Chapter 4 The Lower Thames

Introduction

The previous two chapters have covered the upper part of the Thames catchment, upstream from the London Basin (Chapter 2), and then the middle part of its course, the area in which the longest record of the river's depositional history is preserved and where detailed evidence for its glacial diversion can be observed (Chapter 3). This chapter is concerned with the valley of the Lower Thames, which contains a complex sequence of Middle and Upper Pleistocene deposits laid down under a variety of climatic conditions in both fluvial and estuarine environments.

The division between the Middle and Lower Thames, a purely arbitrary boundary, is conventionally placed in central London. Application of the term Lower Thames to the valley downstream from the Colne confluence at Staines, which has only existed as a Thames course since the glacial diversion, would perhaps provide a more meaningful geographical and geological division. Any problems of definition are largely academic, however, since most of the scientific interest and all of the GCR sites in the post-diversion valley fall either within or downstream from Greater London.

Despite an abundance of important palaeontological and archaeological localities and a long history of research, the succession in the Lower Thames has been poorly understood and a satisfactory correlation with the terraces of the classic Middle Thames region has been demonstrated only recently (Gibbard, 1985; Bridgland, 1988a; Gibbard *et al.,* 1988).

Research history

The first detailed appraisal of the Lower Thames sequence was by Hinton and Kennard (1900, 1905, 1907), who identified (1905) four gravel terraces numbered in declining sequence. The mapping of the three named 'valley gravel' terraces (Boyn Hill, Taplow and Floodplain), established in the Middle Thames (Chapter 3), was extended into the Lower Thames by the Geological Survey on its 'New Series' maps (Sheets 257 and 271; Dewey *et al.,* 1924; Dines and Edmunds, 1925). This mapping did not distinguish between Hinton and Kennard's 1st and 2nd terraces, both of which were classified as 'Boyn Hill Gravel'. King and Oakley (1936) concluded that a simple attitudinal sequence was not applicable to the Lower Thames because, in that part of the valley, repeated rejuvenations and aggradations had resulted in deposits of various ages being laid down at similar elevations. They described a complex sequence of downcutting and depositional phases, the evidence for which was largely archaeological or palaeontological. For example, sediments at different levels were considered to have been laid down sequentially, on account of their having similar assemblages of Palaeolithic artefacts; conversely, deposits beneath single terrace surfaces were sometimes attributed to depositional events widely separated in time, on the grounds of archaeological differences. King and Oakley's sequence offered little hope for the classification of the more widespread unfossiliferous gravels that make up the bulk of the Pleistocene record in the Lower Thames and contain only mixed assemblages of abraded artefacts. Their scheme did, however, gain widespread acceptance, a possible reason for the paucity of subsequent work on terrace stratigraphy in the area, although the rich Palaeolithic and palaeontological sites continued to receive much attention.

The post-war years saw a number of additions made to the original tripartite sequence in the Middle Thames, notably the Lynch Hill Terrace (between the Boyn Hill and the Taplow) and various pre-Boyn Hill aggradations, from the Black Park Terrace upwards (see Chapter 1; Chapter 3 and (Figure 3.2)). Few attempts were made to trace these into the Lower Thames, although Wooldridge and Linton (1955) suggested that the Lynch Hill Terrace was probably represented within the belts of gravel to the east of London mapped as Boyn Hill and Taplow. Wooldridge and Linton provided a description of the terraces in the eastern part of the Lower Thames area in which they adhered closely to the Geological Survey's sequence. However, Evans (1971) returned to a complex scheme in his pioneering attempt to correlate the Thames terrace sequence with the deep-sea record (see Chapter 1). There were considerable similarities between his model and that of King and Oakley, but Evans took the radical step of allocating the various aggradations in the Lower Thames to seven separate warm periods. With the exception of Evans's model, the interpretation of the Lower Thames terrace sequence has, over the past two to three decades, generally followed the conventional Middle and Upper Pleistocene

chronological scheme, as set out by Mitchell *et al.* (1973; see Chapter 1). Various interglacial deposits were described at a number of important sites and were correlated with the Hoxnian or Ipswichian Stages of the East Anglian sequence: examples include the Swanscombe deposits, correlated with the Hoxnian (Kerney, 1971), and the biogenic sediments at Aveley, Ilford, Purfleet and Trafalgar Square, which were assigned to the Ipswichian (Franks, 1960; West *et al.,* 1964; West, 1969; Hollin, 1977). Doubts about some of these correlations were first expressed by Sutcliffe (1960, 1964, 1975, 1976) and later by Allen (1977). As these reservations were expressed during detailed consideration of the most important sites in the area, they will be discussed in more detail in appropriate site reports in this chapter.

In the most recent work in the Lower Thames, local lithostratigraphical nomenclature has been applied to the terrace deposits ((Table 4.1) and (Figure 4.1), (Figure 4.2) and (Figure 4.3); Bridgland, 1983a, 1983b, 1988a; Gibbard *et al.,* 1988). The New Series Geological Survey mapping of the Lower Thames was found to be broadly accurate and was used as the basis for the reclassification of the three gravel formations originally recognized (see (Figure 4.1), (Figure 4.2) and (Figure 4.3) and (Table 4.1)). However, Gibbard (1979) correlated high-level deposits at Dartford Heath, mapped as Boyn Hill/ Orsett Heath Gravel, with the Black Park Terrace, thus adding a possible fourth formation to the Lower Thames sequence (see Wansunt Pit). Bridgland (1983a, 1988a; Gibbard *et al.,* 1988) showed that the Lower Thames sequence below the Boyn Hill level had been mis-correlated with the Middle Thames in the original Geological Survey mapping. He concluded (in collaboration with Gibbard) that the Corbets Tey Gravel of the Lower Thames correlates with the Lynch Hill Gravel of the Middle Thames (Table 4.1), not recognized in the original tripartite classification of the terraces in the latter area. This formation appears on the geological maps of the Lower Thames as Taplow, but the true correlative of the Taplow Gravel of the Middle Thames type area is the Mucking Gravel, which was mapped east of London as Floodplain Gravel.

Beneath the alluvium of the modern floodplain, Bridgland (1983a, 1988a) recognized a further gravel formation, the East Tilbury Marshes Gravel, which is interpreted as a down stream continuation of the Kempton Park (Upper Floodplain Terrace) Gravel of the Middle Thames (Bridgland, 1988a; Gibbard *et al.,* 1988; (Table 4.1)). The gravel sequence in the Lower Thames may be summarized as follows:

Hinton and Kennard (1905)	**Geological Survey**	**Bridgland (1988a)** ***Gibbard et al.*** **(**1988**)**
		East Tilbury Marshes Gravel
Terrace 4	Floodplain	*West Thurrock Gravel* [2]
		Mucking Gravel
Terrace 3	Taplow	Corbets Tey Gravel
Terrace 2	Boyn Hill 1	Orsett Heath Gravel
Terrace 1		*Dartford Heath Gravel'*

Notes: (1) The separation of the Dartford Heath from the Orsett Heath Gravel is not advocated in this volume (see Homchurch and Wansunt Pit). (2) The separation of the Mucking and West Thurrock Gravels is dependent on the interpretation of palynological evidence from the West Thurrock brickearth and is not supported in this volume (see Lion Pit).

Differences in detail between the stratigraphical schemes of Bridgland (1988a) and Gibbard *et al.* (1988) reflect a different emphasis in interpreting and ranking various types of evidence. Bridgland gave priority to terrace stratigraphy, his scheme closely following the altitudinal sequence of gravel formations, whereas Gibbard *et al.* favoured biostratigraphical (particularly palynological) evidence, closely adhering to the post-Anglian chronology of Mitchell *et al.* (1973). This has led to important differences in the interpretation of sites such as Purfleet, Globe Pit (Little Thurrock) and the Lion Pit tramway cutting (West Thurrock); these differences are discussed below (see appropriate reports).

(Table 4.1) The Pleistocene fluvial sequence in the Lower Thames (first published usage of lithostratigraphical terms in reference given in parentheses), with proposed correlations with the Middle Thames sequence, Pleistocene stages and oxygen isotope stages.

Formation *etc* (First publication)	Type locality (National Grid Ref.)	Middle Thames equivalent	Stage	^{18}O
East Tilbury Marshes Gravel (Bridgland, 1983b)	East Tilbury Marshes [TQ 688 784]	Kempton Park Gravel	mid to late Devensian	6–2[7]
(West Thurrock Gravel) (Gibbard et *al.,* 1988)[6]	Lion Pit tramway cutting [TQ 597 779]	(Reading Town Gravel)[6]	(early Devensian)	(?5d)
Interglacial Beds at Trafalgar Square		Brentford deposits'	Ipswichian	5e
Mucking Gravel (Bridgland, 1983b)	Mucking [TQ 689 815]	Taplow Gravel	late Saalian	8–6[4]
Interglacial beds at West Thurrock, Aveley etc.			Intra-Saalian	7
Corbets Tey Gravel (Gibbard, 1985)	Corbets Tey [TQ 570 844]	Lynch Hill Gravel	mid-Saalian	10–8[3]
Interglacial beds at Purfleet and Grays			Intra-Saalian	9
Orsett Heath Gravel (Bridgland, 1983b)	Orsett Heath [TQ 668 803]	Boyn Hill Gravel	early Saalian	12–10[2]
Interglacial beds at Swanscombe			Hoxnian *sensu* Swanscombe	11[2]
(Dartford Heath Gravel) (Gibbard, 1979)'	Wansunt Pit [TQ 514 7360]	(?Black Park Gravel)	(late Anglian)	(12)

1 The separate existence of the Dartford Heath Gravel, the subject of a lengthy controversy, is doubtful (see Wansunt Pit). This is thought to be part of the late Anglian to early Saalian Orsett Heath Formation.

2 The Boyn Hill/Orsett Heath Formation includes the interglacial sediments at Swanscombe, here attributed to ^{18}O Stage 11 (referred to as Hoxnian *sensu* Swanscombe in this volume).

3 Aggradation of the terrace deposits included within the Corbets Tey Formation began prior to the interglacial represented at Purfleet and Grays.

4 Aggradation of the terrace deposits included within the Mucking Formation began prior to the interglacial represented at West Thurrock, Aveley etc.

5 Described by Trimmer (1813) and Zeuner (1959).

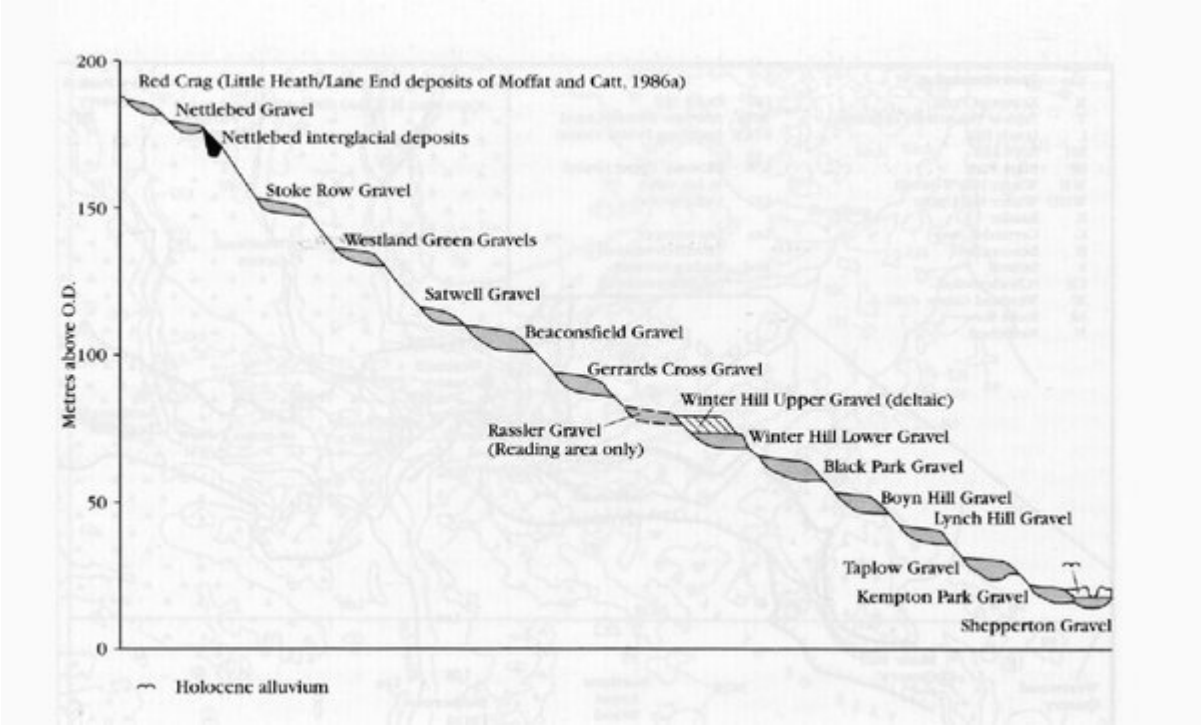
6 The separate existence of the West Thurrock and Reading Town Gravels is disputed in this volume. These are believed to be part of the late Saalian Taplow/Mucking Formation (see West Thurrock and Fern House Pit).

7 The Ipswichian sediments at Trafalgar Square and Brentford are regarded here as part of the Kempton Park Formation (see Chapter 3, Fern House Pit). This formation is considered to represent aggradation from the end of Stage 6 (gravel underlying the Trafalgar Square sediments, the Spring Gardens Gravel of Gibbard, 1985) to the mid-Devensian.

An alternative dating model for the Lower Thames terrace succession is proposed in this chapter, based on the stratigraphical relations between the bedded, largely unfossiliferous gravels, ascribed to periglacial episodes, and the interglacial sediments that occur at various sites. This model, which adheres closely to that outlined by Bridgland (1988a), recognizes two additional fully temperate episodes within the sequence, between the conventional Hoxnian (*sensu* Swanscombe) and Ipswichian (*sensu* Trafalgar Square) Stages ((Figure 4.3); (Table 4.1)). It forms the principal basis for the stratigraphical scheme for the Thames catchment as a whole and for the climatic model for terrace formation, both of which were put forward in Chapter 1. If the Anglian Stage, during which modern Lower Thames drainage was initiated, is correlated with Stage 12 of the oxygen isotope chronology (Bowen *et al.,* 1986b) and the last interglacial (Ipswichian *sensu* Trafalgar Square) with Sub-stage 5e (Gascoyne *et al.,* 1981; Shotton, 1983), three earlier

post-Anglian interglacial episodes remain to be identified on land. Bowen *et al.* (1989) have recently published amino acid ratios from various post-Anglian sediments and suggested that these can be divided into four groupings, equating with the four major post-Anglian temperate episodes, Oxygen Isotope stages 11, 9, 7 and 5. The same number of temperate episodes is now recognized in the Lower Thames sequence; on this basis correlations with the deep-sea record are suggested in (Table 4.1). Details of the evidence from which this model has been assembled are given in the various site descriptions in this chapter.

References



(Figure 3.2) Idealized transverse section through the classic Middle Thames sequence of the Slough-Beaconsfield area. The stratigraphical position of the Rassler Gravel, not preserved in this area, is shown.

Formation *etc* (First publication)	Type locality (National Grid Ref.)	Middle Thames equivalent	Stage	^{18}O
East Tilbury Marshes Gravel (Bridgland, 1983b)	East Tilbury Marshes (TQ 688784)	Kempton Park Gravel	mid to late Devensian	6-2[7]
(West Thurrock Gravel) (Gibbard *et al.*, 1988)[6]	Lion Pit tramway cutting (TQ 597779)	(Reading Town Gravel)[6]	(early Devensian)	(5d)
Interglacial Beds at Trafalgar Square		Brentford deposits[5]	Ipswichian	5e
Mucking Gravel (Bridgland, 1983b)	Mucking (TQ 689815)	Taplow Gravel	late Saalian	8-6[4]
Interglacial beds at West Thurrock, Aveley etc.			Intra-Saalian	7
Corbets Tey Gravel (Gibbard, 1985)	Corbets Tey (TQ 570844)	Lynch Hill Gravel	mid-Saalian	10-8[3]
Interglacial beds at Purfleet and Grays			Intra-Saalian	9
Orsett Heath Gravel (Bridgland, 1983b)	Orsett Heath (TQ 668803)	Boyn Hill Gravel	early Saalian	12-10[2]
Interglacial beds at Swanscombe			Hoxnian *sensu* Swanscombe	11[2]
(Dartford Heath Gravel) (Gibbard, 1979)[1]	Wansunt Pit (TQ 5147360)	(?Black Park Gravel)	(late Anglian)	(12)

1 The separate existence of the Dartford Heath Gravel, the subject of a lengthy controversy, is doubtful (see Wansunt Pit). This is thought to be part of the late Anglian to early Saalian Orsett Heath Formation.

2 The Boyn Hill/Orsett Heath Formation includes the interglacial sediments at Swanscombe, here attributed to ^{18}O Stage 11 (referred to as Hoxnian *sensu* Swanscombe in this volume).

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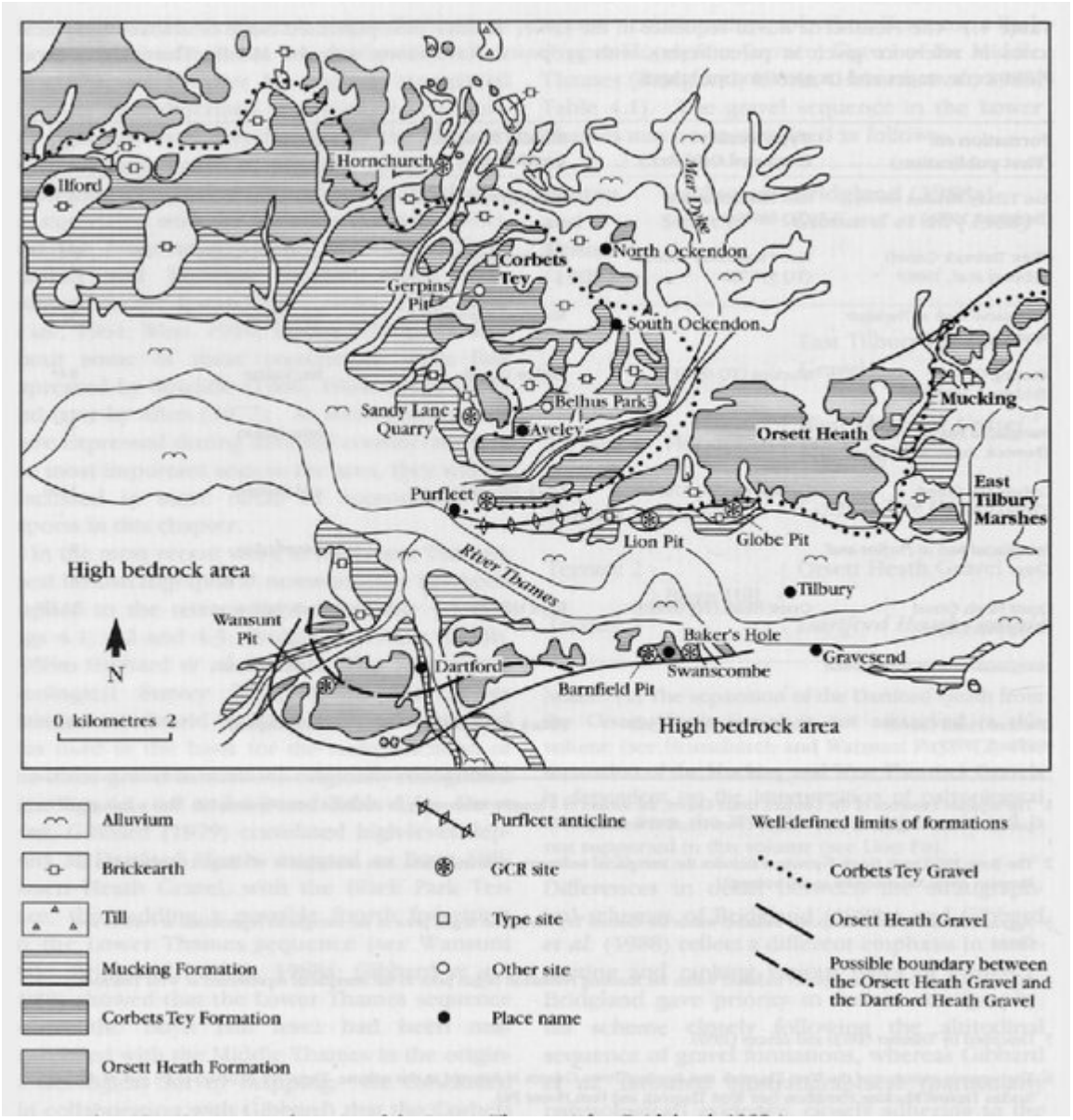
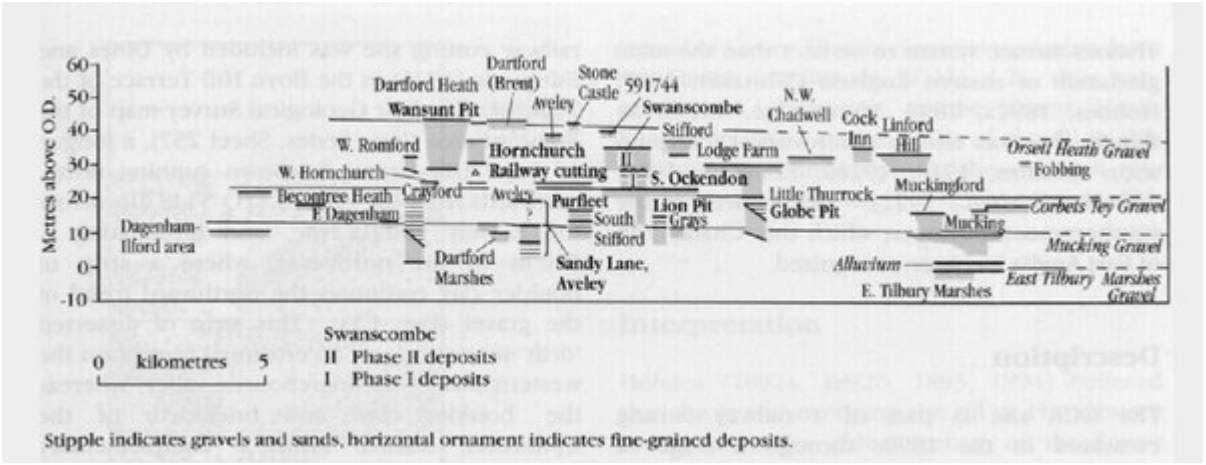
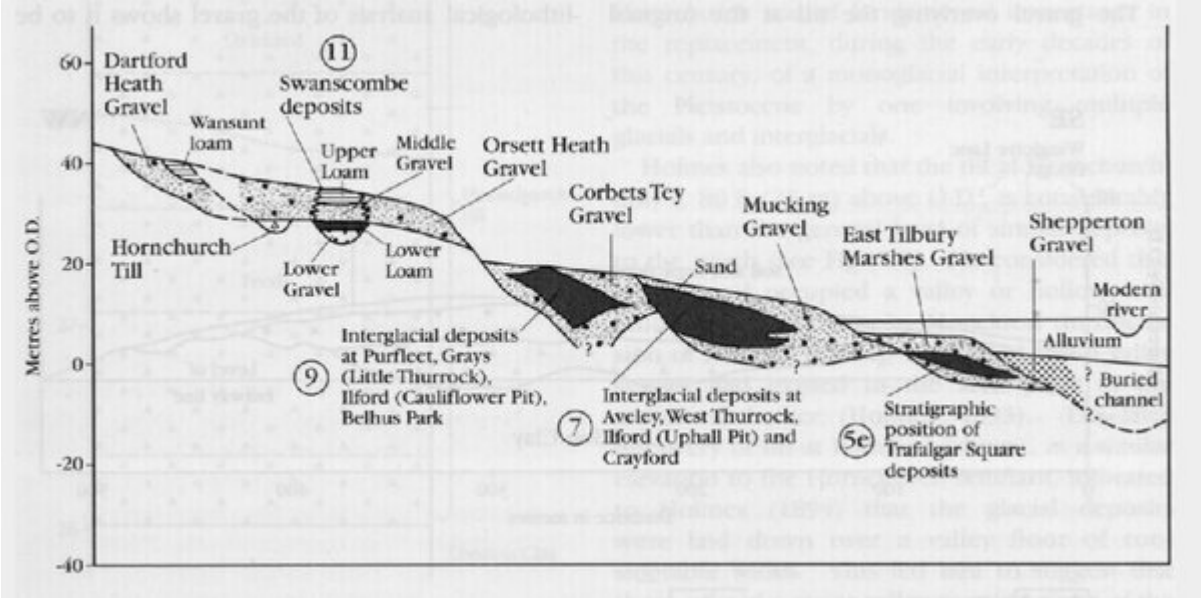
(Table 4.1) The Pleistocene fluvial sequence in the Lower Thames (first published usage of lithostratigraphical terms in reference given in parentheses), with proposed correlations with the Middle Thames sequence, Pleistocene stages and oxygen isotope stages.



(Figure 4.1) The Pleistocene deposits of the Lower Thames (after Bridgland, 1988a).



(Figure 4.2) Longitudinal profiles of terrace deposits in the Lower Thames.



(Figure 4.3) Idealized transverse section through the terraces of the Lower Thames. The odd-numbered (warm) oxygen isotope stages to which the various interglacial deposits are attributed are indicated (numbers in circles). The stratigraphical position of the Trafalgar Square deposits is shown.