Part I

Introduction and Background

Chapter 1

Introduction

High Speed 1 (HS1; formerly the Channel Tunnel Rail Link), is the new high-speed railway linking London to the Continent via the Channel Tunnel (Fig 1). The route of HS1 passes through Kent in south-east England, connecting the tunnel portal at Folkestone via Ashford International to, Ebbsfleet International in north Kent, crossing under the Thames at Swanscombe and then through Essex and East London, via Stratford International to St Pancras International.

The massive engineering and construction project necessitated a major programme of archaeological works, one of the largest ever undertaken in Britain. Desk-based assessment (URL 1994) was followed by an extensive programme of evaluations comprising field walking, trial trenching, test pitting and borehole investigation, largely undertaken between 1994 and 1997. These investigations assessed the impact of the route on archaeological resources, with the aim of mitigating the impact of construction on this finite resource. Where archaeological sites could not be avoided or preserved *in situ* excavations were undertaken in advance of construction. The principal archaeological work for Section 2, commissioned by HS1 (as Union Railways North Ltd at that time), took place between September 2000 and March 2003, and formed part of an extensive programme of archaeological investigation, analysis and reporting carried out in advance of, during and after the construction of HS1.

This study, entitled Thames Holocene, focuses on the alluvial deposits that HS1 passes both over, and indeed through, not only within the River Thames floodplain, but also major tributaries of the Thames, including the Lea, Mar Dyke and Ebbsfleet.

The investigation of alluvial wetland areas within the UK (Coles and Coles 1996) can be traced back into the 19th century (eg, the discovery of the Brigg Raft

Figure 1 The route of HS1 through Kent and into London

– McGrail 1990) but it was only in the 1960s that wetland archaeology as a specialist area of study was first recognised (Van de Noort and O'Sullivan 2006). Since then nearly 50 years of archaeological research into wetland regions have been undertaken in the UK and foremost amongst these are studies focusing on the large, well-preserved prehistoric landscapes of the Somerset Wetlands (Coles and Coles 1986), the Fenland (Hall and Coles 1994), the North West Wetlands (Cowell and Innes 1994), the Humber Wetlands (Van de Noort and Davies 1993) and the Severn Levels (Bell 2007). By contrast, investigation of the Thames Estuary has been piecemeal and usually limited to the London Thames (eg, Milne *et al* 1997; Sidell *et al* 2000; 2002), although this picture is now changing (Seel 2001; Sidell 2003; Haughey 2003; 2007; Batchelor 2009). In most cases these studies have considered the landscape and stratigraphic context of the contained archaeological sites where it is the presence of waterlogged remains, often in undisturbed contexts and in association with the environmental archaeological evidence, which increases the significance and importance of these areas (Coles 1995).

Despite the numerous studies in these wetlands the prediction of locations where archaeological sites may exist beneath the alluvium remains difficult (Coles 1995; Deeben *et al* 1997; Bates 1998; Fulford *et al* 1997; Wilkinson and Bond 2001; Bates 2003; Challis and Howard 2003; Peeters 2006). In these wetland situations, considerable logistical and strategic problems are often encountered where the sequences may exceed 20m or more in depth and contain or bury sediments that potentially contain archaeological material from the last 12,000 years. As a result the sites are often beyond the reach of conventional survey and excavation strategies for assessing likely sub-surface archaeological potential and their subsequent excavation (Bates *et al* 2000a; Peeters 2006). Coupled with the practical issues of working in such circumstances there are also conceptual issues to resolve regarding the nature of the buried resource and its remote identification.

It is precisely such difficulties that were faced during the construction of High Speed 1 (HS1, formerly known as the Channel Tunnel Rail Link) through the Thames and Medway Marshes, where approximately 18km (17%) of the total HS1 route length rests on alluvium deposited during the last *c* 12,000 years (Figs 1 and 2). The remainder of the HS1 route through Kent has been documented elsewhere (Booth *et al* 2011). These alluvial deposits were always considered likely to contain archaeological material but little was known of the true archaeological potential of these deposits (URL 1994). Consequently, the project faced considerable difficulties in attempting to devise a strategy to evaluate, identify and mitigate any archaeology buried within the footprint of the route corridor, which might include tunnel excavations, cut and cover operations, bridge foundations, piling and service diversions among the engineering impacts. In these circumstances it was therefore determined that a geoarchaeological approach to the alluvial corridor would be adopted, through which commonly occurring relationships between sedimentary contexts and archaeology could be highlighted in order to allow predictions regarding the nature and the spatial distribution of areas of high archaeological potential. This process would rely heavily on extant geotechnical information (including that collected by project engineers for design of the scheme) for the route corridor linked to knowledge from previous archaeological and geological discoveries. The findings of the modelling would then inform the project team of the location of areas of high archaeological potential along the route corridor in advance of determining both detailed archaeological investigation and mitigation strategies and construction.

The project should also be viewed in the context of an on-going process of investigation associated with the infrastructure of the rail-link and the Channel Tunnel as well as development within the Thames corridor. Since the construction of the Channel Tunnel started in the late 1980s, geoarchaeological work has been associated with developments that included works at the Folkestone site of Holywell Coombe (Preece and Bridgland 1998) as well as the eastern part of HS1 (Booth *et al* 2011). At the same time, other projects in the Thames Estuary were also adopting a geoarchaeological approach to investigation including work on the Jubilee Line in Central London and in Southwark (Sidell *et al* 2000; 2002) and work on the A13 in East London (Stafford *et al* 2012).

This report describes the methods and approaches used in the project as well as the findings of elements of that survey. Unlike the many wetland archaeological projects recently undertaken in the UK (Coles and Coles 1986; Van de Noort and Davies 1993; Cowell and Innes 1994; Hall and Coles 1994; Bell 2007), where attempts to document regional archaeological histories are made, it is the objective of this volume to describe the methodology that was adopted to tackle these issues, to identify the location of any archaeology beneath the floodplain and to outline the nature of the results. The volume has been written in a manner that describes the way in which the project was undertaken from desk-top inception through strategy design and fieldwork to assessment and analysis. This structure was adopted in order to allow the authors to retrospectively critique the methods and approaches and critically evaluate the success of the project that had a lifespan of some 16 years, during which time methodologies and approaches to alluvial archaeology have seen significant changes. It is our hope firstly that the target audience for this volume is not just the alluvial archaeologist working in the lower reaches of river valleys in NW Europe, but the curators and consultant archaeologists currently in positions of responsibility who may learn from the successes and failures of our approach to this unique set of circumstances. Through this process of self-analysis more robust approaches to alluvial archaeology of lowland rivers and estuaries can be developed in the future. The success or otherwise of the project is measured both in terms of correctly identifying the location of buried archaeological material and confirming the absence of material from those areas of the route considered unlikely to contain archaeological material. That this has been achieved in specified locations along the route corridor (eg, at Tank Hill Road and Thames River Crossing) appears to be justification for this approach. However, we do not restrict ourselves to purely methodological approaches and consequently in the final chapter a consideration is made of the information gained regarding human activity within the route corridor, the palaeoenvironmental data pertaining to landscape evolution, and an evaluation of the success of the approach. The reader is cautioned that this volume is not an attempt to produce a narrative for the development of the Lower Thames in geological and archaeological terms over the last 12,000 years.

This publication is also part of an overall strategy to publish results from the rail link project and should be read in conjunction with the site focused reports (Andrews *et al* 2011a; Leivers *et al* 2007; Barnett *et al* forthcoming; Wenban-Smith *et al* forthcoming). Two sites or areas investigated within the Thames alluvial corridor area are omitted from detailed discussion in this report. The excavation of a major archaeological site at Tank Hill Road (Fig 2; Leivers *et al* 2007) was deemed sufficiently important to form a detailed, stand-alone publication and only an outline summary of the results from this site are presented here. Secondly the Ebbsfleet Valley (Fig 2; Andrews *et al* 2011a; Wenban-Smith *et al* forthcoming) was identified as being a highly complex area in which Pleistocene and Holocene deposits were closely linked and a variety of archaeological materials were present. For this reason only outline summaries are given here.

A further note should be made regarding the duration and nature of the process of investigation undertaken during the lifetime of the project. The complex, varied and fragmentary nature of many of the sequences sampled and recorded, across the 18km of the alluvial corridor, during the 10 years or so between inception of the project and the final phases of field investigation have resulted in a fragmentary archive of data collected by a number of organisations. As a consequence it has been difficult for any one individual to have and maintain an overview of the project from start to finish. One of the authors (MB) has, however, followed the project from an early stage (1994) and has attempted to integrate and provide a seamless overview, the other author (ES) being involved in the HS1 fieldwork for Oxford Archaeology from 1998. Additionally, it should be noted that because of the long duration of the project the initial development of models and ideas used to drive the project began in 1994 and as a result the models used are based on data available in the middle 1990s. Another key issue regarding the data presented in this volume is the nature of the post-excavation strategy adopted in the project. In many cases investigation of samples from interventions consisted of study to assessment level only. This is typically the

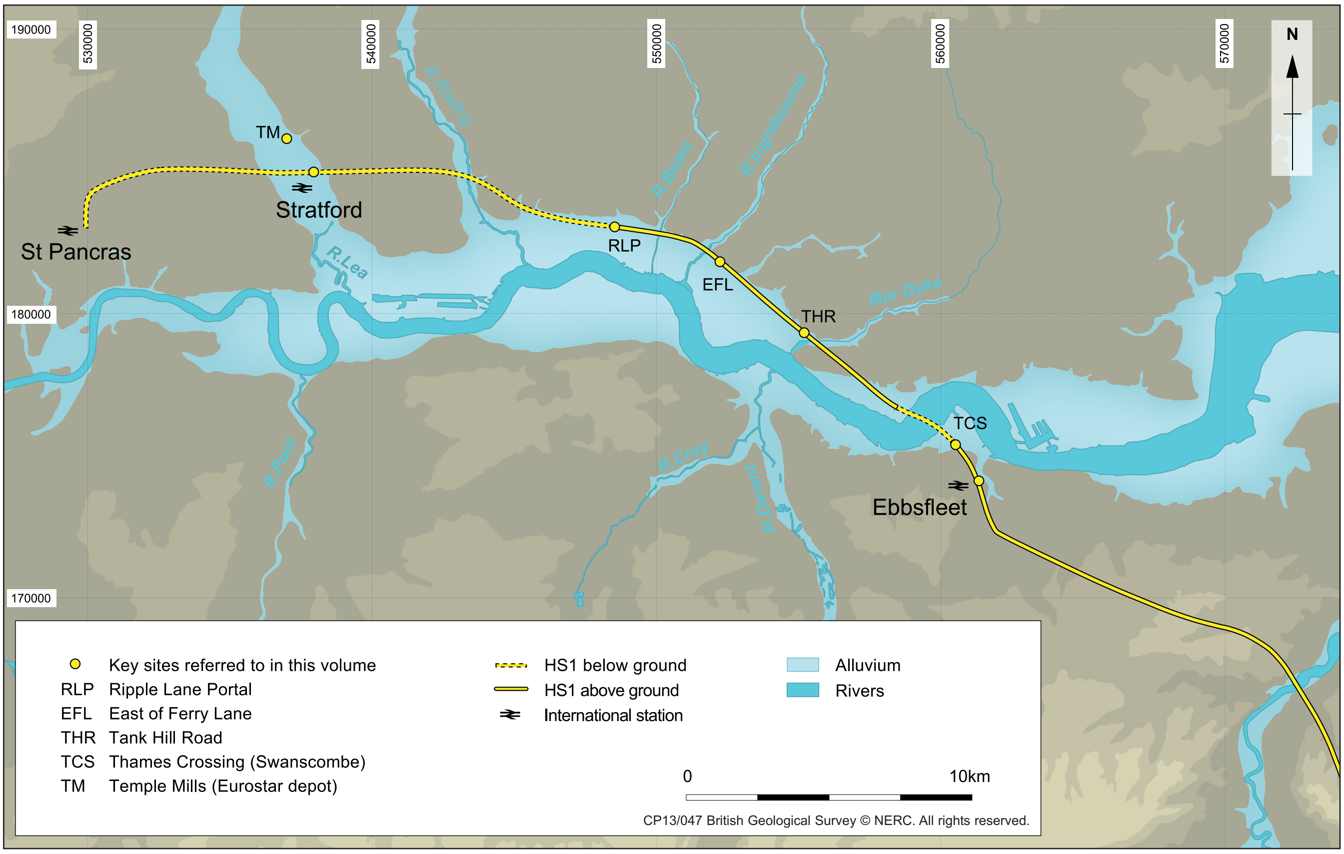

Figure 2 Route corridor of HS1 through the Lower Thames alluvial corridor from Ebbsfleet to St Pancras showing its position relative to alluvial and non-alluvial

case where archaeological material was absent or deemed to be of low significance. As a consequence, detailed analysis level studies were only carried out at Temple Mills and the Thames River Crossing. Elsewhere information (where relevant) is presented from assessment investigations only. Because of the geoarchaeological approach adopted by this study, key factors of importance were to determine environments of deposition for sedimentary units and (where possible) to ascribe age to the sequences. Assessment level investigation in most cases documented these traits to an adequate level to test the robustness of the original desk-top model. This approach reduced the need to investigate in detail the large number of sampling points investigated and limited the inherent expense in undertaking analysis on these numerous sequences. However, it should be made clear that the individual sequences investigated only to assessment level cannot be fully detailed or understood without further analysis. The requirement for such analysis has been prioritised by the degree of relationship with archaeological remains, where known, and with the key aims of this study against the availability of finite resources.

The Route Corridor Described

The route corridor linked to the Thames alluvium consists of four main areas (Fig 2) (the areas of bored tunnels within the bedrock towards St Pancras are not considered in this report and the results of investigations within those areas have been published elsewhere (eg, Emery and Wooldridge 2011). These are:

- The Lea Valley region; associated with the Stratford International Station (Stratford Box) and the Temple Mills engineering works;
- The North Thames Marshes; the main alluvial corridor from the Ripple Lane Portal to Purfleet;
- The Thames Crossing sector; either side of the Thames tunnel;
- The Ebbsfleet Valley.

Today much of the area occupied by HS1 crosses marshland that has seen recent industrial use either as factories, warehousing or hard standing, or it occupies land adjacent to existing rail corridors. The Lea Valley area represents an area of intense urban activity including domestic and rural activity since at least the mid-19th century, and most recently the site of the Olympic Park. By contrast, much of the main alluvial corridor area along the north bank of the Thames has seen predominantly industrial activity only in the last 200 years. Prior to the early 19th century both areas will have been predominantly rural with occasional small settlements and ephemeral activity associated with exploitation of the marshland and localised wharfs along the river frontage.

The location of much of the route across the estuarine alluvium is significant because such tracts of land are a microcosm of much of our coastal wetland areas on which significant pressures currently exist. These areas (particularly in the south-east) are at risk from greenfield industrial and dock development (eg, the new development at London Gateway near Stanford-le-Hope, Biddulph *et al* 2012), brownfield regeneration, replacement and up grading of sea defences in response to global warming, modernisation of the transport networks and the construction of energy installations. In all cases archaeological responses to development would be similar at times and therefore the present study provides a testing ground for the approach, methodology and models required for many of these other developments.

Engineering of the Route Corridor

The route corridor east from the St Pancras terminal lies in tunnels until Stratford is reached where the tunnels come to the surface. The excavations for the station at Stratford were known as the Stratford Box and included cut and cover excavations at either end to allow access to tunnelled sections west to the terminus and east towards Ripple Lane. Stratford Box was 1070m long, up to 50m wide and 16–22m deep. Tunnels carry the line eastwards to Ripple Lane where the tracks emerge through Ripple Lane Portal onto a surface lain formation.

The formation along the north bank of the Thames rests on a piled foundation that runs parallel to existing tracks of the London, Tilbury and Southend Railway for much of the distance. Crossings of north bank Thames tributaries such as the Ingrebourne (Rainham Creek) and Mar Dyke are made on viaducts with extensively piled foundations. Between the Thames Marshes at Mar Dyke and the approaches to the Thames tunnel the rail corridor crosses the Purfleet Anticline via a cutting before exiting the cutting on a steeply graded viaduct descending towards the cut and cover approach to the Thames tunnel.

The Thames crossing is a 3.55km long alignment that is dominated by a 2.5km bored tunnel with a 140m long cut and cover and 160m long retained wall at the north end and a 590m long cut and cover and 150m long retained wall at the south end. Exiting the cut and cover on the south bank the formation climbs passing below the North Kent Line and through a shallow cutting through Chalk and superficial deposits to enter the Ebbsfleet Valley and Ebbsfleet International. Beyond the station the railway crosses the Ebbsfleet and proceeds in a south-easterly direction to form a junction with the branch southwards that carried the line towards Waterloo Station before the high-speed line was completed.

Archaeological Concerns

The principal archaeological issues of concern within the route corridor were highlighted early in the project history when it was recognised that the original desk-top assessment of historic and cultural effects (URL 1994) contained limited information regarding archaeology from the alluvium. Although little information was available from the alluvial sectors of the route corridor it was recognised that potential existed within the wet marshland areas to produce archaeological remains.

These concerns were addressed through the gradual development of a geoarchaeological programme of works initially associated with desk-top data sources for specific sites already identified as problematic, that were subsequently developed into field surveys and assessments. For example, an early desk-top survey of the Purfleet cutting area was followed by initial borehole and trial pit excavations along the line of projected impact. Similar small-scale investigations were undertaken in the Ebbsfleet Valley. However, the early recognition of the problem led to a project focused on using the archive of geotechnical data collected and held at the Geotechnical Management Unit (GMU) within the engineering division of the design team. Investigation of these sources led directly to the production of a geoarchaeological evaluation of the route corridor that was produced by one of the authors (MB) for Oxford Archaeology in 1999 (URN and URS 1999).

In parallel with the emerging geoarchaeological approach to the route corridor, scheme wide project research objectives were being developed (URS 1997) that focused attention on generic issues related to regional and period specific agendas. Together these twin approaches formed the basis for the archaeological response and it is to the former, geoarchaeological, approach that the current volume is based around.

The Alluvial Corridor

The focus of this publication is the alluvial corridor of HS1 within the Thames area, broadly between Ebbsfleet and Stratford International stations (Fig 2). At this point consideration needs to be given to the definition of this term particularly with reference to those areas of HS1 omitted from this study (ie, non-alluvial areas). The term alluvium is used in British Geological Survey (BGS) mapping to define areas of deposit where fine-grained sediments deposited by water (river) action predominate. However, although useful and widely accepted, it is a problematic term, as it frequently confuses several issues. No specific textural properties or sediment properties are implied by this term and those deposits mapped as alluvial sediments in southern England (including the HS1 corridor) might include coarse gravels and sands (channel fills), sands and silts (channel margins and levees), silts and variably sandy or clayey silts (flood overbank deposits). Additionally, peats and other organic deposits (eg, tufa, calcareous marls, etc) may be present. There is also frequently assumed to be a depositional connection between alluvium and a riverine depositional system which is often tenuous, indeed, borehole logs often describe all fine grained sediments as 'alluvial' where they may be estuarine, lacustrine, or even marine in depositional origin.

In geological mapping, alluvium, as a lithostratigraphic term, is often confused with a chronostratigraphic definition of being deposited in the Holocene (the last 11,700 years; *sensu* Walker *et al* 2009). This is unsatisfactory as it then renders subsurface coarse clastic deposits difficult to map. For example, Pleistocene river gravels are 'alluvial' in origin but variably mapped as 'Terrace Gravels' or 'Floodplain Gravels' in the Thames area. River gravels located underlying silty-clay Holocene deposits may be variably interpreted as either Pleistocene or Holocene in age by loggers without evidence for age being presented. This has significant archaeological implications.

These issues combine to make conventionally mapped 'alluvium' as mapped by the BGS of limited value for predicting either facies characteristics (the term facies is used in geology to refer to a body of rock or sediment with specified characteristics that reflect the process and environments of deposition that control sedimentation) or archaeological potential. Further problems pertain to the conjunction with valley floor topographic locations. While much alluvium may be proximal to active stream/river networks this need not be the case particularly where historic drainage has occurred or seasonal 'winterbourne' streams are ephemerally active in Chalk/Limestone geology. In some areas, colluvium as mapped may be relic alluvium from formerly more extensive floodplains.

Also, while deposition from water may typify the process origin of the deposit it should be noted that most river floodplain deposition is i) episodic ii) may involve periodic incursion into an otherwise well-drained cultivated or wooded landscape and iii) does not preclude other forms of deposition (eg, deposition of aeolian dusts). Therefore, while much of a lithostratigraphic alluvial sequence may appear to be characterised by deposition from a water-body, for much of the time period (chronosequence) represented by the alluvial sediments the area of deposition may be both suitable for occupation and attractive for subsistence over prehistoric timescales.

The focus of this study is the alluvium of the River Thames, defined by the limits of alluvium as mapped by the BGS (including marine or estuarine alluvium) or the floodplain of the river. It is recognised that under this broad classification sediments will be present that were deposited by a range of processes and indeed probably bury older Pleistocene sands, gravels and finer sediments (possibly including Pleistocene alluvium in places). Consequently, while the focus of this study has been on the Holocene sediments, elements of the record preserved beneath the floodplain relate to Late Devensian times (and possible older phases within the Late Pleistocene) are also dealt with. Omitted from this study are older alluvial deposits including Head, Brickearth and River Terrace Deposits (*sensu* BGS mapping) present above the river floodplain area.