Chapter 8

Dagenham and Hornchurch Marshes

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The East Roding Valley (Zones T1–T5)

The original 1999 study identified five geo-archaeological zones (Zones T1–T5) between 17.30km and 19.94km (Chap 6 *Window 6* (Fig 17) and *Window 7* (Fig 19)). Zones T1 (17.30–17.66km) and T5 (19.83–19.94km) were designated of medium archaeological priority due to relatively high elevations recorded in the surface of the Pleistocene gravels. The remaining zones were designated low priority. However, the route of HS1 runs deep underground within the London East Tunnel for the entire length of Zones T1 to T5 and construction impact on Holocene deposits was restricted to a single ventilation shaft at 17.785km in Zone T2. Although a watching brief carried out during construction recorded a sequence of Holocene alluvium and peat deposits overlying Pleistocene gravel, no detailed recording or sampling was carried out and no archaeological remains were observed.

West Dagenham Marshes (Zones T6–T7)

The route of HS1 exits the London East Tunnel at Ripple Lane, Dagenham (*c* 20.2km, Zone T6, Figs 19 and 40). From here it traverses the Thames floodplain on a piled slab eastwards across the Dagenham Marshes, approximately 450m north of the river and 200m south of the terrace edge. Prior to construction the area was level waste ground covered with scrub and rough grass, crossed by metalled tracks and railway lines to the north. Recent land-use has been predominantly industrial with much of the area artificially raised above the original floodplain surface, resulting in thick deposits of modern made ground sealing the natural alluvial sequence. The area immediately to the south of the HS1 corridor had previously been occupied by buildings associated with the Gas Works which were destroyed by bombing raids during the Second World War. In the post-war period an oil storage depot was built in its place.

Construction Impacts

Due to the thickness of made ground, construction impact on the natural alluvial sequence, apart from the piling, was restricted to works associated with the tunnel portal, advanced service diversions, and the diversion of the Goresbrook stream to the south. The approach to the tunnel portal consisted of an *in situ* concrete box within a sheet pile cofferdam with an internal diameter of approximately 7m, truncating the alluvial sequence and underlying natural gravel. The service diversions consisted of a series of open cut trenches, within a combined easement of *c* 12–15m to an average depth of *c* 2m. Depth increased to approximately 3m east of Chequers Lane employing closed box shoring techniques. Two pipe-jacked crossings were excavated; beneath the HS1 line and LTS railway (20.6km) via existing caisson chambers, and cofferdam excavation at Chequers Lane (21.0km). The stream diversion, between 20.050km and 20.665km, comprised the excavation of a large open V-shaped cut, *c* 30m wide and *c* 4m deep (-2.4m OD) for approximately 470m, to the south and parallel to the line of HS1. At the eastern end the diversion carried on in a narrow concrete box beneath HS1 for a further *c* 170m.

Key Archaeological Issues

The 1999 study designated Zones T6 and T7 (Chap 6 *Window 7*; Fig 19) of low archaeological priority due to the low elevations in the surface of the Pleistocene gravels. It was predicted that initial inundation of the lower parts of the route corridor, that is in Zone T7, would have occurred during the Late Mesolithic period, by *c* 5000–4800 cal (*c* 6000 ^{14}C BP). It was also proposed an area of floodplain tributary activity may have existed within Zone T7, although no trace of channel activity existed within the overlying peat sequences at this point suggesting that the existence of these channels during the Holocene was of limited duration.

The earliest archaeological finds from the Dagenham area are of Palaeolithic date, including stone tools from the basal Mucking Gravel at Upton Park, Forest Gate, Manor Park and Little Ilford (Wymer 1999, map 10). Later prehistoric finds include the Dagenham Idol, an unusual carved wooden figurine, made from Scots Pine (*Pinus sylvestris*), found during the construction of the Ford Motor Works in 1922. Radiocarbon dating places it in the Late Neolithic to Early Bronze Age period, 2470–2030 cal BC (OxA-1721, 3800±70 BP; Coles 1990). A Late Bronze Age looped and socketed axe was also found to the south of Ripple Road (MoLAS 2000). Timber trackways have been found on a number of sites in East London in the former marshlands, leading down from the first gravel terrace onto the floodplain (Carew *et al* 2009; Meddens 1996; Meddens and Beasley 1990; Stafford *et al* 2012). The majority date to the Bronze Age, with the dates ranging from *c* 2100 cal BC at Woolwich Manor Way Area 1 (Stafford *et al* 2012) to *c* 1000 cal BC at the Tesco site, Barking (Meddens 1996), although a much earlier pair of trackways have been found to the south of the River Thames at Belmarsh West (Hart 2010), dated to *c* 3850 cal BC. Generally they are of timber construction, but also include a metalled causeway located 240m to the north of HS1 at the Hays Storage Depot (Divers 1996). The causeway was 4m wide and consisted of gravel, flint and sand laid over a thick bed of peat and sealed by alluvial clay. The gravel terraces of the Lower Thames are known to have been intensively settled in the Late Iron Age and Roman periods (Wilkinson *et al* 1988). There is significant evidence for settlement in the Barking area, including an Iron Age defended settlement at Uphall (Greenwood 1989; 2001). Barking and Dagenham both appear to have developed as local centres during the Anglo-Saxon period. Dagenham is first mentioned in AD 690 and an abbey of Benedictine nuns was founded at Barking in AD 666. Dagenham is known to have been an early medieval manor and by the 13th century the marshes, which were prone to frequent flooding, were used for fishing, fowling, reed growing and tanning. There are references to floods, marshland management and river defences throughout the medieval period, although more systematic reclamation was undertaken from the 16th and 17th centuries.

Methodologies

Prior to any fieldwork commencing, a desk-top geoarchaeological assessment of borehole records was carried out in the area to be effected by the construction of the Ripple Lane tunnel portal and the Goresbrook stream diversion. The purpose of the assessment was to examine the nature of the buried palaeotopography and characterise the patterns of sediment accumulation across the site, building on the data presented in the 1999 study. Ultimately the assessment aimed to predict the most likely location for the preservation of archaeological remains under threat from construction that could be targeted for evaluation trenching; 48 borehole and test pit records were examined from the HS1 archive (Fig 40). The lithological data was entered into geological modelling software (Rockworks 98) for correlation and analysis into key stratigraphical units.

Following the desk-top assessment three evaluation trenches were excavated to assess the impact of the Goresbrook stream diversion on any archaeological remains (Pl 10). No archaeological remains were identified during the evaluation. The archaeological mitigation strategy comprised a watching brief during construction along the entire length of the diversion. Watching briefs were also carried out during the advanced service diversions immediately to the north and east of the Goresbrook stream diversion, and during the construction of the tunnel portal. A summary of the fieldwork events is presented in Table 19.

Although no archaeological remains were encountered during either the evaluation or watching

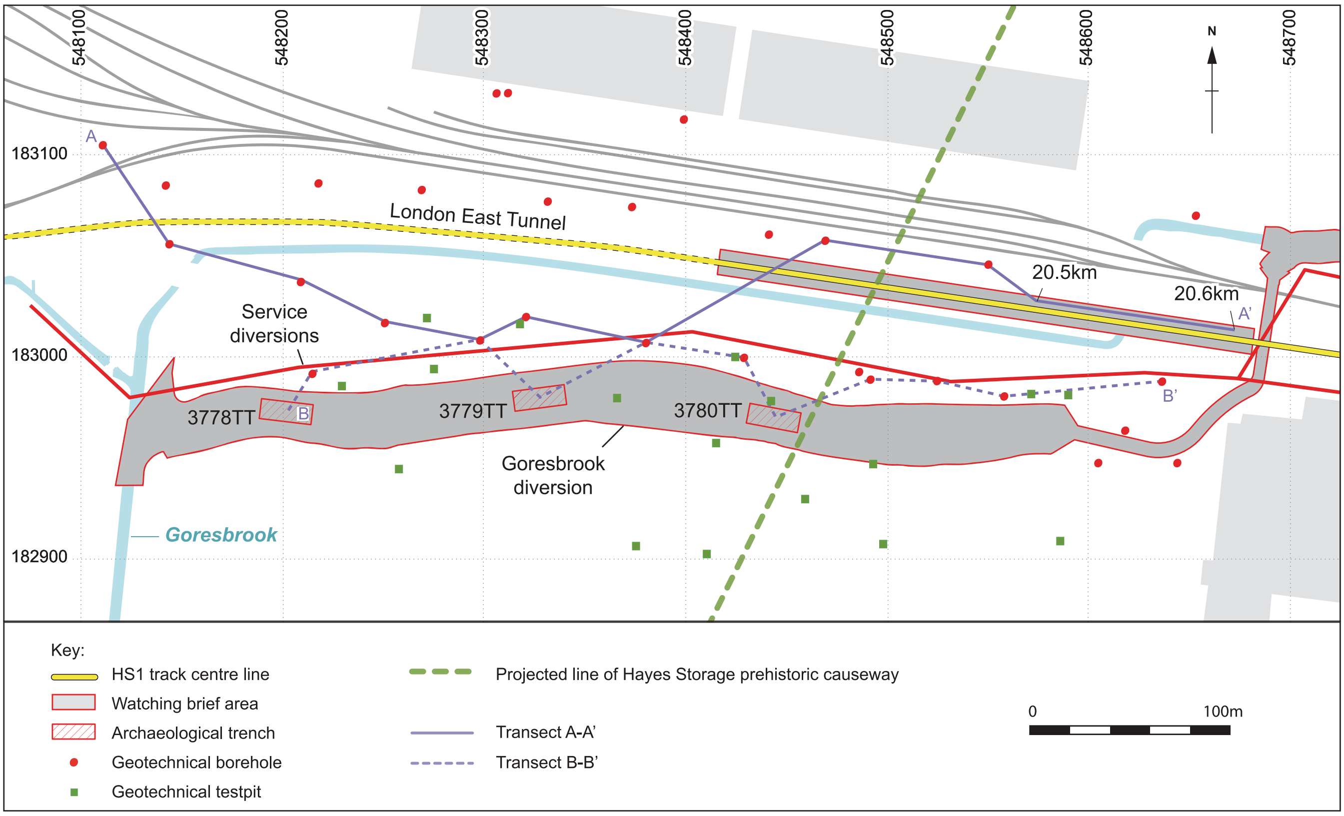

Figure 40 Plan of archaeological and geotechnical interventions, Ripple Lane Portal and Goresbrook

brief phases, a considerable number of palaeo-environmental samples were examined during the lifetime of the project that serve well in characterising the environments of deposition associated with the recorded sediment sequences. Interpretation of the sedimentary sequences was carried out by Elizabeth Stafford. The pollen assessments were carried out by Andrew Haggart (Goresbrook), Lucy Verrill and Elizabeth Huckerby (Ripple Lane Portal) and Rob Scaife (the service diversions), the waterlogged plant remains by Mark Robinson (Goresbrook and the service diversions) and Wendy Smith (Ripple Lane Portal), the diatoms by Andrew Haggart (Goresbrook) and Nigel Cameron (Ripple Lane Portal) and the ostracods and foraminifera for all phases of fieldwork by John Whittaker. Micromorphology (Richard Macphail) was also carried on horizons from the sequence at 20.5km thought to represent an early inundated landsurface (Appendix B, Pls 11A–E). Eight radiocarbon dates were obtained during the assessment and post-excavation stages in order to provide a basic chronological framework for the sediment sequences examined (Appendix A).

Results of the Investigations

Desk-top assessment

The desk-top assessment identified six major stratigraphic units. London Clay bedrock was only attained in some boreholes that penetrated beyond the full depth of the overlying Pleistocene fluvial gravels. Gravel was noted in all boreholes extending across the whole study area. Overlying the gravels was a finer grained sandy clay and sandy silt unit. This unit was not present across the entire site area but was typically missing from parts of the western-central areas. Locally it appeared to become sandier with depth. Directly overlying the gravels and silts was a major peat unit varying between 0.20m and 3.25m in thickness. Differences in the composition of the peat were noted with a zone of lower, woody peat, in places beneath an upper amorphous peat. Sealing the peat lay extensive deposits of minerogenic clay silts. Local variation in the nature of the alluvium was noted, for example, a peat unit was noted at the top of the sequence in a number of boreholes. Made ground capped the alluvial deposits varying between 0.5m and 3.6m in thickness with an average thickness of 2.50m.

Plate 10 Excavations at the Goresbrook diversion

The modelled topography of the gravel surface, that is, the pre-inundation surface of the Thames floodplain is illustrated in Figure 41a. A clearly elevated region is seen towards the western end of the site. This would have formed an island at some point after wetland expansion commenced over the gravel surface (Fig 41b). A low-lying area, probably representing a buried Thames tributary, exists to the east. The distribution of boreholes containing sand at the base of the alluvium is restricted to this area and it was suggested these sands may represent fluvial deposits associated with the infilling of the buried tributary channel. A second tributary may also have existed at the extreme western end of this area. The thickest sequences of alluvium (a combination of the upper silt clay, peat and sandy clay silt) lie within the areas of the possible buried channels. East to west transects of the main stratigraphic units are illustrated Figures 42 and 43. The gravel high is noted towards the western end of the corridor; the sandy clay silt unit can be seen to thin towards this high (Fig 42). On the basis of the projected gravel surface topography through this area the gravel lies on average between depths of -3.5m and -4.5m OD. It was predicted, utilising the modelled data from the Barking Reach area presented in the 1999 study, that the likely timing for onset of sedimentation onto the gravel surface along the line of the stream diversion would be during the Late Mesolithic period at *c* 4700–4000 cal BC (*c* 5800–5300 ^{14}C BP). It was suggested therefore that only Mesolithic artefacts could be expected on the surface of the gravels within this area; later prehistoric material would lie within the alluvial stack and would consist of material deposited in floodplain situations.

Table 19 Summary of fieldwork events, West Dagenham Marshes

Event name	Event code	Type	Zone	Interventions	Archaeological contractor
Goresbrook diversion	ARC GOR00	Evaluation	6	3778TT, 3779TT, 3780TT	Oxford Archaeology
Goresbrook diversion	ARC 32001	Watching brief	6		Oxford Archaeology
West Thames advanced utility diversions	ARC 36100	Watching brief	6–7		Oxford Archaeology
Ripple Lane tunnel portal	ARC 25001	Watching brief	6		Wessex Archaeology

TT = trench

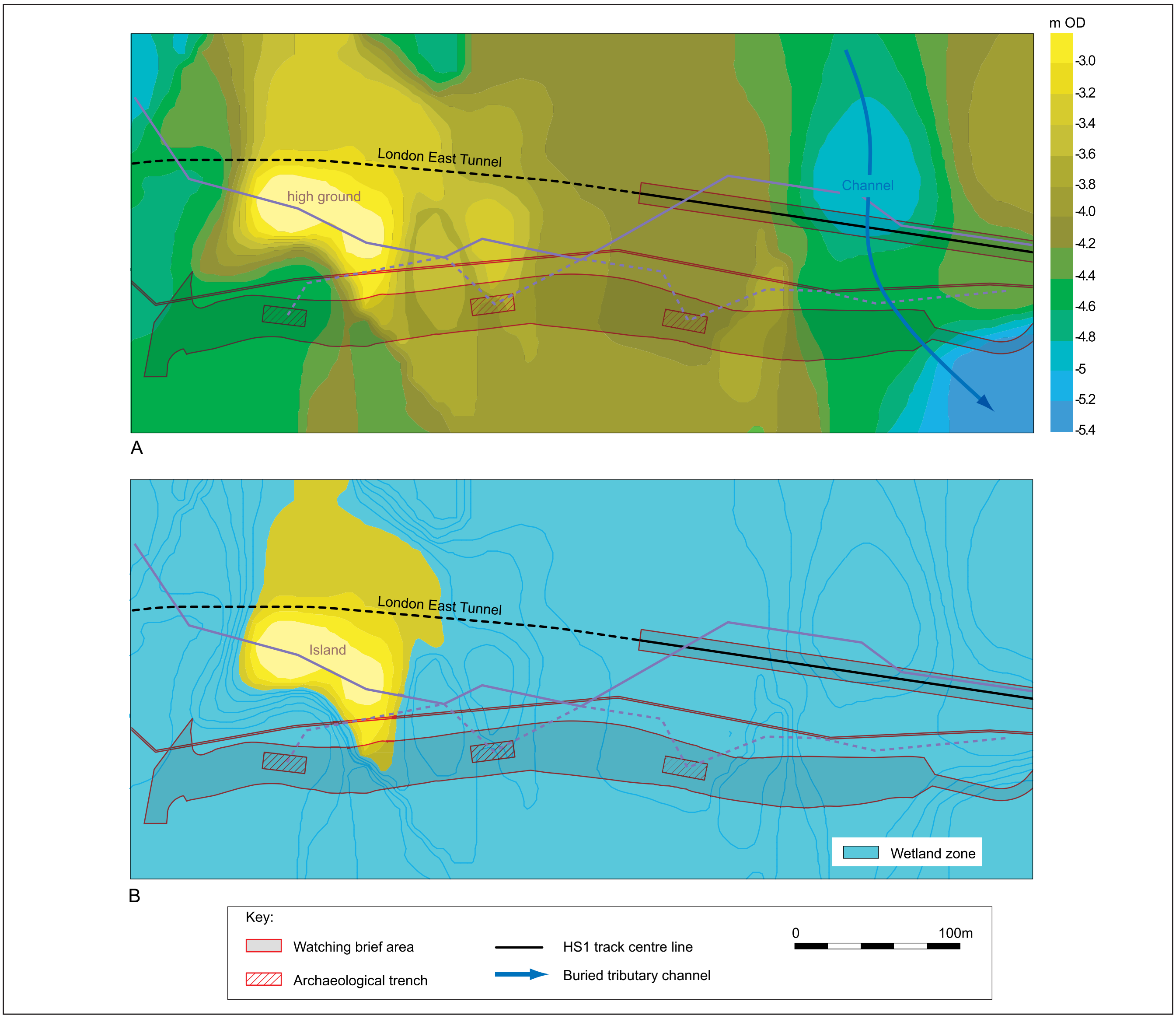

Figure 41 Ripple Lane Portal and Goresbrook: A) Modelled Early Holocene topography; B) Predicted extent of the wetlands at the beginning of the Neolithic (*c* -3.4m OD)

Trench excavations for the Goresbrook Stream diversion

Based on the results of the geoarchaeological modelling it was clear that construction of the Goresbrook diversion was unlikely to impact the Pleistocene fluvial gravels and the Early Holocene landsurface that lay deeply buried beneath substantial thicknesses of alluvium and peat (Fig 43). It would, however, remove the upper part of the peat profile and the upper silt clay alluvium. Three targeted evaluation trenches were excavated along the line of the diversion. Two trenches (3778TT and 3779TT) were sited adjacent to the gravel high. The trench at the eastern extent of the diversion (3780TT) was originally sited in the area marginal to the potential buried tributary and was targeted to coincide with the approximate alignment of the Hays Storage Depot prehistoric causeway. Due to practical restrictions, however, the trench had to be moved 45m to the west (Fig 40). The trenches were excavated in a stepped fashion to a maximum depth of 3.75m, with the base plans measuring 20 x 4m. No archaeological remains were encountered during the evaluation. The stratigraphy exposed was fairly consistent with the preliminary deposit modelling. As predicted only the upper three stratigraphic units; the made ground, silt clay alluvium and the upper part of the peat, were encountered and the investigation was therefore not able to test the modelled Early Holocene surface presented in the desk-top assessment. The watching brief carried out during construction similarly did not identify any archaeological remains to suggest that the Hayes trackway did cross the route. Palaeoenvironmental remains were assessed from the sequences in trenches 3778TT and 3780TT and one radiocarbon date was obtained from the top of the peat in 3780TT (Figs 43 and 44, Appendix A).

Trench 3778TT

In trench 3778TT a layer of undifferentiated mid-reddish-brown peat (context 7808) was encountered at

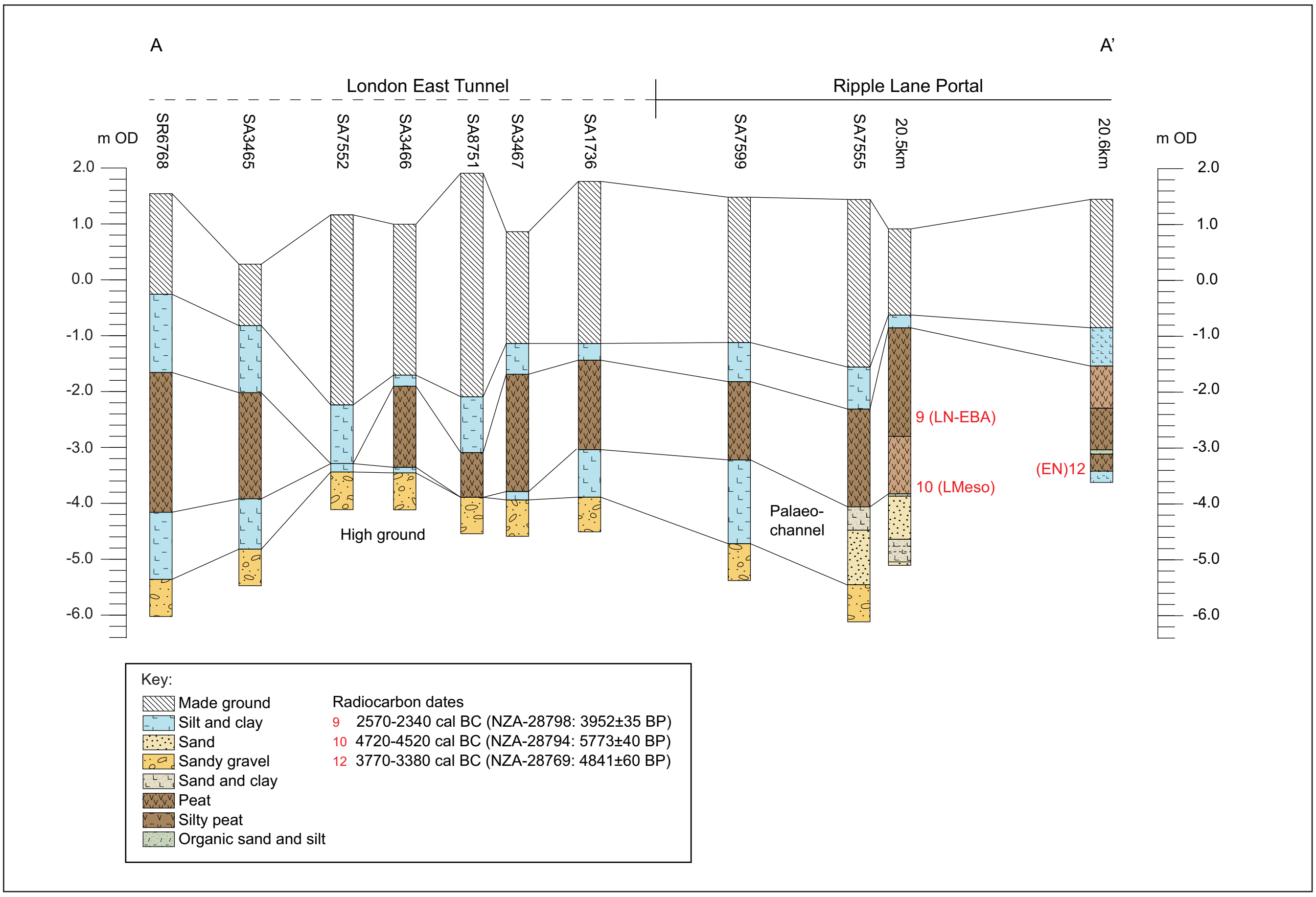

Figure 42 Transect A–A', Goresbrook and Ripple Lane Portal

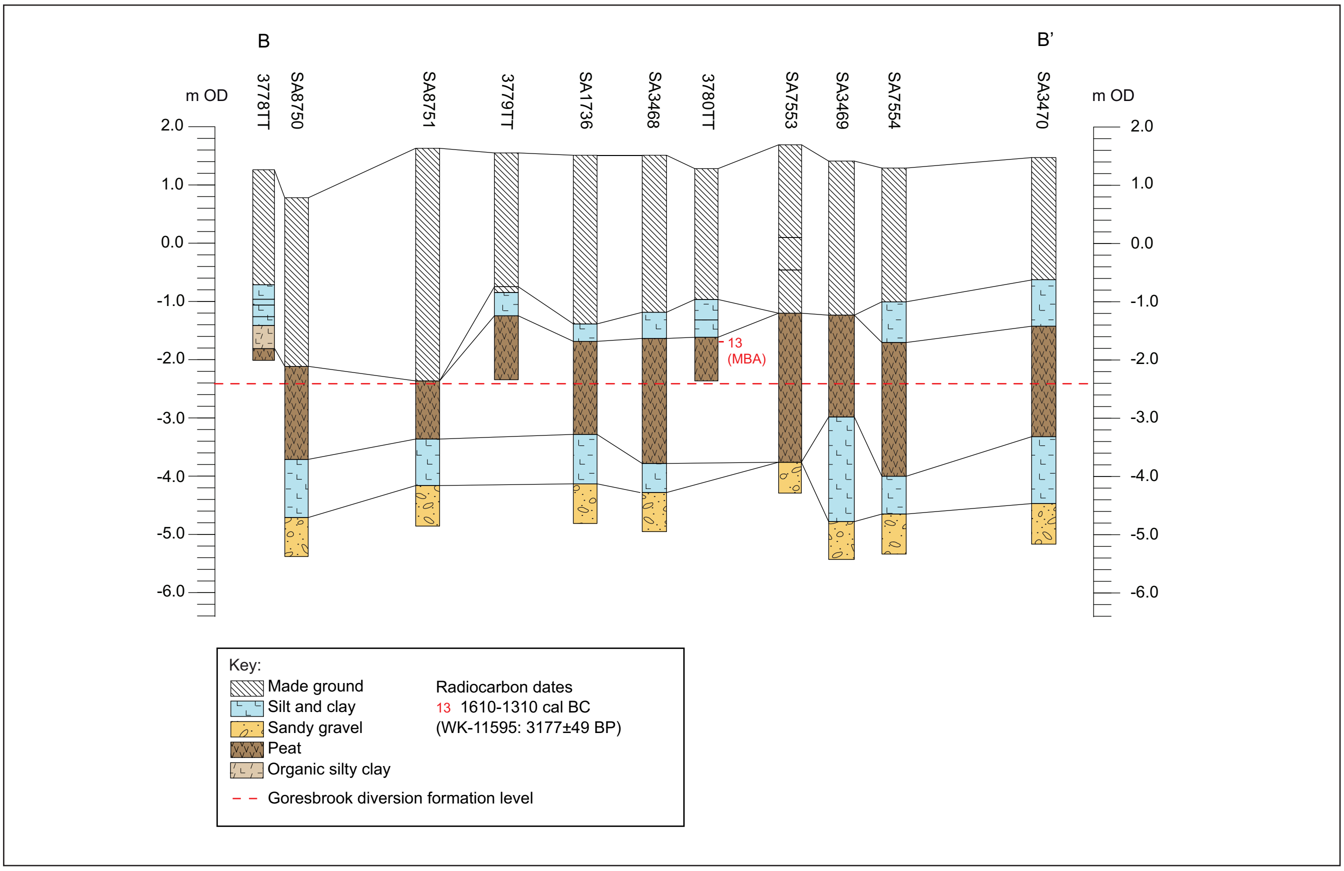

Figure 43 Transect B–B', Goresbrook and Ripple Lane Portal

the base of the excavation (Fig 44). The upper surface of the peat was at a uniform level of *c* -1.80m OD and was recorded to a maximum thickness of 0.50m but was not bottomed. Overlying the peat was a series of horizontally bedded silty clay alluvial deposits, all of which had been affected by discrete areas of modern disturbance. The lowermost deposit directly overlying the peat was a laminated organic grey silty clay up to 0.6m thick (context 7807). This was in turn overlain by a series of structureless yellowish-brown and light grey silty clays and silts (contexts 7806–7803). The sequence was capped by up to 2.25m of modern made ground comprising very mixed clay silts, clinker and building debris.

Peat

The pollen assemblage from the peat (*Table 20*) was dominated by fern spores, including the marsh fern *Thelypteris palustris*, along with an abundance of grasses and sedges. Tree pollen was low but included *Quercus* (oak), *Alnus glutinosa* (common alder), *Betula* (birch), *Ulmus* (elm) and *Pinus sylvestris* (pine). Waterlogged seeds (*Table 21*) included *Carex* sp. (sedges), *Berula erecta* (water parsnip) and *Hydrocotyle vulgaris* (marsh pennywort) suggesting open shallow-water fen conditions with few trees.

Organic clay

At the base of the overlying organic clay the pollen assemblages demonstrated a greater abundance of *Alnus* at 74% TLP. The plant remains also included seeds of *Alnus* as well as *Carex* sp. This suggests the fen at this location may have been succeeded by a brief period of swampy alder woodland. The diatoms, however, from the same level show an abundance of *Cyclotella striata*, a mesohalobous or marine-brackish form which is often abundant in estuaries in the spring plankton (Hendey 1964). The brackish presence is confirmed by the common occurrence of *Coscinodiscus eccentricus*, a polyhalobous form, and *Triceratum favus*, a polyhalobous benthic form often found in the plankton of the North Sea. A brackish saltmarsh component is also suggested with *Nitschia navicularis*, *Nitschia punctata*, *Diploneis didyma* and *Diploneis ovalis*. It seems likely therefore that the site was subject to periodic brackish water incursions, be they of minor inwash or more substantial nature.

Further up the profile the proportion of *Alnus* pollen rose slightly to 78% TLP and there were also small contributions from *Quercus*, *Ulmus*, *Pinus sylvestris* and *Fraxinus excelsior* (ash) which must have been occupying drier locations to landward. The diatoms from the same sample continued to suggest marine inundation with *Cyclotella striata* again abundant but also *Coscinodiscus* sp. including *C. eccentricus*. Other fully marine diatoms included *Grammatophora oceanica* var. *macilenta* and *Rhaphoneis amphiceros*, both of which are usually attached to marine substrates. There was still a brackish element with the common saltmarsh forms *Navicula peregrina*, *N. navicularis* and *Diploneis ovalis*.

There was a change in the pollen flora towards the top of context 7807; *Alnus* frequencies declined being replaced by pollen types suggesting a more open environment. This included Poaceae (grasses), Chenopodiaceae (goosefoots) and Plantaginaceae (plantains). The representation of the other trees such as *Quercus, Ulmus* and *Pinus sylvestris* rose, which could be taken to suggest more successful transport into an open environment. The diatoms were less abundant, although *Cyclotella striata* was still the most common form. This sample also included examples of *Paralia sulcata, Triceratum favus, Hyalodiscus stelliger, Rhaphoneis amphiceros* and *Biddulphia biddulphiana*, confirming a fully marine presence. The presence of *Navicula navicularis* and *Scoliopleura tumida* suggests saltmarsh and sand flats may have existed in the vicinity. It is likely that the site at this point was undergoing a transition to becoming a vegetated saltmarsh.

Upper silts and clays

In the overlying minerogenic deposits of the pollen flora was similarly dominated by Poaceae, Chenopodiaceae and Plantaginaceae, including *Plantago maritima* (sea plantain). *Limonium* (sea lavender) was also present. The oxidised nature of the sediments and presence of Plantaginaceae in such high percentages could imply an open saltmarsh environment existed at the site, which was probably just below the contemporary mean high water spring (MHWS) at this time.

The diatom content was notably less abundant and more fragmentary in contexts 7804–7803. *Cyclotella striata* was still the dominant form with a range of other fully marine diatoms, this time including *Pseudopodosira westii* and *Grammatophora serpentina*. Slight grain size increases in these samples indicate a higher energy environment, perhaps slightly lower in the tidal frame. This may be supported by the pollen preservation, which shows higher counts for indeterminable broken and folded gains but this may equally represent increased sediment movement/load. Preservation of plant remains was also poorer in these upper deposits. The most numerous seeds were *Ranunculus sceleratus* (celery-leaved crowfoot), which occurs on nutrient-rich mud, perhaps indicating enrichment by grazing ungulates in the saltmarshes. The other seeds were either of plants which can occur in wet grassland, such as *Rumex* sp. (dock), *Potentilla* cf *repens* (creeping cinquefoil) and *Juncus* sp. (rush), or are weeds of disturbed habitats, such as *Carduus* sp. (thistle) and *Sonchus asper* (sowthistle).

Trench 3780TT

In trench 3780TT the lowermost deposit encountered was a layer of fibrous, reddish-brown peat (context 8004) which was excavated to a maximum thickness of 0.78m (Fig 44). The top of the peat, at -1.75m OD, was radiocarbon dated to the Middle Bronze Age, 1610–1310 cal BC (WK-11595, 3177±49 BP). The peat was overlain by two distinct layers of alluvium comprising 0.42m of dark grey silt clay (context 8003) and 0.5m of light yellow silty clay (context 8002). The sequence was capped by a 2.05m thick deposit of made ground (8001) comprising light grey silty clay, rubble, clinker and fragments of a metal container. Overall pollen concentration and preservation was poorer in this sequence, though this is greatly influenced by the high figure of indeterminable grains. No identifiable fragments of diatoms were preserved.

Peat

At the base of the sampled peat sequence *Alnus glutinosa* and *Corylus avellana*-type (hazel) pollen were the most abundant

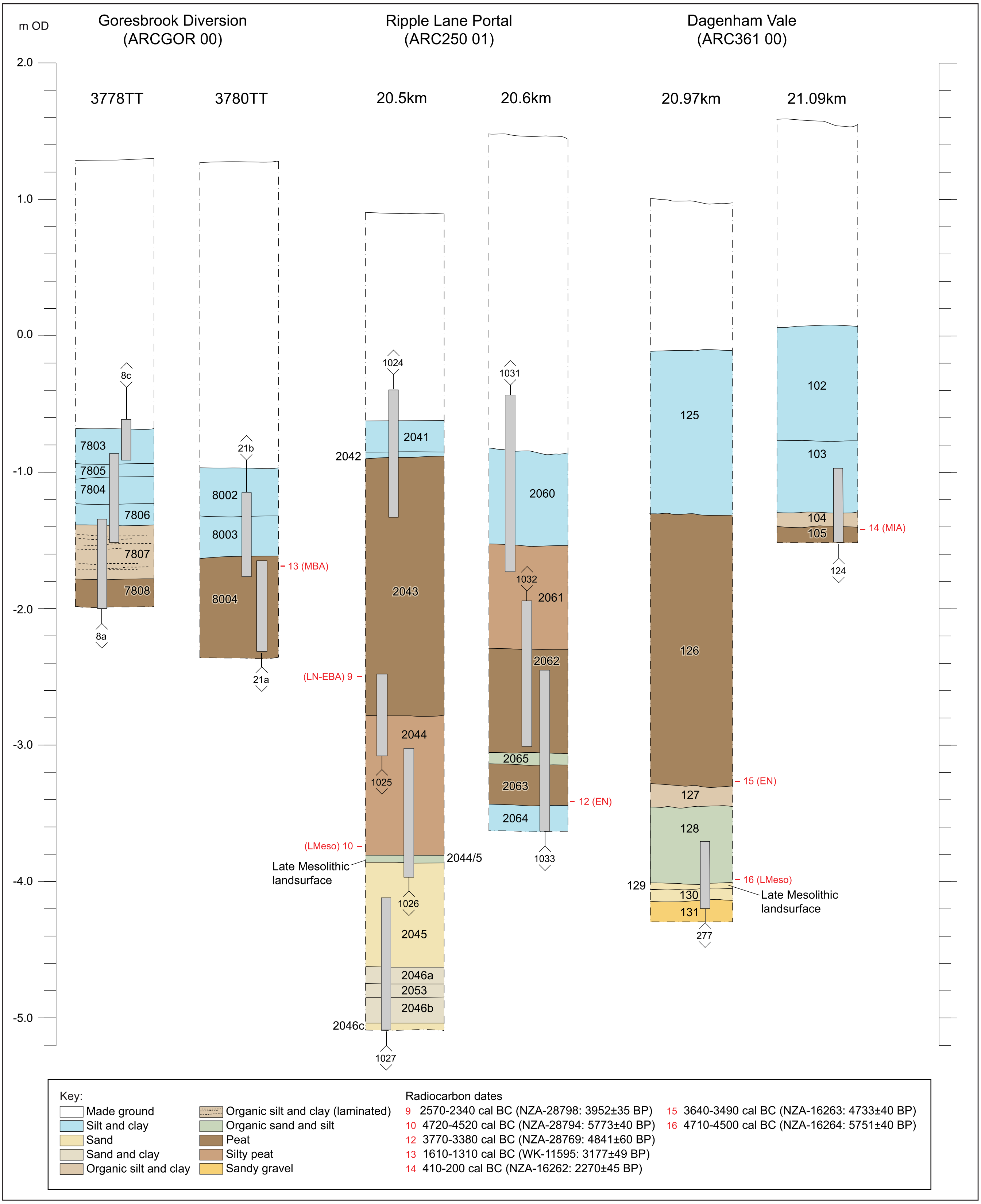

Figure 44 Sample profiles, Goresbrook, Ripple Lane and Dagenham Vale

taxa (*Table 20*). Other trees, including *Betula*, *Quercus* and *Ulmus*, showed a constant presence in all but the lowest level, while *Fagus sylvatica* (beech), *Fraxinus excelsior* and *Tilia cordata* (small-leaved lime) were sporadic in occurrence. With such a sparse pollen record it is difficult to be certain about environmental conditions, although the nature of the stratigraphy suggests organic deposition predominated in an alder carr setting.

A major transition in the pollen spectrum occurred in the upper part of the peat with Poaceae and Cyperaceae (sedges) predominating. This suggests more open conditions now obtained as the site changed from alder carr to reedswamp. The presence of Chenopodiaceae and Plantaginaceae may be taken to suggest the proximity of saltmarsh to the site. The plant remains (*Table 21*) comprised emergent and shallow-water aquatic plants represented by seeds of *Carex* sp. accompanied by *Schoenoplectrus lacustris* (bristle club-rush) and *Potamogeton* sp. (pondweed). There were, however, seeds of plants likely to have been growing on peat that was above the water for most of the year, including *Lychnis flos-cuculi* (ragged robin), *Moehringia trinervia* (sandwort) and *Eupatorium cannabinum* (hemp agrimony). These can all grow in open fen woodland (carr) although no evidence was found of trees in the plant assemblage. The insects from the peat (*Table 22*) similarly suggest shallow-water reed fen with beetles of stagnant water, such as *Colymbetes fuscus* and *Plateumaris braccata* which feed on *Phragmites australis* (common reed), and *Thryogenes* sp. which feeds on reeds or sedges. Terrestrial insects included the dung beetle *Aphodius* sp., suggesting the nearby presence of domestic animals.

Upper silty clays

The pollen assemblages from overlying minerogenic deposits were dominated by Poaceae, Cyperaceae, Plantaginaceae and Chenopodiaceae, which given the context, suggests nearby intertidal saltmarsh. Charcoal concentrations were also extremely high in these levels suggesting nearby activity. The seed assemblage included species of wet, muddy, disturbed pasture, with *Ranunculus repens* (creeping buttercup), *R. sceleratus, Carduus* sp. and *Juncus* sp. The insects support this interpretation with *Longitarsus* sp. and *Apion* sp. feeding on grassland plants, *Hydrobius fuscipes* living in pools of stagnant water and *Aphodius* sp. feeding on the dung of domestic animals in pasture.

Watching brief on the Ripple Lane tunnel portal

Two sample profiles at 20.5km and 20.6km were assessed from the tunnel portal watching brief (Figs 42 and 44). Pollen was preserved in the sediments and provides some environmental information, although the results from the other specialists were rather disappointing. Most of the samples contained iron oxide stained wood fragments or fragments of wood which appeared somewhat crystalline or mineralised. Only small quantities of waterlogged seeds were identified in two samples from the profile at 20.6km and only one sample produced diatom fragments, ostracods and foraminifera at the same location. Four radiocarbon dates were obtained from these sequences (Appendix A), although one from the top of the peat in the sequence at 20.6km (NZA-28710) produced an anomalous date suggesting modern contamination.

Chainage 20.5km

Basal sandy deposits

At 20.5km the basal deposits, between -5.1m and -3.82m OD, comprised a complex series of light yellowish-brown bedded sands, gravelly sands and sandy clays (contexts 2053, 2046 and 2045). These deposits may equate to the fill of the large channel feature identified during the desk-top assessment (shown in Fig 41a). The pollen assemblage from a sandy clay bed (context 2053) consisted of typical fen carr flora (*Table 23*). The most common taxa were undifferentiated fern spores and *Alnus glutinosa* with some *Salix* (willow), Cyperaceae and *Thelypteris palustris* (marsh fern). The pollen source area is likely to have been extremely localised as woodland and open-ground taxa representing dry ground away from the fen were very poorly represented. There was, however, a little evidence for the presence of mixed deciduous woodland on the drier ground away from the channel with *Quercus* and occasional grains of *Ulmus, Tilia, Fraxinus excelsior, Betula, Pinus sylvestris* and *Corylus avellana*-type. A single grain of *Taxus baccata* (yew) was also recorded from this level.

The overlying well-sorted sand (context 2045) is interpreted as water-lain, resulting from channel realignment. At the interface between the sand (context 2045) and overlying peat (context 2044) a thin deposit of organic sandy silt was noted. The pollen assemblage from this level suggested that the floodplain was vegetated by grasses with some alder carr, and that *Betula* and *Corylus*, with some *Tilia* and *Ulmus*, woodland or scrubland persisted. Thin-section analysis of the upper part of context 2045 (Appendix B, Pls 11A–C) revealed it to be composed of bioturbated sands and humic silts, with fine to very coarse woody roots. Fine amorphous organic matter occurred as highly humified microaggregates (excrement pellets; Pls 11A and 11B) along with rare traces of fine sand-size burnt flint and other minerals (Pl 11C). This once-bedded deposit probably formed as accreting colluvial sands and humic alluvial silts, with contemporary weathering and biological activity forming a semi-terrestrial acidic Ah/mor horizon topsoil (Babel 1975). The traces of burnt flint within the sediments suggests nearby occupation. Both Mesolithic and Bronze Age activity at West Heath, West Sussex, produced large amounts of sandy colluvium (Drewett 1989), while there may be a more direct analogue at Star Carr, North Yorkshire where Mesolithic activity is recorded along the interface between colluvial sandy soils and lake peat interface (Macphail 2006; Mellars and Dark 1998). In the immediate vicinity of HS1 attention is drawn to the recent excavations in the valley of the River Beam, Dagenham, which produced *in situ* Early and Late Mesolithic flint scatters on a sandy landsurface, sealed beneath peat and alluvium (Oxford Archaeology 2011), and on the south bank of the Thames at the B&Q site, Bermondsey; where Early Mesolithic activity was recorded along the shores of a palaeolake (Sidell *et al* 2002, 11–17).

Peat

The sand was overlain by a thick peat sequence at -3.82m OD, the bottom of which (context 2044) was radiocarbon dated to the Late Mesolithic at 4720–4520 cal BC (NZA-28794, 5773±40 BP). A second date was obtained from the peat at -2.49m OD producing at Late Neolithic to Early Bronze Age date of 2570–2340 cal BC (NZA-28798, 3952±35 BP). The peat can be divided into a lower brownish-black silty peat with abundant wood fragments (context 2044) and an upper darker, more humified and desiccated, peat (context 2043).

Thin section analysis of the lower part of the peat (Appendix B, Pls 11D–E) revealed the peat occurred above a sloping and irregular boundary, where there were initially bedded fine sands and silts and humified organic matter (mor humus). These beds included rare charcoal or charred organic

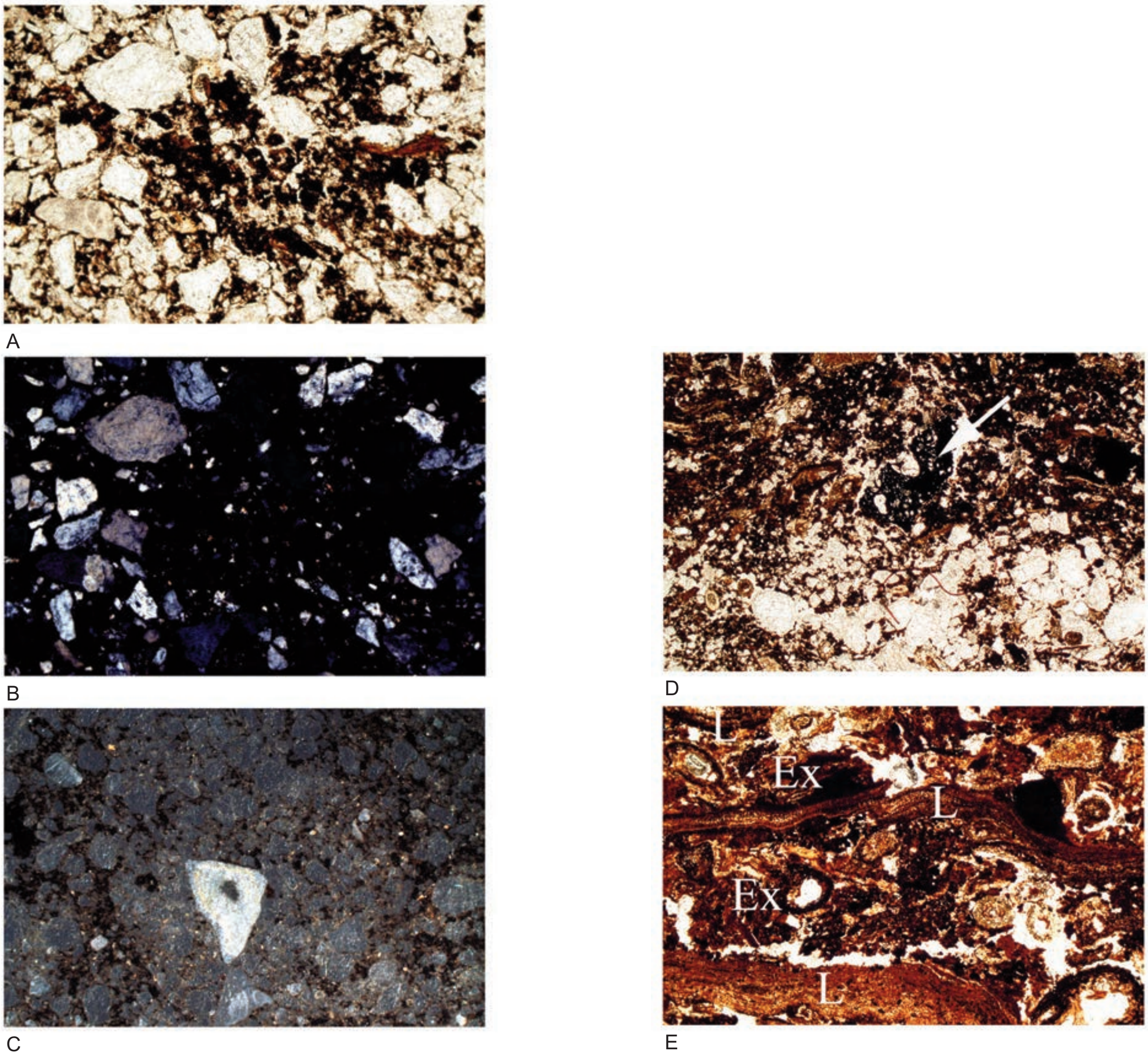

Plate 11 Microphotographs from 20.5km, Ripple Lane Portal. A) Monolith 1026(A), context 2045: Quartz sand and mor humus horizon-like micro-aggregates of amorphous organic matter. Plane polarised light (PPL), frame width is ~2.3mm. B)As A: Under cross polarised light (XPL), showing quartz sand and coarse silt associated with amorphous organic matter, probable relicts of original fine humic and coarse sandy bedding and possibly once a colluvial-wetland sedimentary interface. C) Monolith 1026(A), context 2045: Burnt flint as trace evidence of human impact locally. Oblique incident light (OIL), frame width is ~4.6mm. D) Monolith 1026(A), context 2044: Sand lens and an overlying peaty deposit containing a charcoal fragment (arrow) implying continuing occupation nearby; peats include both partially humified plant fragments and microaggregates of amorphous organic matter (see A. and B.). PPL, frame width is ~4.6mm. E) Monolith 1026(A), upper part of Context 2044: Layered plant remains (L), including leaves, and intercalated excrements (Ex) of soil mesofauna; a typical moder humus and common for woodlands. PPL, frame width is ~2.3mm

fragments (Pl 11D). Upwards, the peat was formed of layers of horizontal compact plant fragments and intercalated pellety amorphous organic matter (Pl 11E). These deposits probably indicate renewed colluviation, again possibly of anthropogenic origin as they contained charcoal within humic fine sands and silts. The layered organic sediments are not typical of peat (Dinç *et al* 1976; Fox 1985), but of a moder humus formed under presumed woodland (Babel 1975), which produced coarse woody roots both here and in context 2045. This is essentially a terrestrial soil feature and at this depth supports the early date for these contexts.

The pollen evidence from the peat indicated the expansion of alder carr on the floodplain with woodland of *Quercus, Corylus, Betula, Tilia* and *Ulmus*, presumably on the drier ground. As the peat became more established, fen carr became reinstated with a ground cover, of *Thelypteris palustris* and Cyperaceae, that dominated the pollen assemblage. The identification of *Typha latifolia* (bulrush) and *Typha angustifolia* (lesser bulrush) at -3.23m OD in the silty peat (context 2044) suggests areas of reedswamp or slow moving rivers and ditches.

In context 2043 the decreasing quantity of silt in the peat is suggestive of declining allochthonous input, and stabilisation of the sedimentary environment. The pollen assemblage suggested a wet fen carr woodland of *Alnus glutinosa*, *Quercus* and *Betula*. The sustained levels of Cyperaceae pollen and the increase in *Osmunda regalis* (royal fern) spores indicate the persistence of fen or bog conditions, although the reduction in aquatic plant pollen and the absence of allochthonous mineral material indicate there was either a marked reduction in open water or an increase in shade from the surrounding canopy. The microscopic charcoal content appears to be highest in the more allochthonous deposits and therefore cannot be interpreted to reflect a local pattern of vegetation burning although this may have existed.

The peat grades upwards into a thin, 0.03m thick disturbed silty clay deposit at -0.88m OD and a substantial deposit of made ground to +0.9 m OD. Unfortunately environmental remains were not examined from the upper part of the peat and alluvium (upwards of -2.49m OD) due to sampling difficulties.

Chainage 20.6km

Basal silty clay and peat

At 20.6km the lowermost deposit encountered comprised a yellowish-brown silty clay alluvium (context 2064), overlain by a thick peat bed between -3.42m and -1.54m OD. The base of the peat was radiocarbon dated to the Early Neolithic at 3770–3380 cal BC (NZA-28769, 4841±60 BP). The lower part of the peat (contexts 2063 and 2062) was well humified and almost black with abundant small woody and bark inclusions. Between these two contexts, at -3.12m OD, the peat graded into a thin bed of dark organic sandy silt, 0.08m thick (context 2065). The upper part of the peat bed (context 2061), from -2.29m, was much siltier and contained large twigs and woody fragments.

The pollen data (*Table 24*) suggested a floodplain dominated by fen carr vegetation in much of the profile, from the lowermost silty clay deposit (context 2064) to around to the top of the woody peat (context 2062). *Alnus glutinosa* was the main taxon, with *Quercus* and a fern understorey. As the peat accumulated, allochthonous input declined and local taxa (principally *A. glutinosa*, Cyperaceae and ferns) dominated the pollen assemblage. The pollen from other taxa is probably under-represented in the pollen sum. From -2.66m OD upwards, reedswamp and then fen conditions began to develop, seen in the progressive peaks of Cyperaceae and *Thelypteris palustris*, and ultimately allogenic input increased as silt began to accumulate in the peat. Towards the top of the silty peat, *A. glutinosa* increased signalling that a wet fen carr woodland was again developing. The seed assemblage from the peat was very sparse comprising eroded seeds of *Betula* and *A. glutinosa*.

Upper silty clay

The peat was overlain by a unit of greyish yellow brown massive silty clay with iron mottling (context 2060) from -1.54m to -0.84m OD The pollen spectrum records a floodplain environment of fen carr with significant areas of grassland or open ground, suggested by the rich assemblage of herbaceous taxa. Two cereal-type pollen grains may indicate agriculture in the area and microscopic charcoal values were generally higher. Context 2060 produced a small diatom assemblage, although *Hantzschia amphioxys* was the only fragment identifiable to specific level. This is a freshwater diatom that is resistant to desiccation. It is a very common aerophilous diatom and therefore the presence of a single fragment is not significant. Ostracods on the other hand were abundant and indicated brackish creeks and mudflats (*Table 25*). Unfortunately the date for the top of the peat produced an anomalous modern date (NZA-28710). However, brackish water ingress driven by marine incursion is likely to have occurred at a broadly similar period to that in the other adjacent sequences and comparisons of elevations and vegetation changes in the upper peat would perhaps suggest a later prehistoric date, assuming a lack of truncation.

Watching brief on the service diversions

Invariably the limited depth of excavation associated with the service diversions meant that only modern made ground deposits were exposed. Cofferdams excavated for the pipe-jacked crossing at Chequers Lane, however, were sufficiently deep to expose the full depth of the sequence to the surface of the Pleistocene gravels. Detailed recording and palaeoenvironmental sampling were undertaken from the lower part of the sedimentary sequence (below -3.10m OD) in the cofferdam immediately east of Chequers Lane at 20.97km. The upper part of the sequence was sampled (above -1.5m OD) during the pipeline main-lay 110m to the east at 21.09km (Figs 44 and 45). Three radiocarbon dates were obtained for these sequences (Appendix A).

Chainage 20.97km

At 20.97km fluvial gravel (context 131) was noted at -4.15m OD, overlain by a deposit of yellowish-brown medium sand (context 130). At the upper surface of the sand was a thin deposit of medium greyish-brown weathered sand (context 129). The weathered sand was sealed by a greenish-grey organic sandy silt (context 128) that became more clayey up-profile (context 127) to -3.3m OD. The interface of contexts 129 and 128 was radiocarbon dated at -3.88m OD to the Late Mesolithic, 4710–4500 cal BC (NZA-16264, 5751±40 BP). Above these deposits was a substantial layer of peat (context 126), that extended upwards to *c* -1.3m OD. The base of the peat was radiocarbon dated to the Early Neolithic, 3640–3490 cal BC (NZA-16263, 4733±40 BP). The peat was overlain by silty clay alluvium and a deposit of made ground to *c* 1.0m OD.

Basal sands

Preservation of environmental remains was poor in the basal sands although ephippia of cladocerans appear to indicate a freshwater environment.

Organic silt and peat

Macroscopic plant remains from the organic silt and lower part of the peat included abundant remains of *Alnus glutinosa* (*Table 26*). Seeds of herbaceous plants ranged from those of woodland floor, such as *Stellaria neglecta* (greater chickweed), through to those of fen woodland, such as *Scirpus sylvaticus* (wood club-rush), to those of shallow water such as *Oenanthe aquatica* gp. (water dropwort). Coleoptera (*Table 27*) included the *Chrysomela aenea* (alder leaf beetle), *Rhynchaenus testaceus* (a weevil which also feeds on alder leaves) and *Phymatodes alni* (wood-boring long-horn beetle), which is sometimes associated with dead alders. The insects also included species of decaying vegetation in fens, such as *Corylophus cassidoides* found in shallow pools of water and *Limnebius nitidus*, and species of aquatic plants, such as *Prasocuris phellandrii* which feeds on aquatic Umbelliferae, including *Oenanthe aquatica*. There was no evidence for environmental change in the sequence. The results suggest alder carr predominated, with areas of shallow water between higher areas of exposed peat.

The pollen evidence (*Table 28*) supports this interpretation with *Alnus* dominant. Cyperaceae with Poaceae were also important probably forming the understorey of the alder woodland. The terrestrial/dryland flora was dominated by trees and shrubs comprising largely *Quercus* and *Tilia* with some *Betula* and *Corylus avellana*-type suggesting adjacent mixed woodland, but *Quercus*/*Tilia* dominated on drier soil. There were few herbs and those which were present are most probably autochthonous elements.

Chainage 21.09km

At 21.09km the top of a peat horizon (context 105), exposed in the base of the pipe trench, was radiocarbon dated at -1.39m OD to the Middle Iron Age, 410–200 cal BC (NZA-16262, 2270±45 BP). The peat was overlain by organic silty clay (context 104) and silty clay alluvium (contexts 103 and 102) to -0.80m OD. The sequence was capped by deposits of made ground to +1.58m OD.

Peat and organic silty clay

Samples from the top of the peat produced some indicators of domestic animal grazing within the fen vegetation, such as seeds of *Potentilla anserina* (silverweed) (*Table 26*), and the scarabaeoid dung beetles *Geotrupes* sp. and *Aphodius* sp. (*Table 27*) There were some differences between the pollen spectra of the peat, the overlying organic silty clay and alluvium but these were not significant enough to warrant pollen zonation in the assessment study (*Table 28*). Trees were consistently 25–30% of TP (excluding *Alnus*) throughout the entire sediment profile. *Quercus* was the most important with occasional *Betula*, *Pinus*, *Picea* (spruce), *Alnus*, *Tilia* and *Fraxinus*. *Corylus avellana*-type was the most important shrub. Herbs were also dominant throughout (60–70%), Poaceae dominated in the peat and organic silty clay (to 60%). Other taxa of importance in the organic silty clay include Chenopodiaceae and single grain of cereal-type pollen. Of the marsh and aquatic component *A. glutinosa* was at highest percentages in the peat and organic silty clay with Cyperaceae and, *Alisma*-type (water plantain) derived from a grass-sedge fen with alder surrounding the wetland margins.

Upper silty clays

Alnus glutinosa values declined in the minerogenic contexts in which *Typha angustifolia* became more important. Of note were the derived and redeposited pre-Quaternary palynomorphs in the mineral sediments. These are strongly indicative of the presence of other reworked Holocene pollen and spores. *Quercus* and *Corylus* remained as a more regional vegetation component. Expanding *Pinus* percentages reflect the propensity of its (saccate) pollen to float and its consequent frequent over-representation in fluvially derived sediments. Cereal-type pollen was present sporadically.

The autochthonous vegetation shows development from grass-sedge fen with near, fringing alder carr. This developed into wetter, poor fen with Cyperaceae. Prior to this, however, there is evidence (104) of freshwater with *Myriophyllum spicatum* (spiked water-milfoil). Increases in Chenopodiaceae and Hystrichospheres (dinoflaggellates) suggest the possibility of saltmarsh habitats within the catchment. Seeds from the alluvial clays were sparse, but included *Callitriche* sp. (starwort), *Alisma* sp., *Mentha* sp. (mint) and *Juncus* spp. These results suggest the fen was replaced up the sequence by marsh with alluvial input.

Ostracods and foraminifera (*Table 29*) suggest some brackish/marine influence throughout, even though some freshwater/terrestrial components also occurred (washed in). The ostracod faunas were dominated by species living in

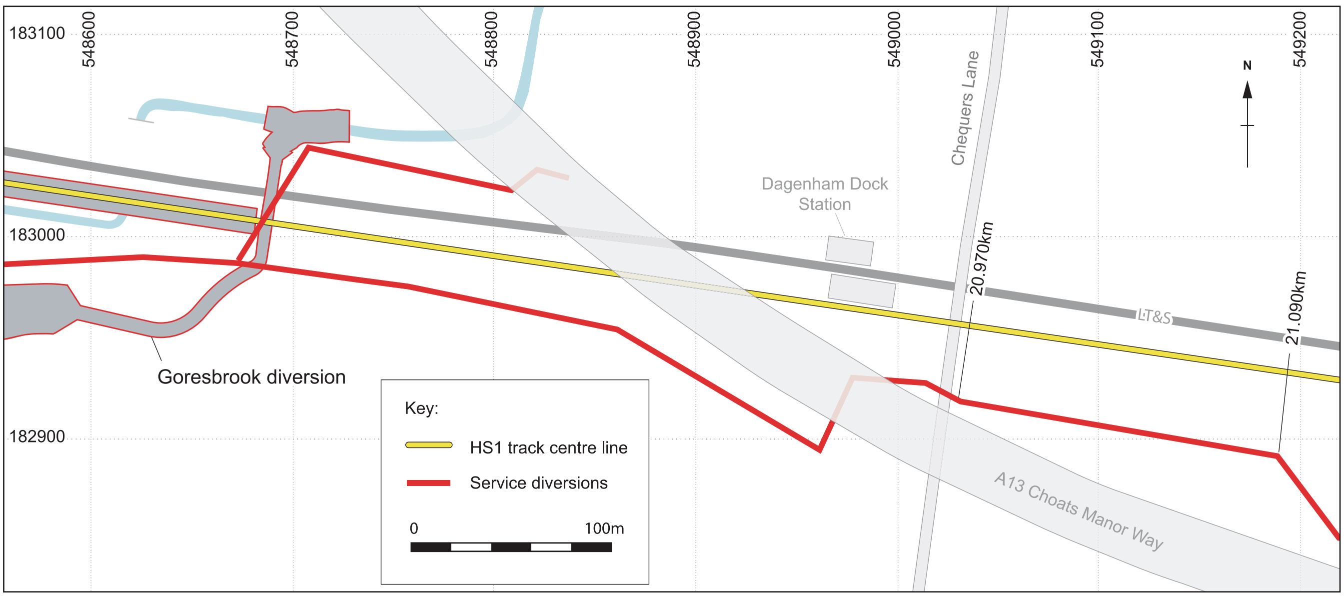

Figure 45 Location of sample profiles, Dagenham Vale

sheltered brackish creeks and intertidal mudflats. These are typified by *Cyprideis torosa, Leptocythere porcellanea, Loxoconcha elliptica* and *Cytherura gibba*, being common to abundant suggesting they are *in situ*. Conversely the freshwater species, usually *Candona* species, were quite rare. The foraminifera were also supportive of a brackish tidal mudflat environment (they were mostly small in size and consist of euryhaline species of *Ammonia, Elphidium* and *Haynesina germanica*). There were also quite a few fully marine species, possibly washed in by a tidal surge. However, two of the species (*Robertsonites tuberculatus* and *Elofsonella concinna*) are of special interest in that they do not live in southern Britain today, or even within the Holocene, being found in more northern climes today. It is suggested they may possibly be reworked from a Pleistocene deposit nearby.

Discussion

The dates and elevations for onset of organic accumulation above the sands and gravels at the tunnel portal site and Dagenham Vale are broadly similar occurring during the later Mesolithic period at *c* -4.0m OD, with peat accumulating during the Early Neolithic and Bronze Age. Overall the peats exposed appeared to be quite variable in character; reddish brown wood peats, silty peats and more humified black peats with abundant reed stems. The pollen work suggests the predominance of open fen and reedswamp with perhaps areas of alder carr to the edges. The variation between the profiles might suggest shifting local environments of fen and alder carr and this may be related to the topography and the presence of a major channel system in the vicinity. A higher silt component within the peat was probably a result of local flooding events. The radiocarbon dates and elevations for the top of the peats also showed variation and this is most likely related to truncation of the upper peat horizon by later alluviation, indicated by the contact between the peat and upper alluvial units being often very abrupt (see Waller *et al* 2006). The earliest date for change to minerogenic sedimentation was the Middle Bronze Age at the Goresbrook diversion (-1.75m OD, 3790TT) and the latest in the Dagenham Vale sequence occurring during the Middle Iron Age (-1.39m OD, 21.09km). The upper alluvium appeared to have formed in an environment of tidal creeks and mudflats although a significant freshwater signature was noted in a number of sequences probably related to inputs from streams from the gravel terrace.

Indirect evidence of Late Mesolithic or earlier human activity was identified during thin section analysis of the interface between the base of the peat and the underlying sands at 20.5km in the form of microcharcoal and burnt flint fragments. In addition there is evidence of colluvial inputs at this level in the sequences which may be of anthropogenic origin. Microcharcoal was also noted to occur within the peat sequences during the pollen assessments. Further east at 21.09km the upper part of the organic sequence, immediately prior to marine inundation was dated to the Middle Iron Age and here scarabaeoid dung beetles *Geotrupes* sp. and *Aphodius* sp. are suggestive of fen vegetation such as rushes that was being grazed by domestic animals.

East Dagenham and Hornchurch Marshes (Zones T8–T12)

The route of HS1 continues on a piled slab alongside the existing London Tilbury & Southend railway line (LT&S) through the Ford Motor Works, immediately north of Dagenham Breach, crossing beneath existing road bridges at Kent Avenue and Thames Avenue (Fig 21). Exiting the Motor Works the railway continues eastwards through the Mudlands before skirting the northern edge of the Riverside Sewage Treatment Works (STW) (Fig 46). At 23.9km the railway traverses Rainham Creek (the Ingrebourne River) on a newly constructed viaduct before continuing eastwards towards Rainham Marsh. Prior to construction the land was occupied by factories and workshops associated with the Motor Works, concreted areas and patches of waste ground containing metalled trackways and railway sidings with ground levels averaging +1.40 to +2.00m OD. In the Mudlands the ground was covered by rough grass and scrub at +0.00–0.10m OD, rising to +0.70m OD at Manor Way and to +2.75m OD alongside the Riverside STW. At Rainham Creek modern flood defence bunds were located on either side of the watercourse.

Construction Impacts

The railway through this part of the route continued on a piled concrete slab. Aside from the piling, there was no direct impact on the underlying alluvium due to the thickness of the overlying made ground. The exception, however, was at Rainham Creek, where the railway passes over the watercourse on a newly constructed viaduct (Fig 47). The 454m three-span viaduct necessitated a minor diversion of the existing creek for a new road underpass. In addition to the main construction phase a series of advanced service diversions were carried out both to the north and south of the LT&S railway. A total of 2585m of open trenching was carried out, of which 595m employed box shoring edge support. The depth of excavation averaged 1.60 to 3.00m depending on the location of existing services. In total 835m of pipejacking was carried out via a series of deep caisson chambers and cofferdams to carry the services beneath existing railway lines and roads.

Key Archaeological Issues

The original 1999 study designated Zones T8–T11 (Chap 6 *Window 8*, Fig 21) of low archaeological priority. It was predicted that all areas were submerged below the sedimentation front during the Late

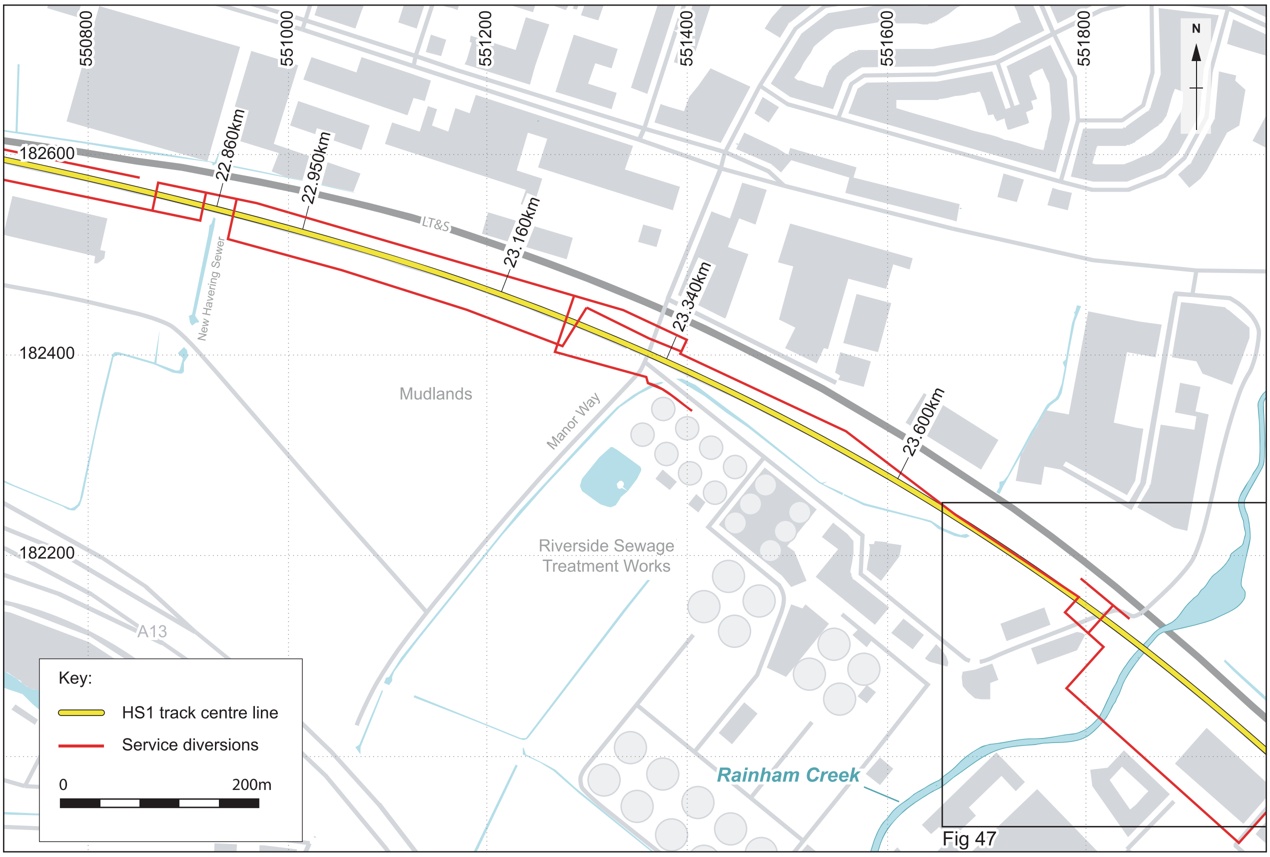

Figure 46 Plan of investigations from Mudlands Farm to Rainham Creek

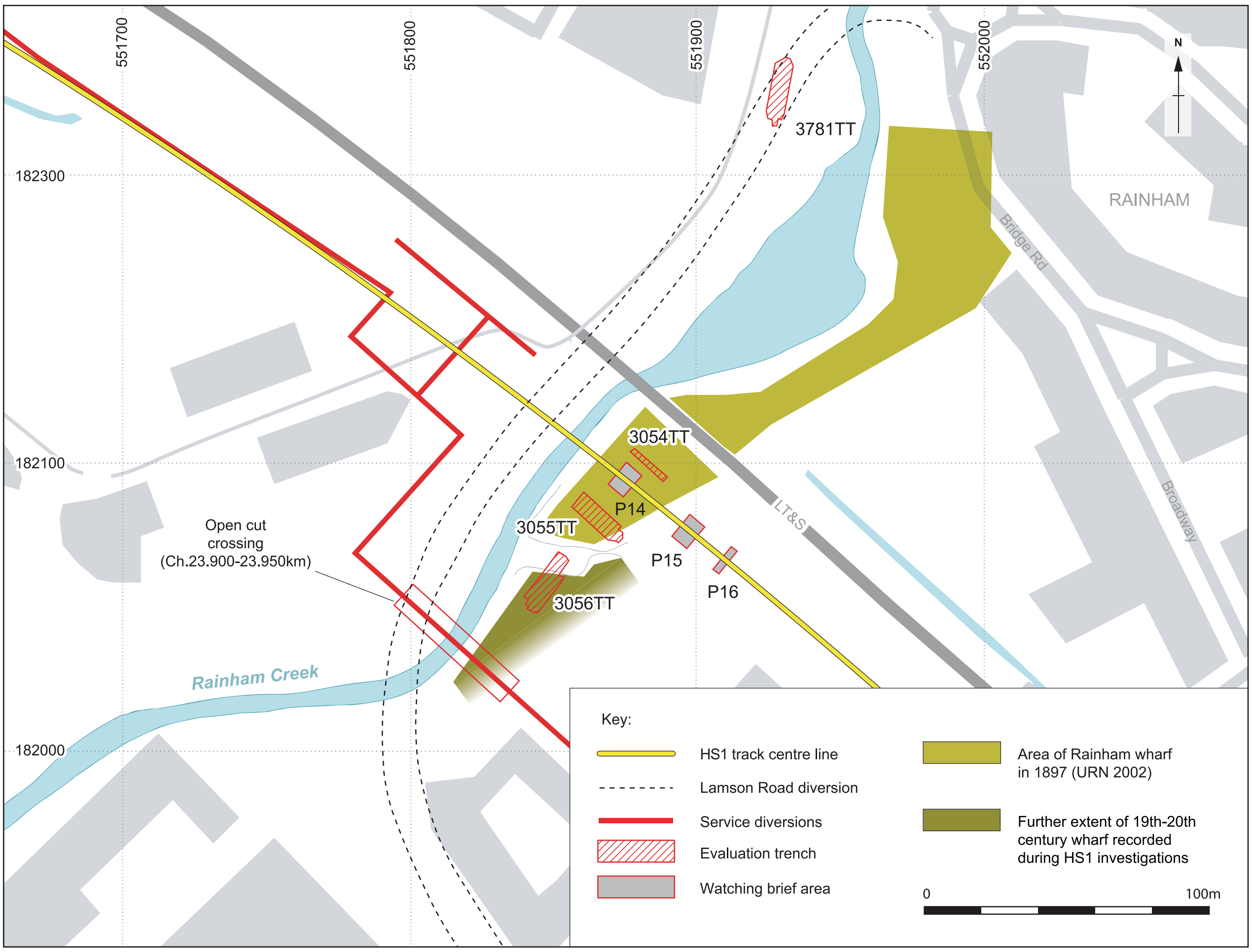

Figure 47 Detailed plan of investigations at Rainham Creek

Table 30 Summary of fieldwork events, East Dagenham and Hornchurch Marshes

Event name	Event code	Type	Zone	Interventions	Archaeological contractor
West Thames advanced utility diversions	ARC 36100	Watching Brief	8–12		Oxford Archaeology
Rainham Creek, Ferry Lane	ARC RAI00	Evaluation	12	3054TT, 3055TT, 3056TT, 3081TT	Essex County Council Field Archaeology Unit
Rainham Creek, Ferry Lane	ARC RAI00	Watching Brief	12		Essex County Council Field Archaeology Unit

TT = trench

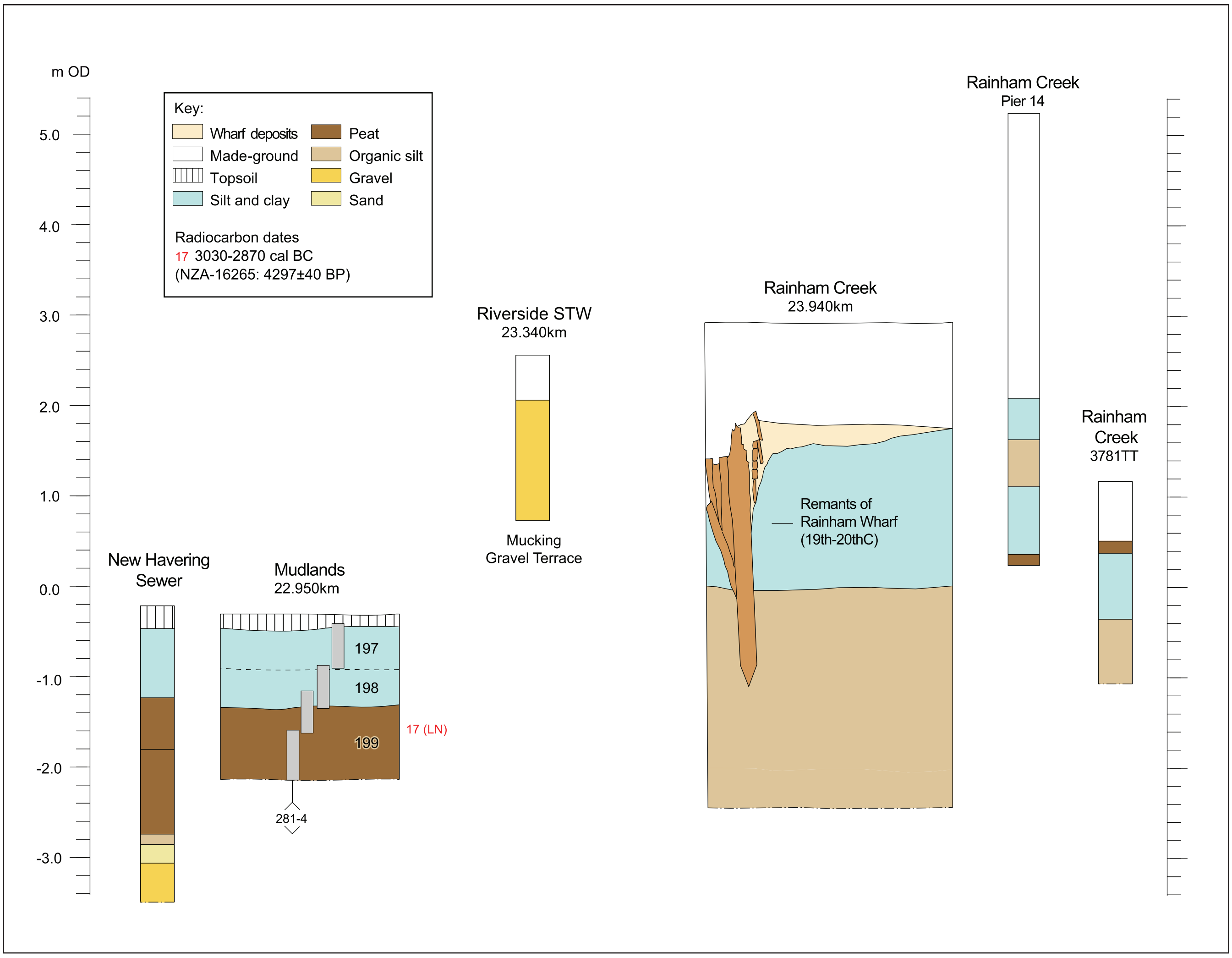

Figure 48 Cross-section from Mudlands Farm to Rainham Creek

Mesolithic at *c* 4800–4300 cal BC (*c* 6000 –5500 ^{14}C BP). Features in the Pleistocene gravel sequences indicated the possible position of two major infilled channels of Late Pleistocene age. A major zone of potential archaeological significance was thought to exist within Zone T12 (23.46–24.13km), corresponding with the Rainham Creek area.

Previous archaeological work has revealed archaeological remains associated with Rainham Creek. At Bridge Road, Rainham, Middle Bronze Age wooden structures were located on the bank of the creek: an insubstantial brushwood trackway constructed using coppiced alder and a small rectangular enclosure (Meddens and Beasley 1990, 244). Roman activity has also been confirmed by excavation in the vicinity. In both these periods the activity encountered probably represented the exploitation of the riverine and coastal environment as opposed to permanent settlement. Rainham village itself was probably founded in the Saxon period, although settlement appears to have been concentrated on the higher ridge to the north, the marshland and creek were probably being exploited for fishing, grazing and some arable cultivation. The creek was probably embanked in this period. It was anticipated that features associated with land reclamation and exploitation may have been present but were likely to have been disturbed by later activity. A post-medieval wharf is known to have existed from the 16th to 20th centuries, although it is possible the wharf was in existence in medieval period as sources mention shipments from London. The first documentary reference to a wharf is dated to 1526, and the location is shown on the Chapman and André map of 1777 in the northern part of the study area on the east bank of the creek. The wharf facilities were improved by Capt. John Harle in the early 18th century. He added granaries and warehouses, and dredged the channel. This wharf continued in use until the 1970s. The wharf to the south of the LT&S railway was built in 1872 by market gardener John Circuit and was last used in 1976 (URN 2002).

Methodologies

The investigation strategy for Zones T8–T12 comprised a pre-construction watching brief on the service diversions. The only archaeological remains identified comprised remnants of a wharf dated to the 19th to 20th century at Rainham Creek (see below). The area was the subject of three targeted evaluation trenches by Essex County Council Field Archaeology Unit (URN 2003) to assess the impact of the proposed road diversion and HS1, although no earlier structures were recorded (Fig 47). A watching brief was also maintained during the construction of the underpass, the viaduct and the Rainham Creek diversion. A summary of the fieldwork events is presented in Table 30. Sampling and assessment of palaeoenvironmental remains for this route section was limited, but did include a shallow profile at 22.950km in the Mudlands (Fig 46) along with a single date from the top of an exposed peat unit (Fig 48). Interpretation of the sedimentary sequences was carried out by Elizabeth Stafford. The palaeoenvironmental work was carried out by Rob Scaife (pollen), Mark Robinson (waterlogged plant remains and insects) and John Whittaker (ostracods and foraminifera).

Results of the Investigations

Watching brief on service diversions

Chainage 21.34–22.86km (The Ford Motor Works)

Due to the thickness of made ground in the area the service diversions rarely exposed more than 0.50m of the underlying alluvial sequences. Where excavation depth did increase, at road and rail crossings, visibility was often hampered due to the method of excavation and access restricted due to safety reasons (Pl 12). No open sections were available for detailed sampling during the excavations of the caisson chambers and cofferdams. The sediment sequences observed in the intermittent deeper excavations comprised very deep alluvial sequences, including a major peat bed, similar to that observed on the West Dagenham Marshes.

Plate 12 Pipeline excavations employing box shoring through the Ford Motor Works

Chainage 22.86–23.90km (The Mudlands and Riverside STW)

East of the Motor Works, in the area formerly occupied by Mudlands Farm (Fig 46), the route is situated at the very edge of the floodplain. Here Holocene alluvial deposits thin against an outcrop of the Mucking Gravel (Fig 21, Zone 11) which was observed during the service diversions (Fig 48). The surface of the gravels reached *c* 2.0m OD along the STW dropping to -3.05m OD beneath the New Havering Sewer (28.860km) in the west and towards Rainham Creek to the east. The gravel was overlain by Holocene alluvium at the eastern and western parts of the route section. A major peat unit, overlain by minerogenic alluvium, exists in these areas, with the surface of the peat averaging *c* -1.00m to -1.20m OD. The maximum thickness of peat observed was *c* 1.60m at the New Havering Sewer (28.860km). No Holocene alluvium existed in the central part of the route section between 23.160km and 23.600km. Here Pleistocene gravel was directly overlain by modern disturbed ground. Along the entire section of the route the diversions ran through a heavily populated service corridor immediately south of the LT&S. Extensive areas of disturbance were frequently noted in the pipeline main-lay and chamber excavations. This was particularly extensive alongside the Riverside STW. In the area immediately west of Manor Way a rapid drop in the elevation of the modern ground to +0.70m OD suggests that the deposits have been substantially truncated or levelled, possibly for construction

Plate 13 Timber revetment at Rainham Creek

purposes. If so, it was thought unlikely that any shallow archaeological features would have survived in this location. No archaeological remains were identified in this section of the route.

Palaeoenvironmental sampling was undertaken at 22.950km where the pipe trench measured *c* 1.8m in depth (Fig 48).

Peat

The gravels were not reached at 22.950km and therefore the Holocene sequence was not bottomed, the basal deposit encountered in the pipe trench comprised a dark brownish-black peat (context 199) between -2.17m and -1.31m OD. The lower part of the peat was very silty and contained abundant woody material but the upper *c* 0.20m was notably darker in colour and well humified. The top of the peat was radiocarbon dated to the Neolithic, 3030–2870 cal BC (NZA-16265, 4297±40 BP). As expected the pollen assessment suggested that the peat accumulated under a floodplain, alder carr environment. This is supported by the seed assemblage that included seeds and catkins of *A. glutinosa* (*Table 32*). The presence of *Lemna* sp. (duckweed) and *Oenanthe aquatica* gp. in the top of the peat however suggests the carr was followed by more open, and possibly wetter, conditions. The environment was freshwater with the basal peat containing decalcified freshwater ostracods (*Table 33*) and common cladoceran remains. *Quercus, Corylus* and *Fraxinus* grew in drier zones (*Table 31*), while nearby dry soils supported *Tilia* woodland, perhaps co-dominant with *Quercus*.

Upper silty clays

The peat was overlain by a bluish-grey silty clay alluvium (context 198) and a deposit of orangey-brown silty clay alluvium (context 197), capped by the modern topsoil to -0.34m OD. Towards the western end of the route section channel features were noted within the upper alluvium, truncating the top of the underlying peat. Seeds were absent from the alluvial clay, apart from *Juncus* spp. The arboreal pollen remained relatively stable, aside from some reduction in *Quercus*, until a drop in tree and shrub types and rise in Poaceae in context 197, indicating a more open environment. There were some indications of saltmarsh/halophytic taxa (Chenopodiaceae) but also strong representation of freshwater reedswamp including *Littorella* (shoreweed), *Typha angustifolia*-type, *Iris* (iris) and Cyperaceae. *Potamogeton*-type may be from pond weed or sea arrow grass (*Triglochin maritima*). Ostracods and formainifera were only present in context 197 indicating a tidal mudflat and creek environment.

Chainage 23.90–23.95km (Rainham Creek)

The advanced service diversions in this area included an open cut crossing of Rainham Creek (Fig 47). The trench measured 50m long and 6.0m wide and was excavated to a depth of -2.6m OD. Edge support involved stepping and battering the sides of the trench and this, together with high water levels, despite de-watering, significantly reduced visibility of the deposits. At the time of the watching brief the ground was covered with rough grass. Modern flood defence bunds were located on either side of the creek and ground levels averaged +2.00 to +3.00m OD. Deposits consisted of modern made ground extending down to +1.62m OD, overlying minerogenic bluish-grey silty clay to -0.15m OD. Mid-brownish-grey organic silty clay with reeds and brushwood fragments extended to -2.20m OD, becoming more organic down profile to the base of excavations at -2.60m OD.

On the western bank of the creek the remnants of a 19th–20th century timber revetment was identified (Fig 48). The structure was overlain by modern dumped deposits and cut into the underlying minerogenic alluvium. The top of this structure was truncated at +1.64m OD. Artefactual material from associated deposits suggested a 19th–20th century date.

Trench excavations at Rainham Creek

The evaluation trenches (3054TT, 3055TT, 3056TT) were targeted specifically to investigate the area for earlier waterfront structures (Fig 47). Although substantial timber revetments were recorded in two of the trenches, flanking a buried tributary channel, all proved to be of 19th–20th century date (URN 2003, Pl 13). The evaluation trenches were relatively shallow (*c* 2.50m deep) and did not penetrate the underlying alluvial deposits to any great depth. The watching brief on the pile caps for the bridge piers recorded a substantial thickness of deposits similar to those described during the pipeline watching brief, although peat was encountered at the base of the excavations on Pier 14 (Fig 48).