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

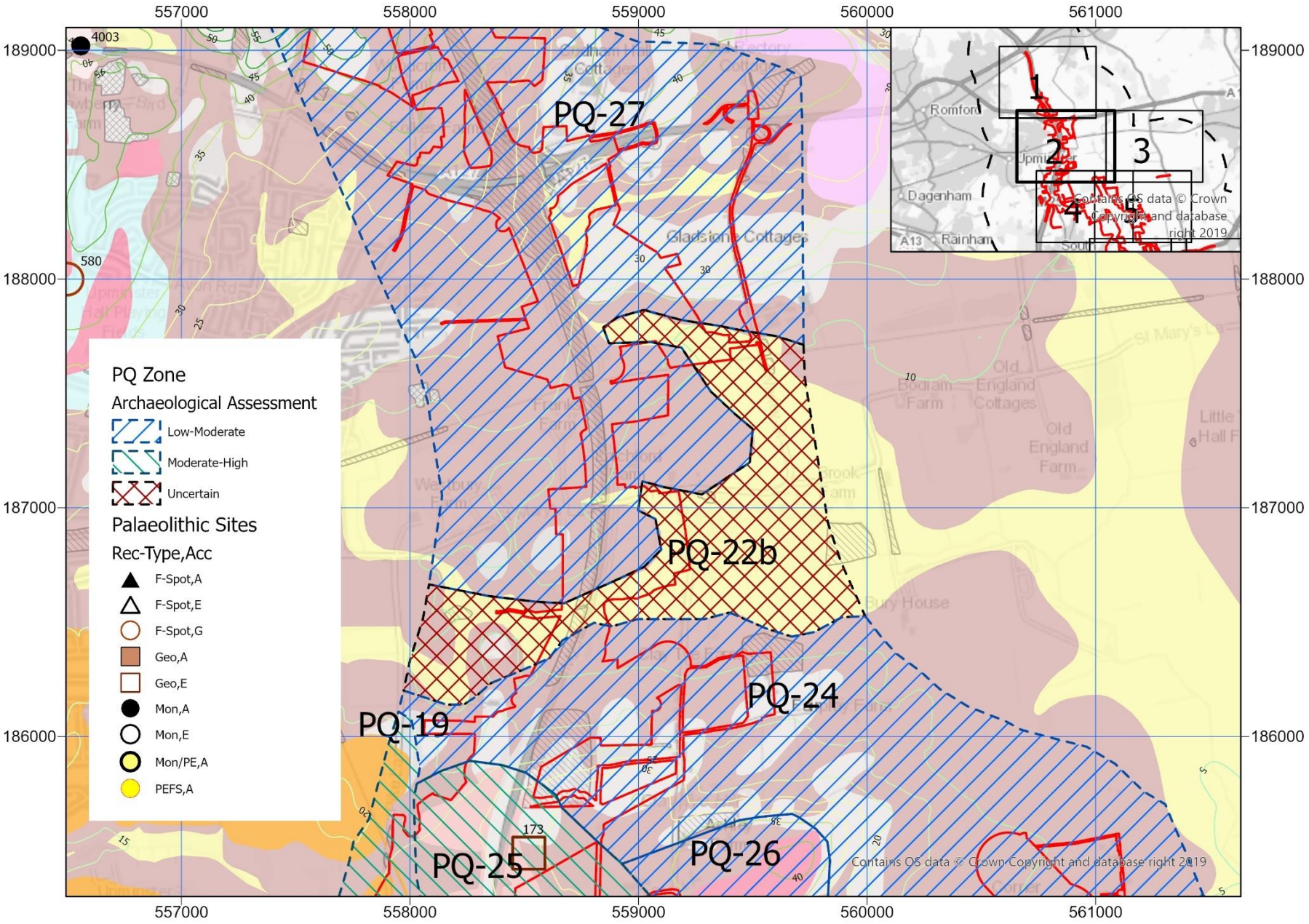


**Figure 18.** PQ zones, Map 2. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

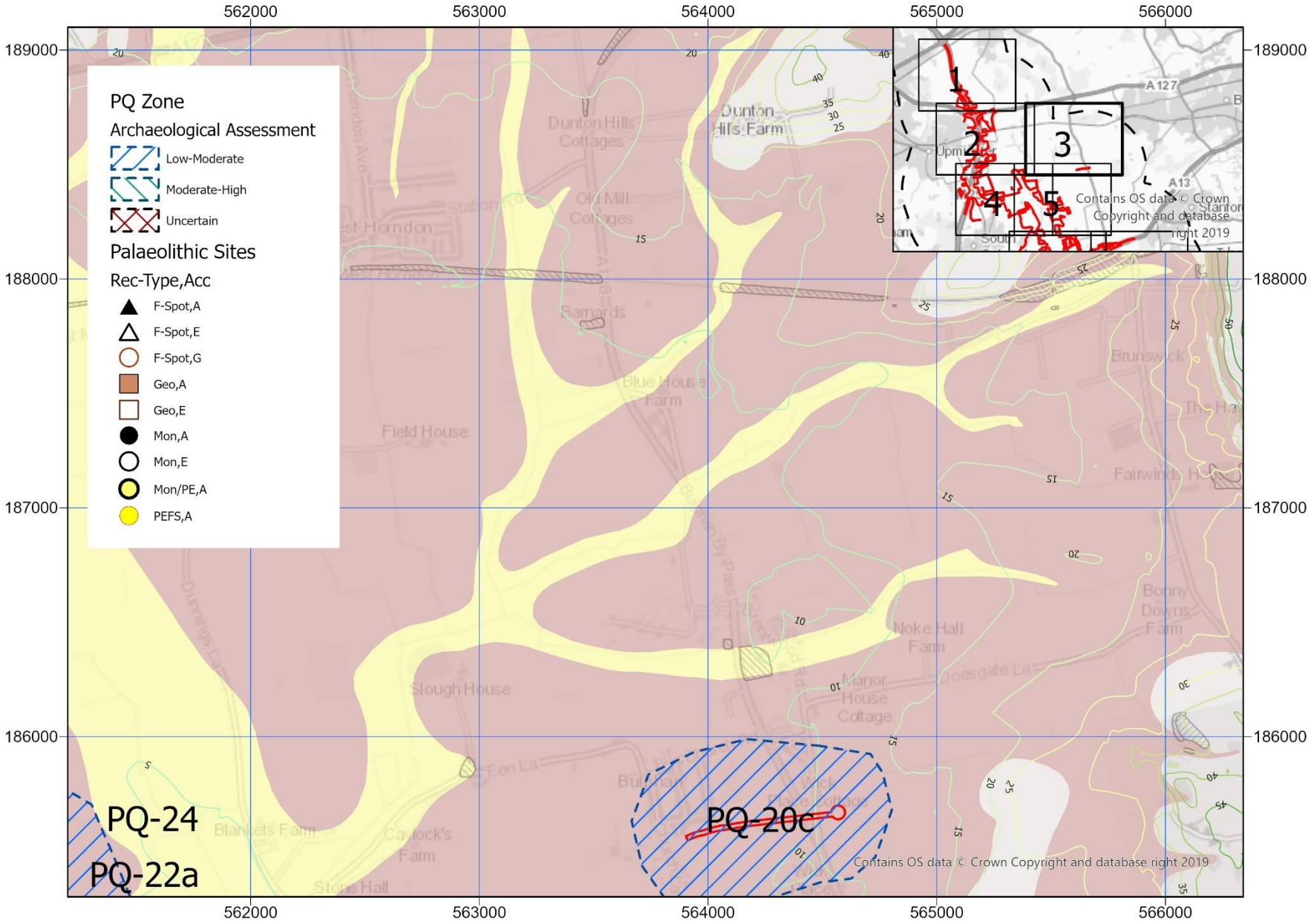


**Figure 19.** PQ zones, Map 3. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

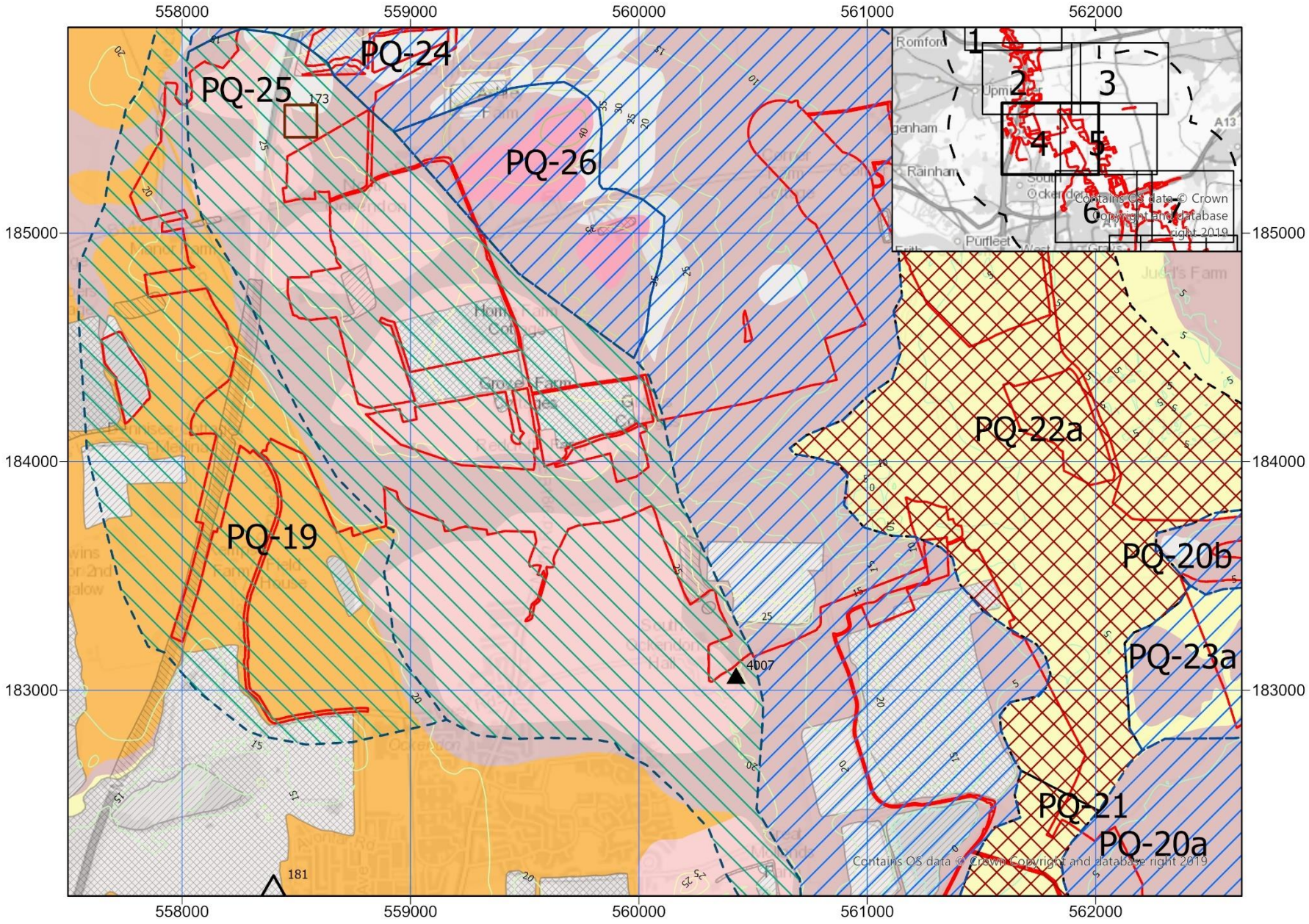


**Figure 20.** PQ zones, Map 4. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

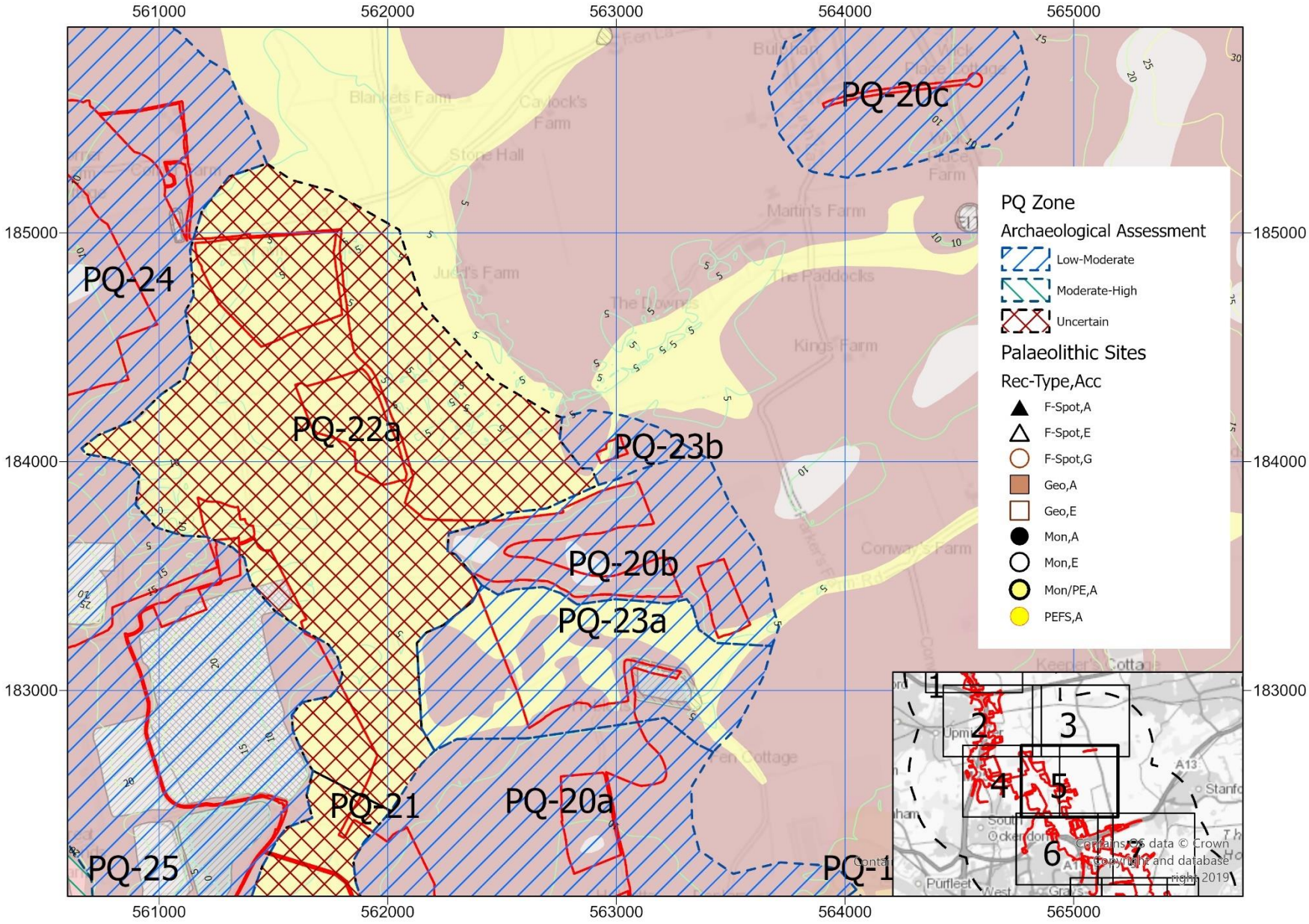


**Figure 21.** PQ zones, Map 5. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

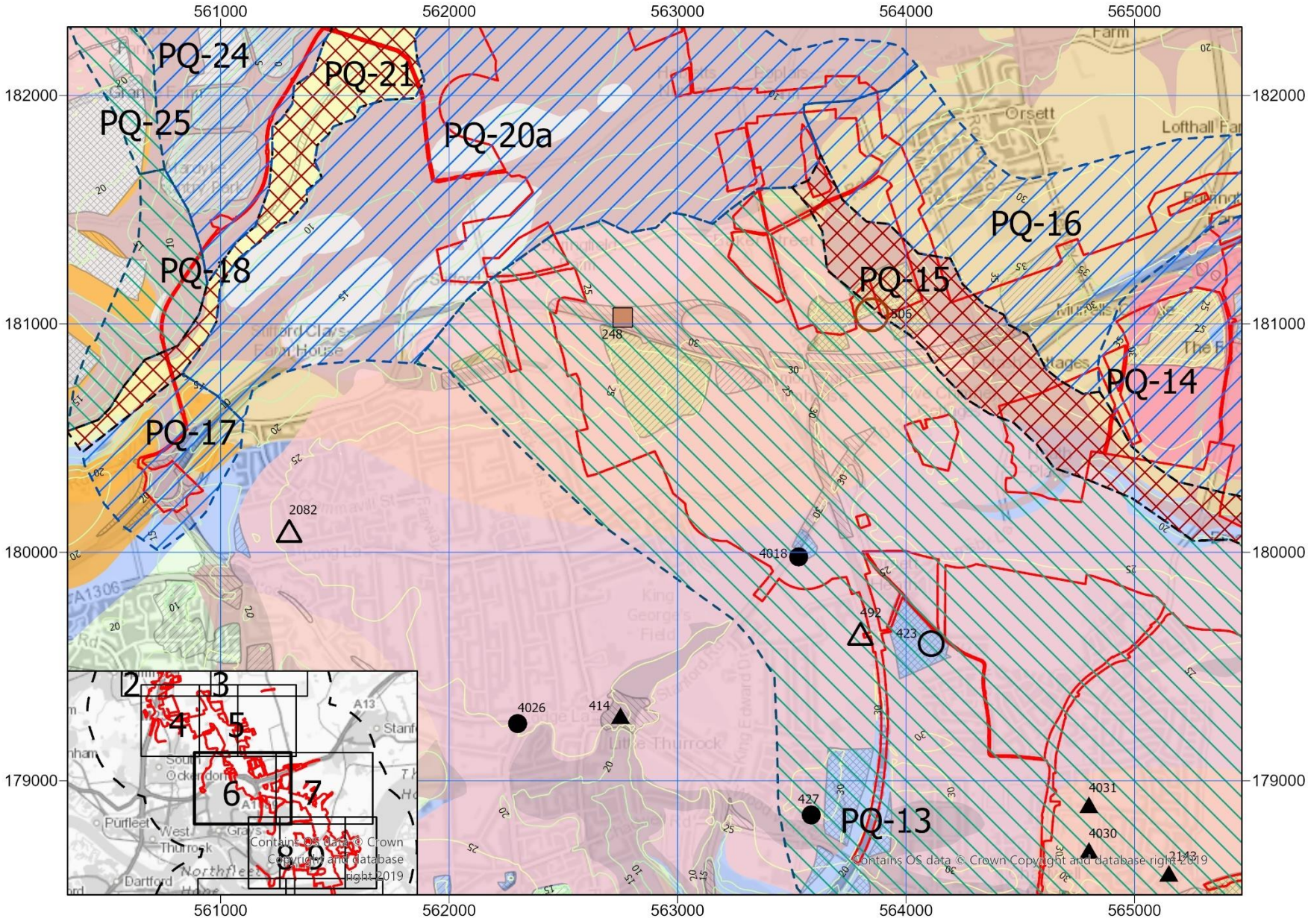


**Figure 22.** PQ zones, Map 6. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

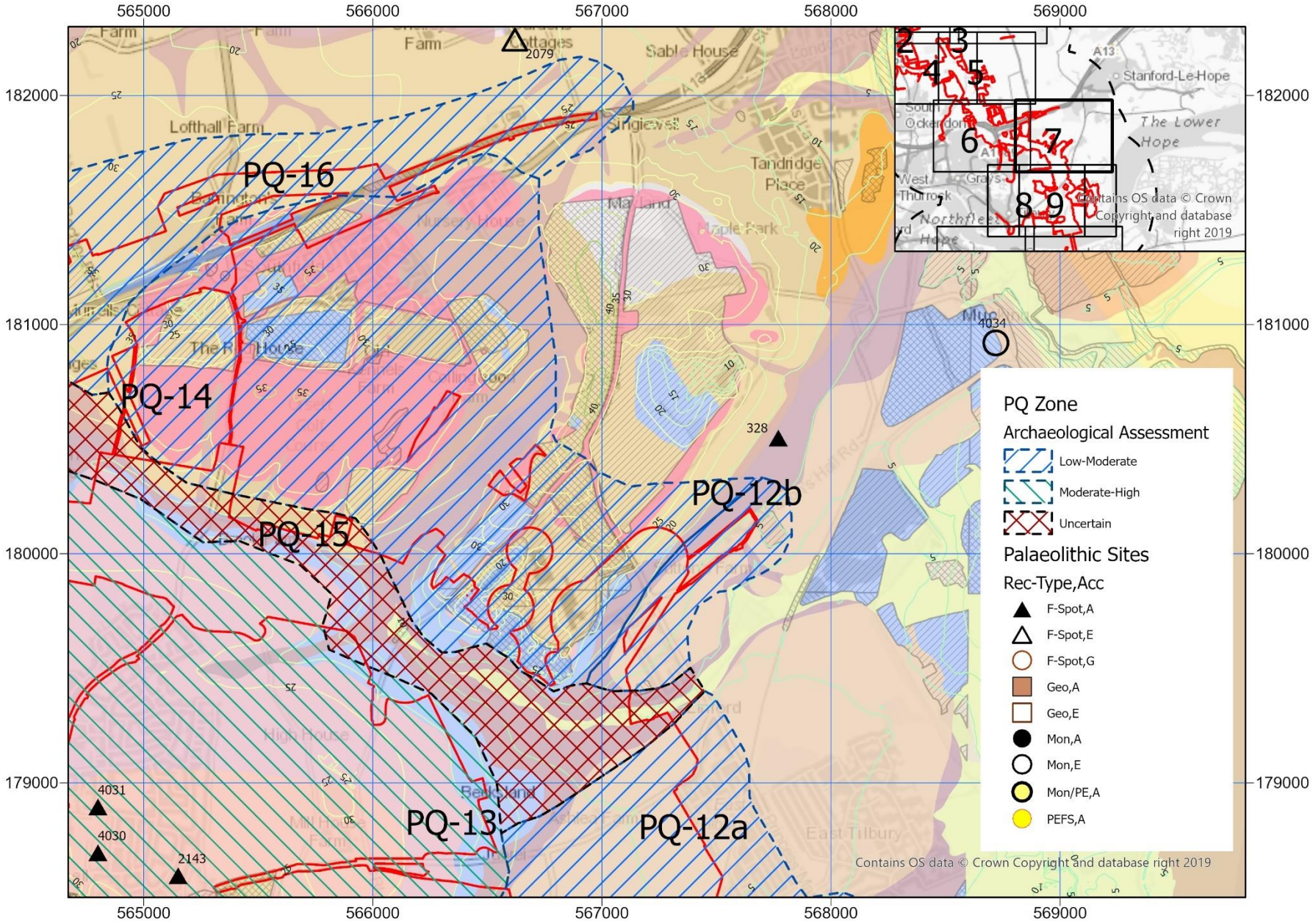


**Figure 23.** PQ zones, Map 7. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

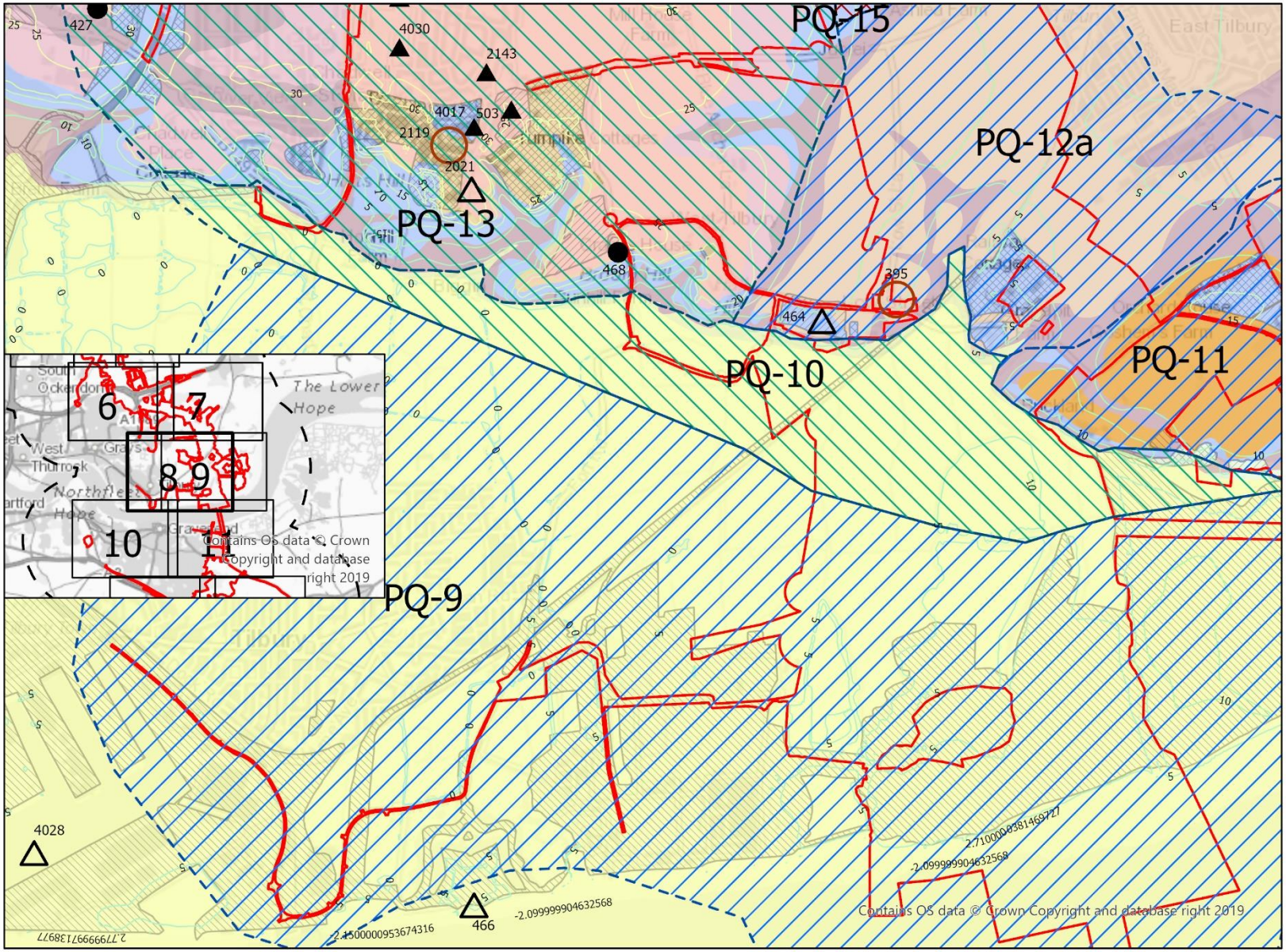


**Figure 24.** PQ zones, Map 8. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

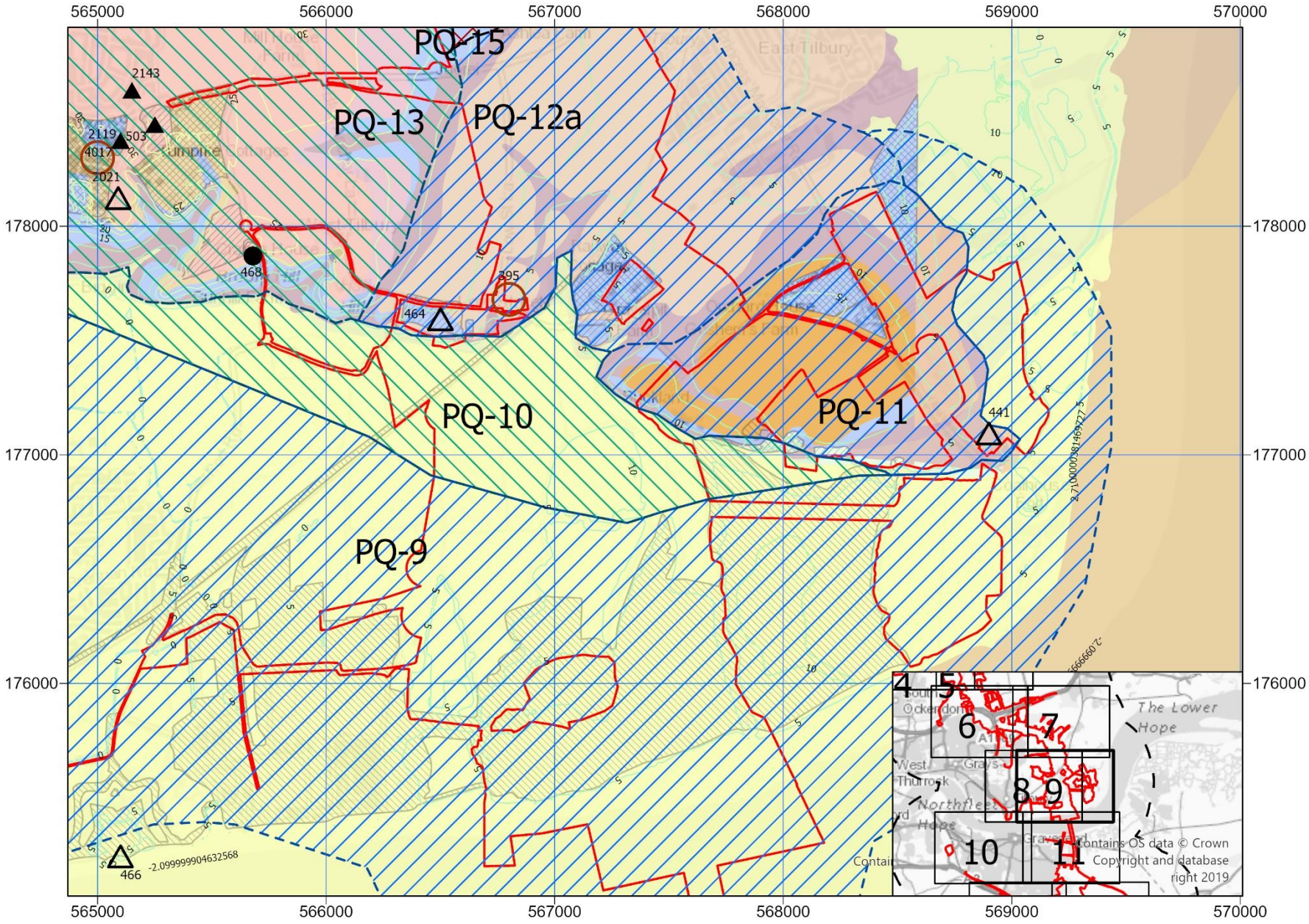


**Figure 25.** PQ zones, Map 9. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

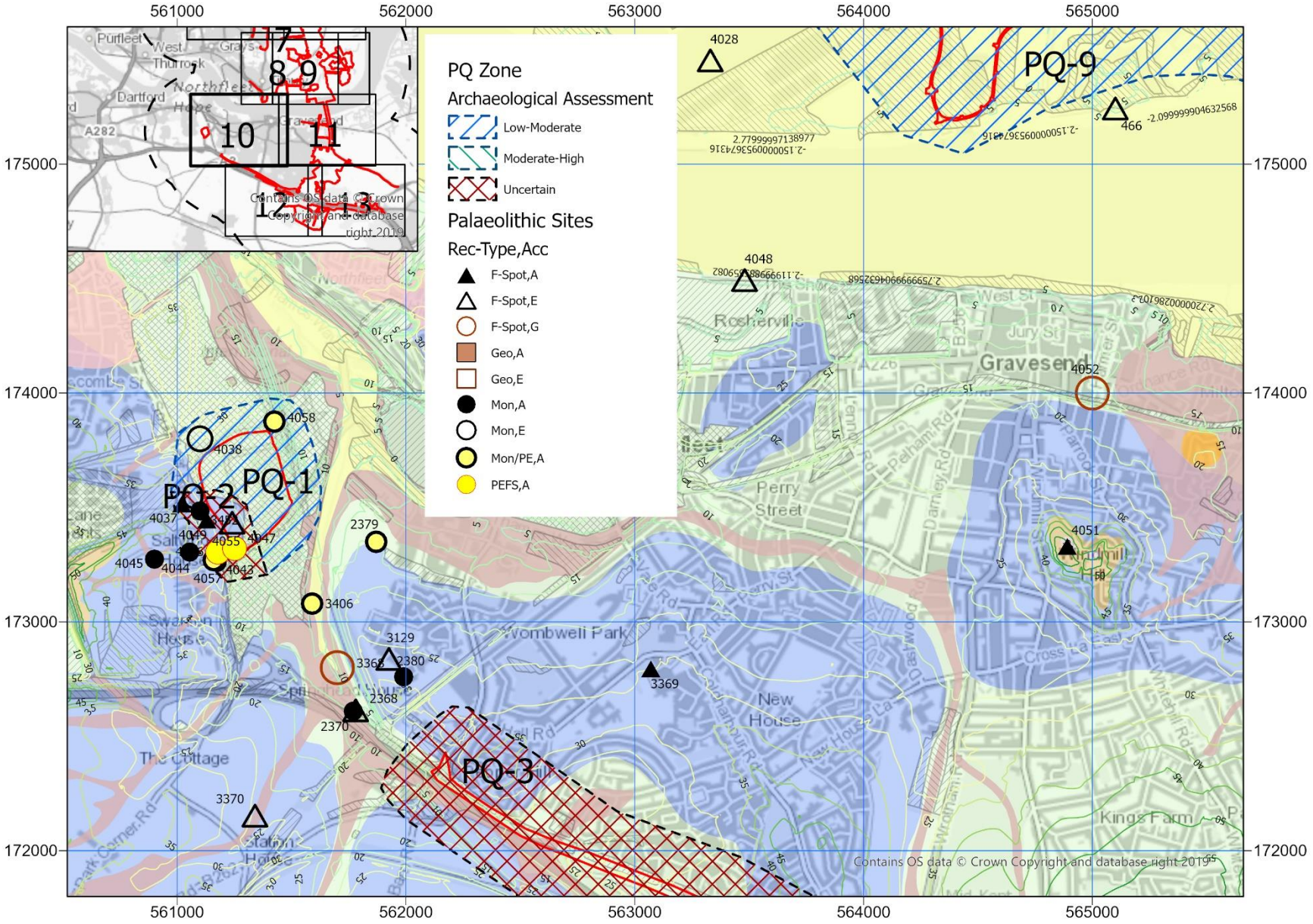


**Figure 26.** PQ zones, Map 10. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

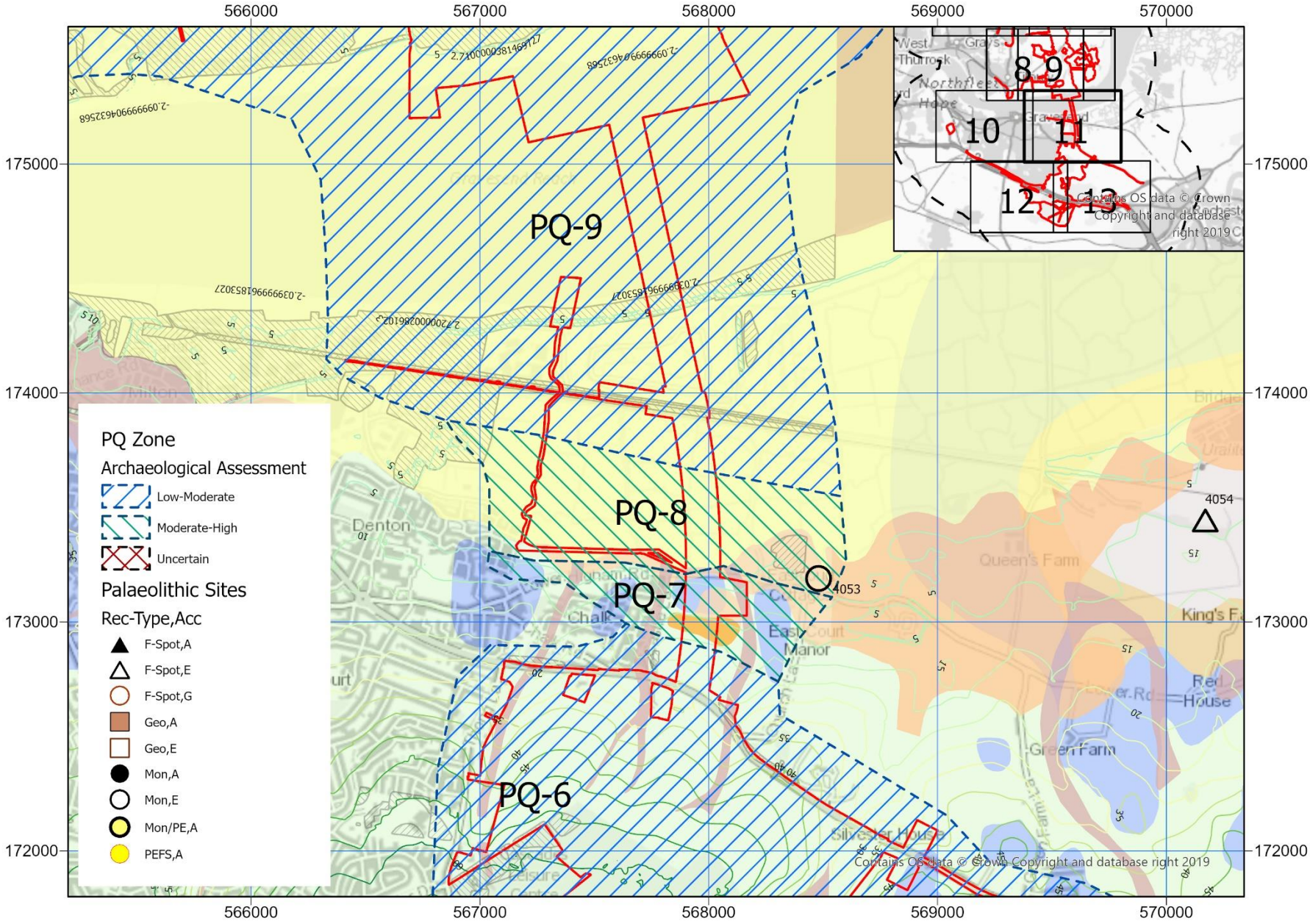


**Figure 27.** PQ zones, Map 11. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

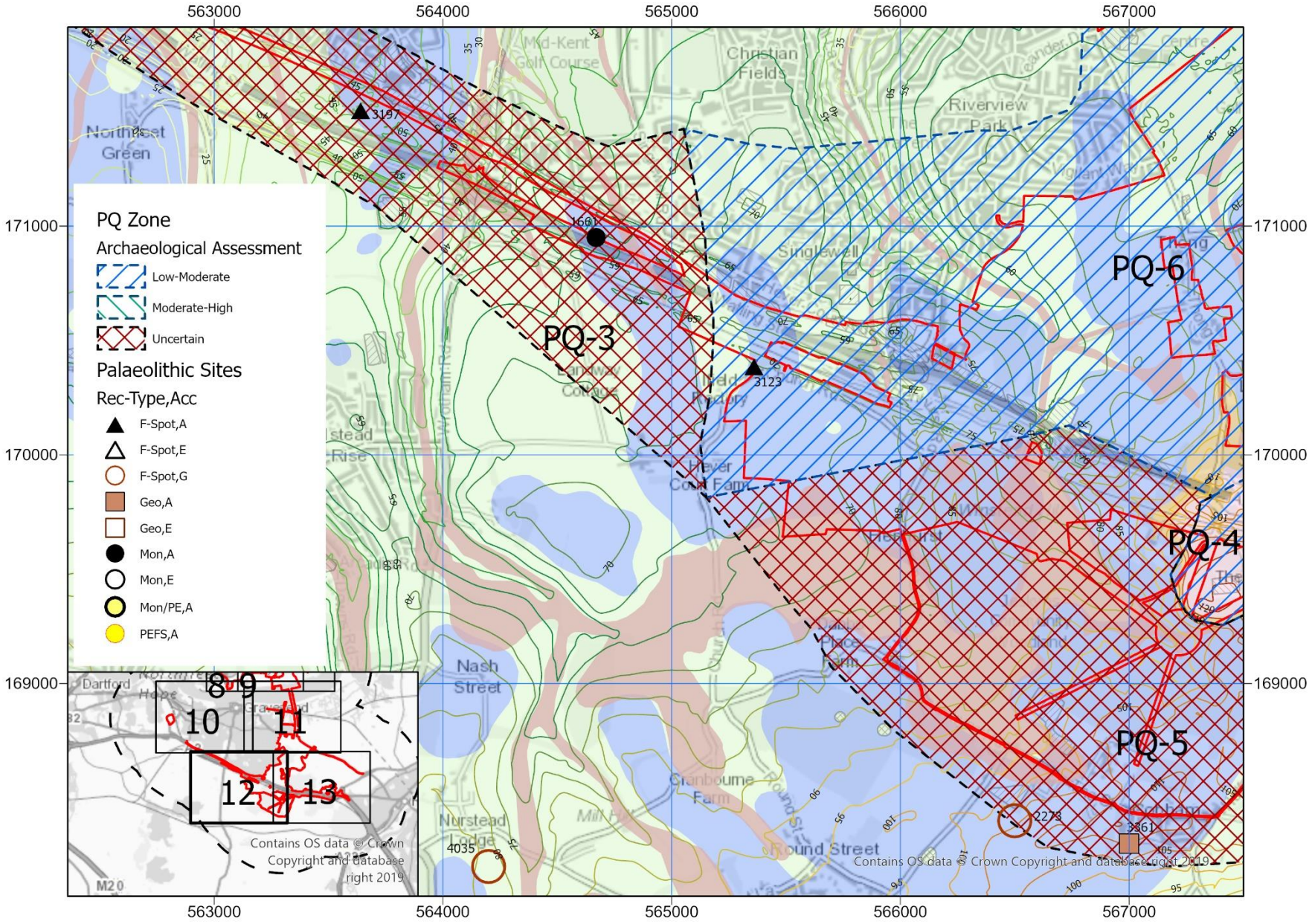


**Figure 28.** PQ zones, Map 12. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

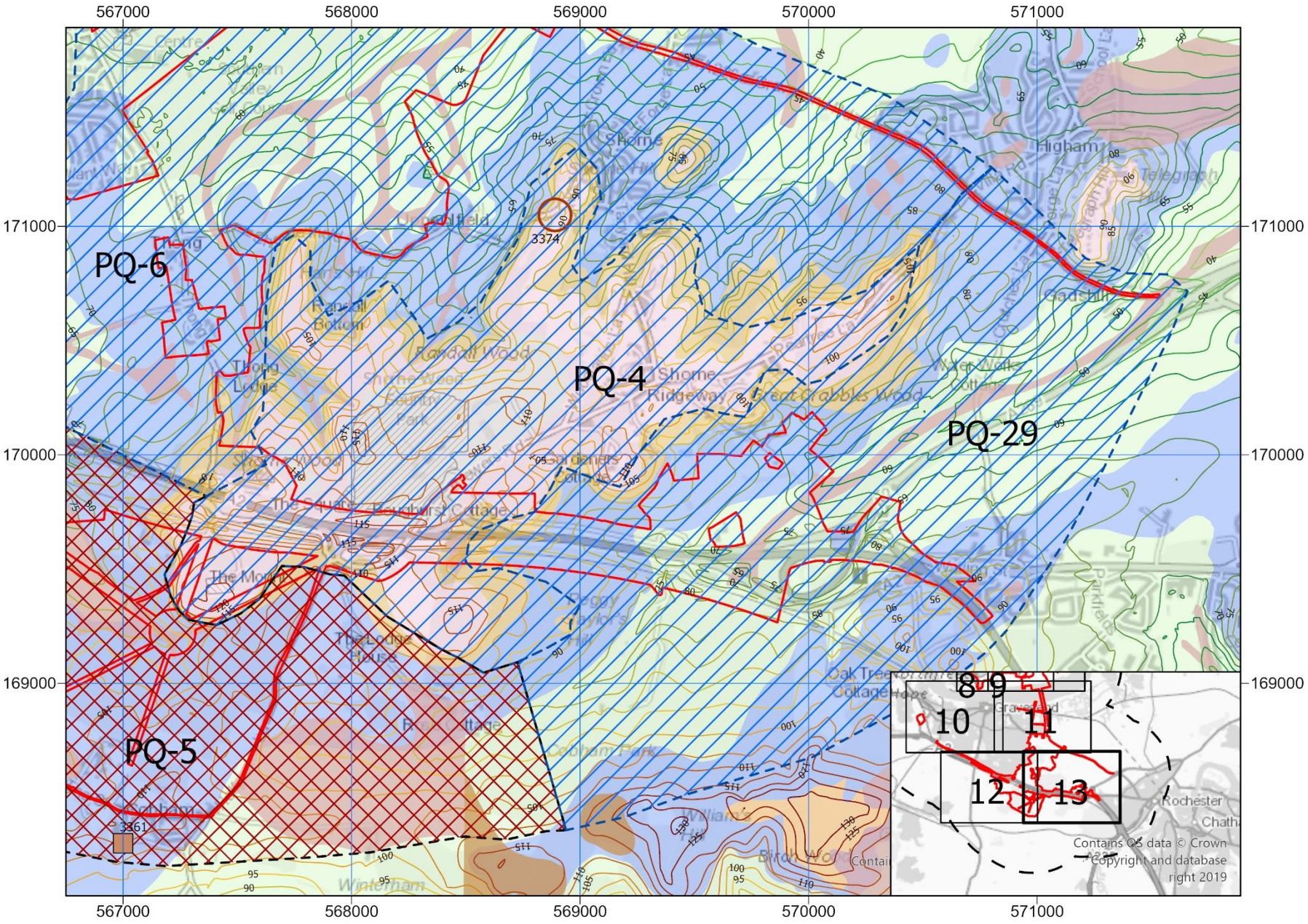


**Figure 29.** PQ zones, Map 13. [Crown copyright OS mapping data reproduced under HE Licence 100030649; geological mapping reproduced under Licence 2017/004 British Geological Survey © NERC. All rights reserved]

# Annexes

# Annex A Glossary of acronyms and technical terms

# Annex A.

# Glossary of acronyms and technical terms

## A.1. Glossary, and acronyms

AAR - acronym for *amino acid dating* (qv)

Amino acid dating - a form of *chronometric dating* (qv) that relies on identifying chemical changes (racemisation) in snail shell during sustained burial

BP - years Before Present; the "present" is technically defined as being in 1950 AD, but precision between AD and BP is mostly unnecessary in the Palaeolithic (apart from in its younger Upper Palaeolithic stage) since its timescales are mostly in the 10s and 100s of thousands of years

Bio-stratigraphy, Bio-stratigraphic dating - dating correlation based on faunal remains, either by a distinctive assemblage of species, with key indicator species present or absent; or by distinctive characteristics of a species, such as changing root-length of water-vole molars or changing spacing of mammoth tooth enamel plates

Chronometric dating - methods of dating that rely directly upon measuring a quantifiable attribute or characteristic, such as proportions of certain chemical compounds (C14 dating or *AAR* - qv), or red light emitted when heated (*OSL dating* - qv)

Clast - a larger-sized constituent in a generally fine-grained deposit, such as a flint pebble in a silty/sandy matrix

DBA - Desk-based Assessment

DCO - Development Consent Order [Act of Parliament that supports delivery of a major project such as LTC (qv)]

Designated - when not being used in a non-specific way, this refers to particular heritage assets that have been designated as having some particular important status, such as being a Scheduled Monument or Site of Special Scientific Interest

DMRB - Design Manual for Roads and Bridges (Highways Agency 2009) - see section "**References**" for main SPAA & RF (qv)

EIA (Scoping Report) - *Environmental Impact Assessment Scoping Report* [LTC (qv) project document produced in October 2017 that reviews the general approach to assessing and mitigating environmental impact, and summarises key relevant information]

Epoch - technical term for sub-divisions of the geological record; *Pleistocene* (qv) and *Holocene* (qv) are properly epochs of the *Quaternary Period* (qv)

ES - *Environmental Statement* [document produced to support the DCO (qv)]

EUP - Early Upper Palaeolithic (qv)

Fluvial - river-related

GI - Ground Investigations, geotechnical investigations (test pits, boreholes, etc) carried out at an early stage of the project process, to inform civil engineering work

Glacial - a distinctly cold episode in the climatic oscillations of the *Quaternary* (qv); this is the correct term for a cold *stage* (qv), and is not synonymous with *glaciation* (qv), which specifically relates to ice-sheet development

Glaciation - ice-sheet development; this typically occurs during cold *stages* or *glacials* (qv), but is not synonymous with these broader terms

HE - Highways England

HER - acronym for *Historic environment record* (qv)

Historic environment record - lists maintained by local authorities of heritage assets in their area; these underpin curatorial decision-making, so their maintenance with up-to-date records and house-keeping for their accuracy and the inclusion of Palaeolithic remains are essential

Holocene - the warm climatic stage (MIS 1) that has continued since the end of the last glacial (the Devensian) approximately 11,700 BP (years Before Present) up to the present day

Hominin - the branch of the human family tree that includes all species, living or extinct, since its divergence from the line that leads to the living apes that are our closest evolutionary relatives (chimpanzees and gorillas)

Interstadial - a warm oscillation within a prolonged and predominantly cool, or cold, stage of the *Pleistocene* (qv), but not so warm or so long as to qualify for full *interglacial* (qv) status

Knap, Knapping - making stone tools by direct percussion, such as with a hammerstone

Lithic - stone, or made of stone; most common raw material for Palaeolithic stone tools in the UK is flint, but other lithic raw material such as chert, quartzite and volcanic tuff were also used, so should not be overlooked

LGM - Last Glacial Maximum, the coldest part of the Last Glacial (the Devensian), between about 24,000 years BP [Before Present] and 15,000 BP

LGS (Local Geological Site) - a site that is considered worthy of protection/recognition for its Earth Science or landscape importance, but is not already protected as SSSI (qv)

LTC - Lower Thames Crossing

LUP - Late Upper Palaeolithic (qv)

Marine isotope stage - numbered peaks and troughs of the global climate curve for the last two million years derived from continuous sedimentary records from the sea-bed; odd numbers represent warm episodes, and even numbers represent cold ones

MEP - *Managing the Essex Pleistocene*. Report produced by Essex County Council (2015) [see **Annex B**]

MIS - acronym for *marine isotope stage* (qv)

NHPP - National Heritage Protection Plan (English Heritage 2011, revised 2013) [**Annex B**]

NPPF - *National Planning Policy Framework*. Government policy and guidance for cultural heritage and planning. Report initially produced in 2012, and then revised in 2019 [see **Annex B**]

NPSNN - National Policy Statement for National Networks

NSIP - Nationally Significant Infrastructure Project

Optically stimulated luminescence - form of *chronometric dating* (qv) applicable to buried sand grains; natural background radiation causes changes in buried sand grains that lead to variation in how brightly they glow when given a controlled optical stimulus

OSL - acronym for *optically stimulated luminescence* (qv)

PEIR - *Preliminary Environmental Information Report*. LTC (qv) project report issued in September 2018 that reviewed the legislative framework applicable to cultural heritage in relation to the new crossing, and reiterated the requirements of the *Environmental Statement* (ES - qv) that will accompany the DCO (qv) application, and the proposed approach to addressing these requirements.

Quaternary, Quaternary Period - The most recent period of geological time, starting *c.* 2.6 million years ago, and containing two epochs, the *Pleistocene* (qv) and the *Holocene* (qv)

Palaeolithic, the "Old Stone Age" - the oldest cultural stage of human, or *hominin* (qv), cultural history, characterised by the manufacture of *lithic* (qv) artefacts; clearly this will occur (and in particular, start) at different times in different parts of the world, depending upon the spread of early artefact-making hominins - has been sub-divided into Lower, Middle and Upper phases in Britain and western Europe

Pleistocene - the older part (or *epoch* - qv) of the Quaternary Period, lasting from c. 2.6 million years BP through to the end of the Last Glacial *c.* 11,700 BP; the Pleistocene is distinguished by a series of cold and warm climatic oscillations, leading to alternating *glacials* (qv) and *interglacials* (qv), marked (in higher latitudes and more mountainous regions) by expansion and retraction of glaciers and more widespread ice-sheets

PQDM - *Palaeolithic and Quaternary Deposit Model* [LTC (qv) project document produced in February 2020 (v1) and then updated in April 2020 (v2) that provides a preliminary assessment of Palaeolithic and geo-archaeological potential for the proposed impact footprint of the LTC (qv)]

SPAA [& RF] - *Standalone Palaeolithic Archaeological Assessment* [*& Research Framework*] [**this document**]. LTC (qv) project document produced in April 2020 that complements the PQDM (qv) and provides more-detailed information on the Palaeolithic potential for different zones of the proposed impact footprint of the LTC (qv), themes and priorities for Palaeolithic work for the LTC archaeological programme, and outline approaches to evaluation.

SHAPE - *Strategic Framework for Historic Environment Activities and Programmes in English Heritage*, policy document published by English Heritage (2008) [see **Annex B**]

SSSI (Site of Special Scientific Interest) - designation by Natural England, of sites that have special scientific interest, usually for geological or environmental reasons; from an archaeological heritage perspective this designation does not have the same statutory weight as being a Scheduled Monument, but it can include important Quaternary sites, and these are almost always of national Palaeolithic importance

Stadial - a cold oscillation within a prolonged and predominantly warm stage of the *Pleistocene* (qv), but not so cold or so long as to qualify for full *glacial* (qv) status

Stage - when not being used in a non-specific way, generally refers to one of the numbered *marine isotope stages* (qv)

Terrace - in the context of Pleistocene (qv) geology, a broadly horizontal landform occurring as a visible step in the side of a river valley; some larger river valleys (such as the Thames, the Trent, the Wiltshire Avon, and the Hampshire Test) can have a staircase of terraces down their valley sides, with each terrace representing a separate series of cold/warm/cold stages of the *Pleistocene* (qv), and with higher terraces being older

Thermoluminescence dating - a form of *chronometric dating* (qv) whereby the time elapsed since a crystalline mineral (such as flint or sediment) was heated can be calculated from the amount of light emitted during controlled heating

TL - acronym for *Thermoluminescence dating* (qv)

UP - Upper Palaeolithic, the later part of the Palaeolithic (qv) period, associated with anatomically modern humans

# Annex B Research Framework and Guidance documents: national and regional

# Annex B.

# Research Framework and Guidance documents: national and regional

## B.1a. National guidelines and research frameworks

2005a, English Heritage. *Discovering the Past, Shaping the Future: Research Strategy 2005-2010*. English Heritage, London.

2005b, English Heritage. *English Heritage Research Agenda: an Introduction to English Heritage's Research Themes and Programmes*. English Heritage, London.

2008, English Heritage. *Strategic Framework for Historic Environment Activities and Programmes in English Heritage* (SHAPE). English Heritage, London.

2010, DCLGE. *Planning Policy Statement 5* (PPS5)*: Planning for the Historic Environment*. Department of Communities and Local Government, England.

2011 (revised 2013), English Heritage. *National Heritage Protection Plan: Framework*. English Heritage, London.

2012 (revised 2019), MHCLG. *National Planning Policy Framework*. Ministry of Housing, Communities and Local Government. HMSO.

## B.1b. National guidelines and research frameworks: Palaeolithic

1998, English Heritage. *Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers*. English Heritage, London.

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

2010, English Heritage. *Research Strategy for Prehistory (Consultation Draft, June 2010)*. English Heritage Thematic Research Strategies, English Heritage, London.

## B.2a. Regional frameworks and Guidance: Greater London

2000, MoLAS. *The Archaeology of Greater London: an Assessment of Archaeological Evidence for Human Presence in the Area now covered by Greater London*. MoLAS monograph. Museum of London Archaeology Service. [Ch 1, Geology and environment (Rackham and Sidell; Ch 2, Lower Palaeolithic (Lewis); Ch 3, Upper Palaeolithic and Mesolithic (Lewis)]

2002, MoL. *A Research Framework for London Archaeology*. Museum of London Archaeology. [Ch 3, Prehistory (Lewis)]

2015, Greater London Archaeological Advisory Service (GLAAS). *Guidelines for Archaeological Projects in Greater London*. Historic England (April 2015)

2015, MoL. *A Strategy for Researching the Historic Environment of Greater London*. Museum of London Archaeology.

2016, Historic England (HE). *Greater London Archaeological Priority Area Guidelines*. Historic England (June 2016).

## B.2b. Regional frameworks and Guidance: East of England (Essex)

1997, Glazebrook J (ed). *Research and Archaeology: a Framework for the Eastern Counties 1, Resource Assessment*. East Anglian Archaeology, Occasional Paper No. 3, Castle Museum, Norwich.

2000, Brown N, Glazebrook J (eds). *Research and Archaeology: a Framework for the Eastern Counties 2, Research Agenda and Strategy*. East Anglian Archaeology, Occasional Paper No. 8, Castle Museum, Norwich.

2011, Medlycott M (ed). Palaeolithic and Mesolithic. In (M Medlycott, ed) *Research and Archaeology Revisited: a Revised Framework for the East of England*: 3-8. East Anglian Archaeology, Occasional Paper No. 24, Castle Museum, Norwich.

2015, Essex County Council. *Managing the Essex Pleistocene: Final Project Report*. Essex County Council Place Services [English Heritage Project 6639, final report by T O'Connor, issued September 2015].

### B.2c. Regional frameworks and Guidance: South-East (Kent)

2010 (rev 2017, and then 2019), Wenban-Smith FF, Bates MR, Bridgland DR, Harp P, Pope MI, Roberts MB. *The Early Palaeolithic in the South-East: South-East Research Framework (SERF), Resource Assessment and Research Agenda for the Early Palaeolithic*. Report submitted to Kent County Council for joint English Heritage and ALGAO project "Research Framework for South-East England" (SERF). https://www.kent.gov.uk/__data/assets/pdf_file/0010/98938/Early-Palaeolithic-chapter.pdf

2011 (rev 2014, 2018, and then 2019), Pope MI, Wells C, Scott B, Maxted A, Haycon N, Farr L, Branch N, Blinkhorn E. *The Upper Palaeolithic and Mesolithic Periods*. Report submitted to Kent County Council for joint English Heritage and ALGAO project "Research Framework for South-East England" (SERF). https://www.kent.gov.uk/__data/assets/pdf_file/0011/98939/Upper-Palaeolithic-and-Mesolithic-Periods.pdf

2018, Bates M, Corcoran J. *Geological and Environmental Background*. Report submitted to Kent County Council for joint English Heritage and ALGAO project "Research Framework for South-East England" (SERF).

### B.2d. Regional frameworks and Guidance: Thames Estuary

1999, Williams, J. & Brown, N., (ed's). *An Archaeological Research Framework for the Greater Thames Estuary*. Essex County Council, County Hall, Chelmsford, Essex.

2005, Chris Blandford Associates. *Thames Gateway Historic Environment Characterisation Project: Final Report*. Unpublished report commissioned by English Heritage, Essex County Council and Kent County Council [text available on-line through Historic England and Archaeology Data Service].

2010, Essex County Council. The *Greater Thames Estuary Historic Environment Research Framework: Update and Revision of the Archaeological Research Framework for the Greater Thames Estuary (1999).* Unpublished Historic England project report available on-line, and through Archaeology Data Service.

# Annex C Key sources and "grey" literature

# Annex C.

# Key sources and "grey" literature

## C.1. Key published sources

Evans J, 1872 (1st ed). *The Ancient Stone Implements, Weapons, and Ornaments, of Great Britain*. Longmans, Green, Reader and Dyer, London.

Evans J, 1897 (2nd ed.). *The Ancient Stone Implements, Weapons and Ornaments of Great Britain*. Longmans, London.

Roe, D.A. 1968. *A Gazetteer of British Lower and Middle Palaeolithic sites*. CBA Research Report 8. Council for British Archaeology, London.

Wymer, J.J. 1968. *Lower Palaeolithic Archaeology in Britain as represented by the Thames Valley*. John Baker, London.

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

Wymer JJ and Bonsall CJ (eds), 1977. *Gazetteer of Mesolithic and Upper Palaeolithic sites in England and Wales*. CBA Research Report 22. Council for British Archaeology, London.

## C.2. "Grey" literature and sources

Essex County Council, Historic Environment Records database [as of September 2019].

Essex County Council & Kent County Council, 2004. *Archaeological Survey of Mineral Extraction Sites around the Thames Estuary*. Project 3374 Report, lodged with Archaeology Data Service, ADS Collection 774, DOI 10.5284/1000016.

Kent County Council, Historic Environment Records database [as of September 2019].

Wenban-Smith FF, Bates MR, Marshall G, 2007a. *Medway Valley Palaeolithic Project Final Report: The Palaeolithic Resource in the Medway Gravels (Kent)*. Unpublished report for English Heritage, available on-line through Archaeology Data Service

Wenban-Smith FF, Bates MR, Marshall G, 2007b. *Medway Valley Palaeolithic Project Final Report: The Palaeolithic Resource in the Medway Gravels (Essex)*. Unpublished report submitted to English Heritage, available online through Archaeology Data Service.

Wessex Archaeology. 1993. *The Southern Rivers Palaeolithic Project, Report No. 2 — The South West and South of the Thames* [vol 1, text; and vol. 2, maps]. Wessex Archaeology, Salisbury.

Wessex Archaeology, 1996. *English Rivers Palaeolithic Project, Report No. 1 — The Thames Valley and the Warwickshire Avon*. Wessex Archaeology, Salisbury.

# Annex D Palaeolithic site-list

# Annex D.

# Palaeolithic site-list

**Contents:**

- D.1. Introductory tables
- D.2. Palaeolithic sites, in/near 3km buffer around consultation footprint
- D.3. Primary source references for Palaeolithic sites

# D.1. Introductory tables

| *Column heading* | *Explanation* |
|---|---|
| **LTC list** | Unique identifier for cultural effects across whole Lower Thames Crossing heritage work |
| **Geo attribution** | Interpretation of likely geological context for Palaeolithic finds - see below, **Table D-2**, for details |
| **PQ zone** | Attribution of the Palaeolithic-Quaternary zone for which previous known finds provide relevant information;<br>- suffix "..-nr" represents "very near to zone"<br>- suffix "..-eq" represents "equivalent to zone" |
| **HER MonUID** | Unique identifier for previous finds within Kent/ Essex/ Greater London HERs, if applicable |
| **Site name** | Site name, and summary information |
| **SRP/ERP, map.site** | Site identification (if applicable) within the two national Palaeolithic surveys of (a) the *Southern Rivers Project* (Wessex Archaeology 1993) for the Kent side of the LTC, and (b) the *English Rivers Project* for the Essex side (Wessex Archaeology 1997) |
| **Sources** | Numeric identifier for sources listed below (**Section D.3**) |
| **Rec -Type** | Record type, one of:<br>Mon - flint artefact/s well-provenanced to a known context<br>Mon/PE - flint artefact/s well-provenanced to a known context, in association with faunal or other palaeoenvironmental remains<br>F-spot - location of flint artefact find/s, with less-reliable info on its/their provenance<br>PEFS (Pleistocene environmental find-spot) - site with faunal or other palaeoenvironmental remains<br>Geo - a significant geological sequence or feature, but lacking artefactual or palaeoenvironmental remains |
| **NGR-E** | OS grid easting, to nearest metre |
| **NGR-N** | OS grid northing, to nearest metre |
| **Acc** | Accuracy of OS grid location, one of:<br>A (Accurate) - site is accurately located based on reliable primary sources<br>E (Estimated) -site location can be estimated with reasonable confidence based on primary sources<br>G (General) - sites and finds from a general area, lacking good information on location and provenance |

**Table D-1**. Explanation of Palaeolithic site-list table entries.

| *Geo attribution* | *Detailed explanation* |
|---|---|
| Alluv - Ebbsfleet | Ebbsfleet Valley, alluvium on floodplain |
| Alluv/Shepp | Thames floodplain alluvium, overlying late Last Glacial Shepperton Gravel, infilling current Thames channel, often 10s of metres deep |
| BH | Boyn Hill Gravel, Thames Terrace - BGS mapping (Sheet 257, Romford) - attributed to Orsett Heath Gravel by Bridgland and Gibbard, and broadly attributed to MIS 12/11/10 |
| BH(Ebbs) | Palaeo-Ebbsfleet fluvial terrace (sand/silt/gravel), of similar age to Thames Boyn Hill Terrace |
| BP | Black Park Gravel, Thames Terrace - BGS mapping (Sheet 257, Romford) - equated with Dartford Heath Gravel by Gibbard, but many BP outcrops in LTC area attributed to Orsett Heath Gravel by Bridgland |
| BP or earlier river gravel, Kent | High level outcrops of fluvial terrace, Anglian or pre-Anglian on S side of Thames estuary |
| BP(Ebbs) | Palaeo-Ebbsfleet fluvial terrace (sand/silt/gravel), of similar age to Thames Black Park Terrace |
| BP-BH(Ebbs)? | BP(Ebbs) or BH(Ebbs) as defined above - uncertain which, without further investigation |
| CWF | Clay-with-flints plateau, residual, or maybe from pockets of brickearth infilling depressions in CWF surface |
| Gl-Lac | Mid-Pleistocene glacio-lacustrine (acc BGS) - over remnant lobe of Anglian till |
| HA | Hackney Gravel, outcrops appear to west of LTC area, intermediate levels between Lynch hill and Taplow |
| Head - CR | Head Coombe Rock, chalk-rich fill where dry valleys have passed through chalk bedrock landscape, and thus a dominant variably sandy chalk-silt context for other clasts such as flint pebbles |
| Head - valley-side spread | Valley-side spread of fine-grained brickearth, esp at We side of ebbsfleet Valley |
| Head DVF | Head, can be gravelly clay/silt, or brickearth - infilling dry valleys |
| Head over Tap/Muck | Head slopewash, over deposits of Taplow/Mucking terrace |
| Head/BH? | From general area with spreads of Head and also BH outcrops; insufficient provenance to attribute material reliably |
| Head/BP? | Head, overlying BP terrace gravel - material could be from within Head, or derived from underlying gravel |
| Head/BP-BH(Ebbs) - residual? | Head, overlying BH(Ebbs) as defined above - material could be from within Head, or derived from underlying gravel, or residual on surface |
| Head/LMB - residual? | Head, unmapped in places, overlying Lambeth Group outcrops - uncertain whether any finds within/under Head, or residual |
| Head/T? | Head, or unmapped patches of terrace sand/gravel |
| Head/ThS | Head, unmapped in places, overlying Thanet Sand - find def within/under Head |
| Head/ThS - residual? | Head, unmapped in places, overlying Thanet Sand - uncertain whether any finds within/under Head, or residual |
| Head/ThS/Chk - residual? | Head, unmapped in places, overlying Thanet Sand and Chalk landscape - uncertain whether any finds within/under Head, or residual |
| Head/ThS-LMB - residual? | Head, unmapped in places, overlying Thanet Sand and Lambeth Group outcrops - uncertain whether any finds within/under Head, or residual |

| | |
|---|---|
| LH(CT) | Lynch Hill Gravel, Thames Terrace - BGS mapping (Sheet 271, Dartford) - Purfleet area just to north of Purfleet anticline, at valley-side edge of this deposit, beyond Belhus organic channel; broadly attributed to MIS 10/9/8 |
| LH(CT-BOC) | Lynch Hill Gravel, Thames Terrace - BGS mapping (Sheet 257, Romford), attributed to Corbets Tey Gravel by Bridgland and Gibbard, and incorporating Belhus organic channel; broadly attributed to MIS 10/9/8 |
| Residual, plateau gravel? | Residual surface finds on plateau, often associated with Lower Pleistocene or Pliocene high-level fluvial gravel outcrops, or maybe Tertiary gravel outcrops |
| Shore, redeposited | Residual shore finds, poss. originating from transported/dumped deposits |
| Tap/Muck | Taplow Gravel, Thames Terrace - BGS mapping (Sheet 257, Romford, and Sheet 271, Dartford), attributed to Mucking Gravel by Bridgland, broadly MIS 8/7/6 |
| Tap/Muck/Ilf | Taplow/Mucking Gravel, and also possibly Ilford Silt (= Grays Brickearths), date range from MIS 9 to early MIS 6 |
| Tap/Muck/LH | Uncertain whether Tap/Muck, or LH - as defined above |

**Table D-2**. Explanation of entries for column 2, “Geo attribution”.

## D.2. Palaeolithic sites, in/near 3km buffer around consultation footprint

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **173** | BH | 25 | MEX1049370 | Ockendon cutting Palaeolithic Watching Brief, M25 - exposure of fluvially-bedded sand/gravel deposits | - | 6, 53, 54 | Geo | 558520 | 185490 | E |
| **181** | LH(CT-BOC) | 17-eq, 18-eq, 19-eq | MEX17513 | Little Belhus Farm Pit, one flint debitage, or miscellaneous presumed-Palaeolithic, implement - uncertain provenance | - | 68 | F-Spot | 558400 | 182150 | E |
| **248** | BH | 13 | MEX18096 | Grey Goose Farm - group of sub-circular crop-mark features, interpreted as of natural origin (periglacial upward-injection of sub-surface sediments?) | - | 72 | Geo | 562760 | 181028 | A |
| **328** | Head/BP? | 14-nr | MEX38151 | Mucking Late Prehistoric and Saxon excavations - "a few rolled artefacts" possibly Palaeolithic | - | 40 | F-Spot | 567550 | 180510 | A |
| **395** | Tap/Muck | 12a | MEX6015 | Tilbury, general area - handaxe listed by Roe in Bradford Museum | ERPP 1, LTV4A.20 | 27, 35, 58, 63, 64, 65, 95 | F-Spot | 566800 | 177680 | G |
| **414** | BH | 13 | MEX6188 | Handaxe found in 1970 at Dene Holes roundabout, Socketts Heath | ERPP 1, LTV4A.08 | 67 | F-Spot | 562750 | 179290 | A |
| **423** | BH | 13 | MEX6214 | Four handaxes, thought to be from pit west of Greyhound Lane, Orsett Heath | ERPP 1, LTV4A.18a | 58, 98 | Mon | 564110 | 179600 | E |
| **424** | Tap/Muck/Ilf | - | MEX6218 | Handaxe from Terrels Hall, Little Thurrock - taken as likely location for mis-reading of "Terrels Hill" | ERPP 1, LTV4A.11a | 58, 98 | F-Spot | 562740 | 177940 | E |
| **427** | BH | 13-eq | MEX6229 | Chadwell St. Mary, handaxe found in situ during construction of Technical College, c. 1957 | ERPP 1, LTV4A.12 | 29, 93, 98 | Mon | 563585 | 178850 | A |
| **430** | Alluv/Shepp | 8-eq, 9-eq, 10-eq | MEX6238 | Tilbury Town, handaxe found on/near Feenan Highway, c. 1967 | ERPP 1, LTV4A.21 | 29, 98 | F-Spot | 564600 | 176700 | A |
| **441** | Tap/Muck/LH | 11 | MEX6286 | East Tilbury, handaxe surface find to north of church (at marsh level) | ERPP 1, LTV4.09 | 29, 98 | F-Spot | 568900 | 177100 | E |
| **464** | Tap/Muck | 12a | MEX6455 | West Tilbury, WG Smith finds in Luton Museum - 16 flakes, of which more than half may have secondary working (according to Roe's 1968 examination) | ERPP 1, LTV4A.20a | 35, 58, 65 | F-Spot | 566500 | 177600 | E |
| **466** | Alluv/Shepp | 8-eq, 9-eq, 10-eq | MEX6469 | "worked flint, possibly Palaeolithic" from Tilbury Fort, West Tilbury | - | 5 | F-Spot | 565100 | 175250 | E |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **468** | BH | 13 | MEX6475 | West Tilbury, Gun Hill Pit - four handaxes and three debitage | ERPP 1, LTV4A.19 | 28, 29, 31, 98 | Mon | 565680 | 177870 | A |
| **492** | BH | 13 | MEX6587 | Orsett, Heath Farm - surface find of one handaxe | - | 19 | F-Spot | 563800 | 179650 | E |
| **503** | BH | 13-nr | MEX6633 | Chadwell St. Mary, Pigg's Pit, to east of Sandy Lane, at its top/northern end - one handaxe attributed to this pit specifically | ERPP 1, LTV4A.16 | 58, 98 | F-Spot | 565250 | 178450 | A |
| **506** | Head/BH? | 13-eq, 15-eq, 16-eq | MEX6657 | Orsett, general area - four handaxes and several debitage in various museum collections | ERPP 1, LTV4A.18 | 5, 35, 58, 64, 65, 98 | F-Spot | 563850 | 181040 | G |
| **580** | BH | - | - | Upminster, general area - two handaxes in the Warren Collection, held at the British Museum | ERPP 1, LTV4.05 | 58, 97, 98 | F-Spot | 556500 | 188000 | G |
| **1661** | Head/ThS | 3, 5-eq, 6-eq, 29-eq | MKE20609 | Fine pointed handaxe found in situ in May 1997, during HS1 evaluation at site "South-East of Tollgate" - site code ARC TGS 97, trench 1863TT | - | 50, 51 | Mon | 564670 | 170950 | A |
| **2021** | BH | 13-nr | MEX1032236 | Two handaxes from unspecified pit at "Sandy Lane, Chadwell St Mary" - the estimated location is the oldest of several pits in the area | - | 98 | F-Spot | 565090 | 178130 | E |
| **2079** | Head/LMB - residual? | 16-eq | MEX18037 | Saffron Garden, handaxe found on surface near farm buildings | - | 2 | F-Spot | 566620 | 182250 | E |
| **2082** | BH | 13-eq | MEX18179 | Stifford, Thurrock, general area - handaxe and a scraper in museum collections, no info on location/context | ERPP 1, LTV4A.04 | 5, 58, 62, 98 | F-Spot | 561300 | 180100 | E |
| **2119** | BH | 13-eq | MEX5915 | Chadwell St. Mary (or "Chadwell"), general area - more than 100 handaxes in various museum collections, as well as several debitage | ERPP 1, LTV4A.17 | 58, 98 | F-Spot | 565000 | 178300 | G |
| **2143** | BH | 13-nr | MEX6249 | Chadwell St. Mary, two handaxes from shallow diggings in gardens of 57 and 67 Sabina Road | ERPP 1, LTV4A.14 | 98 | F-Spot | 565150 | 178600 | A |
| **2182** | LH(CT-BOC) | 17-eq, 18-eq, 19-eq | MEX1036488 | South Ockendon, two flakes found by BO Wymer at unlocated pit "on west side of the road from South Ockendon to Stifford" (Wymer 1985: 314), later modified to "South Ockendon, north of Buckles Lane" (ERPP: 131). | ERPP 1, LTV4A.03 | 98 | F-Spot | 560240 | 180930 | E |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **2273** | Head/ThS - residual? | 5-nr | MKE1376 | Cobham, general area - "broken implements of Palaeolithic type" found by W Whitaker (Evans - 1872: 533 & 1897: 611) | SRPP 2, M5.01 | 34, 35, 58 | F-Spot | 566500 | 168400 | G |
| **2368** | Head/BP-BH(Ebbs) - residual? | 3-eq | MKE20292 | Three Lower/Middle Palaeolithic handaxes, unstratified surface finds during HS1 fieldwork at Springhead Roman Town, towards head of the Ebbsfleet | - | 86 | F-Spot | 561780 | 172620 | E |
| **2370** | Head DVF | 3-eq, 6-eq, 29-eq | MKE20294 | Late Upper Palaeolithic (Long Blade) knapping scatter, found during HS1 fieldwork at Springhead Roman Town | - | 83, 86 | Mon | 561770 | 172610 | A |
| **2379** | Head over Tap/Muck | - | MKE20307 | Six Palaeolithic debitage (varied consition), and part of mammoth tusk, found at Springhead Quarter, Ebbsfleet (field evaluation test pits, TPs 1115-1117) | - | 87 | Mon/PE | 561870 | 173350 | A |
| **2380** | BP-BH(Ebbs)? | - | MKE20308 | Two Palaeolithic flint flakes, found during sieving of palaeo-Ebbsfleet gravels at higher southern part of Springhead Quarter, Northfleet | - | 87 | Mon | 561990 | 172760 | A |
| **3123** | Head/ThS - residual? | 6 | MKE80459 | Church Road, Tollgate - ?Pal ?Levallois flake found in Bronze Age pit during work by MoLAS | - | 52 | F-Spot | 565360 | 170390 | A |
| **3129** | Head/BP-BH(Ebbs) - residual? | - | MKE80563 | Residual Palaeolithic flints (two debitage and a flake-tool), found during open-area Saxon excavation at Springhead | - | 89 | F-Spot | 561925 | 172845 | E |
| **3197** | Head/ThS - residual? | 3-eq, 6-eq, 29-eq | MKE90970 | A2 Activity Park, Gravesend - 3 residual Palaeolithic flakes | - | 3 | F-Spot | 563640 | 171510 | A |
| **3361** | Residual, plateau gravel? | - | MWX20768 | Geological marks at Cobham Park - site apparently identified by MR Bates, and referenced to sources by DR Bridgland - may just reflect BGS mapping of high level gravel outcrops | - | 7, 9 | Geo | 567000 | 168300 | A |
| **3368** | Head/BP-BH(Ebbs) - residual? | - | MWX20814 | Springhead (general area), surface finds of 3 Palaeolithic handaxes and a flake, made prior to early 1960s | SRPP 2, NWK5.8 | 58 | F-Spot | 561700 | 172800 | G |
| **3369** | Head/BP-BH(Ebbs) - residual? | - | MWX20820 | Palaeolithic handaxe from near Wombwell Hall, Gravesend - no info on provenance, presumably a surface find | SRPP 2, NWK5.16 | 58 | F-Spot | 563070 | 172800 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **3370** | Head DVF | 3-eq | MWX20821 | One Tree Field, near Southfleet Station - surface finds of 8 handaxes and 11 pieces of debitage (Stopes Collection) | SRPP 2, NWK5.17 | 58, 79 | F-Spot | 561340 | 172160 | E |
| **3374** | Residual, plateau gravel? | 4-eq | MWX20836 | One handaxe and two Levallois flakes, from general Shorne area - presumed surface finds but no provenance info | SRPP 2, M5.03 | 58 | F-Spot | 568890 | 171050 | G |
| **3406** | Alluv - Ebbsfleet | 8-eq, 10-eq | MKE104432 | Late Upper Palaeolithic flints (Long Blade - cores, blades and flake-tools), Burchell's "Springhead Lower Floor", Ebbsfleet Valley | - | 18, 48 | Mon/PE | 561590 | 173080 | A |
| **3452** | Head - valley-side spread | 2-nr | MKE99903 | Very fine pointed Palaeolithic handaxe from Ebbsfleet, Station Quarter South evaluation, TP 25 | - | 80, 88 | Mon | 561100 | 173485 | A |
| **4000** | Tap/Muck | - | - | Rainham, a few handaxes, cores and debitage from vicinity of 23 Berwick Road | ERPP 1, LTV3.24 | 98 | F-Spot | 553700 | 183300 | G |
| **4001** | HA | - | - | Hornchurch, handaxe from 24 Globe Road (found in garden, post-1945) | ERPP 1, LTV3.25 | 66 | F-Spot | 552210 | 188190 | A |
| **4002** | Tap/Muck | - | GLSMR-060065 | Havering, Launders Lane Pit - two handaxe fragments listed in Essex HER, but no other info on circumstances of discovery or present whereabouts | ERPP 1, LTV3.26 | 66 | F-Spot | 554200 | 182000 | E |
| **4003** | Gl-Lac | - | - | Havering, Upminster, A127 cutting - "North of Martins" - fluvial terrace sequence above till, with mint condition flint artefacts (including two handaxes and a flake-tool) in terrace sequence, as well as burnt flints | ERPP 1, LTV4.01 | 8, 23, 25, 58, 75, 97, 98 | Mon | 556560 | 189020 | A |
| **4004** | LH(CT-BOC) | 19-eq | GLSMR-060605 | Rainham, Gerpins Pit - 8 handaxes found in 1930s, when extensive workings in Lynch Hill/Corbets Tey terrace, with its surface c. 18m OD | ERPP 1, LTV4.03 | 38, 98 | F-Spot | 555500 | 184100 | E |
| **4005** | Head/BH? | - | - | Rainham, Moor Hall Farm - broken tip of handaxe | ERPP 1, LTV4.04 | 98 | F-Spot | 555750 | 181150 | E |
| **4006** | LH(CT-BOC) | 19-eq | GLSMR-060053 | Havering, 54 Coniston Avenue - one handaxe found in rear garden, in 1939 | ERPP 1, LTV4.06 | 38, 91 | F-Spot | 556385 | 185715 | A |
| **4007** | BH | 25 | - | South Ockendon, sharp cordate handaxe found at site of windmill (found on surface after demolition) | ERPP 1, LTV4.10 | 98 | F-Spot | 560425 | 183070 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4008** | LH(CT) | - | - | Purfleet, Botany Pit - handaxes, debitage, Levallois cores/flakes and fossils mammalian remains - BUT, mostly from talus and channel-side areas where interdigitated with chalk-rich valley-side slopewash, rather than in situ in main fluvial gravel bed, so uncertainty over provenance/age | ERPP 1, LTV4.11 | 8, 16, 58, 97, 98 | Mon/PE | 555720 | 178500 | A |
| **4009** | LH(CT) | - | - | Purfleet Greenlands Pit - classic sequence in NE corner. Lowest part of sequence is peak MIS 9 interglacial, but few/no artefacts from this horizon, so uncertain how the more-implementiferous horizons higher up the very thick sequence relate to peak MIS 9. | ERPP 1, LTV4.12 | 16, 38, 55, 59, 98 | Mon/PE | 556890 | 178515 | A |
| **4010** | LH(CT) | - | - | Purfleet, Bluelands Pit: early artefact recovery by Palmer (1975), then tripartite interpretation by Wymer (1985), then further artefact recovery from upper levels by Schreve, but latter unpublished and artefacts are missing. | ERPP 1, LTV4.13 | 16, 55, 59, 98 | Mon | 556840 | 178600 | A |
| **4011** | BH | - | - | Hornchurch rail cutting - Boyn Hill/Orsett Heath (sensu Bridgland) deposits at 29-32m OD, cut into chalky till - "boulder clay" - associated with Anglian glaciation. NB - BGS mapping shows the terrace deposits as Black Park Gravel | ERPP 1, LTV4.15 | 8, 39, 46, 92, 98 | Geo | 554665 | 187335 | A |
| **4012** | HA | - | GLSMR-060074 | Rainham, two handaxes from Aylett's Pit, Warwick Lane | ERPP 1, LTV4.16 | 66 | F-Spot | 554800 | 182900 | A |
| **4013** | Residual, plateau gravel? | - | - | Brentwood, South Weald - large ovate handaxe, found pre-1977, but otherwise no provenance info. | ERPP 1, LTV4.N of | 98 | F-Spot | 557600 | 194300 | G |
| **4014** | LH(CT-BOC) | 17-eq, 18-eq, 19-eq | - | South Ockendon, Gate Hope Drive - core, possibly for Levalloisian blade production, according Wymer. No info on provenance. | ERPP 1, LTV4A.02 | 98 | F-Spot | 557700 | 181080 | E |
| **4015** | Tap/Muck | - | - | Lion Pit tramway cutting, West Thurrock - Levallois working floor (attrib MIS 8) below thick sequence of fossiliferous sands/silts that are attributed to MIS 7. | ERPP 1, LTV4A.05 | 14, 20, 38, 44, 45 | Mon/PE | 559800 | 178200 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4016** | Tap/Muck/LH | - | - | Grays, Grays Thurrock - numerous handaxes, cores, debitage and flake-tools from general area | ERPP 1, LTV4A.11 | 35, 58, 65, 98 | F-Spot | 562000 | 178200 | G |
| **4017** | BH | 13-nr | - | Chadwell St. Mary, Sandy Lane - two handaxes from the pit opened in the 1960s at top/northern end of Sandy Lane, and to its west | ERPP 1, LTV4A.15 | 29, 38, 98 | F-Spot | 565100 | 178380 | A |
| **4018** | BH | 13 | - | Pit to north-east of Hangman's Wood, by road to Orsett - "implements" obtained from c. 7 feet of gravel/sand in late 19th C | - | 42 | Mon | 563530 | 179080 | A |
| **4019** | LH(CT-BOC) | 19-eq | - | Palaeo-environmental remains (molluscs, ostracods, fish, insects and plant macro-fossils) from brown clayey/sandy silt deposits in sewer cutting at Park Corner Farm, Upminster | - | 73 | PEFS | 555050 | 185030 | A |
| **4020** | LH(CT-BOC) | 17-eq, 18-eq, 19-eq | - | Belhus Park cutting, M25 - 2011 investigations, rich palaeo-environmental remains and some flint artefacts found in situ | ERPP 1, LTV4A.01 | 8, 38, 53, 54, 73, 82, 98 | Mon/PE | 557500 | 181200 | A |
| **4021** | LH(CT-BOC) | 17-eq, 18-eq, 19-eq | - | Belhus Park cutting, M25 - 1980-1981 Essex Field Club monitoring, several handaxes and debitage found in situ | ERPP 1, LTV4A.01a | 82 | Mon | 557420 | 181250 | A |
| **4022** | Tap/Muck/Ilf | - | - | Grays Brickearths - early faunal recovery, rich variety of (mostly interglacial) mammalian fossils, as well as a flake-tool | - | 8, 24, 41, 42 | PEFS | 561950 | 178145 | A |
| **4023** | Head/T? | - | - | Five debitage in Stopes Collection from Higham Pits, "Brown's findings" - pits between Dartford and Higham, gravels resting on Chalk, levels ranging from 70 ft to 105 ft OD (Stopes 1895b) | SRPP 2, M5.04c | 71, 79 | F-Spot | 570950 | 172800 | G |
| **4024** | Tap/Muck | - | MEX5918 | Globe Pit, Grays - early find of flake-tool | ERPP 1, LTV4A.07a | 49 | Mon | 562500 | 178150 | E |
| **4025** | Head/BH? | - | MEX6120 | Grays, Dell Road, old chalk pit - handaxe find in base of pit, presumed to have come from terrace deposits at top of quarry face | ERPP 1, LTV4A.06 | 98 | F-Spot | 561620 | 178600 | A |
| **4026** | BH | 13-eq | MEX6135 | Socketts Heath Pit, Palaeolithic finds "failry abundant", and two handaxes in modern museum collections | ERPP 1, LTV4A.09 | 24, 42, 58, 98 | Mon | 562300 | 179250 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4027** | LH(CT) | - | MEX6144 | Globe Pit, Little Thurrock - large assemblage of cores, debitage and flake-tools from Wymer and Snelling excavations (1950s-1960s) in preserved deposits at wooded/thorny area at foot of garden of Mr/Mrs Croot (13 Overcliff Road). | ERPP 1, LTV4A.07 | 11, 15, 17, 38, 58, 69, 96, 97, 98 | Mon | 562520 | 178290 | A |
| **4028** | Alluv/Shepp | 8-eq, 9-nr, 10-eq | MEX6172 | Grays/Tilbury, two "Mousterian" handaxes, one of them a fine bout coupe, possibly found during expansion of Tilbury docks c. 1910-1913, or dredging Thames or tidal basin at/near dock entrance. | ERPP 1, LTV4A.10 | 1, 58, 61, 97, 98 | F-Spot | 563330 | 175460 | E |
| **4029** | Alluv/Shepp | 8-eq, 9-nr, 10-eq | MEX6172 | Tilbury, ovate HA found by R Doyle during dockyard extension in 1968 | ERPP 1, LTV4A.22 | 29, 98 | F-Spot | 562630 | 176500 | E |
| **4030** | BH | 13-eq | MEX6235 | Chadwell St. Mary, handaxe found in 1971 during construction of housing estate to north-east of church | ERPP 1, LTV4A.13 | 98 | F-Spot | 564800 | 178700 | A |
| **4031** | BH | 13-eq | MEX6235 | Chadwell St. Mary, handaxe found in 1971 during construction of housing estate to north-east of church | ERPP 1, LTV4A.13a | 98 | F-Spot | 564800 | 178900 | A |
| **4032** | Tap/Muck/Ilf | - | MEX6465 | Little Thurrock, general area - listed by Roe as "Grays, Little Thurrock" which is slightly to east of main Grays/Grays Thurrock area. | - | 58, 65 | F-Spot | 562600 | 178200 | G |
| **4033** | LH(CT) | - | MEX6681 | Stanford le Hope - reports of three handaxes and several debitage from general area, but no specifics on location or context | ERPP 1, LTV4.14 | 5, 30, 56, 58, 95, 98 | F-Spot | 568500 | 182000 | G |
| **4034** | Tap/Muck | 12b-eq | MEX6894 | Mucking - gravel pit/s; two handaxes and several flakes reported, but no specific info on location/context | ERPP 1, LTV4.08 | 35, 58, 62, 64, 65, 95, 98 | Mon | 568720 | 180920 | E |
| **4035** | Head/ThS /Chk - residual? | 3-eq, 5-eq, 6-eq | MKE1440 | Nursted/Nurstead, general area - "broken implements of Palaeolithic type" found by W Whitaker (Evans - 1872: 533 & 1897: 611) | SRPP 2, NWK2.61 | 34, 35, 58 | F-Spot | 564200 | 168200 | G |
| **4036** | Alluv/Shepp | 9-eq | MKE1525 | Broadness - handaxe (crude/roughout) and flake dredged from Thames bed | SRPP 2, NWK5.15 | 58, 97 | F-Spot | 560500 | 176800 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4037** | Head - valley-side spread | 2-eq | MKE1716 | More than 20 Palaeolithic handaxes from Bevan's Wash-pit, opposite New Barn farmhouse [Treadwell's], and also a Levallois flake and undiagnostic debitage | - | 58, 70, 79 | F-Spot | 561020 | 173520 | A |
| **4038** | Head - valley-side spread | 2-eq | MKE1727 | Palaeolithic handaxe from near New Barn Farm House [Treadwell's] | SRPP 2, NWK5.7 | 58, 79 | Mon | 561100 | 173800 | E |
| **4039** | Head/ThS - residual? | 3-eq, 5-eq, 6-eq, 29-eq | MKE2330 | Surface find of handaxe at Strood Hill, Rochester | SRPP 2, M5.06 | 36 | F-Spot | 572200 | 169400 | A |
| **4040** | Shore, redeposited | - | MKE2606 | Five Palaeolithic handaxes found on foreshore between Cliffe Creek and Lower Hope Point, Cliffe | - | 47 | F-Spot | 571000 | 178000 | G |
| **4041** | CWF | - | MKE39905 | Cuxton, Ranscombe - four handaxes in Rochester Museum, presumed surface finds | SRPP 2, M5.05 | 58, 81 | F-Spot | 571100 | 167700 | G |
| **4042** | BP or earlier river gravel, Kent | - | MKE39923 | Core with Levalloisian characteristics, found in situ in high-level gravels near Higham in 2005 (Medway Valley Project, Whitehouse Farm, TP 9) | - | 81 | Mon | 572315 | 171890 | A |
| **4043** | BH(Ebbs) | 2-nr | MKE43400 | Palaeolithic (Clactonian) HS1 elephant butchery site, Southfleet Road, Ebbsfleet | - | 80 | Mon/PE | 561160 | 173270 | A |
| **4044** | BP(Ebbs) | - | MKE97553 | Lower Palaeolithic 'Clactonian' occupation surface, Ebbsfleet Green - numerous debitage, cores and flake-tools, with several refitting groups | - | 21, 22, 76 | Mon | 561055 | 173305 | A |
| **4045** | Head DVF | 3-eq, 6-eq, 29-eq | MKE97555 | Ebbsfleet Green LUP (Long Blade) scatter - dense scatter with numerous cores, flake-tools and debitage and high proportion of refitting - found in colluvium infilling dry valley cutting into Thanet Sand and ambeth Group bedrock. | - | 21, 22, 77 | Mon | 560901 | 173274 | A |
| **4046** | BH(Ebbs) | 2 | MKE99904 | PEFS - Hoxnian lake-bed sediments with ostracod and mollusc remains - Ebbsfleet, Station Quarter South, TP 31 | - | 88 | PEFS | 561178 | 173305 | A |
| **4047** | BH(Ebbs) | 2 | MKE99904 | PEFS - Hoxnian lake-bed sediments with ostracod and mollusc remains - Ebbsfleet, Station Quarter South, TP 33 | - | 88 | PEFS | 561251 | 173321 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4048** | Shore, redeposited | - | MKE99905 | Several handaxes and debitage from unspecified locations along Northfleet Shore, found late 19th C | - | 79 | F-Spot | 563480 | 174500 | E |
| **4049** | Head - valley-side spread | 2 | MKE99907 | Surface finds of one handaxe and several pieces of debitage, much in fresh condition, from brickearth bank cutting to north of HS1 elephant site | - | 80 | F-Spot | 561130 | 173450 | A |
| **4050** | Head/ThS /Chk - residual? | 5-eq | MWX20789 | Meopham, general area - "broken implements of Palaeolithic type" found by W Whitaker (Evans - 1872: 533 & 1897: 611) | SRPP 2, NWK2.60 | 34, 35, 58 | F-Spot | 564500 | 166100 | G |
| **4051** | Head/ThS-LMB - residual? | 4-eq | MWX20815 | Two handaxes from Gravesend (Milton), Windmill Hill - surface finds | SRPP 2, NWK5.11 | 58 | F-Spot | 564890 | 173335 | A |
| **4052** | Head/T? | 7-eq | MWX20816 | Gravesend, surface finds from the general area - 12 handaxes and two debitage in various museums. | SRPP 2, NWK5.12 | 58 | F-Spot | 565000 | 174000 | G |
| **4053** | Tap/Muck | 7-Nr | MWX20835 | Gravesend, Chalk - handaxe ("implement") and a flake-tool from gravel pits to east of Chalk, north side of Higham Road, at Filborough | SRPP 2, M5.02 | 4, 58 | Mon | 568480 | 173190 | E |
| **4054** | Head/T? | 7-eq | MWX20837 | Three Pal HAs from Higham: one in Cambridge Museum (A and E), and two in Maidstone - one of these latter from unlocated site of "Grain Pit" | SRPP 2, M5.04 | 58, 91 | F-Spot | 570170 | 173450 | E |
| **4055** | Head - valley-side spread | 3-eq, 6-eq | MWX20863 | Two Palaeolithic handaxes, and two pieces of debitage, surface finds near Treadwell's Farm [= New Barn Farm] - Stopes Collection | - | 79 | F-Spot | 561240 | 173440 | E |
| **4056** | Head/T? | - | MWX20867 | Four handaxes in Stopes Collection from Higham, "Odgers Street" - site not located, grid reference given for general spot on higher ground between Chequers Street and Higham [aka Church Street in early 20th C] | SRPP 2, M5.04b | 58, 71, 79 | F-Spot | 571600 | 173200 | G |
| **4057** | BH(Ebbs) | 2 | MWX20876 | More than 30 Palaeolithic handaxes (and also several flake-tools and >100 debitage) from fluvial (palaeo-Ebbsfleet) gravel capping the sequence at the HS1 Southfleet Road "Ebbsfleet elephant" site | - | 80 | Mon | 561175 | 173260 | A |

| LTC list | Geo attribution | PQ zone | HER MonUID | Site name | SRP/ERP, map.site | Sources | Rec - Type | NGR-E | NGR-N | Acc |
|---|---|---|---|---|---|---|---|---|---|---|
| **4058** | Head - CR | - | MWX20959 | Baker's Hole Palaeolithic (Levallois) site (Southfleet Pit, NW corner), Ebbsfleet valley - Levallois cores, flakes and waste debitage, with associated mammalian remains (mammoth, horse, red deer and rhinoceros) | SRPP 2, NWK5.5 | 8, 57, 60, 78, 79, 83, 97 | Mon/PE | 561425 | 173875 | A |

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# Annex E Matrix and criteria for assessment of Palaeolithic potential

# Annex E.

# Matrix and criteria for assessment of Palaeolithic potential

**Categories for *likelihood* and *importance* of Palaeolithic remains**

| *Attribution* | *Likelihood* | *Importance* |
|---|---|---|
| VERY HIGH | Certain knowledge of Pleistocene deposits with lithic or palaeo-environmental remains | Internationally important remains: undisturbed or minimally-disturbed remains; abundant remains from deposits of good stratigraphic and chronological integrity, with biological associations and lithostratigraphic relationships |
| HIGH | High likelihood of Pleistocene deposits with lithic or palaeo-environmental remains | Nationally important remains: undisturbed or minimally disturbed concentrations; deposits with abundant remains (artefactual and/or faunal); important lithostratigraphic sequences and relationships |
| MEDIUM | Reasonable likelihood of deposits with remains | Assets that contribute to regional research objectives: less abundant and disturbed artefactual and/or faunal remains from units of reasonable stratigraphic and chronological integrity; deposits with moderately valuable lithostratigraphic sequences and relationships |
| LOW | Remains are known to occur, but rare | Disturbed and poorly preserved remains from deposits of low stratigraphic and chronological integrity; deposits with minimal lithostratigraphic sequences and relationships |
| NEGLIGIBLE | Deposits with remains very unlikely to occur | Any remains found will be residual and reworked; assets with little or no potential to contribute to research objectives |
| UNKNOWN | Insufficient information on which to assess likelihood | Insufficient information on which to assess importance |

**Table E-1.** Criteria for categories for *likelihood* and *importance* of Palaeolithic remains, mapped onto levels of importance in relation to international, national and regional research frameworks as defined in the EIA Scoping Report (Table 7-3, p87).

**Assessment of Palaeolithic potential**

| *Palaeolithic potential* | *Likelihood* | *Likely importance* |
|---|---|---|
| VERY HIGH | Very high | High |
| | High | Very high |
| HIGH | High | High, Medium |
| | Medium | High, Very high |
| MEDIUM | High | Low |
| | Medium | Medium |
| | Low | Very high, High |
| LOW | Medium | Low |
| | Low | Medium |
| | Negligible | Very high, High, Medium, |
| NEGLIGIBLE | Medium | Negligible |
| | Low, Negligible | Low, Negligible |
| UNKNOWN | Unknown | High, Medium, low or Negligible |
| | High, Medium, low or Negligible | Unknown |

**Table E-2.** Matrix for assessment of Palaeolithic potential, combining categories of *Likelihood* and *Importance* as defined in Table E-1 above.

# Annex F Palaeolithic-Quaternary (PQ) zones: tabular summaries

# Annex F.

# Palaeolithic-Quaternary (PQ) zones: tabular summaries

**Contents:**

- F.1. Introductory tables
- F.2. Palaeolithic-Quaternary zones, PQ-1 to PQ-29 (including PQ-12a,b, PQ-20a,b,c, PQ-22a,b and PQ-23a,b)
- F.3. Key references for PQ zone summaries

## F.1. Introductory tables

| **Zone** | PQ-no. Name of PQ zone |
|---|---|
| **- Topography/ geomorphology** | - Summary description of topography (including ground surface elevation) and geomorphology |
| **- Bedrock geology** | - Solid (pre-Quaternary) bedrock geology |
| **Sediment sequences** | Summary description of Quaternary sediment sequences |
| **Geological interpretation** | Current geological interpretation, including presumed depositional process and stratigraphic attribution (for instance to a particular Lower Thames terrace or gravel body) |
| **Palaeoenvironmental potential** | Review of palaeo-environmental potential, so far as known |
| **Palaeolithic remains** | Review of Palaeolithic artefact finds from zone, and potential based on recoveries from similar deposits, with specific sites referenced to LTC cultural effects list (**Annex D**) |
| **Landscape-zone Research Objectives** | LTC Palaeolithic landscape-zone fieldwork Research Objectives (**Table 13**) |
| **Pal./geo-arch. assessment** | One of three categories: UNCERTAIN, MODERATE-HIGH, or LOW-MODERATE (see criteria below, **Table F-2**) |
| **Stage 1 fieldwork:** - Priorities | Key priorities to address in stage 1 Palaeolithic/geo-archaeological fieldwork |
| - Outline approach | Overview of strategic approach to stage 1 fieldwork |
| **Stage 2 fieldwork:** - Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Most important sources for up-to-date information on zone |

**Table F-1**. Explanation of PQ zone summary table entries.

| *Pal./geo-arch. assessment* | *Criteria, explanation* |
|---|---|
| UNCERTAIN | Too little primary information on Quaternary sequence for an informed assessment to be made; requires stage 1 Palaeolithic/geo-archaeological fieldwork to gather more information, before assessing whether and what further work for stage 2 |
| MODERATE-HIGH | Likely to contain sites with Medium-Very High Palaeolithic potential (see **Annex E** for criteria for Palaeolithic potential); requires stage 1 fieldwork to clarify distribution and potential of key deposits, followed by further work in stages 2 and 3, scope to be determined in light of the stage 1 and 2 results respectively |
| LOW-MODERATE | Likely to contain sites with Negligible-Medium Palaeolithic potential (see **Annex E** for criteria for Palaeolithic potential); scope of stage 1 fieldwork to be specified zone-by-zone, and then need for (or scope of) further work in stage 2 tbc in light of stage 1 results |

**Table F-2**. Categories of initial Palaeolithic/geo-archaeological assessment for PQ zones.

## F.2. Palaeolithic-Quaternary zones, PQ-1 to PQ-29 (including PQ-12a,b, PQ-20a,b,c, PQ-22a,b and PQ-23a,b)

| **Zone** | PQ-1 Ebbsfleet Valley, HS 1 Car Park |
|---|---|
| **- Topography/ geomorphology** | - Low-lying flat ground on west side of Ebbsfleet river, below 20m O.D. |
| **- Bedrock geology** | - Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation |
| **Sediment sequences** | Made ground onto Chalk/backfilled quarry. This zone is a previously-excavated quarry. |
| **Geological interpretation** | Industrial activity and backfilling of old quarry |
| **Palaeoenvironmental potential** | None - numerous important finds pre-quarrying, in particular Pleistocene megafauna such as mammoth and woolly rhinoceros, but all Quaternary sediments thought to be gone |
| **Palaeolithic remains** | Numerous important finds pre-quarrying, in particular the Baker's Hole Levallois site (LTC 4058), but all Quaternary sediments thought to be gone in LTC consultation footprint |
| **Landscape-zone Research Objectives** | NA - this zone is now outside the latest iteration of the project footprint |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:** - Priorities * | NA - this zone is now outside the latest iteration of the project footprint |
| - Outline approach | NA - this zone is now outside the latest iteration of the project footprint |
| **Stage 2 fieldwork:** - Priorities | NA - this zone is now outside the latest iteration of the project footprint |
| - Outline approach | NA - this zone is now outside the latest iteration of the project footprint |
| **Key reference/s** | Wenban-Smith, 1995 |

* NA - this zone is now outside the latest iteration (Design Refinement, July 2020) of the project footprint

| **Zone** | PQ-2 Ebbsfleet Valley (west), to north of HS1 elephant site |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Valley-side on west of Ebbsfleet river. Elevation between 20m and 25m O.D.<br>- Thanet Formation |
| **Sediment sequences** | Brickearth (probably colluvium) overlying fluvial gravels of palaeo-Ebbsfleet river and, maybe in places, fine-grained sediments containing faunal remains and Palaeolithic archaeology |
| **Geological interpretation** | Sequence of sediments associated with the palaeo-Ebbsfleet as previously recorded at the Southfleet Road Elephant site. Probably belonging to MIS 11. Mixture of *in situ* and reworked artefacts and faunal remains depending on context of deposition. |
| **Palaeoenvironmental potential** | High if elements of fine-grained sediments exist in the area; large/small mammals, molluscs, ostracods and pollen all potentially present. |
| **Palaeolithic remains** | Numerous important remains have been found in and beside this area, from deposits likely to extend into it; key sites are the undisturbed HS1 elephant site (LTC 4043), handaxes from palaeo-Ebbsfleet gravels (LTC 4057), handaxes and flakes from the brickearth (LTC 3452, 4049), and palaeo-environmental remains from fluvial/lacustrine sediments (LTC 4046, 4047) |
| **Landscape-zone Research Objectives** | NA - this zone is now outside the latest iteration of the project footprint |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities * | NA - this zone is now outside the latest iteration of the project footprint |
| - Outline approach | NA - this zone is now outside the latest iteration of the project footprint |
| **Stage 2 fieldwork:**<br>- Priorities | NA - this zone is now outside the latest iteration of the project footprint |
| - Outline approach | NA - this zone is now outside the latest iteration of the project footprint |
| **Key reference/s** | Wenban-Smith, 2013 (Chapter 21) |

* NA - this zone is now outside the latest iteration (July 2020) of the project footprint

| **Zone** | PQ-3 Ebbsfleet Valley (upland catchment) |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Upland catchment of both tributaries of the Ebbsfleet river. Valleys trend parallel to zone and cut across zone at 90° Ground surface elevation between 25m and >65m O.D.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation. |
| **Sediment sequences** | Valley sides and plateau surfaces devoid of sediments although thin discontinuous spreads of superficial sediments less than 1m may exist. Valley base contains Head/Colluvial deposits. Sequences in valley base may be consist of course, poorly sorted flint gravels as well as finer grained clay-silts. Potential exists for the presence of buried soils in the sequences. |
| **Geological interpretation** | Cold climate solifluction processes resulting in deposition of Head, probably in late Pleistocene (<20ka B.P.) but earlier phases of slope wash and solifluction may be locally present. Colluviation in late Holocene following deforestation of Chalk from Neolithic/Bronze Age. Any artefacts and faunal remains likely to be reworked although colluvium may contain elements of in situ faunas. |
| **Palaeoenvironmental potential** | Low although colluvium may contain molluscan remains |
| **Palaeolithic remains** | Three Palaeolithic findspots within this area (LTC 1661, 2368, 3197), the former probably representing an undisturbed palaeo-landsurface under older pre-Devensian colluvium on which was found a handaxe and knapping debitage. Other nearby remains from outside the area, but from deposit-types likely to be present in the area, include minimally disturbed Late Upper Palaeolithic knapping scatters (LTC 2370, 4045) from fine-grained colluvial sediments infilling dry valleys, as well as various more-derived lithic finds (LTC 3197, 3370). |
| **Landscape-zone Research Objectives** | RO 2.1-2.2 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | LTC 1661 is a rare type of site, associated with an unmapped spread of Pleistocene colluvium. LTC 4045 is likewise a rare site-type, although associated with mapped dry valley deposits. It is worth doing stage 1 test pitting to (a) investigate whether other Lower/Middle Palaeolithic sites are present in this zone in similar topographic locations to LTC 1661, and (b) to investigate for pre-Last-Glacial-Maximum sequences (including pre-Devensian), and for Late Upper Palaeolithic occupation associated with dry valley colluvial infill. |
| - Outline approach | Test pits located carefully in relation to geological mapping and GI data; useful if can be positioned after seeing base of trial trenches |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc after Stage 1 |
| - Outline approach | Tbc after Stage 1 |
| **Key reference/s** | Wenban-Smith and Bates, 2011; CgMs/MOLA 2015 |

| **Zone** | PQ-4 Shorne Woods Plateau |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - This area forms an interfluve between the Thames and Medway catchment at the present day. Ground surface elevations vary from 75m to at least 120m O.D. Small dry valleys exist and have their origin in the plateau area.<br>- Lambeth Group, Harwich Formation and London Clay Formation |
| **Sediment sequences** | Narrow strips of Head deposits likely to consist of gravels and clay/silt/sands, some possible colluvium may also be present filling the heads of the dry valleys. Thin discontinuous spreads of superficial sediments (?Head) less than 1m thick may exist across parts of the area infilling depressions in plateau, and higher points may have an upper degraded zone of pre-Quaternary bedrock which may contain residual Palaeolithic material. |
| **Geological interpretation** | Topographic high forming the source of a number of small dry valleys. Sediments from solifluction and colluviation present ranging from ?Late Devensian to Holocene. Any artefacts and faunal remains likely to be reworked. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None reliably known from within zone, but finds of a handaxe and Levallois flakes from general Shorne area (LTC 3374) and two handaxes from the analogous high point of Windmill Hill, Gravesend (LTC 4051) |
| **Landscape-zone Research Objectives** | RO 1.1-1.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Is there residual Lower/Middle Palaeolithic material on the high ground? |
| - Outline approach | Test pits located in transects across high ground and level areas |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Wenban-Smith and Bates, 2011 |

| **Zone** | PQ-5 Jeskyns shelf |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - High-ground plateau edge west of PQ-4. Ground surface elevations between 85m and 100m O.D. at the head of dry valleys trending into both the Thames and Medway.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation. |
| **Sediment sequences** | Head deposits consisting of gravels with sand/silt/clay distributed in widespread valley features. |
| **Geological interpretation** | Cold climate Late Pleistocene slopewash (Head) in dry valleys, and possibly some accumulations of Middle Pleistocene colluvium. Any artefacts and faunal remains most-likely to be reworked, although less-disturbed material may be preserved in localised infilled sub-horizontal depressions. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | Several records of surface finds of Lower/Middle Palaeolithic artefacts from general area (LTC 4035, 4039, 4050), as well as nearby discovery of handaxe and debitage from palaeo-landsurface under unmapped colluvium (LTC 1661) |
| **Landscape-zone Research Objectives** | RO 1.1-1.3 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | Basic characterisation and dating of colluvial and dry valley fill deposits - is there evidence for pre-Devensian colluvial deposits in the area? Do they contain Palaeolithic remains of any type, and are there any artefacts less-disturbed than in dry valley fill deposits? |
| - Outline approach | - test pits located in transects across areas mapped as Head<br>- test pits positioned in more-level areas, of areas where depressions in bedrock might have become infilled |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of Stage 1 results |
| - Outline approach | Tbc in light of Stage 1 results |
| **Key reference/s** | Wenban-Smith and Bates, 2011 |

| **Zone** | PQ-6 Thong Lane |
|---|---|
| **- Topography/ geomorphology** | - Dip slope of North Downs (Thames valley) with a series of dry valleys with ground surface elevations between 35m and 80m O.D. |
| **- Bedrock geology** | - Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation and localised outcrops of Lambeth Group and Harwich Formation |
| **Sediment sequences** | Valley sides and plateau surfaces devoid of sediments although unmapped spreads of superficial colluvial sediments may exist. Valley base contains Head/Colluvial deposits. Sequences in valley base may be consist of course, poorly sorted flint gravels as well as finer grained clay-silts. Potential exists for the presence of buried soils and undisturbed palaeo-landsurfaces in the sequences. |
| **Geological interpretation** | Cold climate solifluction processes resulting in deposition of Head, probably in late Pleistocene (<20ka B.P.) but earlier phases of slopewash and solifluction may be locally present, especially on level parts of higher ground in southern part of zone. Colluviation in lower parts of dry valleys in late Holocene following deforestation of Chalk from Neolithic/Bronze Age. Any artefacts and faunal remains likely to be reworked although colluvium may contain elements of in situ material. |
| **Palaeoenvironmental potential** | Low although colluvium may contain molluscan remains |
| **Palaeolithic remains** | One reworked Palaeolithic findspot within this area (LTC 3123). Some important nearby finds from deposit-types likely to occur in this zone, notably a handaxe and knapping debitage from unmapped colluvium (LTC 1661), and minimally disturbed Late Upper Palaeolithic knapping scatters (LTC 2370, 4045) from fine-grained colluvial sediments infilling dry valleys, as well as several nearby finds of most-likely residual/re-worked material (LTC 3197, 4035, 4039, 4055). |
| **Landscape-zone Research Objectives** | RO 2.1-2.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Is there evidence for pre-Devensian colluvial deposits in the area, do they contain Palaeolithic remains of any type, and is there evidence for Late Upper Palaeolithic occupation associated with dry valley colluvium? |
| - Outline approach | - position test pits in relation to topography and geological mapping, near areas where bullhead flint bed likely to have been exposed, and in areas identified as more promising on field visit of 10th June 2020 |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Wenban-Smith and Bates, 2011 |

| **Zone** | PQ-7 Filborough |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Lower part of dip slope of North Downs. Ground surface elevations 5-15m O.D., immediately above floodplain of the Thames. Series of small dry valleys running south/north through area.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation |
| **Sediment sequences** | Consists of a series of fluvial bodies of sand and gravel as well as Head deposits. Head sequences in valley base may be consist of course, poorly sorted flint gravels as well as finer grained clay-silts. Fluvial deposits likely to consist of basal gravels overlain by finer grained sands/silt and capped by gravel (fluvial or Head). |
| **Geological interpretation** | BGS mapping (Dartford) indicates two terraces present as Lynch Hill (Corbets Tey Gravel) and Taplow Terraces (Mucking Gravel). Only place in study area where two (possibly three, see PQ-8) terraces occur in close proximity to each other. Mixture of in situ and reworked artefacts and faunal remains depending on context of deposition. |
| **Palaeoenvironmental potential** | Moderate |
| **Palaeolithic remains** | Several Lower/Middle Palaeolithic artefacts known from nearby area (LTC 4052, 4054), and some specifically from gravel deposits that are likely equivalent to the mapped terrace deposits of this zone (LTC 4053) |
| **Landscape-zone Research Objectives** | RO 2.1-2.3 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | Test pits/boreholes to investigate whether the different mapped terraces are really there? What is the nature of the sedimentary sequences in the different terraces? Are there artefacts, faunal remains and/or materials for dating present? |
| - Outline approach | Closely-spaced test pits in broadly north-south transects transverse to valley-side slope |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Gibbard, 1994 |

| **Zone** | PQ-8 Thames, southern floodplain edge |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Margins of floodplain of the modern Thames with ground surface below 5m O.D. Modern floodplain reclaimed from former saltmarsh.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation |
| **Sediment sequences** | Holocene alluvial sediments consisting of clay/silts and sands with some intercalated peats resting on a series of sandy clay-silts intercalated between flint rich gravels between -5m and -20m O.D. Important buried landsurface likely to be developed at the base of the Holocene sediments. |
| **Geological interpretation** | Holocene alluvium from Mid-Late Holocene overlying a buried landsurface. Sediments beneath the Holocene (i.e. below -5m O.D.) likely to be Pleistocene in age and probably form part of the East Tilbury Marshes Gravel. The fine-grained sediments within the ETMG may be brackish water/estuarine. Range of depositional context in the Holocene indicate in situ and reworked artefacts may occur. Surface of the ETMG may represent a long-developed surface on which in situ material of Late Pleistocene/Early Holocene age may occur. Artefacts unlikely in ETMG due to estuarine context and apparent absence of hominids in MIS 5e. However, unmapped Devensian deposits may be present. |
| **Palaeoenvironmental potential** | Moderate-high |
| **Palaeolithic remains** | Late Upper Palaeolithic remains known from base of alluvium at several sites along southern side of Thames floodplain (eg. LTC 3406). Also, nearby records of Mousterian *bout coupé* handaxes from Tilbury (LTC 4028) suggest there may be unrecognised deposits/remains of this era in places |
| **Landscape-zone Research Objectives** | RO 3.1-3.2 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | What are the nature and age of the sub-alluvial Pleistocene sediments in the zone, and do they have any Palaeolithic remains? What is the nature of the surface of the Pleistocene sediments, and what, if any archaeology rests on this surface? When did Holocene sedimentation begin, and are there Holocene archaeological remains in the alluvium? |
| - Outline approach | Boreholes (and test pits, if ground conditions permit), guided by GI results if available, and closely spaced in broadly north-south transects transverse to presumed eastward fluvial flow |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Bates and Stafford, 2013 |

| **Zone** | PQ-9 Thames, main floodplain |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Main part of floodplain of the modern Thames with ground surface below 5m O.D. Modern floodplain reclaimed from former saltmarsh.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation. |
| **Sediment sequences** | Thick intercalated sequences of peats, clay/silts and occasional sands(3m to -15m O.D.) resting on coarse flint gravels (-15m to -20m O.D.). |
| **Geological interpretation** | Holocene alluvium from Early-Late Holocene overlying a buried landsurface. Sediments beneath the Holocene (i.e. below -15m O.D.) likely to be Pleistocene in age and probably form part of the Shepperton Gravel of Late Devensian age. Range of depositional context in the Holocene indicate in situ and reworked artefacts may occur. Surface of the Shepperton Gravel may represent the late Devensian/early Holocene surface on which in situ material of Late Pleistocene/Early Holocene age may occur. Artefacts unlikely in Shepperton Gravel and likely to be reworked if present. |
| **Palaeoenvironmental potential** | High in Holocene deposits, low in underlying Pleistocene gravels |
| **Palaeolithic remains** | Late Upper Palaeolithic remains known from base of alluvium at several sites along southern side of Thames floodplain (eg. LTC 3406). Also, nearby records of Mousterian *bout coupé* handaxes from Tilbury (LTC 4028) suggest there may be unrecognised deposits/remains of this era in places, although most Palaeolithic remains are most-likely derived and transported (LTC 4036). |
| **Landscape-zone Research Objectives** | RO 3.1-3.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Are the sands seen on the northern side of the zone Holocene or Pleistocene (i.e. the equivalent of those in PQ-8)? When did sedimentation being across the surface of the Shepperton Gravels? |
| - Outline approach | Boreholes, guided to complement (or supplement) GI results, and positioned ed in broadly north-south transects transverse to presumed eastward fluvial flow |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Bates and Stafford, 2013 |

| **Zone** | PQ-10 Thames, northern floodplain edge |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Margins of floodplain of the modern Thames with ground surface below 5m O.D. Modern floodplain reclaimed from former saltmarsh.<br>- Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation |
| **Sediment sequences** | Holocene alluvial sediments consisting of clay/silts and sands with some intercalated peats resting on a series of sands between 0m and -12m O.D. Important buried landsurface likely to be developed at the base of the Holocene sediments |
| **Geological interpretation** | Holocene alluvium from Mid-Late Holocene overlying a buried landsurface. Sediments (sands) beneath the Holocene (i.e. below 0m O.D.) may be Pleistocene in age and probably form part of the East Tilbury Marshes Gravel or major Holocene sand bars. Range of depositional context in the Holocene indicate in situ and reworked artefacts may occur. Surface of the ETMG (if present) may represent a long-developed surface on which in situ material of Late Pleistocene/Early Holocene age may occur. Artefacts unlikely in ETMG due to estuarine context and apparent absence of hominids in MIS 5e. However, unmapped Devensian deposits may be present. |
| **Palaeoenvironmental potential** | Moderate-high |
| **Palaeolithic remains** | Late Upper Palaeolithic remains known from base of alluvium at several sites along southern side of Thames floodplain (eg. LTC 3406). Also, nearby records of Mousterian *bout coupé* handaxes from Tilbury (LTC 4028) and another ovate from Tilbury dock enlargement (LTC 4029) suggest there may be unrecognised deposits/remains of this era in places, although most finds from the floodplain and its margins are probably residual/transported (LTC 430, 466, 4036). |
| **Landscape-zone Research Objectives** | RO 3.1-3.2 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | Boreholes and test pits to address what are the nature and age of the sub-alluvial Pleistocene sediments in the zone, and do they have any Palaeolithic remains? What is the nature of the surface of the Pleistocene sediments, and what, if any archaeology rests on this surface? When did Holocene sedimentation being, and are there Holocene archaeological remains in the alluvium? |
| - Outline approach | Boreholes (and test pits, if ground conditions permit), guided by GI results if available, and closely spaced in broadly north-south transects transverse to presumed eastward fluvial flow |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Bates and Stafford, 2013 |

| **Zone** | PQ-11 Goshems Farm |
|---|---|
| **- Topography/ geomorphology** | - Small topographic high on edge of floodplain with elevations between 5m and 15m O.D. |
| **- Bedrock geology** | - Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation |
| **Sediment sequences** | Sands and gravels between 6m and 10m O.D. (ground surface level mostly 12-15m Od) resting on Thanet Formation |
| **Geological interpretation** | Mostly an outcrop of the Corbets Tey Gravel (= Lynch Hill Terrace, dating to MIS 10-8) as an isolated remnant with younger Pleistocene sediments on all sides, and a small spread at lower elevation forming the southeast part of this zone may represent the younger Taplow Terrace (Mucking Gravel). |
| **Palaeoenvironmental potential** | Low? None known here, although deposits of this age have produced faunal and other palaeo-environmental remains at various nearby locations |
| **Palaeolithic remains** | One findspot from within this zone, a handaxe found on the marsh surface at its southeast corner (LTC 441); its origin uncertain, although it may well have derived from the terrace deposits that dominate this zone. Other nearby terrace deposits of the same age have produced abundant material in places, so this outcrop has some Palaeolithic potential. |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Normal Qs for Pleistocene terrace deposits: what is presence/prevalence of artefactual remains? What is presence/quality/range of biological remains? What is the age of the deposits? |
| - Outline approach | Test pits, positioned in broadly northwest-southeast transects transverse to presumed axis of fluvial flow, and also making sure to investigate valley-side areas of mapped outcrop, and for unmapped terrace deposits |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping; Bridgland 1983 (Ch 4; vol 2: p45) |

| **Zone** | PQ-12a Shearwater Avenue |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Low lying terrace surface with elevations between 5 and 10m O.D.<br>- Thanet Formation |
| **Sediment sequences** | Sands and gravels outcropping between -2m and 4m O.D. with a single exception of a higher subcrop of sand and gravel at 7m to 9m O.D. at northwestern end of zone |
| **Geological interpretation** | Fluvial sediments of the Taplow/Mucking Gravel with a possible outcrop of Corbets Tey Gravel at the northwestern end. It is possible that the BGS mapping here has missed a local outcrop of the older terrace. The inside part of the Mucking Gravel is likely to be preserved in this zone where sequences may be more complete than usual. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | There are moderately-common Lower/Middle Palaeolithic handaxes and debitage found in the late 19th century from unspecified gravel pits in the West Tilbury and Mucking area (LTC 464, 4034) |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | - Normal Qs for Pleistocene terrace deposits: what is presence/prevalence of artefactual remains? What is presence/quality/range of biological remains? What is the age of the deposits?<br>- Also: is the BGS mapping wrong in the northwestern part of the zone? What is the nature of the sequences in the northwestern part of the zone? Is there any material for dating sequences here? |
| - Outline approach | Test pits, positioned in broadly northwest-southeast transects transverse to presumed axis of fluvial flow, and also making sure to investigate valley-side areas of mapped outcrop |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-12b Sutton's Farm |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Low lying terrace surface with elevations between 5 and 10m O.D.<br>- Thanet Formation |
| **Sediment sequences** | Sands and gravels outcropping between -2m and 4m O.D. |
| **Geological interpretation** | Fluvial sediments of the Mucking Gravel |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | There are moderately-common Lower/Middle Palaeolithic handaxes and debitage found in the late 19th century from unspecified gravel pits in the West Tilbury and Mucking area (LTC 464, 4034) |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Normal Qs for Pleistocene terrace deposits: what is presence/prevalence of artefactual remains? What is presence/quality/range of biological remains? What is the age of the deposits? |
| - Outline approach | Test pits, positioned to provide representative coverage of this small area |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-13 Chadwell Saint Mary |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Broadly-horizontal terrace surface with elevations between 20m and >25m O.D, dissected by surface run-off valleys in places around periphery.<br>- Thanet Formation and Lambeth Group. |
| **Sediment sequences** | Sands and gravels with outcrops between 20m and 25m O.D. |
| **Geological interpretation** | Orsett Heath Gravel (mapped as Boyn Hill Terrace by BGS) with valley-side edge of the floodplain potentially preserved along the northwest side of this zone; however this valley-side zone may have been removed by the cutting of the valley associated with PQ-15 |
| **Palaeoenvironmental potential** | No faunal remains known, although should not be ruled out bearing in mind abundant palaeo-environmental remains from nearby Lynch Hill deposits. |
| **Palaeolithic remains** | Numerous records of well-provenanced handaxe and debitage finds from the Boyn Hill/Orsett Heath deposits in this zone (LTC 414, 468, 4018) and around it (503, 4017), as well as further afield (LTC 427, 2119, 4030, 4031). |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | - Some investigations to characterise sequence in area lacking information in central and south-eastern part of zone, as well as in parts of zone near known Palaeolithic sites.<br>- And, normal Qs for Pleistocene terrace deposits: what is presence/prevalence of artefactual remains? What is presence/quality/range of biological remains? What is the age of the deposits? |
| - Outline approach | - Test pits, guided by GI results if available, and positioned in orthogonal northwest-southeast and northeast-southwest transects [the presumed fluvial flow axis is uncertain, but is likely to have been either southwestward, or southeastward]<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping, English Rivers Palaeolithic Survey (Wessex Archaeology 1996) |

| **Zone** | PQ-14 Southfields |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Topographic high, with elevations from 20m to 35m O.D.<br>- Lambeth Group and Thanet Formation |
| **Sediment sequences** | Sands and gravels with some superficial clays and silts with subcrops from 25m to >30m O.D. |
| **Geological interpretation** | BGS mapping attributes this zone to the Black Park Terrace, while Gibbard records essentially the same as Dartford Heath Gravel. By contrast Bridgland describes this as Orsett Heath Gravel. It is noted that elevations of the sediments here are considerably above the Orsett Heath Gravel in PQ-13. Head deposits are also present in small valley systems cut into the Black Park Gravel. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | One wouldn't normally expect Palaeolithic remains associated with the (presumed Late Anglian) Black Park Gravel, although palaeo-landsurfaces with undisturbed remains have been found on the surface of gravel terraces of presumed Late Anglian age on the south side of the Thames, in Dartford, and Ebbsfleet (LTC 4044), where the surviving outcrops are overlooked by higher ground that provided a source for colluvial slopewash to over-ride Palaeolithic remains (not the case in this zone). There is one record near to this zone (LTC 328), of rolled possibly-Palaeolithic artefacts from Late Prehistoric and Saxon excavations at Mucking. |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | What is the age of these deposits? Are they equivalent to the Orsett Heath Gravel? And other normal Qs for Pleistocene terrace deposits: what is presence/prevalence of artefactual remains? What is presence/quality/range of biological remains? |
| - Outline approach | - Test pits; one main north-south transect to match linear north-south impact, and others scattered around to match the various other areas of impact<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Gibbard, 1994. Bridgland, 1994 |

| **Zone** | PQ-15 Brook Farm Channel |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - A valley-like landform running from northwest to southeast between the southeast side of the Mar Dyke valley and the northwest side of the main Thames estuary. It has a central high of around 30m O.D. dropping to less that 20m O.D. to the northwest and 10m O.D. to the southeast.<br>- Lambeth Group and Thanet Formation |
| **Sediment sequences** | No ground-truthed information; probably infilled with a mixture of poorly-sorted flint gravel mixed with clay/silt/sand. |
| **Geological interpretation** | Head filling narrow 'valley-like' feature running northwest to southeast connecting the Mar Dyke basin with the main Thames - a possible Pleistocene drainage exit from the Mar Dyke? |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known associated with this zone. |
| **Landscape-zone Research Objectives** | RO 4.1-4.2 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | Boreholes/test pits to characterise sequence and investigate for artefactual and/or palaeoenvironmental remains |
| - Outline approach | - Test pits, positioned in light of trial trench results, and trying to form closely-spaced broadly northeast-southwest transects<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-16 Loft Hall Farm |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Mar Dyke southwest side, valley-side situation with slopes dipping northwards into Mar Dyke with ground surface elevations of around 30m O.D, abutting north side of Black Park Gravel high that forms zone PQ-14.<br>- Lambeth Group |
| **Sediment sequences** | None recorded above bedrock |
| **Geological interpretation** | Nothing above bedrock (Lambeth Group) |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | There is one surface find of a handaxe from Saffron Garden Farm (LTC 2079), a little to the northeast of this zone, and possibly derived from the Black Park Gravel (BPG), or residual evidence of post-BPG activity in the area. |
| **Landscape-zone Research Objectives** | Not thought likely to be applicable; first task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Ascertain whether any Quaternary sediments present, and if so what is their distribution, and if they have any Palaeolithic potential |
| - Outline approach | A few test-pits, targeted to continue any transects from adjacent zones, and taking account of any information from GI work or trial-trenching |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-17 Cuckoo Lane |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Above southern side of Mar Dyke, where it cuts through southern part of wide spread of Lynch Hill terrace deposits of the Ockendon Loop; ground slopes northward into Mar Dyke along minor south bank dry valley tributary, sloping down northward from c. 20m to 10m O.D.<br>- Thanet Formation and Lambeth Group |
| **Sediment sequences** | Made-up modern ground mostly, although natural sediments may be closer to ground surface nearer the Mar Dyke channel |
| **Geological interpretation** | Corbets Tey Gravel (= BGS Lynch Hill Terrace) with elements of Head deposit infilling dry valley dissecting surface of terrace outcrop |
| **Palaeoenvironmental potential** | High (if terrace deposits encountered); boreholes record peaty deposits, and other nearby parts of the Lynch Hill Terrace have produced rich palaeoenvironmental remains |
| **Palaeolithic remains** | Moderate; none known from this specific locality, but equivalent deposits have produced good and minimally-disturbed remains, including fresh condition artefacts (LTC 181, 2182, 4014, 4020, 4021) |
| **Landscape-zone Research Objectives** | RO 6.1-6.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | - Firstly, to ascertain where Quaternary sediments are present, relying on GI and/or trial trench data so far as possible<br>- Then, to focus fieldwork work only on those areas |
| - Outline approach | Test pits in areas where Quaternary sediments are present |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-18 Mederbridge Road (Ockendon Loop) |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Southeast margin of wide spread of Lynch Hill Gravel on northwest side of Mar Dyke, ground surface sloping down into Mar Dyke valley from 15m to 5m O.D.<br>- Lambeth Group and London Clay Formation |
| **Sediment sequences** | Sand and gravels with peat, clay-silt and poorly-sorted coarse sandy gravels |
| **Geological interpretation** | Corbets Tey Gravel (= BGS Lynch Hill Terrace) with elements of Head deposit infilling dry valleys cut through Corbets Tey Gravel |
| **Palaeoenvironmental potential** | High; boreholes record peaty deposits, and other nearby parts of the Lynch Hill Terrace have produced rich palaeoenvironmental remains |
| **Palaeolithic remains** | Moderate/High; none known from this specific locality, but nearby equivalent deposits have produced good and minimally-disturbed remains, including fresh condition artefacts (LTC 181, 2182, 4014, 4020, 4021) |
| **Landscape-zone Research Objectives** | RO 6.1-6.3 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise sequence affected by LTC footprint, and investigate Palaeolithic and palaeo-environmental potential |
| - Outline approach | Test pits along line of LTC impact |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-19 Kemps Farm, Dennis Road and Manor Farm |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Terrace surface dipping form east to west from 20m to 15m O.D.<br>- London Clay Formation |
| **Sediment sequences** | Sediment subcrop from 8m up to surface elevations of c.24m. Sequences consist of sands and gravels from 8m to 13m O.D. Overlain by organic sediments (including peat) thickening in a northwards direction. These sequences are in turn overlain by gravelly clays and sands. |
| **Geological interpretation** | Part of the Corbets Tey Gravel sequence (= BGS Lynch Hill Terrace) including sediments potentially belonging to the Belhus Organic Channel (Aveley Silts and Sands, *sensu* Gibbard, 1994). Zone covers an area from the middle of the terrace spread to its inner valley-side edge, where it abuts mapped outcrops of Boyn Hill Terrace (Orsett Heath Gravel) at its northern end. |
| **Palaeoenvironmental potential** | Very high; faunal and floral remains anticipated in these deposits. |
| **Palaeolithic remains** | High; nearby equivalent deposits have produced lithic artefacts in moderate abundance, including sharp finds thought to represent minimally-disturbed evidence of contemporary occupation (LTC 181, 2182, 4014, 4020, 4021) |
| **Landscape-zone Research Objectives** | RO 6.1-6.3 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | Bearing in mind the high potential of this zone, and the major impact upon it, some stage 1 investigations are recommended to establish how/if Palaeolithic and palaeoenvironmental potential vary within it, and to see if any areas of particularly high potential can be identified at an early stage |
| - Outline approach | - Test pits, focusing on (a) preliminary spread around all areas of impact, and (b) with a view to subsequently developing broadly WSW-ENE transects, across presumed fluvial flow axis<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Wenban-Smith et al., 2013; Gibbard, 1994 |

| **Zone** | PQ-20a Green Lane, east side of Mar Dyke basin |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Above eastern side of the Mar Dyke basin with topography sloping down westwards from about 15m to 5m O.D.<br>- London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Spread of Head deposits, with occasional bedrock highs poking through |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | First task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible - if sediments present, then RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Ascertain whether any Quaternary sediments present, and if so what is their distribution, and if they have any Palaeolithic potential |
| - Outline approach | A few test-pits, targeted to continue any transects from adjacent zones, and taking account of any information from GI work or trial-trenching |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-20b Castle's Grove, east side of Mar Dyke basin |
|---|---|
| **- Topography/ geomorphology** | - Above eastern side of the Mar Dyke basin with topography sloping down westwards from about 15m to 5m O.D. |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Spread of Head deposits, with occasional bedrock highs poking through |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | First task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible - if sediments present, then RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Ascertain whether any Quaternary sediments present, and if so what is their distribution, and if they have any Palaeolithic potential |
| - Outline approach | A few test-pits, targeted to continue any transects from adjacent zones, and taking account of any information from GI work or trial-trenching |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-20c Bulphan, east side of Mar Dyke basin |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Above eastern side of the Mar Dyke basin with topography sloping down westwards from about 15m to 5m O.D.<br>- London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Spread of Head deposits, with occasional bedrock highs poking through |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | First task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible - if sediments present, then RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Ascertain whether any Quaternary sediments present, and if so what is their distribution, and if they have any Palaeolithic potential |
| - Outline approach | A few test-pits, targeted to continue any transects from adjacent zones, and taking account of any information from GI work or trial-trenching |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-21 Mar Dyke narrows |
|---|---|
| **- Topography/ geomorphology** | - Narrow channel of Mar Dyke from inner basin south-westwards to main Thames floodplain |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Silt/clay and peat |
| **Geological interpretation** | Holocene alluvium |
| **Palaeoenvironmental potential** | High |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise sequence, and evaluate palaeoenvironmental and archaeological potential. When did sedimentation begin in the Mar Dyke in the Holocene? |
| - Outline approach | - Closely-spaced test pits in short transects that are broadly northwest-southeast aligned<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-22a Mar Dyke Basin, main (Fen Farm) |
|---|---|
| **- Topography/ geomorphology** | - Main central part of the Mar Dyke basin with topography below 10m O.D. |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Alluvium or Head deposits on valley floor – potentially a mixture of both. Possible London Clay throughout |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise sequence, and evaluate palaeoenvironmental and archaeological potential. Where is the base of the alluvium, if present? Has the Mar Dyke infilled with Head in the past? |
| - Outline approach | - Test pit transects, aligned broadly east-west, and to continue transects from adjacent zones PQ- 20a, 20b, 23a and 24<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Moorlock and Smith, 1991 |

| **Zone** | PQ-22b Mar Dyke Basin, northwest (Puddle Dock) |
|---|---|
| **- Topography/ geomorphology** | - Northwest part of the main Mar Dyke basin with topography below 10m O.D. |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Alluvium or Head deposits on valley floor – potentially a mixture of both. Possible London Clay throughout |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | UNCERTAIN |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise sequence, and evaluate palaeoenvironmental and archaeological potential. Where is the base of the alluvium, if present? Has the Mar Dyke infilled with Head in the past? |
| - Outline approach | - Test pit transects, aligned broadly north-south, and to continue transects from adjacent zones PQ- 24 and 27<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Moorlock and Smith, 1991 |

| **Zone** | PQ-23a Mar Dyke, eastern margin (Orsett Fen, Hobletts) |
|---|---|
| **- Topography/ geomorphology** | - Eastern margins of the Mar Dyke basin with small topographic highs in marshland. |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel surrounded by sands and silts? |
| **Geological interpretation** | Head deposits outcropping on bedrock that have been eroded by fluvial activity or cold climate downcutting. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise deposits, investigate presence and date of alluvial and/or colluvial deposition, evaluate archaeological and palaeoenvironmental potential |
| - Outline approach | Test pits, aligned so as (a) to continue transects in adjacent zone PQ-22a, and (b) to investigate minor alluvial inlets around edges of zone |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-23b Mar Dyke, eastern margin (Stringcock Fen) |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Eastern margins of the Mar Dyke basin with small topographic highs in marshland.<br>- London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel surrounded by sands and silts? |
| **Geological interpretation** | Head deposits outcropping on bedrock that have been eroded by fluvial activity or cold climate downcutting. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known |
| **Landscape-zone Research Objectives** | RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Characterise deposits, investigate presence and date of alluvial and/or colluvial deposition, evaluate archaeological and palaeoenvironmental potential |
| - Outline approach | Test pits, forming a broadly east-west transect across zone, and with some others to fill in gaps and ensure full coverage of zone |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-24 West side of Mar Dyke basin, east of South Ockendon Hall |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Western side of the Mar Dyke basin with topography sloping down eastwards from about 30m to 5m O.D.<br>- London Clay Formation |
| **Sediment sequences** | Clay with sand and gravel |
| **Geological interpretation** | Spread of Head deposits, with occasional bedrock highs poking through |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known - NB, extensive quarrying for clay has provided no indication of any unmapped Pleistocene terrace deposits, nor produced any Palaeolithic finds |
| **Landscape-zone Research Objectives** | Not thought likely to be applicable; first task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible; then if sediments present, RO 5.1-5.4 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | To investigate for Quaternary sediments near east margin of zone, that continue sequences from zone PQ-22a<br>- To investigate for glacial till or other glacigenic sediments in northwest part of zone, where abuts PQ-25 |
| - Outline approach | - Focus test pitting where lack of Palaeolithic potential cannot be ascertained from GI or trial trench data<br>- Continue transects from zones PQ- 22a, 22b and 25 |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | Moorlock and Smith, 1991 |

| **Zone** | PQ-25 Hall Farm |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Terrace shelf with ground-slope trending down from east to west from >30m to c. 20m O.D, and with higher ground above 25m OD in northern part of zone<br>- London Clay Formation |
| **Sediment sequences** | Clay over laminated sands and silts with a basal gravel. Sediments outcrop between 16m and 24m O.D. |
| **Geological interpretation** | Main aggradation of the Orsett Heath Gravel (mapped by BGS as Boyn Hill Terrace). Inner edge of terrace preserved by the rising ground at east of zone, where abuts mapped outcrops of Black Park Gravel (PQ-26). This spread may include two distinct terraces, a more-northerly one with its surface >25m OD, and a southerly one with its surface >20m OD. Good potential for complete sequence records close to inner margin of terrace, which may clarify terrace attribution and mapping. |
| **Palaeoenvironmental potential** | Moderate to high. Shells occasionally reported from boreholes. Laminated sequences may suggest brackish water sediments potentially containing microfossils |
| **Palaeolithic remains** | Moderate potential; one handaxe record from this zone (LTC 4007), and numerous findspots from nearby zone of equivalent deposits at Chadwell St Mary (see PQ-13) |
| **Landscape-zone Research Objectives** | RO 6.1-6.3 |
| **Pal./geo-arch. assessment** | MODERATE-HIGH |
| **Stage 1 fieldwork:**<br>- Priorities | Bearing in mind the moderate-high potential of this zone for both archaeological and palaeoenvironmental remains, and the major impact upon it, some stage 1 investigations are recommended to establish how/if Palaeolithic and palaeoenvironmental potential vary within it, and to see if any areas of particularly high potential can be identified at an early stage |
| - Outline approach | - Test pits, focusing on (a) preliminary spread around all areas of impact, and (b) with a view to subsequently developing broadly WSW-ENE transects, across presumed fluvial flow axis<br>- May be useful to do boreholes too, if sediments too deep for bottom of Quaternary sequence to be reached by machine-dug test pit |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping; Wessex Archaeology 1996 |

| **Zone** | PQ-26 White Post Farm |
|---|---|
| **- Topography/ geomorphology**<br>**- Bedrock geology** | - Topographic high with elevations from 30m to >40m O.D.<br>- London Clay Formation |
| **Sediment sequences** | Sands and gravels with some clays with outcrops from 25m to >35m O.D. |
| **Geological interpretation** | BGS mapping attributes this high ground to the Black Park Gravel terrace (while Gibbard attributes it as Dartford Heath Gravel, which he regards as the downstream equivalent of the Black Park Gravel). By contrast Bridgland appears to equate these outcrops with his Orsett Heath Gravel, although it isn't totally clear from the scale of his diagrams how his interpretations equate with the outcrops mapped by the BGS in this zone |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known. One wouldn't normally expect Palaeolithic remains associated with the (presumed Late Anglian) Black Park Gravel, although palaeo-landsurfaces with undisturbed remains have been found on its surface on the south side of the Thames, in Dartford, and Ebbsfleet (LTC 4044), where the surviving outcrops are overlooked by higher ground that provided a source for colluvial slopewash to over-ride Palaeolithic remains (not the case in this zone).<br>However, the southeast edge of this zone abuts a spread mapped as Boyn Hill Gravel, which is of higher potential (see PQ-25), so some investigation is worthwhile on both artefact recovery and geological framework grounds. |
| **Landscape-zone Research Objectives** | RO 6.1-6.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | The LTC footprint crosses the west side of this zone, near its boundary with PQ-25. This is an area that might preserve the valley-side edge of the Boyn Hill Terrace abutting the truncated spread of Black Park Gravel. Investigating and, if present, recording this transition should be the priority for stage 1 fieldwork, as well as establishing the presence/prevalence of any archaeological or palaeoenvironmental remains. |
| - Outline approach | - Regularly-spaced test pits along the small linear area of impact<br>- Also some boreholes, if base of Quaternary sediments too deep to be reached by machine-dug test pits |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | Bridgland 1994: 176; Gibbard 1994: 3; BGS mapping |

| **Zone** | PQ-27 Mar Dyke, northern edge |
|---|---|
| **- Topography/ geomorphology** | - Sloping ground to the north of Mar Dyke dipping down to south from *c.*70m to 10m O.D. |
| **- Bedrock geology** | - London Clay Formation |
| **Sediment sequences** | Sands and gravels with variable clay content |
| **Geological interpretation** | Mostly Head covering bedrock. Some isolated patches of Glaciofluvial deposits from the Anglian Ice margins. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known, and none likely |
| **Landscape-zone Research Objectives** | First task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible - if sediments present, then RO 7.1-7.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | Verify presence/nature/potential of Quaternary sediments |
| - Outline approach | - Focus test pits on areas where insufficient information from GI work and/or trial trenching, or to build on relevant data from these work packages<br>- Distribute test pits to (a) ensure even and representative coverage of zone, and its varying topography and geological mapping, (b) to extend a north-south transect from zone PQ-22b toward Gladstone Cottages, and (c) to have some other transects across varying topography and mapped glacigenic outcrops |
| **Stage 2 fieldwork:**<br>- Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping |

| **Zone** | PQ-28 Foxburrow Wood |
|---|---|
| **- Topography/ geomorphology** | - Zone of higher undulating topography at the northernmost end of the LTC scheme footprint |
| **- Bedrock geology** | - London Clay Formation, Claygate Member and Bagshot Formation |
| **Sediment sequences** | Sand, gravel and clay/silts |
| **Geological interpretation** | Stanmore Gravel Formation (Pliocene or Early Pleistocene) and Glaciofluvial deposits locally present. Head outcrops also widespread across the area. |
| **Palaeoenvironmental potential** | Low |
| **Palaeolithic remains** | None known, and none likely |
| **Landscape-zone Research Objectives** | First task is to find out if any Quaternary sediments, from GI and/or trial trench data, if possible - if sediments present, then RO 7.1-7.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:** - Priorities | Verify presence/nature/potential of any Quaternary sediments |
| - Outline approach | Test pits, focusing on areas where Palaeolithic potential (or lack of it) cannot be ascertained from GI or trial trench data |
| **Stage 2 fieldwork:** - Priorities | Maybe none, tbc in light of stage 1 results |
| - Outline approach | Maybe no work required, tbc in light of stage 1 results |
| **Key reference/s** | BGS mapping; Bridgland 1994 (101-105) |

| **Zone** | PQ-29 Park Pale |
|---|---|
| **- Topography/ geomorphology** | - Dip slope of South Downs (Medway valley) with a series of dry valleys with ground surface elevations between 35m and 80m O.D. |
| **- Bedrock geology** | - Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation and Thanet Formation and localised outcrops of Lambeth Group and Harwich Formation at north west edge of zone. |
| **Sediment sequences** | Valley sides and plateau surfaces devoid of sediments although thin discontinuous spreads of superficial sediments less than 1m may exist. Valley base contains Head/Colluvial deposits. Sequences in valley base may be consist of course, poorly sorted flint gravels as well as finer-grained clay-silts. Potential exists for the presence of buried soils in the sequences. |
| **Geological interpretation** | Cold climate solifluction processes resulting in deposition of Head, probably in late Pleistocene (<20ka B.P.) but earlier phases of slope wash and solifluction may be locally present, and may seal relatively-undisturbed Lower/Middle Palaeolithic activity areas where bedrock forms sub-horizontal depressions or plateaux. Colluviation in late Holocene following deforestation of Chalk from Neolithic/Bronze Age; any artefacts and faunal remains likely to be reworked although Holocene colluvium may contain elements of *in situ* faunas. |
| **Palaeoenvironmental potential** | Low, although colluvium may contain molluscan remains |
| **Palaeolithic remains** | None known, although Lower/Middle Palaeolithic remains have been found in areas with similar deposits (LTC 1661 in PQ-3; and LTC 4039), and may represent relatively-undisturbed Lower/Middle Palaeolithic activity areas where bedrock forms sub-horizontal depressions or plateaux, and then these have been infilled by Middle Pleistocene colluvium. Late Upper Palaeolithic remains have also (albeit rarely) been found in fine-grained colluvium infilling dry valleys in chalk bedrock landscapes (LTC 4045). |
| **Landscape-zone Research Objectives** | RO 1.1-1.3 |
| **Pal./geo-arch. assessment** | LOW-MODERATE |
| **Stage 1 fieldwork:**<br>- Priorities | (a) Are there unmapped spreads of older colluvium, covering areas of Lower-Middle Palaeolithic activity on less-sloping parts of dry valley sides, and (b) are there areas of Late Upper Palaeolithic activity in/below spreads of late Last Glacial or early Holocene colluvium? |
| - Outline approach | Test pits, distributed (a) as transects across the Gads Hill dry valley, (b) in other areas so as to ensure representative coverage, and (c) having taken account of any relevant information from GI work or trial trenching |
| **Stage 2 fieldwork:**<br>- Priorities | Tbc in light of stage 1 results |
| - Outline approach | Tbc in light of stage 1 results |
| **Key reference/s** | - |

## F.3. Key references for PQ zone summaries

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# Annex G Walk-over survey: photos

# Annex G.

# Walk-over survey: photos

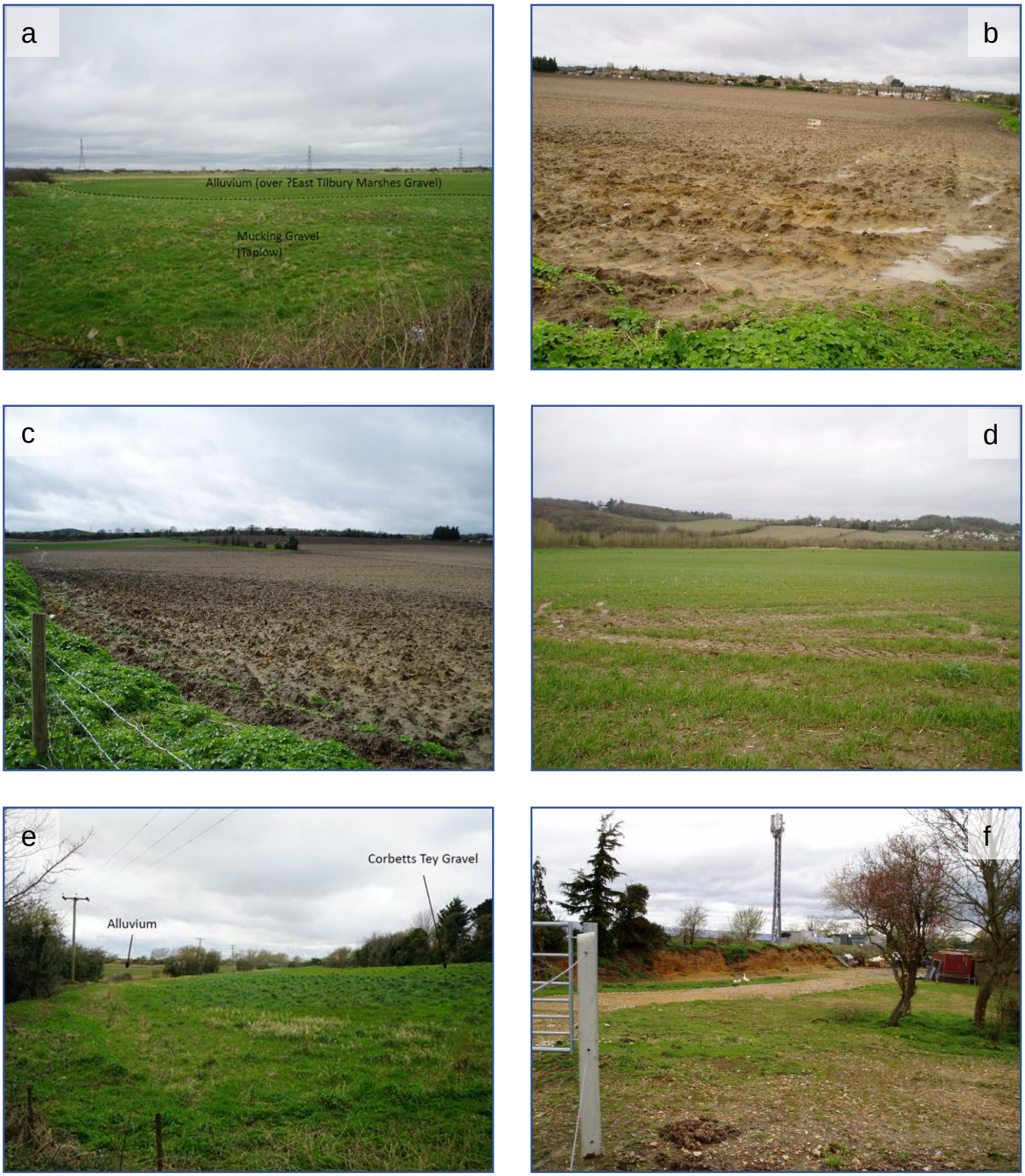


**Fig. G-1. (a)** Taplow (=Mucking) terrace at Chalk (looking NW); **(b)** ?terraces in field at PQ-7 (looking W); **(c)** Shorne Woods plateau (looking S); **(d)** Shorne Woods plateau, looking north across Gads Hill dry valley (looking N); **(e)** Lynch Hill (=Corbets Tey) outcrop at Barvills Farm (looking SW); **(f)** Lynch Hill (=Corbets Tey) outcrop at Barvills Farm (looking N).


**Fig. G-2. (a)** Boyn Hill (=Orsett Heath) terrace bluff at West Tilbury (looking NW); **(b)** Gun Hill Pit, Turnpike Lane, West Tilbury (looking NW); **(c)** cut faces to south of Dene Holes roundabout, Socketts Heath (looking N); **(d)** Mar Dyke basin (looking SW); **(e)** Mar Dyke basin (looking N); **(f)** M25 cutting through Boyn Hill terrace at North Ockenden (looking NE).


**Fig. G-3. (a)** Field in LTC footprint to NE of Dennises Cottages (looking NE); **(b)** field to N of Little Belhus Country Park (looking NW); **(c)** field to N of Little Belhus Country Park (looking SE); **(d)** built-up road network around roundabout at North Stifford (looking S); **(e)** narrowed southwest exit channel of Mar Dyke basin (looking NW); **(f)** narrowed southwest exit channel of Mar Dyke basin (looking SE).

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