

Feasibility Study, Fishlake, South Yorkshire



Geoarchaeological Investigation and Dating Project



Oxford Archaeology North

July 2009

Environment Agency

Issue No: 2009-10/964

OA North Job No: L10109

NGR: TA 655135

Document Title: Feasibility Study, Fishlake, South Yorkshire
Document Type: Geoarchaeological Investigation and Dating Project

Client Name: Environment Agency

Issue Number: 2009-10/964
OA Job Number: L10109

National Grid Reference: TA655135

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SUMMARY

Oxford Archaeology North (OA North) was commissioned by the Environment Agency to undertake a feasibility study for a geoarchaeological investigation and scientific dating of a sediment sequence on land adjacent to the River Don, near Fishlake, Yorkshire (centred NGR TA 655135), which is proposed for a flood alleviation and habitat creation scheme. The client requested that OA North should assess the potential for investigating the sediment sequence that will be impacted by the proposed development. The site is situated on the floodplain of the River Don, between Stainforth in the south-west and Hangsman Hill in the north-east, and covers an area of approximately 4.5 km by 1.25 km.

The main aim of the feasibility study was to characterise the sequence and patterns of accumulation of sediment in the study area and to date the sediments using Optical Luminescence Dating (hereafter OSL dating).

A preliminary auger survey was carried out over a period of two days on 6th and 7th February 2009. This sought to characterise the sediments in the study area by coring along a south-west/north-east transect to the north and south of the River Don, using a standard hand-operated gouge auger down to *c* 2.5m. Thirteen hand auger cores were taken (HA 01-13), and from this information two locations were then selected for mechanical coring (FL1 and FL2) to allow the sediments to be dated by OSL. The coring was carried out on 6th March 2009 using a terrier rig, in the presence of an OA North environmental archaeologist and a member of the OSL dating team from Liverpool University.

On closer examination of the two dating cores, only one proved to contain material suitable for the OSL method of dating (which requires sand or larger-sized silt grains). Therefore, after discussions with the client, it was agreed that the core unsuitable for OSL dating would be radiocarbon dated instead, as it contained suitable organic material.

The lithological and dating results indicate two differing areas of sediment deposition in the north-east and south-west of the study area. The sediments in the south-west, which are dominated by blue-grey organic clays, are likely to represent floodplain alluviation deposits laid down during the early to mid Holocene. The silts and sands in the north-west of the area, however, appear to represent early Holocene riverine deposits that were not inundated by alluviation until much later and, as such, may represent higher, and possibly drier, areas during the time of the deposition of the blue-grey clays in the south-west of the study area. Given the role of such high points in providing access to floodplain environments and their associated wetland resources, it is possible that this area may have been a focus of prehistoric activity.

The feasibility study has successfully shown that OSL dating can be implemented on floodplain deposits that were previously thought not viable for such investigations. However, the study has also shown that OSL dating is dependant on suitable material being available (i.e. sand or larger-sized silt grains). Given these restrictions, this provided the opportunity to explore the implementation of a mixed programme of dating, where suitable sediments are identified, which proved to have considerable benefits. There is a potential to expand this investigation scheme-wide to assess the area of proposed impact with a more detailed approach, perhaps in the form of coring

in a grid pattern, thus identifying levels of high archaeological potential. This would aid identification of areas for further archaeological investigation, which would, in turn, inform the requirements for any necessary mitigation.

Should such an investigation be applied to comparable sites it is recommended that a trial be undertaken initially, in a similar undertaking to that applied at Fishlake, in order to determine whether suitable deposits exist for a more detailed approach.

ACKNOWLEDGEMENTS

OA North would like to thank the Environment Agency for commissioning the work, and for their assistance during the fieldwork; in particular Phil Catherall and Jenny Grinter. Prof Andreas Lang and Dr Barbara Mauz, of the Geography Department of Liverpool University, carried out the OSL dating. Dr Mauz also visited the site and made recommendations for the mechanical coring, which was carried out by Soil Mechanics Ltd. Dr Gordon Cook and his team at Scottish Universities Environmental Radiocarbon Centre (SUERC), East Kilbride, carried out the AMS radiocarbon dating.

Denise Druce and Christina Robinson undertook the preliminary fieldwork and borehole survey. Denise also liaised with the OSL specialist during the retrieval of the cores, submitted the C14 radiocarbon dates, and wrote the report. Pete Schofield georeferenced the borehole data, and Anne Stewardson produced the illustrations. Elizabeth Huckerby assisted with the running of the project and provided advice. Emily Mercer managed the project and edited the report.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF PROJECT

1.1.1 The Environment Agency commissioned Oxford Archaeology North (OA North) to submit proposals to undertake a feasibility study for the geoarchaeological investigation and scientific dating of a sediment sequence on land adjacent to the River Don, near Fishlake, Yorkshire (centred NGR TA 655135). As a flood alleviation and habitat creation scheme is being proposed for the area, the client wanted to evaluate the outlined area by assessing the sediment sequence that will be impacted on by the proposed development.

1.2 OBJECTIVES OF THE PROJECT

1.2.1 The main aim of the investigation was to characterise the sequence and patterns of accumulation of sediment in the study area, in order to identify any potential land surfaces/buried soils, and locate the nature and extent of any waterlogged organic deposits. The survey also sought to identify any significant variations in the deposit sequence, indicative of localised features, such as topographic highs or palaeochannels.

1.2.2 In order to provide a chronological framework for sediment accumulation in alluvial sequences, a second aim of the project was to assess the suitability of dating such deposits by Optical Luminescence Dating (hereafter OSL dating).

1.3 LOCATION, GEOLOGY AND TOPOGRAPHY

1.2.3 The site is situated on the floodplain of the River Don, between Stainforth in the south-west and Hangman Hill in the north-east, near Fishlake, Yorkshire (Fig 1). The proposed development site covers an area of approximately 4.5 km by 1.25 km, which is currently bounded by two flood banks. The area is currently made up of meadows and damp pastures with numerous hedges and drainage ditches.

1.3.2 The River Don flows eastwards from the upland Pennine Coal Measures (at c 460m OD), and from there cuts through a narrow outcrop of Upper and Lower Magnesian Limestone, and down onto the fertile lowlands of the Don Valley and the Humberhead Levels, much of which is only a few metres above sea-level (Ellis 1997). The original course of the River Don flowed north-east across the marshes of Hatfield Chase and joined the River Trent just above its confluence with the River Ouse. In a marshland drainage project of 1627, the river was diverted northwards, to run alongside the westward edge of the most southerly outcrop of the Escrick moraine complex, and then eastwards, where it now joins the River Ouse at Goole (Dinnin 1997).

- 1.3.3 Fishlake is within the boundary of the Humberhead Levels, which is demarcated in the north by the River Aire and the Vale of York. The Humberhead Levels developed in the glacial Lake Humber during the course of the last glaciation due to the impounding of the Humber Estuary. It was bounded in the north by the glacial moraine complex at Escrick. The Humberhead levels fills what was once this vast lake and can contain up to 20m of clay in places. This clay seals former woodland, and is often overlain by deposits of peat (Ellis 1997).

2. METHODOLOGY

2.1 PROJECT DESIGN

- 2.1.1 The methodology outlined in the project design (*Appendix 1*) was adhered to as far as practicable. The original project design stated that the auger survey would consist of cores taken along a transect every 100m, however, the area north of the river Don, marked as Great Ing on the Ordnance Survey map, was not surveyed due to it being demarcated as contaminated land.
- 2.1.2 The project design stated that two locations would be chosen for OSL dating. However, on closer examination only one core proved to contain material suitable for this type of dating method. After discussions with the client, it was agreed that the second core that was unsuitable for OSL dating would be dated by radiocarbon methods, as it contained suitable organic material. It was proposed that each core would be dated at two depths, one near to the present ground surface, and the second between 1.5m and 3m depth below ground level (BGL). In actuality, the depths of the samples for dating were determined by the suitability of the sediments. The two OSL dating samples were at 1.82-1.92m and 3.47-3.68m depth (BGL) in one core (FL1, Fig 2), and the two radiocarbon dating samples were taken at 2.89-2.91m and 3.42-3.44m depth (BGL) in the second core (FL2, Fig 2).



Plate 1: View of the floodplain north of the River Don, showing mechanical terrier rig coring FL1

2.2 FIELDWORK

- 2.2.1 A preliminary auger survey was undertaken in order to characterise the sediments in the study area, along a south-west/north-east transect north and

south of the River Don using a standard hand-operated gouge auger. In total, 13 cores were taken (HA 01 to 13, Fig 2), the locations of which were recorded in three dimensions using a differential GPS (dGPS). The area around Great Ing, on the north side of the river, was not surveyed due to the risk of contamination, which would not be conducive to handling or scientific dating. Each location was augered to a depth of at least 3m, or until the underlying sediments were too compact to penetrate. The sediments of each core were described and recorded in a field notebook. The results have been provided in *Appendix 2*.

- 2.2.2 Two locations where the sediments were believed to be representative of the study area were selected for mechanical coring (FL1 and FL2, Fig 2) to allow the sediments to be dated. The coring was carried out using a terrier rig in the presence of an OA North environmental archaeologist and a member of the OSL dating team from Liverpool University.

2.3 EVALUATION

- 2.3.1 **OSL Dating:** Core FL1 was taken back to the Liverpool OSL laboratories for analysis. The core (taken in 1m lengths) contained up to 4m of silt with varying quantities of clay and sand. Two sections of the core containing higher sand content were chosen for OSL dating. These came from 1.82-1.92m depth (BGL) (1.65 to 1.55m OD) and 3.47-3.68m depth (BGL) (0.00 to -0.21m OD). A technical summary is given in *Appendix 3*.

- 2.3.2 **Radiocarbon Dating:** following the decision to date one of the cores by C14, material for two radiocarbon dates was taken from Core FL2 (Fig 2) at 2.89-2.91m (BGL) (0.49 to 0.47m OD) and 3.42-3.44m depth (BGL) (-0.04 to -0.06m OD). Core FL2 was 4m in depth (taken in metre lengths), and the recorded lithology is shown in Table 1 below. The upper date was taken from near the top of a layer of organic clay with wood remains. The lower came from the lowermost part of this same deposit.

DEPTH (M) BGL (3.38M OD)	LITHOLOGY	C14 SAMPLES
0.0-1.0	Very disturbed topsoil-clay (core discarded)	
1.0-2.7	Blue-grey clay, highly oxidised with possible stabilisation horizon at 1.4m	
2.7-2.8	Blue-grey clay	
2.8-3.5	Very organic clay with wood remains	2.89-2.91m (0.49 to 0.47m OD) 3.42-3.44m (-0.04 to -0.06m OD)
3.5-4	Lost core	

Table 1: Lithology and associated C14 sample depths from FL2

- 2.3.3 The two radiocarbon samples were fairly closely spaced (*c* 0.5m depth apart). However, despite this, given that the sampled sediment consisted of floodplain deposits, with the risk of containing older re-worked material, it was considered that obtaining two dates would be more rigorous.

2.4 ARCHIVE

- 2.4.1 A full professional archive has been compiled in accordance with the project design (*Appendix 1*), and in accordance with current English Heritage guidelines (1991). The archive will be submitted to the Historic Environment Record (HER) for South Yorkshire in Sheffield. OA North practice is to deposit the original record archive of projects with the appropriate Record Office, in this case Sheffield Archives. The Arts and Humanities Data Service (AHDS) online database *Online Access index of Archaeological Investigations* (OASIS) will be completed as part of the archiving phase of the project.

3. FIELDWORK RESULTS

3.1 HAND AUGER SURVEY

3.1.1 Thirteen cores were taken during the first phase of the fieldwork, which consisted of ten in the study area north of the River Don (HA 01-07) and three in the small stretch of proposed development south of the river near to Waterside (HA 08-10). The core locations are shown in Figure 2 (HA 01-13), which shows an area between the two areas of coring north of the River Don that was not surveyed due to a risk of contamination. The cores were also located so as to avoid areas of prior development, such as previous phases of flood defences and habitat creation schemes. The height of the present ground surface in the study area appeared to vary depending on the extent of former reworking-development, between *c* 3 and 4m OD.

3.2 LITHOLOGY OF THE STUDY AREA

3.2.1 The sediment description of each hand auger core is given in *Appendix 2*, and the results indicate two different types of sediment deposition in the study area. The western stretch of the area north of the River Don (HA 01-07, Fig 2) consists of *c* 0.5m of topsoil, overlying blue-grey alluvial clay, which was seen to be highly organic containing wood fragments and hazelnut shells from *c* 2.5m depth (BGL). The upper *c* 2m of this clay was also highly oxidised, which suggests some degree of drying out and/or possible disturbance; the extreme west of the area in particular (HA 01 and 02), appears to have been modified in the past by the creation of a pond and adjoining bank.

3.2.2 The sediment in HA 04 and 05 contained a much higher silt content, and contained much less of an organic component. It is possible that this area represents a former tributary of the river, which is now in-filled.

3.2.3 The sediments on both sides of the river, in the north-east of the study area (HA 08-11, Fig 2), consisted of *c* 1m of blue-grey alluvial clay overlying silts and sands, which were laminated with clay at *c* 2m depth (BGL). Much of the sediment at lower depths was highly dense, which made penetration with the auger below 2.5m difficult.

3.3 INTERPRETATION

3.3.1 The sediments recorded in the study area represent alluvial floodplain deposits. The north-eastern stretch of the site has greater silt and sand content, which suggests deposition took place under much higher energy conditions in this part of the site.

4. DATING RESULTS

4.1 OSL DATES

- 4.1.1 The results of the luminescence age estimation are shown in the technical summary (*Appendix 3*). The material taken from 1.82-1.92m depth (BGL) (1.65 to 1.55m OD) (LV# 373 in OSL report) in Core FL1 was 9800 ± 1400 years old, and that taken at 3.47-3.68m depth (BGL) (0.00 to -0.21m OD) (LV# 375 in OSL report) was 8600 ± 900 years old. Taking into account the error margins both samples have the same early Holocene age.

4.2 RADIOCARBON DATES

- 4.2.1 The results of the two radiocarbon dates and associated calibration curves are shown in *Appendix 4*. The upper sample, taken at 2.89-2.91m (BGL) (0.49 to 0.47m OD) depth in Core FL2 provided a date of 1380-1120 cal BC (3005 ± 35 BP; SUERC 24066), and the lower sample, taken at 3.42-3.44m depth (BGL) (-0.04 to -0.06m OD) was dated to 1930-1740 cal BC (3505 ± 35 BP; SUERC 24067).
- 4.2.2 The two radiocarbon determinations from Core FL2 indicate that the organic deposit at *c* 3m depth in the south-west of the study area accumulated during the Bronze Age period, and thus provide a *terminus ante quem* for the overlying sediment accumulation. It is difficult to ascertain the date of the overlying 3m of sediment, however, it is possible that the blue-grey alluvial clay was deposited quite rapidly. A possible stabilisation horizon at 1.4m may represent a former land surface, which developed as a result of decreased minerogenic accumulation. Nevertheless, the upper 1m of deposit is highly disturbed, possibly as a result of earlier modification of the floodplain deposits. Therefore, if any archaeological remains or activity layers were to exist in the upper layers, they are likely to be unprovenanced.

4.3 DISCUSSION

- 4.3.1 The dating results indicate that the sand and silt deposits in the north-east of the study area are up to 5000 years older than the blue-grey, organic deposition in the south-west of the study area. The large age difference is surprising and may indicate disparate formation processes in operation between the two areas, however possible errors with either/or of the dating results should not be overlooked.

5. CONCLUSION

5.1 DISCUSSION

- 5.1.1 The lithological and dating results indicate two differing areas of sediment deposition in the north-east and south-west of the study area. The sediments in the south-west, which are dominated by blue-grey organic clays, are likely to represent floodplain alluviation deposits laid down during the early to mid Holocene. The silts and sands in the north-east of the area, however, appear to represent early Holocene riverine deposits that were not inundated by later alluviation until much later.
- 5.1.2 Given the limitations of the coring depth, the exact relationship between the blue-grey and organic clays in the south-west of the area, and the silts and sands in the north-east is unclear. Similarly, given that the coring was restricted to just two transects, the nature of the sediments in their wider context is also unclear. For example, it is not certain whether the older sands and silts represent an isolated outcrop or 'island' in relation to the younger clays, or whether they form a much larger context within the floodplain environment which, in places, was re-worked by later fluvial activity and alluviation. This question could only be answered with a much more in-depth coring programme, such as that carried out with success by OA North in the Alt Valley, Merseyside (OA North 2006). Here, a programme of detailed coring, laid out in a grid pattern every *c* 40m apart, identified higher sand areas adjacent to a floodplain, which were likely to have been foci for Mesolithic activity.
- 5.1.3 It is possible that the sands and silts in the north-east of the study area represent higher, and possibly drier, land during the early-mid Holocene (upper OSL date is *c* 1m higher than upper C14 date). However, the fact that they were subsequently concealed by blue-grey clay suggests that they were subjected to later flooding. Given the role of such islands in providing access to floodplain environments and their associated wetland resources, it is possible that this area may have been a focus of activity and, therefore, archaeological potential.

5.2 CONCLUSION

- 5.2.1 The feasibility study has successfully shown that OSL dating can be implemented on floodplain deposits that were previously thought not viable for such investigations. However, the study has also shown that OSL dating is dependant on suitable material being available (i.e. sand or larger-sized silt grains).
- 5.2.2 Given these restrictions, this provided the opportunity to explore the implementation of a mixed programme of dating, where suitable sediments are identified, which proved to have considerable benefits. For example, the results show that the sand and silt in the north-east of the study area was laid down during the early Holocene period, and possibly remained relatively

undisturbed until the late Holocene and the deposition of the uppermost blue-grey clay. Conversely, the blue-grey organic clay deposits in the south-west of the area accumulated up to 5000 years later, during the mid Holocene, this sequence of events would not have been identified without the two types of dating evidence. It is possible that the sands and silts formed higher and drier 'islands' within the floodplain environment, and as such may have provided a focus for prehistoric activity. However, this is uncertain based on the present geomorphological data, and would need to be investigated further.

5.3 RECOMMENDATIONS

- 5.3.1 The level of reconnaissance utilised in the study has proved to be adequate for assessing the suitability of floodplain deposits for various forms of dating. However, there is a potential to expand this investigation scheme-wide to assess the area of proposed impact with a more detailed approach, perhaps in the form of coring in a grid pattern, thus identifying levels of high archaeological potential. This would provide information on areas that may be of archaeological significance, which could then form a focus for further, more detailed evaluation to determine the requirements for any necessary mitigation.

6. BIBLIOGRAPHY

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7. ILLUSTRATIONS

7.1 FIGURES

Figure 1: Site location

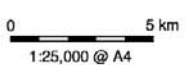
Figure 2: Location of the geoarchaeological investigations

7.2 PLATES

Plate 1: View of the floodplain north of the River Don, showing mechanical terrier rig coring FL1



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Figure 1: Site location

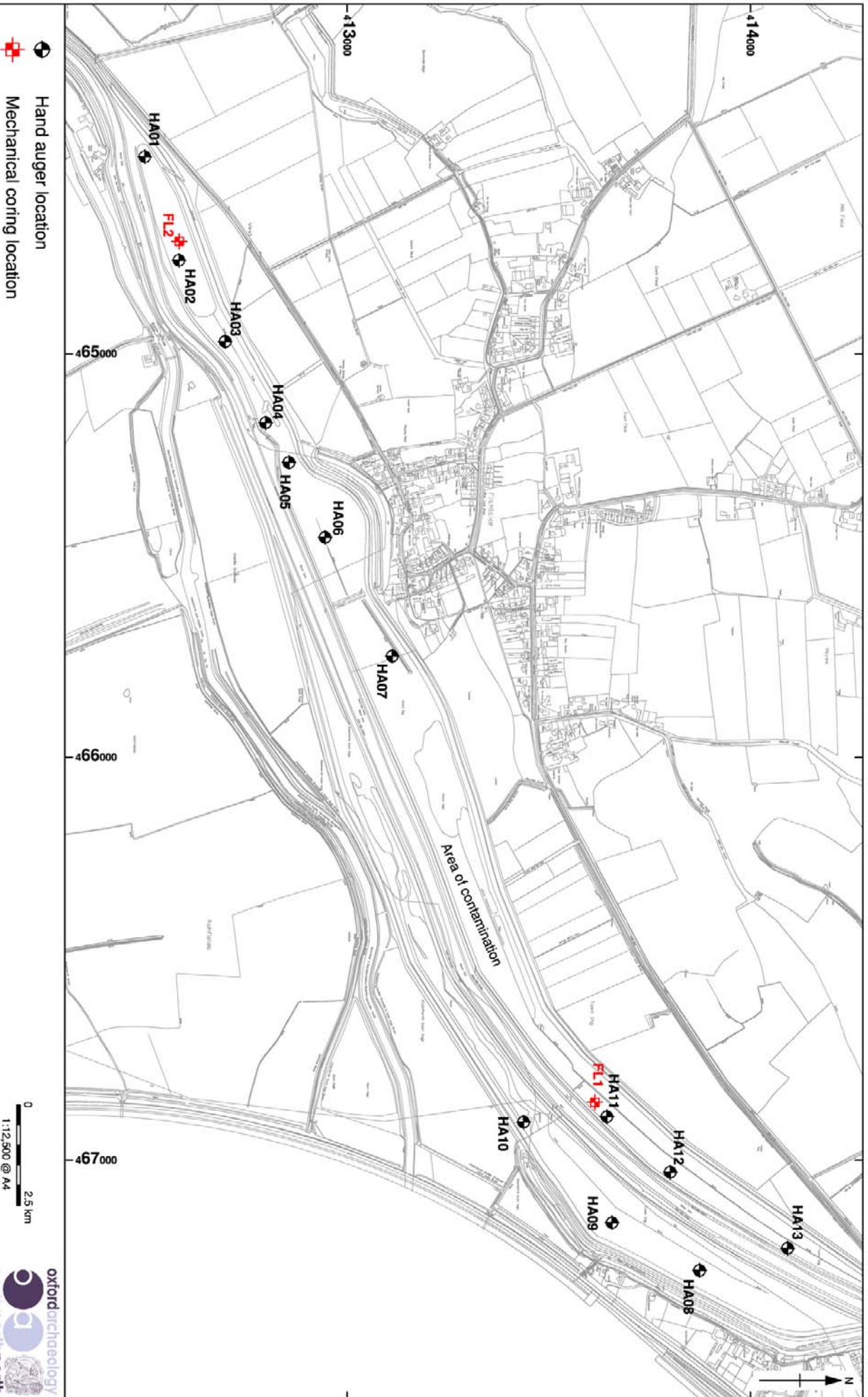


Figure 2: Location of the geotechnical investigations

APPENDIX 1: PROJECT DESIGN

1. INTRODUCTION

1.1 PROJECT BACKGROUND

1.1.1 The Environment Agency (hereafter the 'client'), has requested that Oxford Archaeology North (OA North) submit proposals for a geoarchaeological investigation and scientific dating of the sediment sequence of land adjacent to the River Don, nr Fishlake, Yorkshire (centred NGR 4655 4135), which is proposed as a flood alleviation and habitat creation scheme. The site location plan for the feasibility study area was supplied by Scott Wilson on behalf of the client. Due to the site being within an area of high archaeological potential, the client requested that OA North should assess the sediment sequence that will be impacted on by the proposed development prior to any construction works commencing on site.

1.1.2 **Location, and Topography:** the site is situated on the floodplain of the River Don, between Stainforth in the south-west and Hangsman Hill in the north-east, nr Fishlake, Yorkshire (centred 4655 4135). It covers an area of approximately 4.5 km by 1.25 km.

1.2 QUALITY ASSURANCE

1.2.1 Oxford Archaeology (OA) is a Registered Archaeological Organisation with the **Institute of Field Archaeologists (no 17)**. OA is not at present ISO certified but operates an internal QA system governed by standards and guidelines outlined by English Heritage and the Institute of Field Archaeologists.

1.2.2 **Standards:** it is OA's stated policy to adhere to current professional standards set by IFA, English Heritage, Association of Local Government Archaeological Officers, Museums Organisations. OA helps the profession to develop and establish standards by serving on national working parties (eg recently on archives), and conforms with current legislation and national and local policy standards for archaeology health and safety and other relevant matters.

1.2.3 OA has established technical manuals, procedures and policies which control its work covering field recording, finds retention and discard, finds storage and handling, environmental sampling and processing, archiving and post-excavation. These have been developed to conform with best professional practice.

1.2.4 **Staff:** OA ensures that its staff are fairly recruited, fairly employed, and properly qualified for their work whether by formal qualification or by established and verifiable experience. OA have established terms and conditions of employment and a system of staff representation to ensure regular consultation on employment matters.

1.2.5 **Procurement of services and materials:** OA procures subcontracted work on the basis of value for money, considering quality, track record and service, as well as cost. OA regularly reviews quality of subcontracted work and uses tendering procedures for major sub-contracts.

1.2.6 Procurement of materials is on the basis of quality and availability, as well as cost, especially in respect of long-term storage of archives (OA adheres to archive quality photographic materials and processes, archive quality boxes etc).

1.2.7 **Working Practices:** management procedures ensure that all work conducted within the Company and all end product reports to clients are monitored and evaluated whilst they are in progress, during compilation, and after completion.

1.2.8 **Data Acquisition and Security:** for fieldwork projects OA always removes records and finds from site every day, and ensures equipment is secured.

2. OBJECTIVES

2.1 The investigation aims to:

- Characterise the sequence and patterns of accumulation in the study area along a transect to a maximum depth of 3m, the depth of major stratigraphic units, the character of any potential land surfaces-buried soils within these sediments and to date the upper sediments at two locations;

- Identify significant variations in the deposit sequence indicative of localised features such as topographic highs, or palaeochannels;
- Identify the location and extent of any waterlogged organic deposits and retrieve suitable samples for Optical Luminescence Dating (hereafter OSL dating);
- To make available the results of the investigation.

3 METHOD STATEMENT

3.1 INTRODUCTION

3.1.1 The following work programme is submitted in line with the objectives summarised above.

3.2 AUGER SURVEY

3.2.1 An auger survey will be undertaken along the line of the pylons at approximately 4 metre intervals possibly with some additional cores in the projected line of the Vallum.

3.2.2 The boreholes will be drilled, as specified in the brief, using a terrier rig to retrieve windowless samples in 1 metre lengths. An OA specialist will advise the contractor on the positioning of the boreholes and will be present in the field. It is expected that the cores will be to a depth of four metres although this may be greater if deeper deposits are recorded. The cores will be capped and taken to the laboratory for recording. If the ground is impenetrable by a Terrier rig it may be necessary to use a percussion rig to obtain continuous sampling and therefore there is a contingency for this.

3.2.3 Each location will be recorded in three dimensions with a GPS.

3.2.4 The equipment will comprise a standard terrier rig.

3.2.5 Each location will be augered to a depth of 4m or until the underlying glacial tills-boulder clay have been proven, whichever is reached first and providing no obstructions are encountered.

3.2.6 The profile will be recorded on a summary *pro-forma* sheet and significant layers identified. Relative depths will be noted and a description of the deposits (colour texture, compaction and inclusions) using standard quaternary (Late Devensian and Holocene) terminology will be made. This will follow the English Heritage Geoarchaeology Guidelines (2004).

3.2.7 The project will be carried out by a suitably qualified OA North environmental archaeologist.

3.2.8 The site archive will include both a photographic record and maps showing the locations of the cores.

3.2.9 **Contingency plan:** a contingency costing may also be employed for unseen delays caused by prolonged periods of bad weather, vandalism, discovery of unforeseen complex deposits and which require specialist advice. This has been included in the costing provided at the end of this document and would be charged in agreement with the client.

3.2.10 **Access:** liaison for basic site access will be undertaken through the client and it is understood that there will be access for both pedestrian and plant traffic to the site.

3.3 REPORT AND ARCHIVE

3.3.1 **Report:** three bound copies of a written synthetic report will be submitted to the client together with one on a CD in a single pdf file. The report will include:

- a site location plan related to the national grid;
- a front cover to include the NGR;
- the dates on which the fieldwork was undertaken;
- a concise, non-technical summary of the results;
- an explanation to any agreed variations to the brief, including any justification for any analyses not undertaken;
- a description of the methodology employed, work undertaken and results obtained;
- plans or sections, as necessary, at an appropriate scale showing the location and position of deposits;

- a description of any specialist work undertaken and the results obtained;
 - a copy of this project design and indications of any agreed departure from the details;
 - the report will also include a complete bibliography of sources from which data has been derived.
- 3.3.2 **Confidentiality:** all internal reports to the client are designed as documents for the specific use of the client, for the particular purpose as defined in the project brief and project design, and should be treated as such. They are not suitable for publication as academic documents or otherwise without amendment or revision.
- 3.3.3 **Archive:** the results of all archaeological work carried out will form the basis for a full archive to professional standards, in accordance with current English Heritage guidelines (*Management of Archaeological Projects*, 2nd edition, 1991, UKIC,1990). The project archive will include summary processing and analysis of all features, finds, or palaeoenvironmental data recovered during fieldwork, which will be catalogued by context.
- 3.3.4 The deposition of a properly ordered and indexed project archive in an appropriate repository is essential. The archive will be provided in the English Heritage Centre for Archaeology format and a synthesis will be submitted to the Client.
- 3.3.5 **OASIS:** the data will be entered into OASIS records, the online database of archaeological events.
- ## 4 HEALTH AND SAFETY
- 4.1 OA North provides a Health and Safety Statement for all projects and maintains a Unit Safety policy. All site procedures are in accordance with the guidance set out in the Health and Safety Manual compiled by the Standing Conference of Archaeological Unit Managers (1997). A written risk assessment will be undertaken in advance of project commencement and copies will be made available on request to all interested parties.
- 4.2 Full regard will, of course, be given to all constraints (services etc) during the geoarchaeological investigation as well as to all Health and Safety considerations. As a matter of course the Unit uses a U-Scan device prior to any excavation to test for services, however, this is **only an approximate location tool**. Any drawings or knowledge of live cables or services that may pose a risk to OA North staff during evaluation **must be made known to the project manager** of OA North before site work. This will ensure the risk is dealt with appropriately.
- 4.3 A portable toilet with hand washing facilities will be provided and located on or adjacent to the site.
- 4.4 Any known contamination issues or any specific health and safety requirements on site should be made known to OA North by the client or main contractor on site to ensure all procedures can be met.
- 4.5 Should areas of previously unknown contamination be encountered on site the works will be halted and a revision of the risk assessment carried out. Should it be necessary to supply additional PPE or other contamination avoidance equipment this will be costed as a variation.
- ## 5 OTHER MATTERS
- ### 5.1 WORK TIMETABLE
- 5.1.1 **Auger Survey and retrieval of samples for OSL dating:** approximately three days will be required to undertake the fieldwork for this element.
- 5.1.2 **OSL dating:** it is expected that the results of the OSL dating will be available in 2-4 months.
- 5.1.3 **Report:** the report and archive will be produced following the completion of all the fieldwork and return of the OSL dating results. Submission of the report will be dependent on the availability of the results of the OSL dating. The archive will be deposited within six months of completion of the report.
- 5.1.2 **Scheduling:** following receipt a formal written agreement OA North would be able to commence the work early in January 2009.

5.2 INSURANCE

5.2.1 OA North has a professional indemnity cover to a value of £2,000,000; proof of which can be supplied as required.

6. STAFFING

6.1 The project will be under the direct management of **Emily Mercer** (OA North Project Manager) to whom all correspondence should be addressed.

6.2 The fieldwork will be undertaken by an OA North environmental archaeologist experienced in this type of project. Due to scheduling requirements it is not possible to provide these details at the present time. All OA North environmental archaeologists are experienced in auger surveys and will be under the direction of **Elizabeth Huckerby** (OA North environmental manager).

6.3 The OSL dating will be undertaken under the auspices of **Professor Andreas Lang** and **Dr Barbara Mauz** of the **Geography Department, Liverpool University**.

REFERENCES

English Heritage, 1991 *Management of Archaeological Projects*, second edition, London

English Heritage, 2004 *Geoarchaeology: using Earth Sciences to understand the archaeological record*, London

SCAUM (Standing Conference of Archaeological Unit Managers), 1997 *Health and Safety Manual*, Poole

UKIC, 1990 *Guidelines for the Preparation of Archives for Long-Term Storage*, London

APPENDIX 2: HAND AUGER LOGS

HA no.	NGR	OD height (m) of ground surface	Depth-1 (m) BGL	Depth-2 (m) BGL	Lithology
01	4645 4125	3.71	0	0.5	topsoil
			0.5	0.7	topsoil with clay
			0.7	2.4	very mottled (oxidised) blue-grey clay
02	4648 4126	3.38	0	0.45	topsoil
			0.45	1.95	very mottled (oxidised) blue-grey clay
			1.95	2.35	blue-grey clay
			2.35	2.5	blue-grey clay with wood remains
			2.5	3.0	dark grey clay with wood and hazelnuts
03	4650 4127	3.28	0	0.5	topsoil
			0.5	2.1	very mottled (oxidised) blue-grey clay
			2.1	2.4	blue-grey clay with wood (ash?) remains
			2.4	3.6	brown clay with wood remains
04	4652 4128	3.68	0	0.7	topsoil
			0.70	1.5	very mottled (oxidised) blue-grey clay
			1.5	2.25	orange-brown clay
			2.25	2.5	brown clay silt
			2.5	3.0	brown silt
05	4653 4128	4.20	0	0.7	topsoil
			0.7	1.0	orange-brown silt
			1.0	2.3	brown organic clay silt
			2.3	2.8	very mottled (oxidised) blue-grey clay
			2.8	3.0	blue-grey silty clay
06	4654 4129	3.04	0	0.5	topsoil
			0.5	1.25	brown silty loam
			1.25	2.3	blue-grey clay
			2.3	2.5	wood-degraded wood and clay
			2.5	3.0	blue-grey clay with wood remains
07	4657 4131	3.11	0	0.3	topsoil
			0.3	1.75	very mottled (oxidised) blue-grey clay
			1.75	2.25	blue-grey clay
			2.25	2.4	very organic clay with wood fragments
			2.4	3.5	organic clay with wood remains
08	4673 4139	3.40	0	0.3	topsoil
			0.3	0.5	topsoil with clay
			0.5	1.25	blue-grey mottled (oxidised) clay

			1.25	1.80	grey-brown silty sand
			1.8	2.5	orange silty sand
09	4671 4136	3.37	0	0.3	topsoil
			0.3	2.4	very mottled (oxidised) blue-grey clay
10	4669 4134	2.60	0	0.3	topsoil
			0.3	0.75	very mottled (oxidised) blue-grey clay
			0.75	3.5	orange-brown clay silt
11	4669 4136	3.47	0	0.3	topsoil
			0.3	0.5	topsoil with clay
			0.5	0.9	very mottled (oxidised) blue-grey clay
			0.9	1.2	orange clay silt
			1.2	1.75	orange silty sand
			1.75	2.25	orange silt with bands of clay; highly mixed deposit
12	4670 4138	3.47	0	0.3	topsoil
			0.3	0.7	orange clay silt
			0.7	1.8	orange silt
			1.8	3.0	orange silt with bands of clay; highly mixed deposit
13	4672 4140	3.62	0	0.1	topsoil
			0.1	0.6	orange-brown clay (stiff)
			0.6	1.0	sandy silt, band of clay at base
			1.0	1.2	orange-brown silty clay
			1.2	1.5	orange clay silt
			1.5	2.5	orange silt with bands of clay; highly mixed deposit

APPENDIX 3: OSL LABORATORY REPORT

Dating Laboratory
Luminescence
University of Liverpool

ph.: ++44-151-7942850
fax : ++49-151-7942866
email: mauz@liv.ac.uk
www.liv.ac.uk/geography/OSL

Department of Geography

Liverpool L69 7ZT
UK

Liverpool, 2nd July 2009

Dr. Barbara Mauz

Susan Packman

Report on luminescence age estimation

Samples (laboratory codes): LV372, 373, 374, 375

Origin: Fishlake, Yorkshire

Collaboration with: Denice Druce, Oxford Archaeology North, order number: L3789

Sample collection: 4th March 2009

Arrival of samples: 5th March 2009

Sample preparation

1. Drying samples for water content measurement and gamma spectrometry
2. Packing for gamma spectrometry
3. Wet sieving and preparation of 150-180 μm grains for LV373, and 90-150 μm grains for LV375.
4. Removal of organics with H_2O_2 and carbonates with HCl acid (no reaction).
5. Mineral separation using heavy liquids at 2.62 s.g. and 2.76 s.g.
6. 48% HF for 40 minutes.
7. Re-sieving at 100 μm for LV373 and 90 μm for LV375.

LV372 and LV374 were discarded from further analysis after a discussion with Denise Druce on the 18th March 2009. Therefore, all samples underwent steps 1 and 2 (in list above) and only LV373 and LV375 were processed through steps 3-7.

Equivalent dose (D_e) determination of quartz samples

Equipment: Risø TL/OSL reader, EMI 9635QA photomultiplier, 41 blue LEDs

Irradiation: $^{90}\text{Sr}/^{90}\text{Y}$ β -source, dose rate: $0.092 \pm 0.0015 \text{ Gy s}^{-1}$

Risø I Stimulation: 41 blue LED's emitting $470 \pm 30 \text{ nm}$, delivering $\sim 30 \text{ mW cm}^{-2}$ (at 90% power), IR – 1 1W laser diode $830 \pm 10 \text{ nm}$, delivering 270 mW cm^{-2} (at 90% power and 160 mW cm^{-2} at 60% power)

Detection: Hoya U340, 7.5mm transmitting $\sim 260 - 390 \text{ nm}$

Measurement protocol: single aliquot regenerated dose using ≥ 100 aliquots per sample of 2 mm size; preheat according to results from preheat tests.

Dose rate determination

Equipment: 1) γ -spectrometer, coaxial Ge-detector, efficiency 33%, low level design; external dose rate: element concentration of U, Th, and K resulting from low level γ -spectrometry; energy conversion: Ademiec and Aitken (1998); attenuation of β -rays in quartz grains: Mejdahl (1979); internal dose rate of quartz has not been determined, but assumed to $0.03 \pm 0.01 \text{ Gy ka}^{-1}$. Cosmic ray contribution was estimated by means of the mean burial depth of the sample (Prescott and Hutton, 1994).

Systematic uncertainties

The following were considered: water content, γ -spectrometry, source calibration, cosmic ray contribution, internal dose rate of quartz.

Total uncertainty

This was calculated using error propagation including systematic uncertainties and random uncertainties from the sample; in the table quoted at the 1σ level.

Data and rights

All analytical data are listed in the tables. All rights on the analytical data presented here are preserved to the Luminescence Dating Laboratory of the University of Liverpool.

Report:

All samples were subjected to: a) D_e test and b) preheat/dose recovery test before a full D_e analysis was conducted. The quartz of the 2 samples showed a number of unsuitable properties:

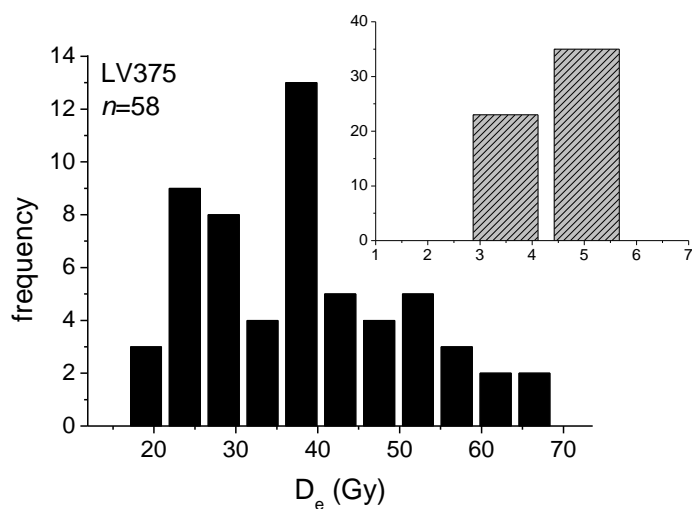
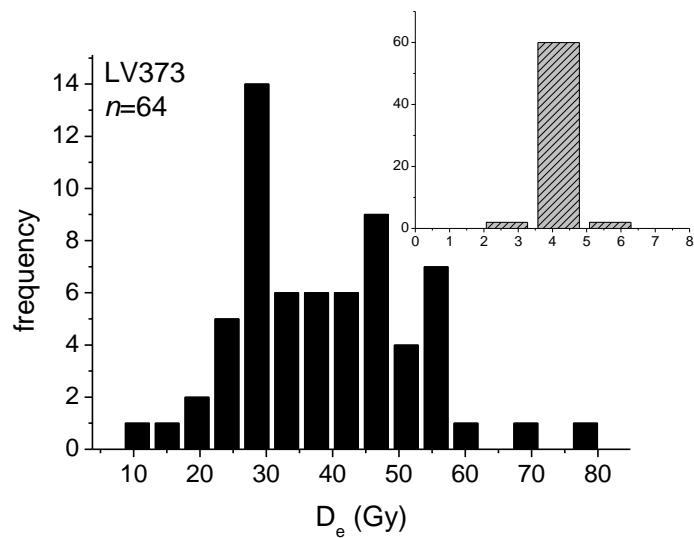
- low sensitivity to laboratory dose
- lack of purity (feldspar contamination)
- large slow component and partly an ultrafast component

Dominant reason for rejection of aliquots was thermal transfer being $>5\%$ of the natural signal and poor recycling ratio confirming the above listed properties. LM-OSL measurements on three aliquots for each sample further confirmed that an ultrafast component was present. Generally five components were required for best-fit analysis: ultrafast, fast, and slow 1, 2 and 3. Various methodologies were applied to find the most suitable measurement procedure to remove the ultrafast component. A double SAR approach was chosen, with a high temperature heating of $280^\circ\text{C}/10\text{s}$ prior to measurement of all OSL signals from 2mm aliquots. In addition high temperature stimulation was given after each test dose measurement to reduce the effects of thermal transfer.

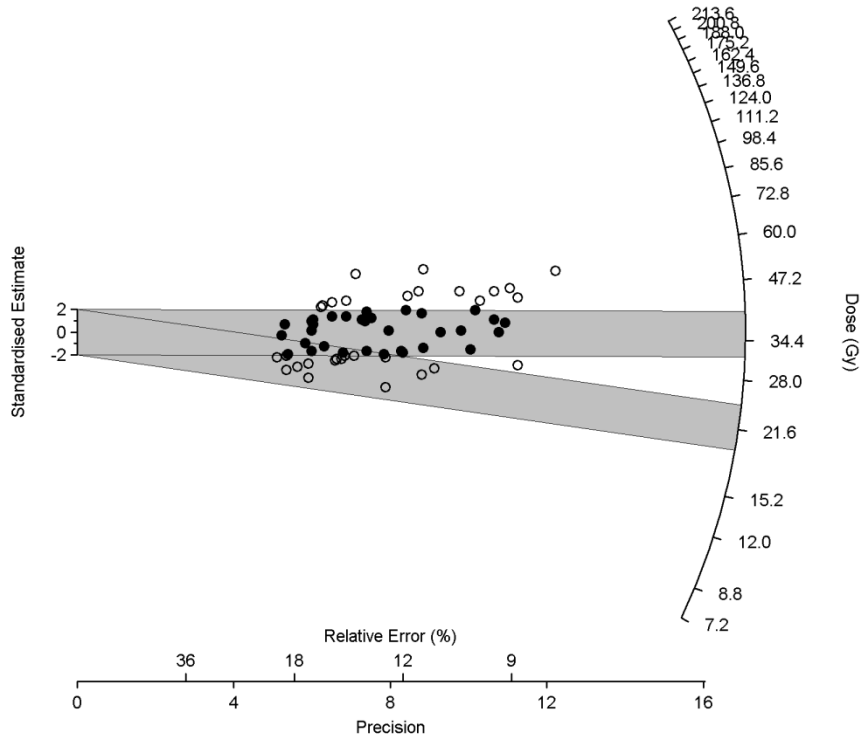
Results:

LV#	Depth in core (cm)	<i>n</i>	Mean D_e (Gy)	σ	MAM D_e (Gy)	Water content (%)	Dose rate (Gy/ka)	Age ($ka \pm 1\sigma$)
372	80-70					26 \pm 2		
373	92-82	144	36.6 \pm 1.6	40	22 \pm 3	23 \pm 2	2.25 \pm 0.11	9.8 \pm 1.4
374	94-79					23 \pm 2		
375	68-47	135	36.1 \pm 1.7	36	22 \pm 2	24 \pm 2	2.55 \pm 0.14	8.6 \pm 0.9

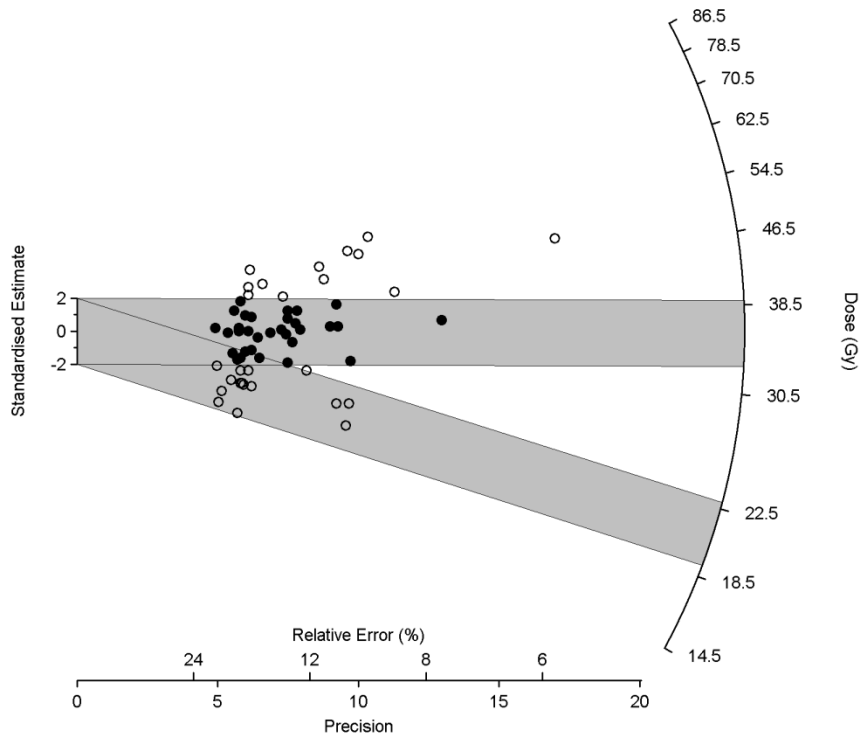
Within error margins both samples have the same early Holocene age.



Histograms of D_e data from LV373 and LV375. Insets show $\log D_e$ data (dashed gray). The dose distribution is very wide, typical for a fluvial sediment. It is characterised by poor bleaching and inhomogeneous sediment matrix, revealed by the $\log D_e$ distribution (in gray). This is also a typical characteristic of alluvial sediments. The distribution of LV375 is more skewed than the one of LV373.



LV373. Radial plot of D_e data. Middle grey bar points to the mean value (~ 36 Gy), lower bar points to the D_e resulting from MAM-3 statistics ($D_e=22\pm 3$ Gy).



LV375. Radial plot of D_e data. Middle grey bar points to the mean value (~ 36 Gy), lower bar points to the D_e resulting from MAM-4 statistics ($D_e=22\pm 2$ Gy).

APPENDIX 4: RADIOCARBON DATING CERTIFICATES



Scottish Universities Environmental Research Centre

Director: Professor A B MacKenzie Director of Research: Professor R M Ellam

Rankine Avenue, Scottish Enterprise Technology Park,
East Kilbride, Glasgow G75 0QF, Scotland, UK

Tel: +44 (0)1355 223332 Fax: +44 (0)1355 229898 www.glasgow.ac.uk/suerc

RADIOCARBON DATING CERTIFICATE

19 June 2009

Laboratory Code SUERC-24066 (GU-19088)

Submitter Denise Druce
Oxford Archaeology North
Mill 3, Moor Lane Mill
Lancaster
LA1 1GF

Site Reference Fishlake, Yorkshire
Sample Reference Core Site 2: 2.89-2.91m

Material Organic Sediment : Humic Acid

$\delta^{13}\text{C}$ relative to VPDB -27.5 ‰

Radiocarbon Age BP 3005 \pm 35

- N.B.**
1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.
 2. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal3).
 3. Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :-

Date :-

Checked and signed off by :-

Date :-

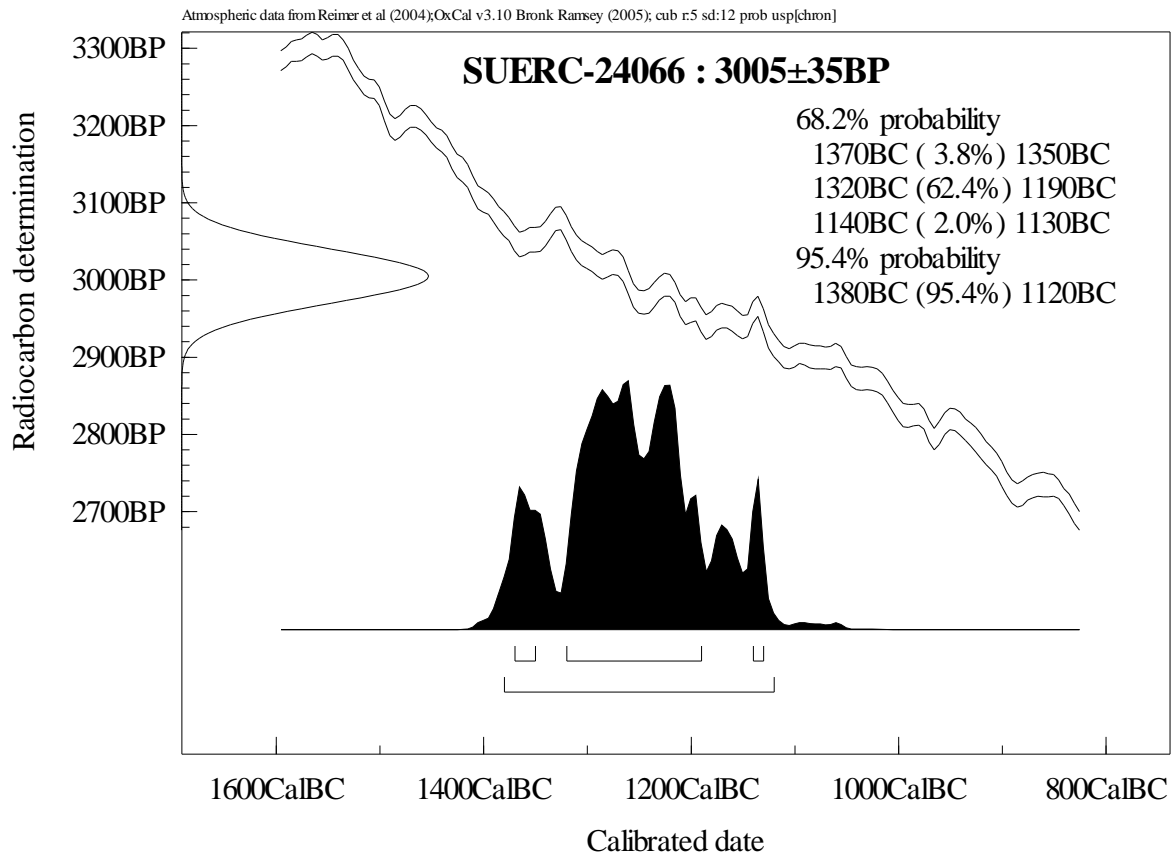


The University of Glasgow, charity number SC004401



The University of Edinburgh is a charitable body,
registered in Scotland, with registration number SC005336

Calibration Plot





Scottish Universities Environmental Research Centre

Director: Professor A B MacKenzie Director of Research: Professor R M Ellam

Rankine Avenue, Scottish Enterprise Technology Park,
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RADIOCARBON DATING CERTIFICATE

19 June 2009

Laboratory Code SUERC-24067 (GU-19089)

Submitter Denise Druce
Oxford Archaeology North
Mill 3, Moor Lane Mill
Lancaster
LA1 1GF

Site Reference Fishlake, Yorkshire
Sample Reference Core Site 2: 3.42-3.44m

Material Organic Sediment : Humic Acid

$\delta^{13}\text{C}$ relative to VPDB -27.5 ‰

Radiocarbon Age BP 3503 \pm 35

- N.B.**
1. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.
 2. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal3).
 3. Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Conventional age and calibration age ranges calculated by :-

Date :-

Checked and signed off by :-

Date :-

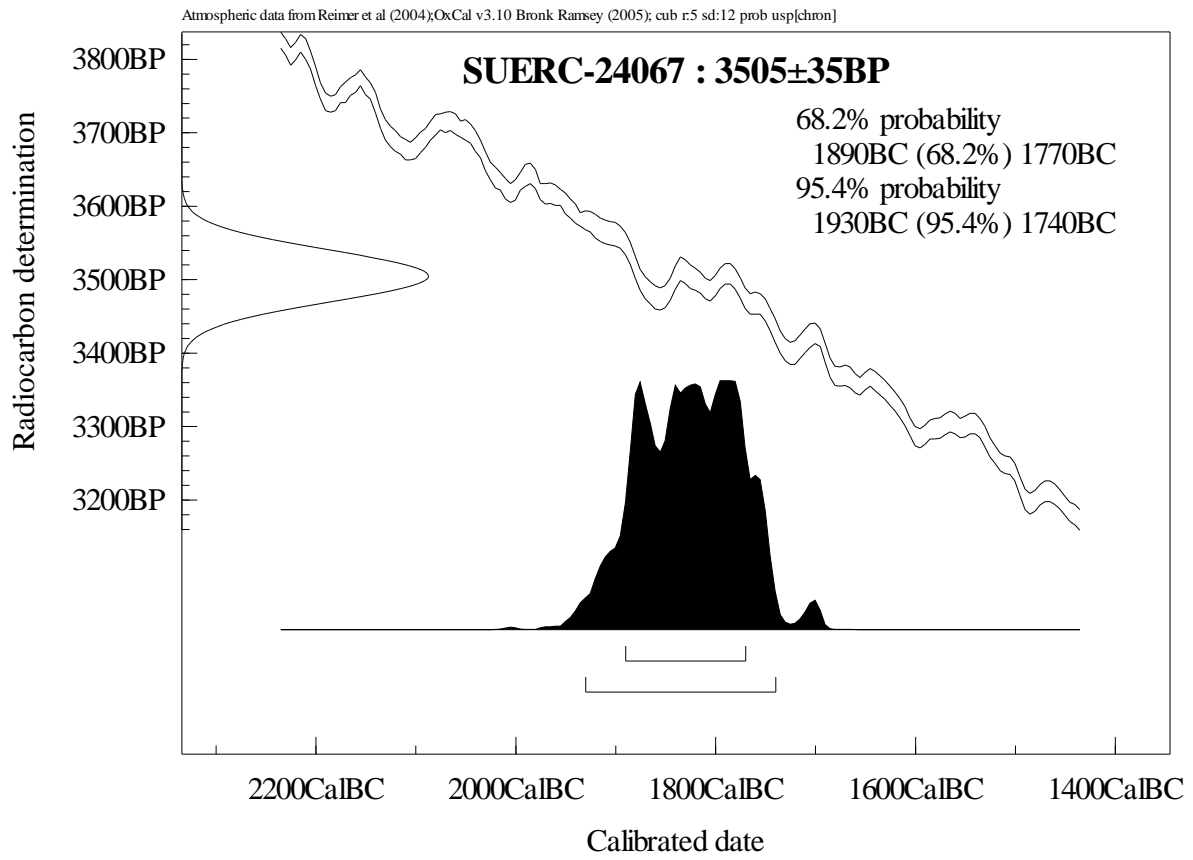


The University of Glasgow, charity number SC004401



The University of Edinburgh is a charitable body,
registered in Scotland, with registration number SC005336

Calibration Plot



Atmospheric data from Reimer et al (2004);OxCal v3.10 Bronk Ramsey (2005); cub r:5 sd:12 prob usp[chron]

