

APPENDIX 1 - ASSESSMENT OF GEOARCHAEOLOGY

1.1 Geoarchaeology

By M Bates

Introduction

- 1.1.1 Investigation of the geoarchaeology of the exposed sequences involved visits to the site to either i) log sequences and advise on procedures for sediment and soil micromorphology sampling and, where appropriate, advise field staff on the recording of sequences exposed during excavation or ii) provide verbal comment on exposed sections.
- 1.1.2 Where section logging was required standard geological terminology was used to record sequences (see below). As part of this work a number of samples were recovered to allow for further specialised investigation.
- 1.1.3 The aims and objectives of the geoarchaeological input to this phase of works focused on identifying and interpreting stratigraphy and buried soil horizons within contexts associated with the late-glacial and Holocene environments. This work and the assessment were designed to specifically address Fieldwork Event Aims (see Section 2.2, aims 2 and 5).

Methodology

- 1.1.4 This report focuses on the description and interpretation of three sequences revealed during the course of archaeological investigation of the White Horse Stone (ARC WHS98), the Boarley Farm site (ARC BFW98) and the Pilgrim's Way site (ARC PIL98) areas. Detailed profile descriptions and interpretations are presented for two investigation areas (ARC WHS98, section 440 and section 1098 and Pilgrim's Way section, ARC PIL98) that were recorded in the field by the specialist geoarchaeologist (Tables 14.1.5-6).
- 1.1.5 Sequences were recorded down-profile using standard geological terminology used in Quaternary science (Jones *et al*, 1999). Context descriptions are provided for the relevant parts of the sections specific to the geoarchaeological aims (Tables 14.1.5-6).

Quantifications

- 1.1.6 Two profiles (or section complexes) were examined as part of this assessment. Context descriptions for units related to section 440 and a section adjacent to (1098) at the ARC WHS98 site, and from beneath the Pilgrims' Way sequence (ARC PIL98), are presented in Tables 14.1.5-6.
- 1.1.7 The profile recorded at White Horse Stone (ARC WHS98, section 440) contained a sequence of Pleistocene and Holocene sediments recorded to a depth of c. 1.5m below the ground surface. This profile was orientated at 90° to the main axis of the valley and crossed the full width of the valley bottom area. A single, major buried soil horizon was identified in this sequence, context 4144, that rested on chalk and flint rich sediments interpreted to be late Pleistocene solifluction sediments (4151, 4551). The presence of the pedogenic horizon immediately above the late Pleistocene deposits implies the presence of an unconformity of some considerable duration spanning much of the early Holocene. This has recently been confirmed by age estimates of 4911±60 BP (NZA-11463) and 4974±60 BP (NZA-11464) from a Neolithic structure cut into this interface and buried by the pedogenic horizon. The

pedogenic horizon is buried by a series of colluvial slope wash sediments (4012, 4145, 4146, 4147, 4148, 4149, 4150 and 4152).

- 1.1.8 The sediments within this profile have been sampled at four locations along the trench profile using both sediment monolith tins (Table 14.1.1) and soil kubiena tins (Table 14.1.2).

Table 14.1.1: Sediment monolith record data, ARC WHS98. Section 440

Monolith number	OAU sample numbers	Contexts sampled
1	104	4149, 4144, 4151
2	105	4012, 4152
3	106	4144, 4151
4	107	4144, 4151
5	108	4012, 4147, 4146
6	109	4146, 4145
7	110	4012, 4148, 4147, 4146
8	111	4146, 4145, 4144
9	191	4145, 4144, 4551
10	192	4145, 4144, 4551

Table 14.1.2. Kubiena tine record data, ARC WHS98. Section 440

Kubiena number	OAU sample numbers	Contexts sampled
1	112	4144
2	113	4144
3	114	4144, 4151
4	115	4144
5	116	4146
6	117	4146, 4145
7	118	4145, 4144
8	119	4145, 4144
9	120	4147, 4146
10	121	4146, 4145
11	122	4144

- 1.1.9 The stratigraphic position of the buried soil horizon (4144) is similar to that of other buried soil horizons that have been widely reported in south east England (e.g. at Kiln Combe in East Sussex – Bell 1983). A similar horizon had been tentatively identified in previous investigations of this part of the route corridor (Union Railways Ltd 1997a). The buried soil horizon is overlain by colluvium that is typical of sequences inferred to have formed from slope wash processes (Bell 1983; Bell and Boardman 1992).
- 1.1.10 A more extensive sequence of valley side deposits were exposed in excavations at the southern end of the White Horse Stone site (section 1098) adjacent to and beneath the Pilgrim’s Way section (ARC PIL98). Two major sections were drawn and the key contexts present described (see Table 14.1.6). The stratigraphic sequences exposed in these trenches revealed extensive sequences of deposits interpreted to date from the end of the last cold period underlying a sequence of colluvial sediments and deposits related to the Pilgrim’s Way track. The sedimentary units thought to date to the late glacial phase are similar to those previously reported from the area (ARC WHS97, Trench 3035TT, section 1) during the evaluation phase of works at the site (Union Railways, 1997a). A tentative correlation between contexts revealed in the various trenches is presented in Table 14.1.3.

Table 14.1.3. Relationship of contexts between sections at White Horse Stone and Pilgrim's Way.

Interpreted sedimentary unit	WHS 98, section 440	WHS 97, ARC 3035TT (Union Railways, 1997a)	WHS 98, section 1098	PIL 98, Pilgrim's Way Section
Colluvial sediments	4012, 4145-1450, 4152	630	9000-9004	9003-9004
Main post-glacial pedogenic horizon	4144	631	9005	9005
Post 'Allerød' solifluction deposits	4151, 4551	635	9006-9007	9006-9007
'Allerød' pedogenic horizon	Not present	636	9008	9008
Pre 'Allerød' solifluction deposits	Not present	637-640	9009	9009-9010

- 1.1.11 The units identified have been sampled with sediment monolith samples being taken to sample key units (Table 14.1.4).

Table 14.1.4. Context numbers and sample details: ARC WSH98, section 1098 and Pilgrim's Way (PIL 98).

OAU sample numbers	Contexts sampled
177	9004, 9005, 9006
978	981, 982, 983, 984

- 1.1.12 The uppermost sediments are typical of valley side colluvial deposits of Holocene date (9000-9004) similar to those noted in section 440 (see above). These deposits bury a well-developed unit preliminarily interpreted as a buried soil horizon of later Prehistoric date (9005). The underlying sediments consist of a sequence of units containing variable quantities of gravel sized particles (both chalk and flint rich) (9006, 9007, 9009, 9010). Within this sequence, thought to have formed under cold climate periglacial slopewash conditions, lies a sediment (9008) thought to be similar to the horizon known elsewhere in Kent as the Allerød soil¹ (Kerney, 1963; Preece and Bridgland, 1998). Considerable complexity was noted within these units (see sub-divisions 1-9, context 5008).
- 1.1.13 A further point to note concerns the discovery of large numbers of sarsen boulders within the excavated areas (e.g. see Figure 4, Union Railways (South) Ltd., 1999). The geological origin of these boulders remains to be fully determined, however recent work on similar boulders from other localities in southern England may provide clues as to the mode of formation, and reasons for the concentration of such boulders, in the valley base area of the site (e.g. see Ullyott *et al.*, 1998, 2000; Catt and Hepworth 2000).

¹ The late glacial interstadial soil horizon that is widely recognised in south eastern England has been given the name the Allerød soil (Kerney, 1963) and this terminology is widely used today (e.g. see Preece and Bridgland, 1998). Within the Medway catchment area the site at Upper Halling has recently been designated as the regional stratotype for the late glacial sequences (including both the late glacial soil horizon and the solifluction deposits above and below the soil horizon). This is known as the Upper Halling Bed and forms part of the Brook Formation (Gibbard and Preece, 1999). All deposits discussed in this report and assigned to the late glacial period would therefore be equated with the Upper Halling Bed. Other terms may also be used to describe the late glacial soil horizon including the Windermere Soil however, this term is inappropriate due to chronological discrepancies at the type site (Prof. Mike Walker pers. comm. July 2000). In this report the term late glacial soil horizon is used and this equates with use of the term Allerød soil as proposed by Kerney (1963).

Provenance

- 1.1.14 The stratigraphy that is present and described at the White Horse Stone and Pilgrim's Way site is representative of well known sequences that are preserved elsewhere in Kent. The contexts described fall into two groups of sequences:
- 1.1.15 A lowermost group of deposits dominated by coarse flint and chalk rich gravels (and an intercalated weathering horizon or soil development, e.g. context 9008) deposited during the late Pleistocene under typically cold climate conditions (the exception to this is the buried soil horizon that would have developed under milder conditions during the late glacial interstadial 11-12ka BP) and an upper group of silts deposited by hillwash processes during the later part of the Holocene.

Conservation

- 1.1.16 A considerable quantity of undisturbed sediment samples exists from these trenches (see Tables 14.1.1, 2 and 4). These samples contain material from both the major post-glacial soil horizon (contexts 4144, 631 and 9005) and the late glacial (Allerød) soil horizon (636, 9008). Desiccation of these samples will occur over time. Investigation of the soil micromorphological properties of the samples could be undertaken and this would necessitate impregnation of the sample rendering it inappropriate for any other forms of investigation. However, this is only a problem with sample 978 from the Pilgrim's Way section where a specific kubiena tin was not taken for micromorphological investigation. Impregnation and preparation of thin-sections through these deposits would provide a stable, long-term archive record of the nature of the buried soils horizons at this site.

Comparative material

- 1.1.17 Comparable material to the sedimentary units identified during the fieldwork have been identified at number of locations within the CTRL (Union Railways Ltd., 1997b) corridor and beyond within southern England. Extensive sequences of late glacial and Holocene sedimentary units exist and have been the subject of assessment from the Nashenden Valley within the CTRL corridor (Union Railways Ltd., 2000 in prep.). Late Pleistocene and Holocene slope deposits have also been encountered within the Ebbsfleet Valley evaluation works (Union Railways Ltd., 1997c). Within the Medway Valley the late glacial soil horizon is well known from Upper Halling (Kerney 1963; Preece 1998) and a well dated sequence of late glacial/Holocene deposits have been investigated at the site of the Channel Tunnel portal at Holywell Coombe (Preece 1992; Preece and Bridgland 1998).

Potential for further work

- 1.1.18 Investigation of the sites described here aimed to focus on the potential of these sites for revealing new data regarding:
- 1.1.19 The nature of late glacial/early Holocene palaeoenvironmental change contemporary with the earliest stages of the recolonization of Britain by plants, animals and importantly humans at the end of the last cold phase and the development of the changing Holocene landscape.
- 1.1.20 The presence of sediments clearly associated with the final phase of the Pleistocene were noted to contain fossiliferous material in places. In comparison to other sites along the CTRL (e.g. Nashenden Valley) the sections at White Horse Stone are significantly better developed and more widespread in their preservation than previously thought. Potential exists here to investigate the timing and nature of environmental change during this time period.

Updated research aims

- 1.1.21 Themes concerning the late Glacial/Holocene environment have the potential to be addressed.

Late Glacial/Holocene environment

- What is the character of the late glacial and early Holocene environment?

Recommended further work

- 1.1.22 This will include a full report on the sequences described here integrated with other lines of environmental evidence and incorporating both the radiometric and OSL dating.

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Table 14.1.5: Context/Sediment description: ARC WHS98, section 440 (11/9/98)

Context Number	Stratigraphic description	Inferred processes of deposition
4012	Mid grey-brown silt with common sub-angular chalk pellets (5-20 mm). Occasional angular flint clasts (20-40 mm). Unit is loose and structureless. Modern roots penetrate through unit. Large (c.10 mm wide) empty root canals are present. Mollusc fragments noted.	Holocene colluvium.
4144	Dark brown soft, friable silt. Contains common chalk clasts (4-6 mm) of sub-rounded to sub-angular shape. Unit is loose and unconsolidated. Rare angular flint clasts and common white precipitate in root canals (2-4 mm long) noted. Upper part of unit contains large (40-80 mm), clasts of angular tabular flints resting parallel to upper surface of unit.	Pedogenic horizon.
4145	Dark brown clayey-silt. Homogenous and firm. Shell fragments, very small (1-2mm) chalk and flint particles noted. A network of root canals containing secondary /carbonate precipitate noted. Base of unit is marked by a zone of large angular flint cobbles (c. 50mm in size).	Holocene colluvium.
4146	Reddish-brown to grey slightly clayey-silt with very fine chalk grains (1-2mm). Occasional angular flint clasts (20-50mm). Patches of ?carbonate precipitate noted in places. Empty branching root canals noted. Shell fragments are common. Unit is compact and firm with a slightly blocky structure.	Holocene colluvium with possible weathering and ?soil formation.
4147	Mid grey-brown silt with common sub-angular chalk pellets (5-20 mm). Common angular flint clasts (20-80mm). Unit is loose and structureless. Modern roots penetrate through unit. Large (c. 10mm wide) empty root canals are present. Mollusc fragments noted.	Holocene colluvium.
4148	Reddish-brown silt with common sub-angular chalk pellets (5-20mm). Occasional angular flint clasts (20-40mm). Unit is loose and structureless. Modern roots penetrate through unit. Large (c.10mm wide) empty root canals are present. Mollusc fragments noted.	Holocene colluvium.
4149	Dark to mid-brown clay-silt with common large, angular flint clasts (<80mm). Chalk clasts appear to be angular and increase in size up-profile from <10mm to >20mm. Structureless and moderately dense and compact.	Holocene colluvium.
4150	Mid greyish-brown silt. Chalk and flint clasts are present (typically sub-angular shape and 20-40mm in diameter). Occasional larger clasts up to 6cm. Modern roots are present and large (10mm wide) empty root canals. Mollusc fragments common.	Holocene colluvium.
4151	Yellowish-white chalk pellet gravel with chalky silt matrix. Chalk clasts are very common, sub-angular in shape and typically less than 10mm.	Periglacial solifluction.
4152	Coarse clast supported flint gravel. Clasts are angular, 40-100mm in diameter and probably slightly rolled. Some flint clasts appear to be shattered <i>in situ</i> . Matrix consists of light brown silt. Large empty root canals penetrate unit. Sediment is dense and compact.	Holocene colluvium.
4551	Light yellowish-brown to strong yellowish-brown silt containing chalk and flint clasts. Very dense and compact. Flints are 20-40mm, angular and sharp. Chalk clasts are angular and <5mm. Empty root canals penetrate unit.	Periglacial solifluction.

Table 14.1.6: Profile WHS 98 Section 1098 and PIL 98 section (21/9/98)

Context Number	Stratigraphic description	Inferred processes of deposition
9006	Light greyish-brown chalk pellet gravel with a chalky silt matrix. Clasts (<10mm) are common at base and decrease in frequency up-profile. Unit is soft and malleable.	Cold climate slope wash deposit.
9007	Very well bedded white to very pale grey silt with dark greyish-brown silt. Laminae dip downslope and are wavy, undulating and discontinuous. Large angular blocks of flint (40-140mm in diameter) occur. Occasional small chalk clasts (<10mm) are present.	Cold climate slope wash deposit.
9008	Brownish-grey silt with occasional small chalk clasts. Unit appears to become darker up-profile. Occasional black flecks are noted within unit (?charcoal). Occasional possible root traces (small, 2-3mm wide, branching systems).	Weathered silt, subject to incipient pedogenesis.
9009	The upper part of this unit consists of a yellowish-brown silt with common small (<5mm) sub-angular chalk clasts. In places chalk content increases up-profile. Unit is dense, compact, structureless and massive. The lower part of this unit consists of pale brown to brownish-yellow chalk pebble gravel. The unit is matrix supported and clasts of chalk are typically 10-40mm in size and sub-angular but rolled. Unit is structureless and contains no flint.	Cold climate slope wash processes.
9010	Light yellowish-brown chalk rich silt with very common flint clasts. The unit is matrix supported. Chalk clasts are poorly sorted, 10-40mm and sub-angular and rolled. Flints are typically less than 100mm in size, poorly sorted and angular. In places the flints are shattered <i>in situ</i> . The unit is massive and structureless.	Cold climate solifluction processes.

