ASSESSMENT OF ARCHAEOLOGICAL REMAINS FROM A BOREHOLE SURVEY AT THE FORMER FRUIT AND VEGETABLE MARKET, HYLTON ROAD, WORCESTER

Nick Daffern

With contributions by Keith Wilkinson and Laura Griffin

Illustrations by Carolyn Hunt

19 August 2010
Revised 9 September 2010

Historic Environment and Archaeology Service,
Worcestershire County Council,
Woodbury Building,
University of Worcester,
Henwick Grove,
Worcester WR2 6AJ

Project 3516
Report 1784
WCM 101819

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Part 1 Project summary

An archaeological borehole survey was undertaken at the former fruit and vegetable market, Hylton Road, Worcester (NGR SO 84176 55008).

The investigation was undertaken on behalf of CgMs Consulting, and their client the University of Worcester as part of an agreed programme of mitigation works.

Six boreholes were sunk using a percussive auger rig to recover continuous/windowless cores with the aim of sampling alluvial and/or organic deposits that could be assessed for environmental remains and their potential for geoarchaeological analysis.

The geoarchaeological assessment encountered gravels of a probable Late Devensian date in the bottom of all of the boreholes. These were overlain by undisturbed organic muds which are interpreted as being deposited in a seasonally inundated floodplain. Alluvial silts were also identified in the lower, undisturbed sections of the sequence, which were interpreted as being deposited within a channel or channel margin environment.

The radiocarbon dating of these channel/channel margin deposits from 4.46m below ground surface in Borehole 5 produced an early Neolithic date (Cal BC 3640 to 3500 and Cal BC 3440 to 3380, Beta-281895). This compared favourably with the pollen analysis which indicated that the pre-Lime Decline wildwood was still present upon the raised terraces, with the immediate floodplain environment being a combination of wet woodland such as alder and willow carr, interspersed with patches of wet grassland and "scrubby" ground.

The Neolithic date of this deposit is of particularly significance as to the author's knowledge; this is the only Neolithic deposit with environmental potential that has thus far been identified within the city of Worcester.

A very well preserved rim sherd of a Severn Valley ware (fabric 12) necked bowl/jar form of the mid-late 1st century to 2nd century AD, was recovered from 3.40m below ground surface in Borehole 6. Radiocarbon dating of organic sediment from the same depth in Borehole 6 also produced a Roman date of Cal AD 210 to 390 (Beta-281896).

A significant quantity of post-medieval/modern activity was identified, truncating and burying these deposits. Associated with this, two fragments of post-medieval roof tile, which are likely to date to the 18th century, were retrieved from within sediments from Borehole 5.

Undated cultural remains were identified including a possible midden deposit 1.85 - 2.00m below ground surface in Borehole 1 and a burnt clay surface 2.69 - 2.82m below ground surface in Borehole 4. These indicate the potential for *in-situ* archaeological remains on the site.

All of the deposits encountered during the present works were sealed by at least 1.5m of made ground with a maximum depth of 3.76m of overburden identified in borehole 5.

Part 2 Detailed report

1. Background

1.1 Reasons for the project

An archaeological borehole survey was undertaken at the former fruit and vegetable market, Hylton Road, Worcester (NGR SO 84176 55008; Fig 1) for CgMs Consulting and on behalf of their client the University of Worcester as part of an agreed programme of mitigation works

1.2 Project parameters

The project conforms to relevant sections of the *Standard and guidance for an archaeological watching brief* (IfA 2008), *Statement of standards and practices appropriate for archaeological fieldwork in Worcester* (WCC 1999) and the *Manual of Service practice: fieldwork recording manual* (CAS 1995).

In addition, the sampling and environmental analysis conforms to relevant sections of *Environmental Archaeology: a guide to the theory and practice of methods, from sampling and recovery to post-excavation* (English Heritage 2002) and *Environmental archaeology and archaeological evaluations* (AEA 1995).

The project also conforms to a project proposal (including detailed specification) which was produced (HEAS 2010).

1.3 Aims

The aims of this archaeological assessment were:

- to describe and assess the significance of the heritage asset with archaeological interest;
- to establish the nature, importance and extent of the archaeological site;
- to assess the impact of the proposed development on the archaeological site

In particular, the research priorities and aims as identified in *An archaeological resource assessment and research framework for the city of Worcester*" (WCMAS 2007) should be considered. Within the scope of this project, they include the following, although this list is not exhaustive:

- The dating, character and origins of Severn alluviation (RP1.3)
- Location and characterisation of palaeochannels of the Severn (RP1.4)
- Investigation and mapping of Holocene terraces and alluvium (RP1.8)
- Investigation of Holocene flooding (RP1.9)
- Understanding of the hydrological system and identification of areas of potential and preservation (RP1.10)
- Environmental change in Worcester's hinterland (RP7.21)

In addition, priorities for research as identified within the West Midlands Research Framework (Hurst and Jackson 2002; White, 2002; Greig, 2007)

- To identify, analyse and make available detailed reference pollen diagrams with long chronological sequences
- To identify and analyse environmental evidence from river valleys with suitable palaeochannel deposits and concentrations of prehistoric activity
- To study the history of river valley alluviation as this is strongly linked to human activity, especially woodland clearance.

- To study the regional and local environmental setting of settlement and ceremonial sites
- To integrate an understanding of the geo-environmental contexts of prehistoric economies and social life with interpretations of the material culture evidence.
- To integrate an understanding of the geo-environmental contexts of the Romano-British economy and social life with interpretations of the material culture evidence (including eco-factual materials) in an attempt to map the technical and industrial developments during the period.
- To determine the most appropriate methodologies for detecting the cultural material, ecofactual, and structural evidence for the transitional phase at the end of the Roman period within the context of the PPG16 environment.

2. Methods

2.1 Documentary search

Prior to fieldwork commencing a search was made of the Historic Environment Record (HER). In addition to the sources listed in the bibliography the following were also consulted:

Cartographic sources

- Young, G, 1779, Map of the City of Worcester
- Bentley 1840, map of the City of Worcester
- Ordnance Survey 1887, 1905, 1930, 1938 (extracts from) *Worcestershire* SO 85NE, 1:5000

2.2 Fieldwork methodology

2.2.1 Fieldwork strategy

A detailed specification has been prepared by the Service (HEAS 2010) and approved by James Dinn, planning archaeologist for Worcester City Council

Fieldwork was undertaken between 22 June and 23 June 2010. The site reference number and site code is WCM 101819

Six boreholes were sunk along a northeast to southwest transect across the middle of the site, using a Competitor mini-tracked percussive auger rig to recover continuous/windowless cores of *c*100-80mm in diameter and 1m length with the aim of sampling alluvial and/or organic deposits that could be assessed for environmental remains and their potential for geoarchaeological analysis.

Additional continuous/windowless cores were sunk and opened on-site for contamination assessment and geotechnical analysis. This therefore allowed the archaeologists to undertake soil recording and finds retrieval from geotechnical cores. These cores were retrieved from a separate borehole sunk directly adjacent to those sunk for the archaeological sequences.

2.2.2 Structural analysis

All fieldwork records were checked and cross-referenced. Analysis was effected through a combination of structural, artefactual and ecofactual evidence, allied to the information derived from other sources.

2.3 Artefact methodology, by Laura Griffin

2.3.1 Artefact recovery policy

The artefact recovery policy conformed to standard Service practice (CAS 1995; appendix 4).

2.3.2 Method of analysis

All hand-retrieved finds were examined and a primary record was made on a Microsoft Access 2000 database. They were identified, quantified and dated to period.

The pottery was examined under x20 magnification and recorded by fabric type and form according to the fabric reference series maintained by the service (Hurst and Rees 1992) and www.worcestershireceramics.org.

2.4 Geoarchaeology methodology, by Keith Wilkinson

The cores were passed to ARCA on 1 July 2010 and were studied in the laboratory between 5 and 7 July 2010.

The plastic sleeves containing the cores were slit open and the retained sediments cleaned to expose a fresh face, photographed and then described according to standard geological criteria (Tucker 1982, Jones *et al* 1999, Munsell Color 2000). The resultant lithological data was input into a database of the geological utilities program Rockworks v 2006 (RockWare 2008) and this used to generate the tabular data included in Appendix 1.

2.5 Environmental archaeology methodology

2.5.1 Sampling policy

The environmental sampling strategy conformed to standard Service practice (CAS 1995; appendix 4). The sampling of material for radiocarbon dating and pollen analysis was undertaken by staff at ARCA during the geoarchaeological analysis.

2.5.2 Palynological remains

Five $2cm^3$ samples were taken from Borehole 6 for assessment, the exact depths of which are given within the results section below. These were selected based upon their position in the sequence to give an even spread whilst attempting to address questions of preservation raised in the geoarchaeological analysis.

The samples were submitted to the laboratories of the Department of Geography & Environment at the University of Aberdeen for chemical preparation following standard procedures as described by Barber (1976) and Moore *et al* (1991). The full methodology is described in Appendix 2.

Where preservation allowed, pollen grains were counted to a total of 150 land pollen grains (TLP) for assessment purposes using a GS binocular polarising microscope at x400 magnification. Identification was aided by using the pollen reference slide collection maintained by the Service, and the pollen reference manual by Moore *et al* (1991). Nomenclature for pollen follows Stace (2010) and Bennett (1994).

Fungal spores and parasite ova were noted with rapid identification being undertaken to genus level. Identifications were aided through reference material maintained by the Service and reference manuals Kirk *et al* (2008) and Grant-Smith (2000).

2.5.3 Radiocarbon dating methodology

Two samples were submitted for Accelerated Mass Spectrometry (AMS) dating to Beta Analytic Inc.

One sample was taken from organic sediment 4.46 - 4.47m below ground surface (BGS) from Borehole 5 and the second, again from organic sediment, 3.39 - 3.41m BGS from Borehole 6.

2.6 The methods in retrospect

The methods adopted allow a high degree of confidence that the aims of the project have been achieved

3. Topographical and archaeological context

No Scheduled Ancient Monuments, Registered Battlefields or Registered Parks or Gardens occur within the site boundaries.

The archaeological background of the site has been extensively discussed by Lockett and Jones (2001), Archaeological Solutions (2005) and Patrick (2010) therefore only a brief description will be given. Also, as a full discussion regarding the topography and stratigraphy is given below by Wilkinson (Section 4.3), it will not be discussed here.

The site has previously been subject to three phases of archaeological investigation, an evaluation (Lockett and Jones 2001), a watching brief (Vaughan 2008) and a desk-based assessment (Archaeological Solutions 2005). The former produced a residual Mesolithic flint scraper and a residual sherd of Roman Severn Valley ware pottery from alluvial deposits which underlay the modern and post-medieval deposits which cover the entirety of the site. These alluvial deposits have been identified as those most likely to have potential for the recovery of significant archaeological evidence.

In addition, a Palaeolithic hand axe has been recovered *c* 20m to the north of the site (WCM 100695) indicating the potential for further prehistoric archaeological remains.

4. Results

4.1 Artefact analysis, by Laura Griffin

The artefactual assemblage recovered is summarised in Table 1.

The artefactual assemblage consisted of a single sherd of Roman pottery and two fragments of post-medieval roof tile (see Table 1).

The sherd of Roman pottery was retrieved from approximately 3.40m below ground surface in Borehole 6. This sherd was very well preserved and came from the rim of a Severn Valley ware (fabric 12) necked bowl/jar form of the mid-late 1st century to 2nd century AD (Webster 1976, 25; no 19).

The presence of this sherd is consistent with the small amount of Roman material previously identified on the site during earlier stages of works.

The post-medieval roof tile was retrieved from 3.84-3.88.m below ground surface in Borehole 5 and is most probably of an 18th century date. It is not reminiscent of roof tiles found in Worcester from the earlier post-medieval and it would therefore appear to be later.

period	material	count	weight (g)
Roman	Pottery	1	24
post-medieval	Roof tile	2	104

Table 1 Quantification of the assemblage by period

4.2 Geoarchaeology, by Keith Wilkinson

There was an average 20% sediment loss/compression in each of the boreholes. Therefore the depths quoted in the text that follows are accurate to an estimated ±0.1-0.2m.

4.2.1 Stratigraphy

The Hylton Road site lies *c* 50m to the west of the River Severn and is mapped by the British Geological Survey (BGS) as lying on Quaternary Alluvium. ‘Alluvium’ technically includes all deposits accreting in fluvial environments, but in practice the BGS use the term as a surrogate for Holocene channel and floodplain deposits. The alluvium at Hylton Road overlies sediments of the Sidmouth Mudstone Formation (in previous geological maps of Worcester the Sidmouth Mudstone Formation has been incorporated within the Triassic Mercia Mudstone Group), which also occurs as surface outcrops *c* 200m to the east and the west of the Hylton Road site (ie the Severn has cut down through these sediments in the Late Pleistocene to carve out its present channel and floodplain.

Strata recovered in the borehole cores comprise Quaternary alluvium (channel and floodplain deposits), probable archaeological deposits and recent made ground. In the text below the stratigraphy is reviewed in stratigraphic order while the lithological data are plotted graphically in Figure 3.

?Pleistocene gravels

Matrix- and clast-supported gravels of rounded and sub-rounded quartzite and sandstone clasts contained within a silt to medium sand matrix were found at the base of all boreholes. Matrix-supported strata were always found overlying clast-supported gravels suggesting that the matrix is an interstitial fill post-dating primary gravel deposition. There is a trend for the elevation of the upper contact of the gravels to dip in a north-easterly direction (ie towards the river) from *c* 12.6m AOD in Borehole 2 to *c* 10.0m AOD in Borehole 5 and Borehole 6. This suggests that the gravels have been truncated by subsequent channel development. Nevertheless the south-westernmost borehole (Borehole 1) seems to have been drilled through a further channel and as a result the upper contact of the gravel is at a lower elevation to that in Borehole 2 (ie *c* 11.7m AOD). The gravel strata encountered in the boreholes are likely to form part of the Floodplain Terrace of the River Severn, a unit that was deposited in the Devensian Late Glacial. Subsequent channel development causing the south-west to north-easterly dip is likely to be a Holocene phenomenon.

Holocene fine-grained alluvium

Alluvial silts and clays were found conformably overlying the gravels in Borehole 1 (11.7-12.4m OD), Borehole 4, Borehole 5 and Borehole 6 (10.0-11.0m OD). The conformable contact is likely to be the result of the silts and clays forming the interstitial fill of the uppermost gravel strata. The basal fine-grained alluvial strata comprise heavily iron stained and structureless silts and clays. The iron stains are the result of redox processes (ie fluctuations in the height of the water table, and are therefore post-depositional). The iron stained silts and clays are conformably overlain by grey brown alluvial silts and clays that lack iron stains, but which instead contain occasional fine lenticular organic mud beds demonstrating continuous waterlogging since deposition. These data suggest the redox processes witnessed by the iron staining of lower fine-grained beds must have operated prior to the deposition of the grey brown alluvial silts and clays. Therefore it would seem likely that the iron-stained silts and clays were deposited on a seasonally inundated floodplain. The grey brown silts and clays on the other hand are likely to have formed within a channel or in a channel marginal environment given the lack of iron stains and the preservation of bedding structures. Presently available evidence provides only inexact chronological indications for the deposition of the fine-grained alluvial strata, but given that the probable archaeological deposits discussed below are likely to be of Roman date, a Roman or earlier date can be inferred for the alluvial silts and clays. Only in the fine-grained deposits noted in Borehole 1 was any cultural material noted, this being granular and coarse sand-sized charcoal.

?Archaeological deposits

Probable archaeological deposits were found unconformably overlying the fine-grained alluvium in Borehole 4, Borehole 5 and Borehole 6, and overlying gravels in Borehole 3. Further midden-like deposits which may be archaeological were also found overlying fine-grained alluvium in Borehole 1. These sediments are classified as *probable* archaeological deposits as they contain artefacts (tiles and red pottery) which appear distinct from those in the overlying made ground and which may be of Roman age.

Between Borehole 3 and Borehole 6 the ?archaeological deposits dip in a north-easterly direction from *c* 13.1m OD to *c* 11.5m OD, while in Borehole 1 the ?midden deposits outcrop between *c* 12.5 and 13.0m OD. The properties of the ?archaeological sediments vary, but most comprise redeposited cultural material rather than debris resulting from primary activity. In Borehole 3, Borehole 4 and Borehole 5 the ?archaeological deposits consist of fragmented ceramics, charcoal and mortar in a humic silt and clay matrix. The latter may be derived from cess and other cultural organic waste. However, a single possible *in situ* burnt clay surface was noted at 12.22-12.17m OD in Borehole 4. The ?archaeological deposits in Borehole 6 outcrop between 11.1 and 11.8m OD and seem to comprise fine cultural debris that have been deposited in a shallow pool. The latter is represented by bedded organic muds containing macroscopic waterlogged plant remains and charcoal. The possible midden deposits in Borehole 1 consist of organic muds containing waterlogged wood fragments and charcoal, but are also characterised by a cess-like odour.

The ?archaeological deposits noted between Borehole 3 and Borehole 6 follow the same slope seen in the underlying gravels and suggest that at the time of occupation that topography still existed. The deposits appear to represent reworked/redeposited cultural material which probably originated at the top of the slope (eg around Borehole 4). The cultural material seen in Borehole 6 is likely to be a distal spread emanating from further upslope that has been washed into a shallow pool and incorporated within the organic sediments accumulating there.

Made-ground

Deposits resulting from post-medieval use of the site are found in the top of all the boreholes. Indeed the former south-west to north-east dip of the site seen in the upper contact of the gravels and the ?archaeological deposits has been reversed by the deposition of substantial quantities of building and other debris in the north-eastern part of the site (particularly Borehole 5 and Borehole 6). This made ground comprises fragmented bricks, cinders, hard core and diamict in which these constructional materials are mixed with silts and clays derived from imported soils. Local variation makes correlation of beds within the made ground between boreholes difficult. However, it does appear that a spread of sand and rounded quartzite gravel (perhaps derived from an adjacent fluvial terrace) was emplaced between Borehole 3 and Borehole 5.

4.2.2 Assessment

The basal gravels are likely to have formed in a braided river environment in the Devensian Late Glacial period. Although people were present in England for much of the Late Glacial, they are unlikely to have frequented such a high energy fluvial environment. No organic preservation was noted in the gravels. For these reasons the gravels are assessed as having LOW archaeological and palaeoenvironmental potentials.

The fine-grained alluvium probably accumulated initially in a floodplain and then a channel or channel marginal environment. The only cultural material present in these deposits were charcoal fragments in Borehole 1. However, these latter represent secondary depositions that relates to activity at an unknown location along the river bank. The fine-grained alluvium thus has a LOW archaeological potential. The oxidised silts and clays at the base of the fine-grained sequence are unlikely to contain well preserved waterlogged plant macrofossils (none were visible as the cores were being studied), while pollen preservation is also likely to be poor. However, the channel/channel marginal deposits that overlie the oxidised sediment do contain waterlogged plant remains and the potential for providing useful palaeoenvironmental and palaeoeconomic data is likely to be high and therefore, collectively the fine-grained alluvium is assessed as having MODERATE to HIGH palaeoenvironmental potential.

The probable archaeological deposits noted in Borehole 1, Borehole 4, Borehole 5 and Borehole 6 are mostly secondary. Nevertheless they suggest the presence of archaeological activity nearby, while the possible burnt clay surface noted in Borehole 4 may be evidence for a structure. Indeed the chances of encountering *in situ* archaeological material in a 100mm diameter borehole are relatively low so any presence is of significance. Therefore assuming that the ?archaeological deposits *are* archaeological they are assessed as having a HIGH archaeological potential. Organic preservation within these same deposits also appears good, while the organic muds containing fine cultural debris noted in Borehole 6 appear suitable for palynological study. Due to the presence of *in situ* archaeological material and good organic preservation the ?archaeological deposits are also classified as having a HIGH palaeoenvironmental potential.

The made ground is likely to have accumulated mostly within the last 200 years and is better assessed by conventional archaeological works rather than in boreholes. It has a LOW palaeoenvironmental potential.

4.3 Radiocarbon dating

Two samples were submitted to Beta Analytic Inc for AMS (Accelerator Mass Spectrometry) radiocarbon dating. The results of which are contained in Table 2. The full radiocarbon report is appended as Appendix 3.

Borehole number and depth	Material	Laboratory code	Measured Age	13C/12C	Conventional Age	OxCal calibrated age (95.4% probability or 2 sigma)
Borehole 5: 4.46 – 4.47m	Organic Sediment	Beta -281895	4770 +/- 40 BP	-26.2 o/oo	4750 +/- 40 BP	Cal BC 3640 to 3500 (Cal BP 5590 to 5450), Cal BC 3440 to 3380 (Cal BP 5390 to 5330)
Borehole 6: 3.39 – 3.41m	Organic Sediment	Beta-281896	1750 +/- 40 BP	-25.1 o/oo	1750 +/- 40 BP	Cal AD 210 to 390 (Cal BP 1740 to 1560)

Table 2 Radiocarbon dating results

4.4 Pollen analysis – Borehole 6

The palynological evidence recovered is summarised in Table 3

2.94m – 2.95m

Pollen preservation within this sample was good although concentrations were low. Therefore a complete assessment count could not be achieved although species diversity for such a low concentration of remains was greater than would be expected.

Tree and shrub pollen represented 52% TLP with *Alnus glutinosa* (alder); *Tilia cordata* (lime) and *Corylus avellana*-type (hazel) were the dominant contributors with lesser contributions by *Quercus* (oak) and *Ribes rubrum*-type (red currant).

Herbaceous species contributed the remaining 48% TLP with Poaceae indet (grasses) and Caryophyllaceae (pink family), *Centaurea cyanus* (cornflower), Lactuceae undiff (chicory/dandelion/sow thistle), *Linum bienne*-type (pale flax/ flax), *Plantago lanceolata* (ribwort plantain) and cf *Silene flos-cuculi* (ragged robin) being identified.

The sole spore identified was that of *Pteropsida* (mono) indet (ferns) although several fungal spores of the bracket fungi *Ganoderma* sp were present, a genus of wood-decaying fungi which grow on both coniferous and hardwood tree species causing decay and loss of strength (Schwarze and Ferner, 2003).

3.40m – 3.41m

Pollen preservation and concentration within this sample was poor with many grains being excessively folded and/or broken resulting in non-identification. Additionally, the majority of the grains that were identified exhibited pitting of the grain wall suggesting taphonomic processes have caused preferential preservation.

This hypothesis is supported by the much greater presence of *Cichorium intybus*-type (chicory/dandelion) the grains of which are decay resistant. Single grains of Poaceae indet, *Quercus*, *Salix* (willow) and *Ulmus* (elm) were also identified as were the spores of *Polypodium* (polypody) and *Pteropsida* (mono indet.

3.80m – 3.81m

Pollen preservation and concentration in this sample were very poor with only four identifiable grains present within the prepared slide; these were of Poaceae indet and a single grain of *Centaurea cyanus*. Additionally, two spores of *Pteropsida* (mono) indet were also identified.

Fungal spore preservation was slightly better although they were often concealed by detritus or folded causing identifying features to be masked. Spores included *Ganoderma* sp and *Pithomyces* sp; the latter is commonly identified in soil and on decaying plant material particularly on dead leaves and plant litter.

4.40m – 4.41m

Pollen preservation and concentrations within this sample was much improved in comparison to the previous samples with good species diversity and therefore a complete 150 TLP grain count was achieved. Similarly to the upper sample (2.94-2.95m) the percentage contribution of trees/shrubs (53% TLP) compared to herbaceous species (47% TLP) was relatively even.

The main contributors of trees and shrub pollen were *Alnus glutinosa* (26% TLP) and *Tilia cordata* (16% TLP) with contributions of less than 5% TLP being made by *Betula* (birch), *Corylus avellana*-type, *Frangula alnus* (alder buckthorn), *Quercus*, and *Salix*.

Poaceae indet (26% TLP) was the dominant contributor of herbaceous pollen. *Urtica dioica* (stinging nettle) (7% TLP) was the second highest contributor with remaining species including Apiaceae (carrot family), Chenopodioideae (goosefoot subfamily), Cyperaceae undiff (sedge family), *Plantago lanceolata*, *Ranunculus acris*-type (meadow buttercup) and *Rumex acetosa* (common sorrel) contributing less than 5% TLP.

Spores of *Pteridium aquilinum* (bracken) were frequently identified in addition to those of *Polypodium* and *Pteropsida* (mono) indet.

Fungal spores of *Ganoderma* sp were also identified as were those of *Cladosporium* sp, one of the most ubiquitous molds, which is often found in soil, plant litter and upon decaying leaves.

4.80m – 4.81m

Pollen preservation and concentrations within this sample were very poor with very little identifiable remains present, even detritus which had been a feature of previous samples was largely absent.

Alnus glutinosa and *Pinus sylvestris* were the only identifiable tree species identified and Poaceae indet was the solitary contributor of herbaceous pollen. Spores of *Pteropsida* (mono) indet were also identified in low concentrations.

Latin Name	Family	Common Name(s)	2.94-2.95m (BH6)	3.40-3.41m (BH6)	3.80-3.81m (BH6)	4.40-4.41m (BH6)	4.80-4.81m (BH6)
Alnus glutinosa	Betulaceae	alder	5			40	2
Betula	Betulaceae	birch				1	
Corylus avellana -type	Betulaceae	hazel	3			8	
Frangula alnus	Rhamnaceae	alder buckthorn				1	
Pinus sylvestris	Pinaceae	Scot's pine					1
Quercus	Fagaceae	oak	1	1		4	
Ribes rubrum-type	Grossulariaceae	red currant	1				
Salix	Salicaceae	willow		1		2	
Tilia cordata	Malvaceae	small-leaved lime	4			25	
Ulmus	Ulmaceae	elm		1			
Poaceae undiff	Poaceae	grass	3	1	3	39	4
Apiaceae	Apiaceae	carrot family				1	
Caryophyllaceae	Caryophyllaceae	pink family	3				
Centaurea cyanus	Asteraceae	cornflower	1		1		
Chenopodioideae	Amaranthaceae	goosefoot subfamily	1			2	
Cichorium intybus -type	Lactuceae	chicory/dandelion		6			
Cyperaceae undiff	Cyperaceae	sedge				3	
Lactuceae undiff	Asteraceae	chicory/dandelion/sow-thistle	1				
Linum bienne -type	Linaceae	pale flax/ flax	1				
Plantago lanceolata	Plantaginaceae	ribwort plantain	1			6	
Plantago sp	Plantaginaceae	plantain	1				
Ranunculus acris -type	Ranunculaceae	meadow buttercup				5	
Rumex acetosa	Polygonaceae	common sorrel				4	
cf Silene flos-cuculi	Caryophyllaceae	ragged robin	1				
Urtica dioica	Urticaceae	stinging nettle				11	
		TLP Grains counted	**27**	**10**	**4**	**152**	**7**
Polypodium	Polypodiaceae	polypody		2		3	
Pteridium aquilinum	Dennstaedtiaceae	bracken				12	
Pteropsida (mono) indet		ferns	1	1	2	9	2

Table 3 Results of pollen analysis of material from borehole 6

5. Synthesis

5.1 Late Pleistocene

The solitary deposit associated with this period comprised matrix- and clast-supported gravels which are likely to have been deposited in the Devensian Late Glacial encountered at the base of all boreholes. Due to the date of the deposits, either the last Glacial Maximum (25,000 – 16,000 BP) or the Younger Dryas/ Loch Lomond stadial (11,000-10,000 BP), it is unlikely that these deposits will produce evidence of human activity as it is during these periods that much of Britain was abandoned due to the cold climate.

The only evidence for the Late Upper Palaeolithic from the West Midlands comes from King Arthur's Cave, Herefordshire from which Creswellian (*c* 12,500 and 12,000 BP) Points were recovered (Myers, 2007, 25) and due to the active nature of glacial fluvial systems it is unlikely that any *in situ* archaeological material of this period would be encountered.

5.2 Prehistoric

The dating of organic sediment from 4.46 – 4.47m BGS in Borehole 5 to the early Neolithic is of particular interest as Greig (2007a, 43) states that "Few Neolithic sites have been found in the West Midlands region, and of these fewer still have produced environmental evidence". He continues that "Sites located in river valleys may have been buried under alluvial deposits: indeed where sub-alluvial sites have been investigated in the region, evidence of Neolithic occupation sometimes emerges".

Although no artefactual evidence from the Neolithic has been identified, unsurprising given the nature of the investigation, its presence cannot be entirely discounted as it would appear that *in situ* alluvial deposits from this period survive within the site boundary as indicated by the geoarchaeological evidence which states that the "grey brown silts and clays… are likely to have formed within a channel or in a channel marginal environment given the lack of iron stains and the preservation of bedding structures" (*ibid*.).

The pollen evidence supports this early date due to the high percentage of lime pollen from the sample 4.40 – 4.41m BGS in Borehole 6.

Lime is thought to have been a considerable, if not dominating, component of wildwood of the Midlands lowlands during the Neolithic and the work of Brown (1982) at Ashmoor Common and Callow End, Worcestershire and Greig (2007b) at Wellington, Herefordshire both support this prevalence of lime. The 16% TLP of lime encountered in the Hylton Road sequence compares extremely favourably with high percentages noted at other local sites such as Ashmoor Common (16% TLP) and Callow End (27% TLP; Brown, 1982) especially given that lime pollen is generally regarded to lie in Iversen's B_2 group of pollen contributors; "exceptionally small producers or their pollen is ineffectively spread because a majority drops to the ground with the flowers and is never released " (Faegri *et al* 1989, 126).

The anthropogenic lime decline (Turner 1962) which occurred at variable times across the country appears to have occurred *c* 2000-2250 cal BC at Wellington, Herefordshire (Greig 2007b) and Clifton, Worcestershire (Head and Daffern, forthcoming) and *c*2300-2850 cal BC at Cookley, Worcestershire (Greig forthcoming) and therefore, due to the abundant lime grains that were encountered within the present sequence, it is proposed that the grey brown silts predate this decline, therefore placing the deposit within the Neolithic period.

The remaining species identified during the pollen analysis indicate that the immediate floodplain environment was a wet woodland with a combination of alder and willow carr interspersed with patches of wet grassland and "scrubby" ground where tree fall has created space for an understory to develop as indicated by the presence of grasses, alder buckthorn, ribwort plantain, meadow buttercup, stinging nettle and birch (possibly *B. pubescens* (downy birch) due to its preference to wetter ground when compared to *B. pendula* (silver birch) but this must remain speculative).

The flanks of the floodplain would have been marked by the transition between floodplain and wildwood vegetation with marginal, drier and/or disturbed ground species such as hazel, birch, bracken and stinging nettles before giving way to the denser, established lime and oak wildwood which would have lain on the terrace slopes and continued off into the wider landscape.

5.3 Roman

The retrieval of the Roman pottery sherd of the mid-late 1st- 2nd century AD was unexpected due to the limited nature of the works undertaken. It cannot be confirmed whether the sherd was residual as was the case with the Roman material retrieved during the earlier evaluation (Lockett and Jones 2001) although the very well preserved nature of the sherd in combination with the radiocarbon dating (Cal AD 210 to 390) taken from the same depth goes some way to confirming that the deposits are *in situ*.

Pollen evidence from this deposit was particularly poor with no species being encountered which could confirm or refine the dating proposed by the artefactual and radiocarbon dating.

5.4 Medieval

The tentative identification of deposits as being medieval in date comes from the pollen analysis of the yellowish brown well sorted silt/clay from 2.94m – 2.95m BGS in Borehole 6 which contained solitary grains of cornflower, flax and red currant. Cornflower and flax are often associated with medieval cultivation, either as a weed of cereals in the first case or grown to produce fibre, cloth or oil in the latter (Greig 1988 and 1991). Unfortunately, due to the incomplete count and singular nature of the identifications from this sample, no certainty can be placed upon them for accurate dating as cornflower has been present in Britain since the late Roman period (Straker *et al* 2005), if not earlier, and the identification of *Linum bienne*-type may be pale flax (*L. bienne*) which is native rather than the introduced cultivated flax (*L. usitatissimum*) although this is unlikely due to the drier grassland and coastal distribution of pale flax.

It is often quoted that red currant was introduced to Britain in the medieval period but the truth of this is unclear and Stace (2010, 124) regards the species as "probably native" and therefore there is uncertainty whether it can be used as an accurate indicator of date.

5.5 Post-medieval/modern

Material of post-medieval/modern origin was encountered in all of the boreholes to a minimum of 1.50m depth BGS although this overburden/made ground becomes much thicker to the east of the site, for example at 3.76m BGS in Borehole 5.

The deposition of this made ground was obviously associated with the development of the site to facilitate the construction of the fruit and vegetable market. There is also the possibility of truncation due to the extraction of clay associated with the brick yards as shown on Young's 1779 map, although the exact location of these is difficult to pinpoint.

Much of the made ground/overburden will be due to the requirement to stabilize prior to construction and raise the ground above standing water level as the 1849 Board of Health Inquiry report describes the site environs as "... partially inhabited lands in St Clement's beyond the river, are also low, marshy and entirely undrained. ... The lowest part of St Clement's is not the river bank, but a sort of valley parallel to the river, and 200 yards from it" (James Dinn, pers comm). This statement would tend to suggest that the relict channels were still identifiable within the topography and would have "reactivated" during flood events. This statement is supported by the first and second edition OS map (Figs 4 and 5) which show that land to the rear of Chequers Lane was still liable to flooding after the development of the Hylton Road frontage.

5.6 Undated

The majority of the archaeological deposits identified in the geoarchaeological assessment are undated. The significant quantities of post-medieval and modern activity encountered and the limited insight provided by borehole sampling mean that caution must be advised before drawing any conclusions. Despite this, the Roman radiocarbon date and well preserved Severn Valley Ware pottery suggest that the deposits identified in the geoarchaeological assessment as being cultural in origin, the midden deposits in Borehole 1 and the clay surface in Borehole 4 being of particular interest, have the potential to be stratified archaeological deposits dating to the Roman period or later being sealed by the post-medieval and modern activity.

6. Significance

The most significant deposits identified during these works are the Neolithic channel or channel margin deposits identified from the radiocarbon dating, geoarchaeology and pollen analysis. To the best of the author's knowledge, this is the only Neolithic deposit with environmental potential that has been identified within the city of Worcester. This is supported by the following from the *Archaeological resource assessment and research framework for the city of Worcester* (WCMAS 2007, 17) which states that "To date, then, there is little (probably no) stratified evidence for earlier prehistoric activity in Worcester" and it is therefore of great significance.

This deposit has greatly assisted and has further potential in addressing certain aims as outlined in the resource assessment (*ibid.*)

- The dating, character and origins of Severn alluviation (RP1.3)
- Location and characterisation of palaeochannels of the Severn (RP1.4)
- Investigation and mapping of Holocene terraces and alluvium (RP1.8)
- Investigation of Holocene flooding (RP1.9)
- Understanding of the hydrological system and identification of areas of potential and preservation (RP1.10)

- Identification of stratified Neolithic – early Bronze Age remains in the city centre (RP2.3)
- Environmental change in Worcester's hinterland (RP7.21)

In addition, the identification of Roman deposits from the site is of significance as recent works on the western bank of the River Severn at St John's have identified archaeologically significant remains of Roman date (Wainwright 2010) and this site could potentially provide information regarding the interaction of Roman St Johns with the River Severn and the Roman settlement on the eastern bank.

This location is also significant as it has been hypothesised that there could be a river crossing of Roman date within this area through the projection of the known road layout from the eastern bank towards the River Severn as identified at The Butts (Burrows and Cutler 2004) although as no definitive evidence has been identified for this crossing, this hypothesis must remain speculative (Hal Dalwood pers comm).

7. Conclusions

The assessment identified deposits of archaeological and palaeoenvironmental significance although these were sealed by extensive quantities (at least 1.5m) of modern overburden associated with the development of the site for its former function as the fruit and vegetable market.

The midden deposits from Borehole 1 and the *in situ* burnt clay surface in Borehole 4 identified in the geoarchaeological assessment are of unknown date but the survival of these deposits indicates a MODERATE to HIGH archaeological significance as the likelihood of encountering structural evidence within the limited scope of a borehole survey is low.

The palaeoenvironmental potential of these deposits is unknown although the organic preservation was identified as being good with the survival of bedded organic muds, waterlogged wood fragments and charcoal. The work of Greig (1981) on a medieval barrel latrine indicates that midden/cess deposits from within Worcester have the potential to be productive for palaeoenvironmental analysis.

The fine grained alluvium, in particular the channel fill/ margin silts, has been assigned as possessing a HIGH potential for further palaeoenvironmental and geoarchaeological analysis based upon the good preservation of palynological remains. The dating from the middle of this deposit (4.46-4.47m) to the early Neolithic is particularly significant as to the authors knowledge; this is the only Neolithic deposit with environmental potential that has thus far been identified within the city of Worcester.

Also, as the material for dating was taken from the middle of the deposit, it is considered that the underlying and overlying grey brown silts could provide a pollen sequence spanning the Mesolithic/Neolithic with the potential to refine the chronology and understanding of significant environmental and vegetational events such as The Elm Decline (Parker *et al* 2002), The Lime Decline (Turner 1962) and the initiation of cereal cultivation within this area of the Severn Valley thus making this deposit of great regional significance.

8. Publication summary

The Service has a professional obligation to publish the results of archaeological projects within a reasonable period of time. To this end, the Service intends to use this summary as the basis for publication through local or regional journals. The client is requested to consider the content of this section as being acceptable for such publication.

An archaeological borehole survey was undertaken at the former fruit and vegetable market, Hylton Road, Worcester (NGR SO 84176 55008).

The investigation was undertaken on behalf of CgMs Consulting, and their client the University of Worcester as part of an agreed programme of mitigation works.

Six boreholes were sunk using a percussive auger rig to recover continuous/windowless cores with the aim of sampling alluvial and/or organic deposits that could be assessed for environmental remains and their potential for geoarchaeological analysis.

The geoarchaeological assessment encountered gravels of a probable Late Devensian date in the bottom of all of the boreholes. These were overlain by undisturbed organic muds which are interpreted as being deposited in a seasonally inundated floodplain. Alluvial silts were also identified in the lower, undisturbed sections of the sequence, which were interpreted as being deposited within a channel or channel margin environment.

The radiocarbon dating of these channel/channel margin deposits from 4.46m below ground surface in Borehole 5 produced an early Neolithic date (Cal BC 3640 to 3500 and Cal BC 3440 to 3380, Beta-281895). This compared favourably with the pollen analysis which indicated that the pre-Lime Decline wildwood was still present upon the raised terraces, with the immediate floodplain environment being a combination of wet woodland such as alder and willow carr, interspersed with patches of wet grassland and "scrubby" ground.

The Neolithic date of this deposit is of particularly significance as to the author's knowledge; this is the only Neolithic deposit with environmental potential that has thus far been identified within the city of Worcester.

A very well preserved rim sherd of a Severn Valley ware (fabric 12) necked bowl/jar form of the mid-late 1st century to 2nd century AD, was recovered from 3.40m below ground surface in Borehole 6. Radiocarbon dating of organic sediment from the same depth in Borehole 6 also produced a Roman date of Cal AD 210 to 390 (Beta-281896).

A significant quantity of post-medieval/modern activity was identified, truncating and burying these deposits. Associated with this, two fragments of post-medieval roof tile, which are likely to date to the 18th century, were retrieved from within sediments from Borehole 5.

Undated cultural remains were identified including a possible midden deposit 1.85 - 2.00m below ground surface in Borehole 1 and a burnt clay surface 2.69 - 2.82m below ground surface in Borehole 4. These indicate the potential for *in-situ* archaeological remains on the site.

All of the deposits encountered during the present works were sealed by at least 1.5m of made ground with a maximum depth of 3.76m of overburden identified in borehole 5.

9. Acknowledgements

The Service would like to thank the following for their kind assistance in the successful conclusion of this project, Cathy Patrick (CgMs Consulting), James Dinn and Sheena Payne-Lunn (Worcester City Council), Keith Wilkinson (ARCA) and Darden Hood (Beta Analytic).

10. Personnel

The fieldwork and report preparation was led by Nick Daffern. The project manager responsible for the quality of the project was Tom Vaughan. Fieldwork was undertaken by Nick Daffern, Elizabeth Pearson and Emily Beales, finds analysis by Laura Griffin, geoarchaeological analysis by Keith Wilkinson, environmental analysis by Nick Daffern and illustration by Carolyn Hunt.

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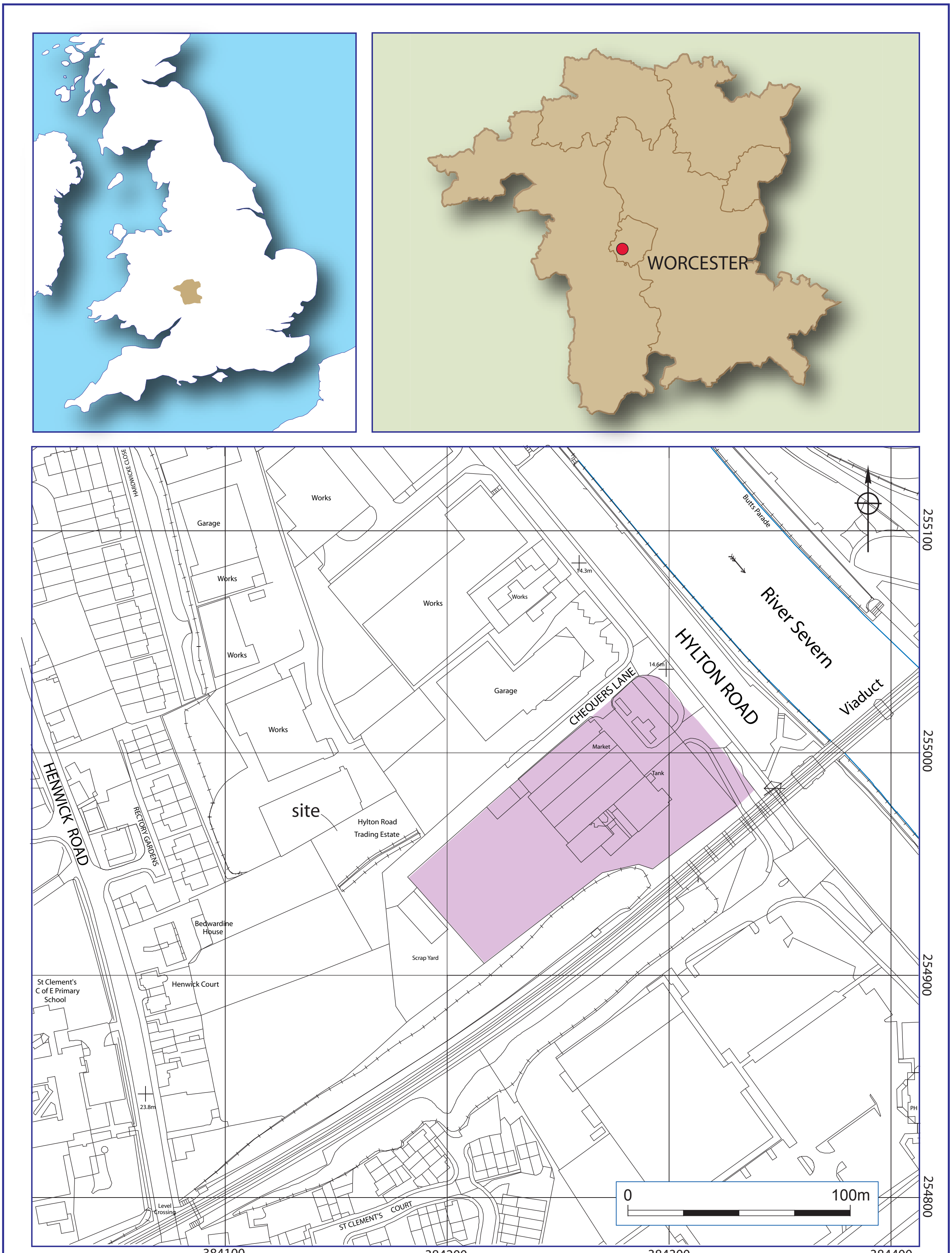
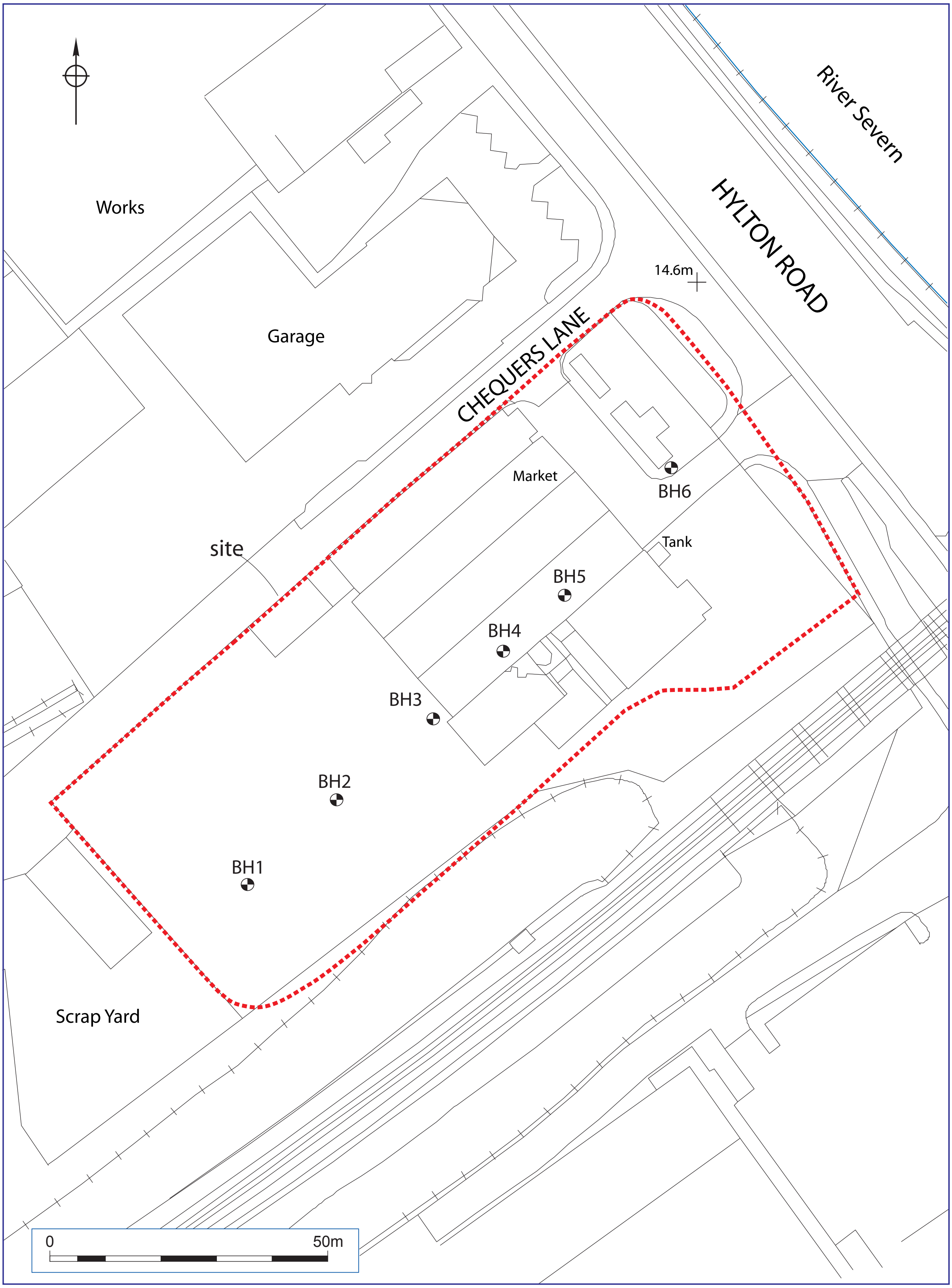
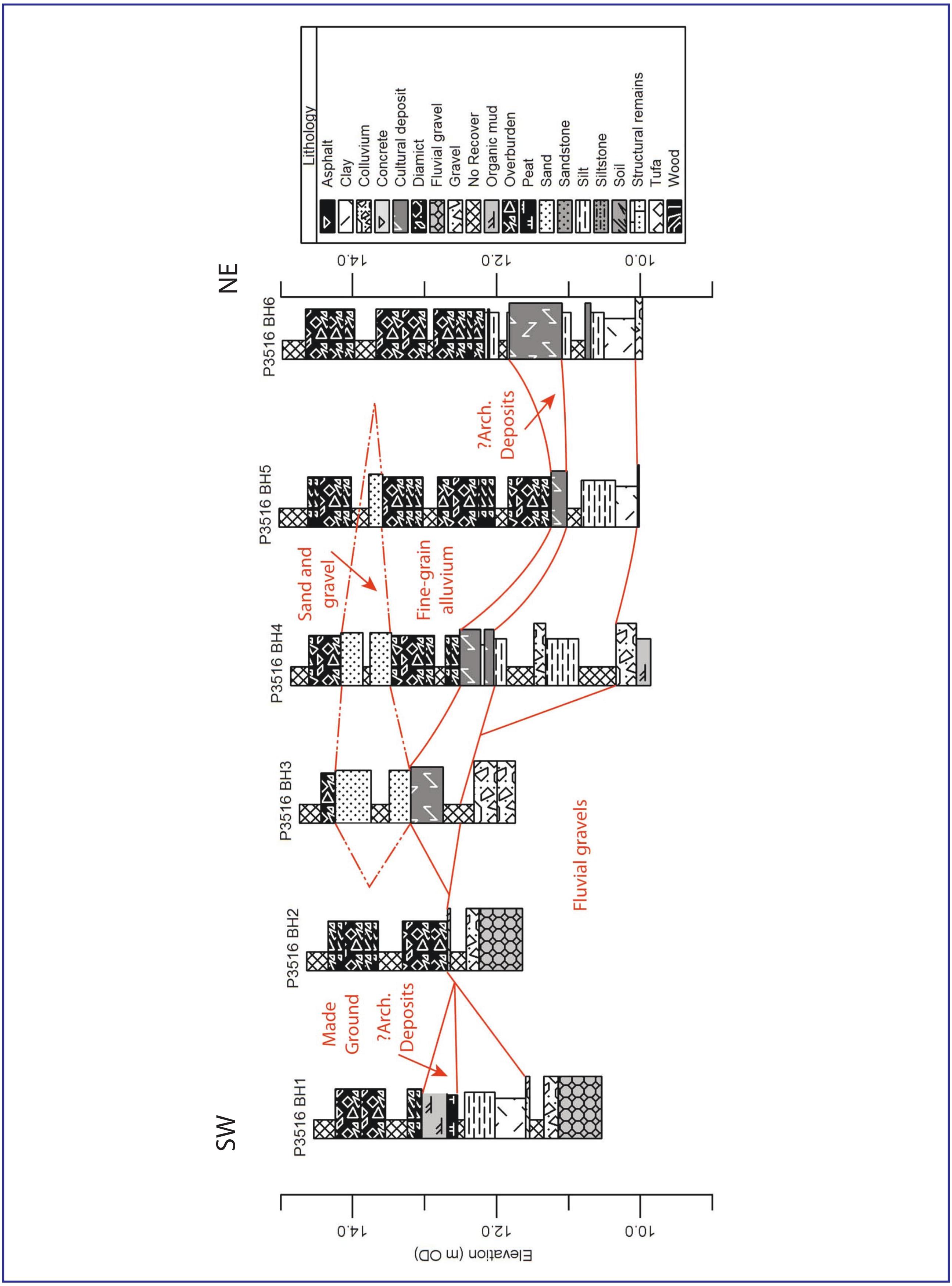
Figures



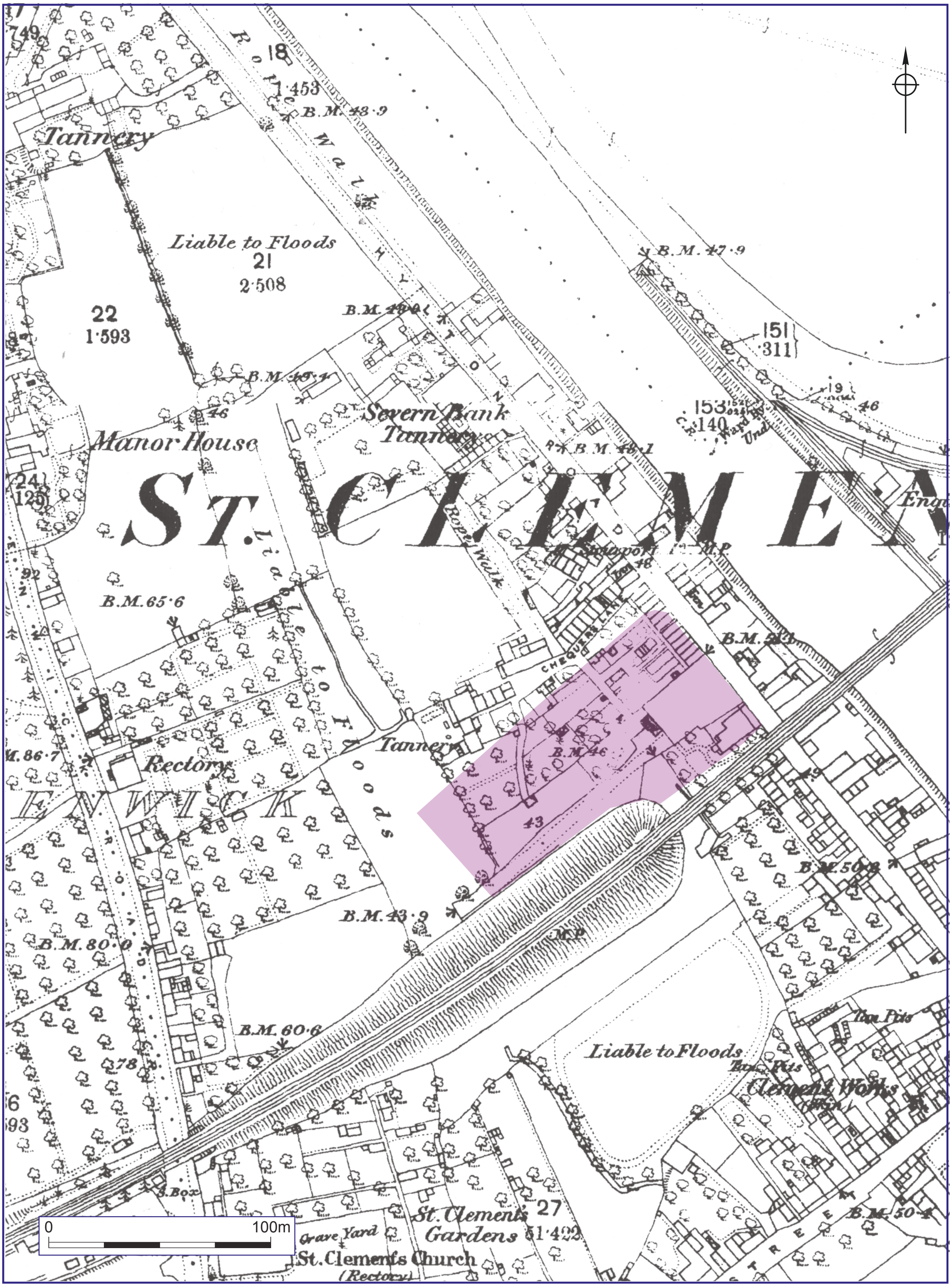
Location of the site *Figure 1*



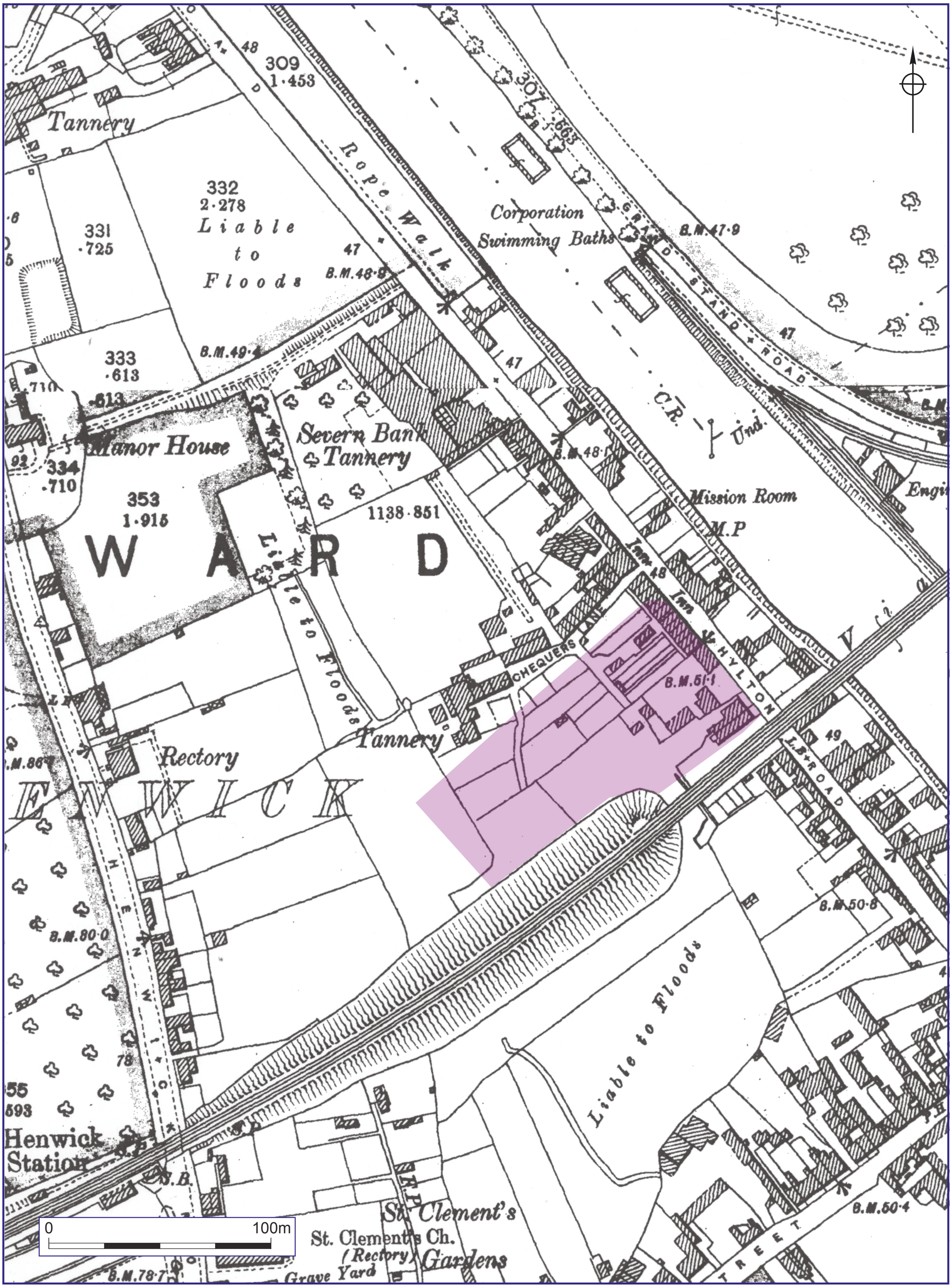
Location of boreholes *Figure 2*



South-west to north-east composite cross section of the borehole stratigraphy of Hylton Road, Worcester (produced by Keith Wilkinson) *Figure 3*



Extract from 1st edition OS, 1888 *Figure 4*



Extract from 2nd edition OS, 1904 Figure 5

Plates

Plate 1 Borehole 5 geotechnical sequence (opened on site for contamination analysis)

Plate 2 Borehole 6 geotechnical sequence (opened on site for contamination analysis)

Appendix 1 Lithological Descriptions

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 1	0.00	0.30	No Recover	Void
	0.30	0.65	Overburden	2.5 Y 4/1 dark grey diamict of sub-angular pebble and fine cobbled-sized hardcore in a silt/clay matrix. Sharp boundary to:
	0.65	1.00	Overburden	Cobble-sized sub-angular brick fragments in a 7.5 YR 4/2 brown weathered brick matrix. Poorly sorted.
	1.00	1.30	No Recover	Void
	1.30	1.42	Overburden	Cobble-sized sub-angular brick fragments in a 7.5 YR 4/2 brown weathered brick matrix. Poorly sorted. Sharp boundary to:
	1.42	1.50	Overburden	10 YR 3/2 very dark greyish brown humic medium sand to clay. Occasional granular sub-angular charcoal at base. Poorly sorted. Grading into:
	1.50	1.85	Organic mud	10 YR 3/2 very dark greyish brown humic silt/clay with frequent coarse sand-sized charcoal fragments. Well sorted. Sharp boundary to:
	1.85	2.00	Peat	10 YR 2/2 very dark brown humic silt/clay (peat) with frequent cobble-sized wood fragments. Cess-like odour.
	2.00	2.10	No Recover	Void
	2.10	2.52	Silt	2.5 Y 4/1 dark grey well sorted silt/clay with frequent coarse sand-sized charcoal fragments. Sharp boundary to:
	2.52	2.95	Clay	10 YR 5/2 greyish brown oxidising to 7.5 YR 4/4 brown silt/clay. Some oxidation follows vertical root channels. Well sorted. Sharp boundary to:
	2.95	3.00	Gravel	7.5 YR 4/3 brown matrix supported gravel of sub-rounded cobble-sized quartzite and sandstone clasts in a silt/clay matrix. Poorly sorted.
	3.00	3.20	No Recover	Void
	3.20	3.40	Gravel	7.5 YR 4/3 brown matrix supported gravel of sub-rounded cobble-sized quartzite and sandstone clasts in a silt/clay matrix. Poorly sorted. Sharp boundary to:
	3.40	4.00	Fluvial gravel	7.5 YR 4/2 brown medium sand with frequent rounded and sub-rounded quartzite and sandstone clasts in 100mm thick sets of gravel-rich and gravel-poor sediments. Moderately sorted.

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 2	0.00	0.30	No Recover	Void
	0.30	0.42	Overburden	10 YR 4/2 dark greyish brown fine diamict of sub-angular, pebble-sized hardcore in silt/clay matrix. Sharp boundary to:
	0.42	0.52	Overburden	Fragmented cobble and pebble-sized sub-angular brick. Sharp boundary to:
	0.52	0.80	Overburden	10 YR 3/1 very dark grey silt/clay with frequent coarse sand-sized charcoal and coal pieces. Occasional boulder-sized concrete and pebble-sized brick fragments. Poorly sorted. Diffuse boundary to:
	0.80	0.92	Overburden	10 YR 4/2 dark greyish brown silt/clay and fine sand with occasional pebble-sized coke/coal fragments. Poorly sorted. Diffuse boundary to:
	0.92	1.00	Overburden	10 YR 3/1 very dark grey silt/clay with frequent medium sand-sized brick and coal fragments. Poorly sorted.
	1.00	1.33	No Recover	Void
	1.33	1.72	Overburden	10 YR 3/1 very dark grey silt/clay with frequent medium sand-sized brick and coal fragments. Poorly sorted. Diffuse boundary to:
	1.72	1.96	Overburden	10 YR 3/2 silt/clay with frequent granular-sized rounded quartzite clasts and occasional rounded, cobble-sized brick fragments. Poorly sorted. Diffuse boundary to:
	1.96	2.00	Gravel	10 YR 4/2 dark greyish brown silt/clay with frequent pebble-sized sub-rounded and rounded quartzite clasts. Poorly sorted.
	2.00	2.22	No Recover	Void
	2.22	2.40	Gravel	10 YR 4/2 dark greyish brown silt/clay with frequent pebble-sized sub-rounded and rounded quartzite clasts. Poorly sorted. Diffuse boundary to:
	2.40	3.00	Fluvial gravel	10 YR 4/3 brown matrix-supported gravel of sub-rounded and rounded quartzite and sandstone clasts in a silt/clay to medium sand matrix. Matrix fines upwards while gravel is found concentrated in 100m-thick sets.

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 3	0.00	0.30	No Recover	Void
	0.30	0.50	Overburden	10 YR 3/2 very dark greyish brown fine to medium sand with frequent cobble to pebble-sized sub-angular brick fragments. Poorly sorted. Diffuse boundary to:

	0.50	1.00	Sand	10 YR 4/3 brown medium to coarse sand with frequent sub-rounded to rounded pebble and granular quartzite and sandstone clasts. Poorly to moderately sorted (redeposited terrace sediments).
	1.00	1.25	No Recover	Void
	1.25	1.55	Sand	10 YR 4/3 brown medium to coarse sand with frequent sub-rounded to rounded pebble and granular quartzite and sandstone clasts. Poorly to moderately sorted (redeposited terrace sediments). Diffuse boundary to:
	1.55	2.00	Cultural deposit	10 YR 2/2 very dark brown humic silt/clay with moderate pebble to cobble-size sub-angular brick and mortar fragments. Moderate twig fragments to pebble size. Poorly sorted.
	2.00	2.43	No Recover	Void
	2.43	2.75	Gravel	10 YR 4/2 dark greyish brown silt to medium sand with frequent rounded and sub-rounded quartzite and sandstone pebbles. Moderately sorted. Diffuse boundary to:
	2.75	3.00	Gravel	5 YR 5/3 reddish brown matrix-supported gravel of pebble-sized rounded and sub-rounded quartzite and sandstone clasts in a silt to coarse sand matrix. Moderately sorted.

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 4	0.00	0.25	No Recover	Void
	0.25	0.70	Overburden	7.5 YR 4/3 brown fine diamict of pebble and fine cobble-sized hardcore/metamorphic sub-angular clasts in a medium sand to silt matrix. Diffuse boundary to:
	0.70	1.00	Sand	7.5 YR 3/3 dark brown medium sand with frequent to moderate sub-rounded and rounded quartzite and sandstone pebbles and fine cobbles. Homogeneous. Moderately sorted.
	1.00	1.10	No Recover	Void
	1.10	1.40	Sand	7.5 YR 3/3 dark brown medium sand with frequent to moderate sub-rounded and rounded quartzite and sandstone pebbles and fine cobbles. Homogeneous. Moderately sorted (redeposited terrace sediment). Sharp boundary to:
	1.40	1.87	Overburden	10 YR 4/1 dark grey humic silt/clay with moderate pebble-sized plaster fragments at top. Iron sheeting at 1.53m, red pottery at 1.83m. Moderately sorted. Diffuse boundary to:
	1.87	2.00	Overburden	10 YR 5/3 brown silt/clay with occasional pebble to granular-size mortar and red pottery fragments. Poorly sorted. Diffuse boundary to:
	2.00	2.15	No Recover	Void
	2.15	2.23	Overburden	10 YR 4/1 dark grey humic silt/clay with moderate pebble-sized plaster fragments. Moderately sorted. Sharp boundary to:

	2.23	2.35	Overburden	Brick
	2.35	2.64	Cultural deposit	10 YR 3/2 very dark greyish brown silt/clay with frequent fine roots. Moderate pebble-sized red pottery and mortar. Occasional sub-rounded and rounded quartzite pebbles. Moderately sorted. Sharp boundary to:
	2.64	2.69	Clay	5 YR 3/4 dark reddish brown ?burnt clay with occasional granular to pebble-sized sub-rounded quartzite clasts. Poorly sorted. Sharp boundary to:
	2.69	2.82	Cultural deposit	10 YR 3/2 very dark greyish brown humic/fibrous silt/clay with vertical plant roots. Rare pebble-sized brick/pottery fragments. Moderately sorted. Diffuse boundary to:
	2.82	3.00	Silt	2.5 Y 4/1 dark grey well sorted silt/clay with occasional granular to coarse sand-sized iron stains. Diffuse boundary to:
	3.00	3.38	No Recover	Void
	3.38	3.54	Gravel	2.5 Y 3/2 very dark greyish brown silt to medium sand with moderate rounded and sub-rounded quartzite pebbles. Poorly sorted (collapse). Sharp boundary to:
	3.54	4.00	Silt	2.5 Y 4/1 dark grey well sorted silt/clay with occasional granular to coarse sand-sized iron stains.
	4.00	4.52	No Recover	Void
	4.52	4.80	Gravel	2.5 Y 3/2 very dark greyish brown silt to medium sand with moderate rounded and sub-rounded quartzite pebbles. Poorly sorted (collapse). Sharp boundary to:
	4.80	5.00	Organic mud	2.5 Y 3/1 very dark grey humic silt/clay. Well sorted (damaged during drilling).

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 5	0.00	0.40	No Recover	Void
	0.40	0.48	Overburden	2.5 Y 2.5/1 black clast-supported gravel of pebble and granular-sized cinders and cobble-sized brick fragments. Poorly sorted. Sharp boundary to:
	0.48	0.56	Overburden	Brick. Sharp boundary to:
	0.56	0.88	Overburden	10 YR 4/3 brown diamict of sub-angular pebble to cobble-sized hardcore in a granular to silt hardcore matrix. Sharp boundary to:
	0.88	1.00	Overburden	Clast-supported gravel of sub-angular hardcore pebbles and cobbles.
	1.00	1.25	No Recover	Void
	1.25	1.44	Sand	10 YR 3/4 dark yellowish brown medium sand with frequent sub-rounded quartzite and sandstone pebbles and granules (redeposited terrace). Poorly sorted. Diffuse boundary to:
	1.44	1.75	Overburden	10 YR 3/1 very dark grey humic silt/clay with moderate granular to pebble-sized brick fragments increasing downwards and including plaster below 1.65m. Poorly sorted. Sharp

			boundary to:
1.75	1.88	Overburden	Brick. Sharp boundary to:
1.88	2.00	Overburden	10 YR 3/1 very dark grey humic silt/clay with moderate granular to pebble-sized brick fragments increasing downwards and including plaster below 1.65m. Poorly sorted.
2.00	2.20	No Recover	Void
2.20	2.75	Overburden	7.5 YR 3/4 dark brown silt to medium sand with frequent sub-rounded granular quartzite clasts, occasional granular and pebble-sized brick fragments, moderate granular-sized charcoal and discrete patches of plaster. Poorly sorted. Sharp boundary to:
2.75	2.80	Overburden	Brick. Sharp boundary to:
2.80	2.90	Overburden	10 YR 4/4 dark yellowish brown silt to medium sand with moderate pebble-sized sub-angular brick fragments and granular plaster. Poorly sorted. Diffuse boundary to:
2.90	3.00	Overburden	10 YR 3/2 very dark greyish brown silt to medium sand with frequent coarse sand and granular-sized plaster. Moderate sub-angular pebble-sized brick. Poorly sorted.
3.00	3.18	No Recover	Void
3.18	3.63	Overburden	10 YR 4/2 dark greyish brown matrix-supported gravel of sub-angular brick pebbles and cobbles in a silt/clay matrix. Moderate coarse sand-sized plaster. Poorly sorted. Diffuse boundary to:
3.63	3.76	Overburden	2.5 Y 3/1 very dark grey silt to medium sand with moderate sub-rounded quartzite and sub-angular brick pebbles. Moderate coarse sand-sized plaster. Poorly sorted. Diffuse boundary to:
3.76	3.78	Silt	2.5 Y 4/2 dark greyish brown well sorted silt/clay. Diffuse boundary to:
3.78	4.00	Cultural deposit	10 YR 4/2 dark greyish brown silt/clay with moderate pebble-sized sub-rounded plaster, granular charcoal and single cobble-sized tile fragments at 3.84-3.88m. Poorly sorted.
4.00	4.20	No Recover	Void
4.20	4.67	Silt	5 Y 4/1 well sorted dark grey silt/clay with thin lenticular beds of 5 Y 2.5/1 black organic medium sand to silt at 4.30-4.33m, 5 Y 2.5/1 black organic mud at 4.47-4.48m and single sub-rounded sandstone pebble at 4.48-4.50m. Well sorted. Diffuse boundary
4.67	4.98	Clay	7.5 YR 4/4 brown silt/clay (becoming redder downwards). Occasional granular-sized organic patches throughout. Well sorted. Sharp boundary to:
4.98	5.00	Gravel	7.5 YR 4/4 brown matrix-supported gravel of sub-rounded and sub-angular sandstone and quartzite granules and pebbles in a silt/clay matrix. Poorly sorted.

Bore	Top (m)	Base (m)	Lithology	Comment
P3516 Borehole 6	0.00	0.32	No Recover	Void
	0.32	0.64	Overburden	Brick. Solid to 0.40m and fragmented below that. Sharp boundary to:
	0.64	0.85	Overburden	10 YR 2/1 black silt/clay with moderate granular-sized plaster and sub-angular pebble-sized brick and white-glazed pottery fragments. Poorly sorted. Diffuse boundary to:
	0.85	1.00	Overburden	10 YR 3/1 very dark grey silt/clay with frequent granular plaster and pebble-sized brick fragments. Moderate granular charcoal. Poorly sorted.
	1.00	1.30	No Recover	Void
	1.30	2.00	Overburden	10 YR 4/2 diamict of sub-angular cobble and pebble-sized brick, pebble and granular-sized plaster and charcoal in a silt to medium sand matrix. Matrix becomes infrequent below 0.50m and unit is thereafter a poorly sorted clast-supported gravel.
	2.00	2.10	No Recover	Void
	2.10	2.40	Overburden	10 YR 3/2 very dark greyish brown fine diamict of sub-angular pebble to fine cobble-sized brick and pebble to granular-sized charcoal in a silt to course sand matrix. Occasional rounded quartzite pebble-sized clasts. Poorly sorted. Diffuse boundary to:
	2.40	2.55	Overburden	10 YR 2/2 silt to medium sand with occasional sub-angular pebble to fine cobble-sized brick fragments. Poorly sorted. Diffuse boundary to:
	2.55	2.65	Overburden	10 YR 3/2 very dark greyish brown fine diamict of sub-angular pebble to fine cobble-sized brick and pebble to granular-sized charcoal in a silt to course sand matrix. Occasional rounded quartzite pebble-sized clasts. Poorly sorted. Diffuse boundary to:
	2.65	2.80	Overburden	Clast-supported gravel of sub-angular pebble-sized brick clasts lacking any matrix. Sharp boundary to:
	2.80	2.85	Silt	10 YR 5/4 yellowish brown well sorted silt/clay with moderate coarse sand sized iron stains. Rare granular sized plaster fragments. Well sorted. Sharp boundary to:
	2.85	2.87	Overburden	Clast-supported gravel of sub-angular pebble-sized brick clasts lacking any matrix. Sharp boundary to:
	2.87	3.00	Silt	10 YR 5/4 yellowish brown well sorted silt/clay with moderate coarse sand sized iron stains. Rare granular sized plaster fragments. Well sorted.
	3.00	3.12	No Recover	Void
	3.12	3.15	Silt	10 YR 5/4 yellowish brown well sorted silt/clay with moderate coarse sand sized iron stains. Rare granular sized plaster fragments. Well sorted. Sharp boundary to:
	3.15	3.88	Cultural deposit	2.5 Y 3/1 very dark grey humic silt/clay with moderate rounded and sub-rounded quartzite pebbles and granules, granular burnt mortar, and granular-sized plant fragments. Poorly sorted.

			Sharp boundary to:
3.88	4.00	Silt	5 Y 5/1 grey silt/clay with moderate to frequent iron stains.
4.00	4.20	No Recover	Void
4.20	4.28	Cultural deposit	2.5 Y 3/1 very dark grey humic silt/clay with moderate rounded and sub-rounded quartzite pebbles and granules, granular burnt mortar, and granular-sized plant fragments. Poorly sorted (collapse). Sharp boundary to:
4.28	4.46	Silt	5 Y 5/1 grey silt/clay with moderate to frequent iron stains. Diffuse boundary to:
4.46	4.90	Clay	7.5 YR 5/3 brown silt/clay (oxidised) with moderate coarse sand and granular-sized iron stained patches throughout. Well sorted. Diffuse boundary to:
4.90	5.00	Gravel	7.5 YR 5/3 matrix-supported gravel of sub-rounded and rounded granular and pebble-sized sandstone and quartzite clasts in a silt/clay and medium sand matrix. Single lenticular bed of 7.5 YR 5/6 strong brown medium to coarse sand at 4.90m

Appendix 2 Pollen processing methodology (Tim Mighall, Department of Geography & Environment, University of Aberdeen)

ABSOLUTE POLLEN ANALYSIS: PREPARATION SCHEDULE

PRECAUTIONARY NOTES: All procedures, up to stage 25, should take place in the fume cupboard. Read precautionary notices on fume cupboard before starting. Ascertain whereabouts of First Aid equipment NOW. Please wear laboratory coat, gloves and goggles when dealing with all chemicals. Please organize fume cupboard carefully to maximize workspace. Use the containment trays provided. Always keep the fume cupboard door down as far as practically possible. Make sure the fume cupboard is switched on and functioning correctly.

A) SOLUTION OF HUMIC COMPOUNDS

1) Switch on hotplate to heat water bath. Prepare 12 to 16 samples concurrently.

HCl. is an irritant and can cause burns. Wear gloves. Wash with water if spilt on your skin.

Using a clean spatula, place a known volume or weight of sediment (c. 2cm^3) and one spore tablet in each 50ml centrifuge tube. Add a few cm^3 of distilled water (enough to cover the pellet and tablets) and a few drops of 2M HCl. Wait until effervescence ceases, then half fill tubes with 10% KOH; place in a boiling water bath for 15 minutes. Stir to break up sediment with clean glass rod. Return HCl and KOH bottles to the chemical cabinet.

2) Centrifuge at 3,000 rpm for 5-6 minutes, ensuring first that tubes are filled to the same level. This applies throughout the schedule (Mark 7 on centrifuge).

3) Carefully decant, i.e. pour away liquid from tube, retaining residue. Do it in one smooth action.

4) Disturb pellet using vortex mixer; add distilled water, centrifuge and decant.

5) Using a little distilled water, wash residue through a fine (180 micron) sieve sitting in filter funnel over a beaker. NB Be especially careful in keeping sieves, beakers and all tubes in correct number order. Wash residue on sieve mesh into petri dish and label the lid. If beaker contains mineral material, stir contents, wait four seconds, then decant into clean beaker, leaving larger mineral particles behind. Repeat if necessary. Clean centrifuge tube and refill with contents of beaker.

6) Centrifuge the tubes and decant.

B) HYDROFLUORIC ACID DIGESTION

***(Only required** if mineral material clearly still present. Otherwise, go to stage 13)*

NB Hydrofluoric acid is extremely corrosive and toxic; it can cause serious harm on contact with eyes and skin. Rubber gloves and mask/ goggles MUST be worn up to and including stage 11. Please fill sink with H_20; have $CaCo_3$ gel tablets ready. Place pollen tube rack into tray filled with sodium bicarbonate.

7) Disturb pellet with vortex mixer. Add one cm^3 of 2M HCl.

8) With the fume cupboard sash lowered between face and sample tubes, very carefully one-third fill tubes with concentrated HF (40%). Place tubes in water bath and simmer for 20 minutes.

9) Remove tubes from water bath, centrifuge and decant down fume cupboard sink, flushing copiously with water.

10) Add 8cm^3 2H HCl to each tube. Place in water bath for 5 minutes. Do not boil HCl.

11) Remove tubes, centrifuge while still hot, and decant.

12) Disturb pellet, add distilled water, centrifuge and decant.

C) ACETYLATION

NB Acetic acid is highly corrosive and harmful on contact with skin. Wash with H_20 if spilt on skin.

13) Disturb pellet, add 10cm^3 glacial acetic acid, and centrifuge. Decant into fume cupboard sink with water running during and after.

14) Acetic Anhydride is anhydrous. Avoid contact with water. The acetylation mixture can cause severe burns if spilt on skin. Wash with water.

15) Make up 60cm^3 of acetylation mixture, just before it is required. Using a measuring cylinder; mix acetic anhydride and concentrated sulphuric acid in proportions 9:1 by volume. Measure out 54cm^3 acetic anhydride first, then add (dropwise) 6cm^3 concentrated H_2S0_4 carefully, stirring to prevent heat build—up. Stir again just before adding mixture to each tube.

Disturb pellet; then add 7cm^3 of the mixture to each sample.

16) Put in boiling water bath for 1-2 minutes. (Stirring is unnecessary—never leave glass rods in tubes as steam condenses on the rods and runs down into the mixture reacting violently). One minute is usually adequate; longer acetylation makes grains opaque. Switch off hot plate.

17) Centrifuge and decant all tubes into large (1,000ml) beaker of water in fume cupboard. Decant contents of beaker down fume cupboard sink.

18) Disturb pellet, add 10cm^3 glacial acetic acid, centrifuge and decant.

19) Disturb pellet, add distilled water and a few drops of 95% ethanol centrifuge and decant carefully.

D) DEHYDRATION, EXTRACTION AND MOUNTING IN SILICONE FLUID

20) Disturb pellet; add 10cm^3 95% ethanol, centrifuge and decant.

21) Disturb pellet; add 10cm^3 ethanol (Absolute alcohol), centrifuge and decant. Repeat.

22) Toluene is an irritant. Avoid fumes.

Disturb pellet; add about 8cm^3 toluene, centrifuge and decant carefully into 'WASTE TOLUENE' beaker in fume cupboard (leave beaker contents to evaporate overnight).

23) Disturb pellet; then using as little toluene as possible, pour into labelled specimen tube.

24) Add a few drops of silicone fluid - enough to cover sediment.

25) Leave in fume cupboard overnight, uncorked, with fan switched on. Write a note on the fume cupboard *'Leave fan on overnight - toluene evaporation',* and date it. Collect specimen tubes next morning and cork them. Turn off fan.

26) Using a cocktail stick, stir Contents and transfer one drop of material onto a clean glass slide and cover with a cover slip (22mm x 22mm). Label the slide.

27) Wash and clean everything you have used. Wipe down the fume cupboard worktop. Remove water bath from fume cupboard if not needed by the next user. Refill bottles and replace them in chemical cabinets.

Appendix 3 Radiocarbon dating results

BETA ANALYTIC INC.
DR. M.A. TAMERS and MR. D.G. HOOD
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305-667-5167 FAX:305-663-0964
beta@radiocarbon.com

REPORT OF RADIOCARBON DATING ANALYSES

Dr. Nick Daffern — Report Date: 8/1/2010

University of Worcester — Material Received: 7/14/2010

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 281895	4770 +/- 40 BP	-26.2 o/oo	4750 +/- 40 BP

SAMPLE : P3516/BH5/4.46-4.47
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (organic sediment): acid washes
2 SIGMA CALIBRATION : Cal BC 3640 to 3500 (Cal BP 5590 to 5450) AND Cal BC 3440 to 3380 (Cal BP 5390 to 5330)

Sample Data	Measured Radiocarbon Age	13C/12C Ratio	Conventional Radiocarbon Age(*)
Beta - 281896	1750 +/- 40 BP	-25.1 o/oo	1750 +/- 40 BP

SAMPLE : P3516/BH6/3.39-3.41
ANALYSIS : AMS-Standard delivery
MATERIAL/PRETREATMENT : (organic sediment): acid washes
2 SIGMA CALIBRATION : Cal AD 210 to 390 (Cal BP 1740 to 1560)

Dates are reported as RCYBP (radiocarbon years before present, "present" = AD 1950). By international convention, the modern reference standard was 95% the 14C activity of the National Institute of Standards and Technology (NIST) Oxalic Acid (SRM 4990C) and calculated using the Libby 14C half-life (5568 years). Quoted errors represent 1 relative standard deviation statistics (68% probability) counting errors based on the combined measurements of the sample, background, and modern reference standards. Measured 13C/12C ratios (delta 13C) were calculated relative to the PDB-1 standard.

The Conventional Radiocarbon Age represents the Measured Radiocarbon Age corrected for isotopic fractionation, calculated using the delta 13C. On rare occasion where the Conventional Radiocarbon Age was calculated using an assumed delta 13C, the ratio and the Conventional Radiocarbon Age will be followed by "*". The Conventional Radiocarbon Age is not calendar calibrated. When available, the Calendar Calibrated result is calculated from the Conventional Radiocarbon Age and is listed as the "Two Sigma Calibrated Result" for each sample.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.2:lab. mult=1)

Laboratory number: **Beta-281895**

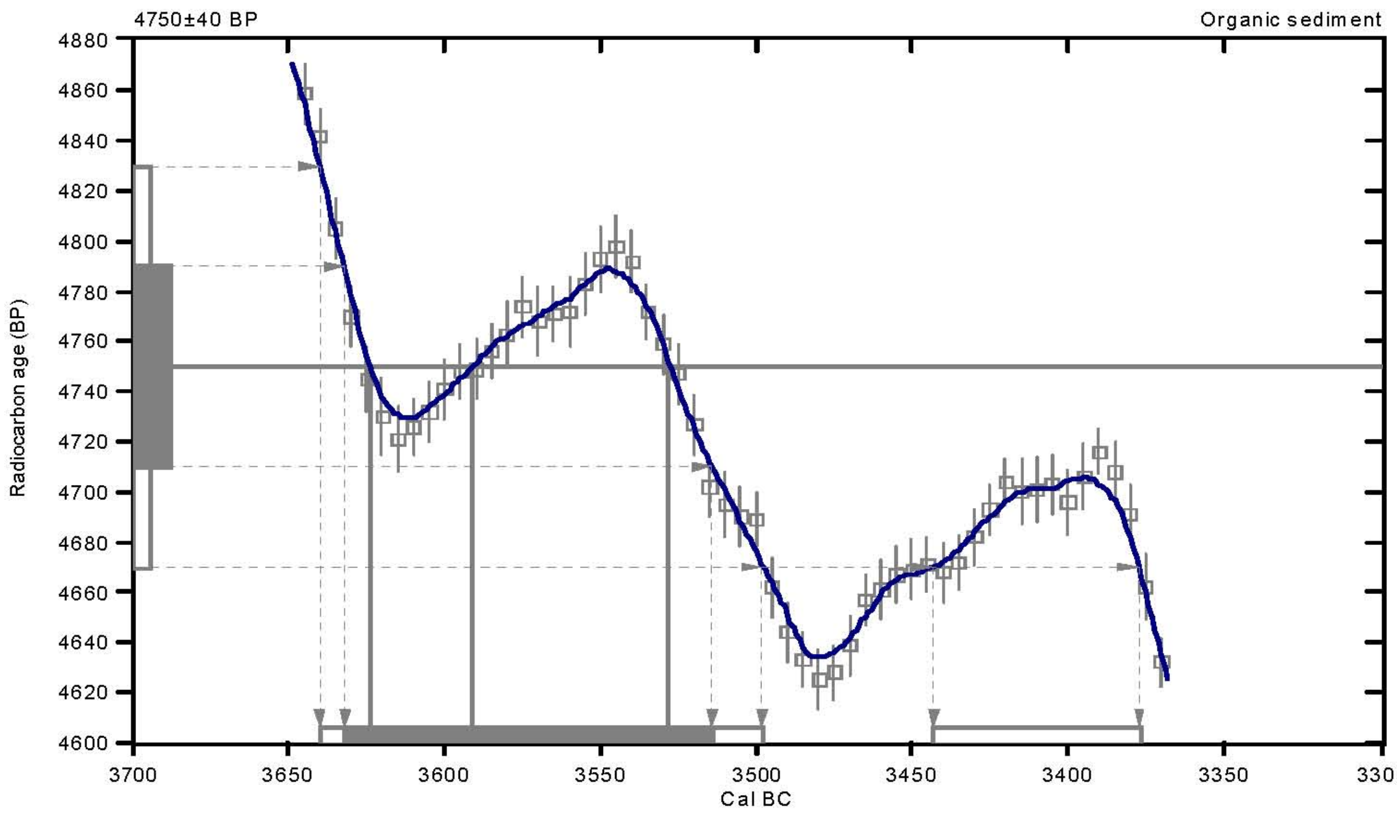
Conventional radiocarbon age: **4750±40 BP**

2 Sigma calibrated results: **Cal BC 3640 to 3500 (Cal BP 5590 to 5450) and**
(95% probability) **Cal BC 3440 to 3380 (Cal BP 5390 to 5330)**

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal BC 3620 (Cal BP 5570) and
Cal BC 3590 (Cal BP 5540) and
Cal BC 3530 (Cal BP 5480)

1 Sigma calibrated result: Cal BC 3630 to 3510 (Cal BP 5580 to 5460)
(68% probability)



References:

Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Beta Analytic Radiocarbon Dating Laboratory

4985 S.W. 74th Court, Miami, Florida 33155 • Tel: (305)667-5167 • Fax: (305)663-0964 • E-Mail: beta@radiocarbon.com

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.1:lab. mult=1)

Laboratory number: **Beta-281896**

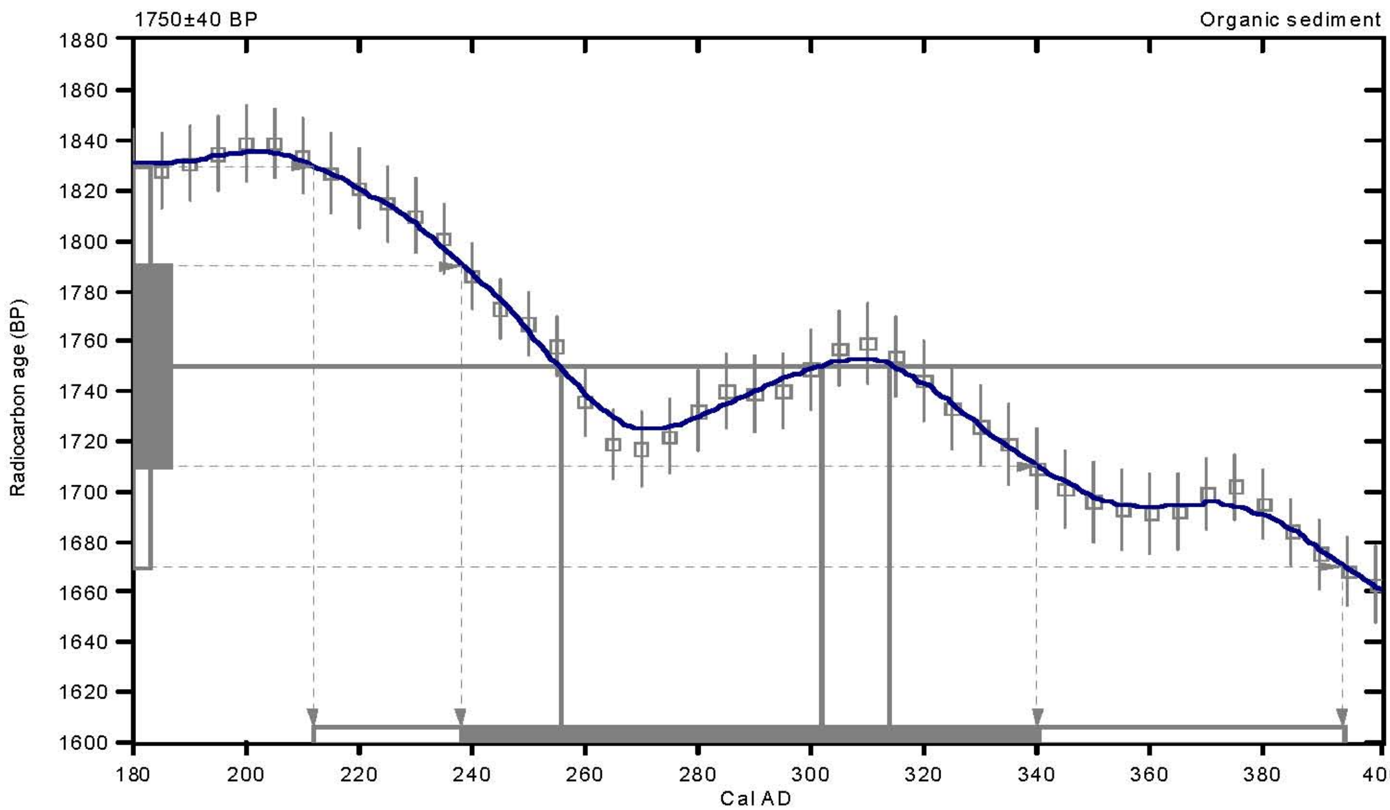
Conventional radiocarbon age: **1750±40 BP**

2 Sigma calibrated result: **Cal AD 210 to 390 (Cal BP 1740 to 1560)**
(95% probability)

Intercept data

Intercepts of radiocarbon age
with calibration curve: Cal AD 260 (Cal BP 1690) and
Cal AD 300 (Cal BP 1650) and
Cal AD 310 (Cal BP 1640)

1 Sigma calibrated result: Cal AD 240 to 340 (Cal BP 1710 to 1610)
(68% probability)



References:
Database used
INTCAL04
Calibration Database
INTCAL04 Radiocarbon Age Calibration
IntCal04: Calibration Issue of Radiocarbon (Volume 46, nr 3, 2004).
Mathematics
A Simplified Approach to Calibrating C14 Dates
Talma, A. S., Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

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Appendix 4 Technical information

The archive

The archive consists of:

2	Fieldwork progress records AS2
3	Augerhole Record Sheets AS26
4	Digital Photos
5	Pollen preparations (in vials)
5	Pollen slides
1	Box of finds

The project archive is intended to be placed at:

Worcestershire County Museum
Hartlebury Castle
Hartlebury
Near Kidderminster
Worcestershire DY11 7XZ
Tel Hartlebury (01299) 250416