



ALSF AGGREGATE EXTRACTION IN THE KIRKHAM AREA

Project Design



Oxford Archaeology North



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1. INTRODUCTION

1.1 BACKGROUND

- 1.1.1 In April 2005 English Heritage commissioned Oxford Archaeology North (OA North) and the Department of Geography, Liverpool University, to undertake a programme of investigation into the potential impact of sand and gravel mineral aggregate extraction on the archaeological resource of the Ribble Valley, in Lancashire and North Yorkshire. With the exhaustion of some substantial mineral extraction sites around Preston, there is potential for the establishment of new sites, which would have an inevitable impact upon the known and yet to be identified archaeology of the area. The original study examined the high-pressure area for sand and gravel extraction in the Ribble Valley, but it also estimated the mineral aggregate resource base within the wider region to understand the character of the known resource.
- 1.1.2 The original project was designed building on groundwork by Jennie Stopford (EH), developing the original brief and building links with Lancashire County Council and the Environment Agency. The Project Design also benefited from discussions with Peter Iles, Lancashire County Archaeologist, Dr Susan Stallibrass, English Heritage Scientific Advisor for the North West, and EH personnel (OA North and Liverpool University 2005). This provided for two study areas in the Lower Ribble Valley and the Upper Ribble. The Lower Ribble study area, between Preston and Sawley, was a known area of soft aggregate extraction and had considerable potential for the expansion of the industry to exploit new reserves. The Upper Ribble area, between Settle and Hellifield, had been identified as an additional potential resource of soft aggregate and as such had the potential for exploitation.
- 1.1.3 A key outcome from the original project was the recognition of additional areas of potential aggregate extraction within and around the study areas, and in particular two areas were identified as priorities for subsequent study~ the Kirkham end moraine and the Craven Lowlands. The programme of research undertaken during the original Ribble ALSF project developed methodologies and datasets that make important contributions to the disciplines of archaeology, geomorphology and Quaternary Science. The original research programme has provided a considerable need for publication targeting both academic and lay audiences. The publication programme is a key component and is outlined in this project design. The additional areas proposed for study have equal justification because both have long histories of aggregate extraction, contain current or recent planning applications and are targeted areas of search in both counties (pers. comm. Yorkshire County Council Minerals Officer; Entec, 2005; Geoplan 2006). In the context of a coherent research design targeting the Kirkham moraine in the first instance makes strategic sense for a number of reasons: overlap in terms of mineral type (sand and gravel) with the original Ribble contract, relevance and contribution to items in the publication programme; and the landbank status for sand and gravel aggregate is more pressing than that for solid aggregates in either county. Consequently the new research component of this project design focuses on sand and gravel mineral extraction in the Kirkham area, but uses a modified study area outline that reflects the true extent of deposit rather than the arbitrary outlines defined in the Entec and Geoplan reports and the programme of work will enhance understanding of the distribution of workable mineral. It is important iterate that the focus on sand and gravel mineral deposits does not denude

the value of future work in the Craven Lowlands, but with the time constraints of the current ALSF round Kirkham is a more pressing concern.

- 1.1.4 **Kirkham End Moraine:** assessment of the Kirkham End Moraine complex (NGR SD 420 320) (Fig 1) shows that the area has considerable potential for usable mineral, but at present our knowledge of the mineral resource is poor. The improved understanding of the deglacial history arising from the original project can be used to inform future sand and gravel investigation within the county; identifying ice-marginal settings, glaciofluvial or lake-edge glaciolacustrine environments around the Lower Ribble glacial lake, should highlight excellent candidate locations for good-quality aggregate. Geomorphological interpretation linked to the available borehole and section evidence would improve an understanding of the distribution of minerals within the moraine complex. Clearly, the Kirkham moraine is an Area of Search that would benefit from detailed investigation of the geomorphology and Quaternary geology. However, the extent and nature of the aggregate is poorly constrained within earlier reports (eg Geoplan Ltd 2006), although the area has been the subject of three planning applications and sustained mineral aggregate extraction in the last 20 years. One of the main constraints is that the geomorphology of the region is poorly understood and, given the ice marginal context, proximity to the edges of major ice streams and association with the Ribble ice-dammed lake, considerably more could be achieved through a programme of geomorphological research.
- 1.1.5 Apart from limited fieldwork during the English Heritage-funded North West Wetlands Survey, the area has been subject to relatively little archaeological work, and the HER for this area is consequently limited. However, the limited investigations undertaken suggest that the area has a rich archaeological resource. The moraine lies to the south of the extensive Fylde wetlands, and settlement activity seems to have been concentrated on these better drained areas. It therefore has a relatively high density of archaeological remains from all periods; in particular, the area has been described as ‘one of the most dense areas of Neolithic and Bronze Age activity in the North West’ (Middleton 1996, 96). A series of Roman camps, culminating in a stone-built fort of the second century, attest to a Roman military presence to the west of Preston (Howard-Davis and Buxton 2000), which was linked to Ribchester and Walton-le-Dale by a network of roads. The extent to which the extensive wetlands acted as a block to settlement in the medieval period is difficult to assess; however, the one principal town in the area developed on the moraine at Kirkham and there is a concentration of medieval settlement to the south of the Fylde wetlands. Palaeoenvironmental research in the area has been limited so far to the work undertaken as part of the North West Wetlands Survey, and Tooley’s work (1978) on sea-level change.
- 1.1.6 The project proposed below would extend the study area of the Ribble Valley ALSF Aggregate Extraction project to encompass (1) the Lancashire County Council *Minerals Plan* Areas of Search within the Kirkham End Moraine region (Fig 1).
- 1.1.7 The work programme presented differs from a previously submitted variation (OA North and Liverpool University 2006), in that it is tightly focused on a relatively small area identified as containing significant potential resources for mineral aggregate, which were beyond the scope of the original project. The work programme is also achievable within an eight month timeframe, as a result of benefits gained from the original project, such as the completion of an agreed and compatible database structure. This project design is presented in accordance with English

Heritage's guidelines for *Management of Archaeological Projects* (MAP 2) (English Heritage 1991).

2. AIMS AND OBJECTIVES

2.1 AIMS

2.1.1 The aims of this project, like those of the original ALSF Aggregate Extraction in the Ribble Valley Project (OA North and Liverpool University 2005), are principally to provide baseline data to assess the potential impact of aggregate extraction in the study area upon the archaeological and palaeoenvironmental resource, as defined in Objective 2 of the Aggregates Levy Sustainability Fund (English Heritage 2005a). The aims are thus:

- to produce data that contributes to the needs of both planners and curators, and the archaeological community at large;
- to establish the effect that extraction has had and may continue to have on the archaeological and palaeoenvironmental resource;
- to enable a better understanding of the archaeological resource within the archaeological community and amongst the aggregate industry stakeholders;
- to allow better working practices to be developed, facilitating interaction and understanding between the archaeologists and other professionals.

2.2 OBJECTIVES

2.2.1 The proposed project will highlight those areas within the defined areas that are most likely to be affected by short-term proposals for aggregate and sand extraction, as defined by the Lancashire County Council *Minerals Plan* (Entec, 2005; Geoplan Ltd 2006), and also the long-term potential for extraction as determined by geological constraints. The project will have the following objectives:

- i) to collate, within a GIS, all available data on past, current and future aggregate extraction within the proposed study areas, including British Geological Survey BritPits data and the Directory of Mines (BGS), Lancashire (LCC) or Regional Aggregate Working Party (NW RAWP) sources;
- ii) to map within the GIS the mineral aggregate resources within areas of search, drawing upon BGS maps, and published and unpublished academic geomorphological and geological mapping;
- iii) to assess the character and condition of the archaeological resource;
- iv) to enhance the Lancashire HER by means of documentary and secondary sources, and by linking into the Environment Agency and National Rivers Authority historic environment reports and database, the Historic Landscape Characterisation for Lancashire HLC (Ede and Darlington 2002), and the Countryside Agency Joint Character Areas for the North West region (Countryside Agency 2005);
- v) to undertake a comprehensive GIS-based survey of the late Quaternary and Holocene geomorphology, using a combination of field survey and LiDAR/NextMAP elevation data. Field survey and LiDAR data will allow comprehensive identification of the glacial landforms and geology, and assess

- the potential for workable aggregate deposits within the glacial outwash and ice contact geology;
- vi) to undertake a comprehensive assessment of the boreholes in the archives of the BGS and Highways Authorities and to undertake field recording of available sections in current and former extraction sites;
 - vii) to undertake a survey of published and unpublished archaeological, geoarchaeological, and geomorphological research to produce a greatly enhanced GIS database;
 - viii) to examine the potential impact upon the archaeological and palaeoenvironmental resource of changes to the ground-water levels, caused by aggregate extraction or other similar intrusions to the landscape.
 - ix) to produce a range of academic journal articles, and also develop a popular publication intended for a 'lay audience' that documents the 'landscape and cultural development of the Ribble Valley', which would be targeted at the local community.

3. METHODOLOGY

3.1 AREA OF STUDY

3.1.1 The study area has been defined to investigate areas of sand and gravel in the glacial terrain of the Kirkham area, which has the potential to be exploited for aggregate. The proposed area of study is based on the Ribble ALSF project (OA North and Liverpool University 2007), interpretation of the available geological mapping, and the knowledge gained from the *Minerals Plans* Area of Search (Geoplan Ltd 2006) (Fig 1).

3.2 MANAGEMENT AND PROJECT CO-ORDINATION (TASKS 1-4)

3.2.1 ***Project Management (Tasks 1 and 2)***: the project is a joint endeavour between the OA North and Liverpool teams that worked on the original project (OA North and Liverpool University 2007) and, as such, some project management occurs in each organisation. OA North provides the overall Project Manager who is the main contact for English Heritage and responsible for overall project management and the financial management of the project. The co-ordination and running of each element of the project will be undertaken by appropriate lead-members within each team, using the experience gained in the Ribble ALSF project (*ibid*).

3.2.2 ***Liaison and Management Meetings (Task 3)***: regular liaison between the collaborators is crucial to the success of projects of this nature, and will be particularly important in the initial stages of the research. Liaison between OA North and Liverpool University has, during the Ribble ALSF project, been facilitated through the use of a dedicated file store server, websites, email contact and telephone, typically on a weekly basis.

3.2.3 ***Project Management (Task 4)***: project progression will be guided by project management meetings attended by RC, JQ and JS, who will review progress of the project against the goals and timetable as defined in the Task list and the associated Gantt chart (*Appendix 2*).

3.2.4 ***GIS preparation (Task 5)***: the digital infrastructure has been set up and tested during the Ribble ALSF project (*ibid*) and so there is added value from this project. For instance, there will only need to be a limited amount of initial liaison over any revisions to the design of the database and GIS systems. The GIS component is developed in ArcGIS 9.0-9.2, using the 3D and Spatial Analyst extensions. Output of vector GIS data will be in shapefile or geodatabase format. This will not only allow us to produce output that is compatible with other systems, eg Mapinfo and other bespoke systems, but will provide the most functionality and flexibility during the project and for the end users. The database format is Access 97, which is backward compatible with previous Access formats, can be read by all later formats, and can be readily imported into other database formats as required. The use of ArcGIS and Access allow for full interactivity between the two components. During the Ribble ALSF project (OA North and Liverpool University 2007), compatibility was ensured with the major stakeholders (EH, LCC, EnAg and ADS) and this approach will be continued here.

3.2.5 **Modern Mapping (Task 6):** this project will require the collation of a wide range of contemporary mapping data for the study areas, although much of this is already available from the Ribble ALSF project and so this task is essentially a check for comprehensive coverage for the new study areas. The datasets are the Ordnance Survey (OS) Mastermap coverage (under County Council licences), Digital Elevation Datasets from the Environment Agency (LiDAR), NextMAP coverage purchased from Intermap technologies, and the OS Profile dataset. Other sources of information already compiled that are crucial for the project include environmental constraint information from English Nature (SSSIs, NNRs, etc), historic environment information from English Heritage, and agricultural land usage (DEFRA), all from the MAGIC web site. The MAGIC site contains further statutory information, such as the boundaries of the Forest of Bowland AONB, Sites of Special Scientific Interest (SSSIs), Scheduled Monuments, Listed Buildings, Registered Parks and Gardens, Parishes, and Townships, and District Boundaries. HLC mapping is available for Lancashire from 2002 (Ede and Darlington 2002) and was incorporated and enhanced within the GIS for the Ribble ALSF project (OA North and Liverpool University 2007). Further enhancement of HLC data for the new study areas will be completed and will allow the modern landscape to be set in context, and identify locations that may have been used for past aggregate extraction.

3.3 DESK-BASED DATA COLLECTION AND ANALYSIS: NEW AREA

3.3.1 **Collate Available Geological Data (Task 7):** some preliminary analysis and compilation of necessary datasets was achieved during the Ribble ALSF project, but this needs to be built on to ensure comprehensive coverage. All data compilation will be on a GIS framework underpinned by OS Mastermap baseline mapping, and the location, characteristics and age of all deposits potentially exploitable for aggregates within the study area will be collated. Evidence of usable aggregate sources will be derived from the Lancashire Mineral Planning Authority record of current and old aggregate permissions, and the current *Minerals* and *Waste Local Plans* (Geoplan Ltd 2006). Records of active, dormant and exhausted quarry workings will be collated from the BGS BritPits datasets, which records all quarry workings since 1835. Additional information on current and past workings will be derived from the North West England Regional Aggregate Working Parties (RAWP), and the Lancashire *Minerals* and *Waste Local Plan* will be consulted. Lancashire County Council has commissioned three sand and gravel surveys in the last 15 years (Allot and Lomax Ltd 1990; ENTEC UK Ltd 2005; Geoplan Ltd 2006), and these identified preferred areas of search, but none of them have been underpinned by a geomorphological and lithofacies-based analysis to enhance understanding of the spatial pattern of deposits outside the outlines provided by British Geological Survey (BGS) maps. BGS digital mapping will be incorporated within the GIS as a first approximation for the sand and gravel (drift) aggregate. Understanding of the sand and gravel mineral (Kirkham) will be greatly enhanced with this programme.

Data sources	Availability
BGS 1:50,000 mapping	LCC licence
BGS Britpit database	Costed (<i>Section 5.4</i>)
LCC A ggregate Surveys	Available
LCC, Minerals and Waste Local Plan	Available
LCC Extinct, Dormant and Active pits	Available

NW RAWP reports	Available
Academic papers and unpublished work	Available

- 3.3.2 **Obtain and Incorporate Data Sources about Aggregates (Task 8):** the aggregate data sources will be incorporated within the GIS framework and used to formulate a sampling strategy to obtain borehole information from the BGS and Highways Authorities borehole archives. The borehole information will be used to enhance the aggregate mapping, and identify the nature of deposits. The large existing database of boreholes obtained during the Ribble ALSF project (OA North and Liverpool University 2007) will be consulted throughout to avoid duplication of effort. The products of this investigation will be an enhanced aggregate assessment and GIS archive of borehole information. The geological data will also underpin subsequent investigation of the Quaternary and Holocene geomorphology.
- 3.3.3 **Historic Mapping (Task 9):** a range of historic maps for the study areas will be consulted, including, amongst others, Saxton (1577), Speed (1610), and Yates (1786), along with the tithe maps for the areas. The OS 1st edition maps at 1:10,560 scale (published 1844-1852), and also OS 2nd and 3rd edition maps at 1:10,560 will be included. The historic OS maps have been Scanned and georeferenced for use in a GIS by The Lancashire County Archaeological Service. It has been agreed to loan copies of these maps to OA North for the duration of the Kirkham ALSF project. The earliest maps, however, may not be of sufficient accuracy to be fully georeferenced. This work will inform a map regression for the study areas, to identify archaeological remains and worked-out quarries, all of which may have had an historic impact on the archaeological resource.
- 3.3.4 **Aerial Photographs (Task 10):** historic and contemporary aerial photography will be studied in order to identify new archaeological and palaeoenvironmental features, such as buried palaeochannels, in the study areas, and to enhance the dataset of previously known features. Discussions have been undertaken with David MacLeod, Head of Mapping and Reconnaissance of the English Heritage Aerial Survey Team, in connection with the incorporation of the new study area into the English Heritage National Mapping Programme. As there is potential to expand on this earlier survey, through the use of the LiDAR data, it would be sensible to ensure that the output is compatible with the aerial photography database in the NMR. Further discussions with the Aerial Survey Team will be implemented to facilitate this. For the Kirkham area, aerial photography will be obtained from the HER and NMR and will be used to augment the LiDAR survey, and in particular will provide coverage of those areas where LiDAR coverage is unavailable.
- 3.3.5 **Archaeological and Palaeoenvironmental Data Capture (Task 11):** the Lancashire Historic Environment Record (HER) will be accessed for the new study area. These are available in database form, and will be incorporated into the GIS as the primary source of information on archaeological interventions in the study area. A further search will be undertaken of both published and unpublished literature, in the form of university theses and grey literature, such as commercial client reports, with the aim of producing a bibliography of archaeological and palaeoenvironmental interventions. If new interventions are identified as a result of this procedure they will be added to the archaeological database and GIS layer, otherwise data on known sites will be used to enhance the relevant entry in the database. The work will also entail data capture for the new area from the Lancashire Record Offices, and the NMR.
- 3.3.6 Likely sources of grey literature will be the records of commercial archaeological work in the study area, many of which will be recorded in the Archaeological

Investigations Project (AIP), compiled by Bournemouth University. It is anticipated that the HER and AIP will provide basic data on these events, which may be followed up by correspondence with the units identified as required, and any enhancements to the information in the HER will then be added to the archaeological database. The search will include investigation of a broad range of methodological approaches that will be appropriate to the investigation and analysis of aggregates, and will link in with other aggregate studies undertaken elsewhere in the country.

- 3.3.7 ***Integration and analysis of aggregate, environment and heritage datasets (Task 12)***: the aggregate, palaeoenvironmental and heritage data, compiled in Tasks 5-11, will be assimilated and entered into the database. The data entry will incorporate a transcription of the results of each dataset and will be georeferenced, where possible, within the dataset. The usability of this dataset will necessitate that it is properly cross-referenced and sourced. Given the size of the datasets, this will be a time-consuming process.
- 3.3.8 Spatial analysis of coincidence of archaeological heritage and usable aggregates involves interrogating the heritage data with respect to both the identified aggregate prospects and geomorphological/geological data. The GIS will be used to interrogate the data from the perspective of a particular type of heritage site, or by archaeological period, for particular aggregate types, or for geological / geomorphology substrate ages and types.
- 3.3.9 ***Incorporation, processing and analysis of DEM datasets (Task 13)***: the GIS database will be enhanced through the acquisition of further digital data, particularly hydrogeological and LiDAR data for the study area from the Environment Agency and NextMAP digital elevation datasets from Intermap Technologies. Both datasets are the product of airborne mapping techniques that use a laser or radar to measure the distance between the aircraft and the ground, resulting in the production of a highly detailed terrain model. This will create a digital elevation model (DEM), which will also yield slope and aspect raster datasets (direction of face). LiDAR is only partially available for the Kirkham study area. NextMap data are available to assist the geomorphic research for the study area. The compilation of these datasets, already partly undertaken during the Ribble ALSF project, will be completed (Task 12).
- 3.3.10 ***Geomorphic Analysis (Task 14)***: using the LiDAR dataset, a comprehensive geomorphological map will be produced for the Kirkham study area, identifying and mapping the range of glacial and fluvial landforms. This entirely desk-based analysis will allow more accurate assessment of sand and gravel prospects (Task 13).
- 3.3.11 ***Enhancement of Archaeological Record using LiDAR (Task 15)***: the distribution of cultural remains and topographic features in the GIS will be enhanced by further examination of the LiDAR data in conjunction with the aerial photographs. The examination of this data will facilitate the detection of sub-surface cultural remains and geoarchaeological features, such as sand islands, and intercalated peat deposits. The very precise model that is produced by the LiDAR data also has the potential to record subtle archaeological surface features, as well as cropmarks, by defining the upper surface of crops.
- 3.3.12 ***Initial characterisation, risk and archaeological value assessment using all datasets (Task 16)***: a cell-based analytical technique will be used to establish the predicted distribution of the archaeological resource based on the observed evidence, coupled with analysis of topographical conditions and palaeoenvironmental potential. The

observed archaeological resource will be combined with a topographical model for the study area. A grid will be placed over the study area for use in the cell-based modelling. Each cell in the grid will be given a value for each of the factors that are considered to affect the positioning of sites, such as slope, aspect, elevation, vegetation, geology, soil type, and proximity to water. The values for the cells that contain known sites will then be compared to the values across the whole grid to establish which variables do affect site distribution, and to what extent. A weighting system will then be used to denote the importance of each factor, and each value that the factor can take, and the cells in the study grid will be assigned a score based on the total of these weights. The scores will be divided into zones of high, medium or low potential, where the cells with the highest total score are deemed to have the highest archaeological potential. The result of this will be a map showing the predicted archaeological potential throughout the study area. A characterisation of the area will be defined on the basis of the character of the observed archaeological resource and the archaeological scoring of the analysis, which will use the methodology developed during the original project (OA North and Liverpool University 2007), a refinement of the methodology of the Lynher Valley project (Cornwall Archaeology Unit 2002).

- 3.3.13 ***Collation, analysis and enhancement of the archaeological data (Task 17):*** the archaeological study will incorporate a comprehensive literature search. The data will be analysed and collated, and cross-referenced with the existing HER data for Lancashire. The HER data will be enhanced and expanded and the georeferencing will be refined. It will entail the integration of published and unpublished archaeological sites and finds within the GIS. This work will generate a synthesis of all the archaeological data for the study area, and will produce considerably enhanced and expanded HER databases.

3.4 ARCHAEOLOGICAL AND GEOLOGICAL FIELD INVESTIGATION

- 3.4.1 ***Ground Truthing of the Archaeological Model (Task 18):*** a limited programme of fieldwork will be undertaken to ground truth the distribution of archaeological features revealed by the LiDAR data and the results of the initial characterisation. There will be a rapid walkover survey of clearly defined sections of the study area to map archaeological features and compare these with the LiDAR and aerial photographic data. The intention is firstly to examine area of archaeology highlighted by the LiDAR data and assess whether this provides a comprehensive record of the archaeological features within the landscape. It will also examine apparent gaps in the archaeological data from the LiDAR and desk-based study, but which have potential for further study. This will examine whether there are any surface features within the areas and if not assess from ground observation what topographical and geomorphological factors may have affected site visibility. An assessment will be made as to whether gaps in the record are real or apparent and will examine whether the *lacunae* relate to geomorphological/geological factors such as erosion and /or alluviation.
- 3.4.2 ***Refinement of Characterisation of Archaeological Value (Task 19):*** following the ground truthing of the archaeological model, the results will be fed into the database and the characterisation model will be refined. This will lead to the definition of the polygons representing character areas in the final output datasets.

- 3.4.3 **Analysis and Enhancement of Geological Datasets (Tasks 20):** a tightly constrained programme of field mapping, specific site visits and borehole analysis is required to characterise the geomorphological heritage and aggregate potential.
- 3.4.4 **Geomorphology: Ground Truthing the Data (Task 21):** a programme of fieldwork will be undertaken to ground truth existing unpublished and derived Nextmap- and LiDAR-based mapping (Task 14). This programme of geomorphological truthing will also identify locations of exposed sections, palaeochannels, hollows, and any depositional settings conducive to organic sedimentation. This programme of work is an essential phase, but is not time consuming owing to the reliability of desk-based analysis using Nextmap and LiDAR demonstrated by the Ribble ALSF project. The other key aspect of the field programme involves visits by both Liverpool and OA North palaeoenvironmental staff to log the sediments and stratigraphy at key locations within the Kirkham area. A brief palaeoenvironmental assessment will be undertaken of these cores, which in the Kirkham area will potentially allow comparisons with palaeoenvironmental work previously undertaken in the Fylde as part of the North West Wetlands Survey (Middleton *et al* 1995).
- 3.4.5 **BGS Borehole Archives (Task 22):** interpretation of the landform sequence will be enhanced through consultation with the BGS archive of boreholes, which should identify the composition, nature and thickness of the deposits. There is good coverage of boreholes available in the archives held by the BGS and Highways Authorities for both study areas, obtained during construction of the M6 and other roads, various pipelines and building constructions, and when prospecting for aggregates. The borehole information will be compiled as part of Task 6. This analysis phase will involve crucial three-dimensional interpretation of the nature of the deposits (eg the long-profile section from the Kirkham area based on the M55 borehole series (Fig 2)). Preliminary examination of the BGS archive shows that there is a high density of boreholes in the study area and analysis of these is critical to an understanding of the geomorphological and geological potential of the deposits.

3.5 ANALYSIS

- 3.5.1 **Analysis, Spatial Patterning of Archaeology against Landscape Taphonomy (Task 23):** interrogation and analysis of the database will identify any spatial and / or temporal patterning in the archaeological presence. The work will link into the substantial palaeoenvironmental resource obtained as part of the North West Wetlands Survey in the Fylde (Middleton *et al* 1995). The analysis will also link into the HLC dataset and the geomorphological analysis, and will assess the spatial distribution with respect to both contours and the hydrology to explain settlement patterns. It will also link patterns in the archaeological resource with the present day and historic communications within the proposed study areas. The work will assess whether any gaps in the patterns are real or apparent, reflecting erosion or burial of sites.
- 3.5.2 **Analysis of Geological Datasets (Task 24):** the integrated mapping and borehole data will be used to identify prospect ranking and aggregate value of targets within the study areas, drawing upon the considerable experience that the Liverpool team have from previous assessments of sand and gravel resources in north-west Wales (Thomas *et al.*, 2003) and the environmental capacity survey of aggregate extraction across the whole of Wales, both for the Welsh Assembly Government. The geomorphology layers produced during the desk-based mapping and validated by fieldwork and borehole analysis will be used to create a GIS layer of aggregate resource blocks,

including estimates of quality, volume and planning constraint, and so will highlight areas of potential threat to the geoarchaeological resource from potential future aggregate extraction. An overview of the palaeoenvironmental data abstracted from the coring will be compiled, set against existing palaeoenvironmental datasets in the and Kirkham area.

- 3.5.3 ***Finalise Risk/threat Characterisation, incorporating Geology and Archaeology (Task 25)***: the maps showing areas of predicted archaeological potential, and threats from aggregates extraction or hydrological changes, will be combined in the GIS to create a single map highlighting those areas that are both high in archaeological potential and subject to a considerable threat. The format of this will be such that it can be delivered to all key stakeholders and other appropriate agencies as required to slot into their existing GIS systems.

3.6 OUTCOMES AND DELIVERABLES

- 3.6.1 ***Gazetteer (Task 26)***: a gazetteer of archaeological sites for the study area will be compiled using published and grey literature; this will include an assessment of the complexity and character of the archaeological resource, and will contribute to the final report. This will be submitted to the Lancashire HER and NMR, and will also be incorporated within the report.
- 3.6.2 ***Project Report (Deliverable 1) (Task 27)***: a report will be compiled to provide an assessment of the findings in the study area, in accordance with *Appendix 4* of Management of Archaeological Projects (English Heritage 1991). This will detail the results of the analysis of the geological, aerial photographic, and LiDAR datasets, and identify the geomorphological and palaeoecological resource in the study area. This will examine the potential for the various techniques for the remote identification of this resource and present an assessment of the prehistoric and historic geomorphology. The report will draw upon the methodology and background of the Ribble ALSF project (OA North and Liverpool University 2007), allowing savings of both time and cost, the reports concentrating on the data generated for the study area.
- 3.6.2 This report will clarify the areas of likely potential aggregate deposits and the overlap with areas of potential archaeological sensitivity. The report will include an assessment and statement of the actual and potential archaeological significance of the archaeological resource, and will incorporate the analysis of the LiDAR data. The report will include the gazetteer of archaeological sites identified in the course of the project and an assessment of the range and character of the archaeological resource (Task 26). It will include maps showing the zones of archaeological potential based on actual evidence, and prediction based on geomorphological evidence.
- 3.6.3 An assessment will be undertaken of the state of knowledge of the age and environmental associations of the aggregate deposits in conjunction with their respective geoarchaeological potential. The results and analysis of the modelling will be presented and the report will highlight those areas of aggregate deposits with respect to the areas of identified archaeological and palaeoenvironmental potential. They will examine the evidence for the age of these deposits, and identify where there are gaps in our knowledge of the historic environment and where there are *lacunae* within the archaeological dataset. The report will examine the extent to which these *lacunae* reflect limitations of site visibility, areas of truncation, or areas of limited archaeological activity at any time. The report will describe and examine the results of the desk-based study for the area, and will assess the success of the techniques in

their capacity to identify the extent and character of the archaeological resource. The study will also identify where gaps in knowledge exist and where targeted fieldwork is needed to improve our understanding of these deposits.

- 3.6.4 The report will assess the impact on the historic environment of current and future aggregate extraction and associated changes in water levels in the respective study area. The analysis may highlight possible mitigation strategies such as agri-environmental targets by cross-referencing between the survey data, palaeoecological data, geological data, and the Lancashire *Minerals and Waste Local Plan* (Geoplan Ltd 2006). It is intended that a quantitative assessment should be provided of the threats created by aggregate extraction, which have an impact upon the archaeological resource. This report will highlight where there is potential for glacially formed aggregates, which may be used for small-scale extraction. Maps of the study area will identify broad zones of archaeological potential and threats to this resource based on geomorphological and geological characteristics and archaeological associations. By sharing concerns about the possible deterioration of the archaeological record with a wide range of stakeholders, it is hoped to minimise the damage to the Historic Environment from the range of identified threats.
- 3.6.5 ***Produce and deliver hardcopy maps, ARCGIS layers and database files to EH, LCC and archive within ADS, NMR (Deliverable 2) (Task 28)***: the maps showing areas of predicted archaeological potential, and threats from aggregate extraction or hydrological changes will be combined in the GIS to create a single map highlighting those areas that are both high in archaeological potential and subject to a considerable threat. The format of this will be such that it can be delivered to all key stakeholders and other appropriate agencies as required to slot into their existing GIS systems. The enhanced GIS digital archive will be passed back to the Lancashire HER. The digital data will also be submitted for digital recasting and long-term storage with the ADS.
- 3.6.6 ***Distribution/dissemination to the Stakeholders (Task 29)***: outreach, to the interested parties and stakeholders, is an essential prerequisite of such a management-orientated project. It is proposed to initiate this process by both informal and formal means. As the project will entail close co-operation and dialogue with the stakeholders, the opportunity will be taken to disseminate the goals and wider aspirations.
- 3.6.7 In addition a presentation of initial and final results will be made to the relevant stakeholders, who comprise members of the OA North and Liverpool teams, representatives of English Heritage (EH), Lancashire County Council (LCC), North West Regional Aggregate Working Parties (RAWP) and the Environment Agency (Env Ag). This will take the form of short presentations to individual stakeholder meetings (such as RAWP and the curators).
- 3.6.8 ***Distribution of the Report***: the report will be distributed as digital copies to all stakeholders and interested parties. A distribution list compiled for the Ribble Aggregates project will be enhanced in the course of the project to make it more pertinent to the needs of the present Kirkham study. In addition paper copies of the final reports will also be sent to those stakeholders that are most actively involved in the project and will include English Heritage, WARP, and Lancashire County Council
- 3.6.9 ***Academic Publication of the Ribble ALSF Project (Task 30)***: the Ribble ALSF project comprised an integrated collaboration between archaeologists, palaeoecologists, geomorphologists, geologists and radiocarbon dating experts. When amalgamated with the results of work in the proposed area of study detailed in this project design, the work will have advanced our understanding of the archaeological

development and environmental history of the Ribble Valley to a large extent. In addition, it has used innovative techniques, such as LiDAR remote sensing, coupled with extensive radiocarbon dating of aggregate deposits, to refine an understanding of the geomorphic development of the valley. In summary, there is potential for the production of a range of academic journal articles, and also a booklet intended for a 'lay audience' that documents the 'landscape and cultural development of the Ribble Valley', which would be targeted at the local community. This would form an integrated package of publication, achievable within the project timeframe, and would incorporate the contribution of the English Heritage dating team (P Marshall and D Hamilton), who are keen to collaborate on the radiocarbon dating and geoarchaeological history.

- 3.6.10 *Methodological Advances in Geomorphology and Archaeology*: the programme of research undertaken during the original Ribble ALSF project, and hopefully advanced by the project proposed here, has developed methodologies and datasets that make important contributions to the disciplines of archaeology, geomorphology and Quaternary Science. Within the archaeological investigation, the use of LiDAR has been a revelation and provides the scope for the production of a paper outlining the methodology for the interrogation of LiDAR data and a critical comparison against conventional approaches using oblique and vertical aerial photography.
- 3.6.11 *Fluvial Geomorphology and the Development of the Ribble*: the research undertaken addressing the fluvial development of the Ribble Valley has produced a detailed inventory of the landforms throughout the river system from its source, through various main-stream mid-catchment reaches, and downstream to the lower Ribble system. This programme of mapping and interpretation has been supported by comprehensive radiocarbon dating of the sediment and landform sequence. Seventy-one radiocarbon age determinations were obtained on samples from six sites that were investigated as part of the Ribble ALSF project, which were intended to provide a chronology for the Ribble fluvial geomorphic sequences and associated palaeoecological sites. This suite of dates complements an existing database of 17 radiocarbon dates for the Brockholes meander of the lower Ribble (Chiti 2004; Gearey and Tetlow 2006) and 12 radiocarbon dates from the Forest of Bowland, in the Hodder system (Harvey and Renwick 1987; Chiverrell *et al* 2007). In total, the database of radiocarbon dates for the Ribble Valley amounts to 100 radiocarbon dates, which is a formidable base from which the approaches and problems of securing chronological control for histories of fluvial development can be addressed.
- 3.6.12 Understanding fluvial development and how rivers have produced landform and sediment sequences over the last 15,000 years is conventionally underpinned by radiocarbon dating of organic materials preserved within the sediments of river terraces and the fills of alluvial basins. Rarely, however, have researchers had the benefit of the quantity and quality of radiocarbon dating that was available to the Ribble ALSF project. Here the radiocarbon dating used targeted hand-picked and identified plant remains; most horizons have been dated twice using two independent samples; chronologies for terrace units were based on dating the top and basal floods within several palaeochannel fills for a terrace fragment; and Bayesian modelling techniques have been used to constrain events like channel and terrace abandonment using the stratigraphic relationships and sequence between samples. From these results it is proposed to publish theoretical contributions that explore: a) how Bayesian modelling can assist unravelling the complicated chronologies produced by dating of fluvial sequences; b) how the approach used for the Ribble shows that many

previous studies incorporating radiocarbon dating may not have captured the true picture of the chronological evolution of the target river system because issues like the reworking of organic materials and the time-transgressive nature of change is prevalent in most of the fluvial systems; and c) the implications of the geochronology for the Ribble Valley in the understanding and interpretation of other river systems.

- 3.6.13 In addition, it is recognised that the fluvial geomorphology of British river catchments inside the limits of the last glaciation reflects the response to the cumulative impact of landscape recovery during deglaciation and the early Holocene, as well as base-level changes driven by fluctuating sea-level, climate changes / flooding events during the Holocene, human-mediated changes in vegetation cover during the later Holocene, and the changing ability of rivers to transmit sediment through the system. Transmission is a key issue that needs to be considered when discussing sediment flux through river systems, because sediment cycling and temporary storage are critical components of the sediment conveyor that rivers provide (Lang *et al.*, 2003). The number of dated sequences and the geochronological control developed for different parts of the river system allows the main external forcing factors (climate, weather, vegetation cover and base-level change) to be addressed alongside internal factors like spatial and temporal variability in sediment storage and transmission. From this work it is intended to publish a theoretical contribution that explores the issues relating to connectivity and the forcing of change in the fluvial system.
- 3.6.14 **Paper Outputs: Fluvial and Glacial History of the Ribble Valley:** in parallel to the theoretical contributions outlined above, four other contributions can be made to the scientific literature that explore the Late Pleistocene and Holocene evolution of 1) the Calder; 2) the Hodder and Forest of Bowland; 3) the Ribble/Wharf watershed; and 4) the main reach of the lower Ribble. The proposed publications on the Hodder and the Wharf watershed have the additional dimension that they address the coupling relationships and connectivity between hillslopes and the fluvial systems. In addition, the detailed researches on the glacial geology of lowland Lancashire will contribute to forthcoming revisions of the BGS (British Geological Society) map sheets for Preston and the surrounding area. In collaboration with Dick Crofts and Adrian Humpage of the BGS, a further output from the Ribble ALSF project will be a paper on the deglaciation of lowland Lancashire.
- 3.6.15 **Archaeological Landscape Development:** it is also proposed that an article be prepared that examines the impact of the use of GIS and LiDAR on our understanding of the development of the cultural landscape. This article would place most emphasis on the results of the study rather than on the methodology used, and would examine the patterns of settlement and other activity in the valley, in terms of the development of occupation on the valley floor from the prehistoric period through to the present. It is proposed that the article be published in the journal *Landscape*.
- 3.6.16 **Journal Articles:** the journal articles are as followed with the numbers linked to the task list:
1. Chiverrell, R.C., Thomas, G.S.P., Foster, G.C., Sediment – landform assemblages and digital elevation data: a refined methodology for the assessment of sand and gravel reserves, *Engineering Geology*;
 2. Thomas, Chiverrell, Foster, The deglaciation of lowland Lancashire, *Journal of Quaternary Science*;

3. Chiverrell, Foster, Hamilton, Marshall and co, Bayesian model-based approach to the radiocarbon dating of fluvial sediment and landform sequences, *Quaternary Science Reviews*;
4. Chiverrell, Foster, Hamilton, Marshall and co, Sediment transmission and storage: the implications for landform development, *Catena*;
5. Chiverrell, Foster, Hamilton, Marshall and co, Late Pleistocene and Holocene evolution of the Calder, Lancashire, *Journal of Quaternary Science*;
6. Chiverrell, Foster, Hamilton, Marshall and co, Hillslope - fluvial system linkages: geomorphic evolution of the Hodder, Forest of Bowland, *Geomorphology*;
7. Chiverrell, Foster, Hamilton, Marshall and co, Forcing of change in the fluvial system, Ribble Valley, North West England, *Earth Surface Processes and Landforms*;
8. Quartermaine, Cook, and Wearing, The Ribble Valley: the investigation of an old landscape through new techniques, *Landscape*;
9. Quartermaine, Cook, and Wearing, The impact of the use LiDAR techniques on the recording of landscapes, *Landscape*;

3.6.17 **Popular publication: the Environmental and Archaeological History of the Ribble Valley (Task 31-34):** in addition to, and building upon, the suggested academic papers, it is proposed that a booklet entitled *The Ribble Valley: the development of the landscape* should be produced. This would involve the entire team and result in an integrated history of the Ribble Valley, communicating the findings and output from the Ribble ALSF Project in a format accessible to an educated lay audience. This would examine how the geomorphology of the valley has developed from the retreat of the glaciers through to the modern day and would have a large number of illustrations, including reconstructions of the valley landscape at different stages of the story. The booklet would represent an accessible resource for the local community, contributing a local understanding of the development of the valley and the benefits that can result from a study of those areas directly affected by aggregate extraction. The compilation of the popular publication is split into four tasks, comprising production of the draft publication for comment (Task 31), the revision of the text and figures (Task 32), printing of the publication (Task 33) and distribution (Task 34).

4. RESOURCES AND PROGRAMMING

4.1 THE RESEARCH TEAM

4.1.1 ***Oxford Archaeology North:*** OA North is the northern office of Oxford Archaeology and is the largest archaeological contractor in north-west England. The unit, as the Cumbria and Lancashire Archaeological Unit, was formed in 1979, and developed out of the appointment in 1976 of a research officer for Lancashire. The unit became the Lancaster University Archaeological Unit in 1988, and in 2001 it transferred to form the northern office of Oxford Archaeology, trading as Oxford Archaeology North. OA North is an Institute of Field Archaeologists (IFA) Registered Archaeological Organisation (no 17).

4.1.2 OA North has in-house expertise with databases and considerable expertise in the collation, amalgamation and interrogation of large and variable datasets. Its staff have also been major contributors to the recently completed archaeological Research Framework for the North West (Brennand 2006; 2007), part funded by English Heritage. OA North has undertaken many of the large strategic projects in the North West, including the English Heritage-funded North West Wetlands Survey, which examined the lowland wetlands of the seven north-western counties of England. It has undertaken major surveys of the marginal uplands throughout the county (eg Quartermaine and Leech forthcoming), and has undertaken major GIS studies of the area, including a recent study into the upland peats of the North West, and is currently preparing a GIS-based Urban Archaeological Database for Carlisle.

4.1.2 ***OA North Team:***

Jamie Quartermaine BA Hons, Surv Dip MIFA (Senior Project Manager)

Jamie's primary specialism is in landscape survey and he has been at the forefront of the development of landscape recording since he joined the unit in 1984. He was involved in the development of total station digital recording, surface modelling, GPS (Global Positioning System) survey and CAD draughting. Within building recording he has similarly been able to develop innovative techniques that improve the quality and cost-effectiveness of surveys, particularly the use of a reflectorless total station and the economical recording of inaccessible timber structures and the use of laser scanning techniques.

Since 1995 Jamie has been a project manager, and has been involved in the management of over 350 projects, but has also been able to undertake research on the development of the upland landscapes of north-west England. He has considerable experience in training personnel in the varied aspects of digital recording and was involved in the training of a Nepalese survey team to undertake a comprehensive recording programme of a large seventeenth-century palace on the outskirts of Kathmandu.

Jamie's particular expertise is in landscape and industrial archaeology. He has had a considerable involvement in industrial monuments and landscapes from around the region, which include the Maryport Ironworks, Backbarrow Ironworks, the Lead mines and smelt mills of Greenside, Nenthead (both in Cumbria), Grassington (North Yorkshire) and Snailbeach (Shropshire). He has recently completed a book on the

archaeology of Thomas Telford's Holyhead road through North Wales (Quartermaine *et al* 2003).

His primary area of research is into the development of the upland landscapes of northern Britain. This was initiated with the surveys of the Lake District National Park (Quartermaine and Leech forthcoming) and the Langdale Axe Factories in 1984 (Claris and Quartermaine 1989). He has continued to undertake extensive surveys and publish the results over the subsequent period. All landscape surveys undertaken by OA North have been directed or managed by Jamie and he also managed the Ribble ALSF project.

Rachel Newman, BA Hons, FSA (Director: OA North)

Following a period of research for a PhD on the archaeological landscape of the Barony of Gilsland, Cumbria at Durham University (1978-81), Rachel joined the Cumbria and Lancashire Archaeological Unit. During the 1980s she directed many excavations in Cumbria, at Egremont, Kendal, Piel Castle, Furness Abbey and particularly at the early medieval site at Dacre. As Assistant Director, she managed a series of projects throughout the north west of England, including excavations in advance of the Shell UK Northern West Ethylene Pipeline, at Fremington and Low Borrowbridge, and at Davenham in Cheshire, and from 1994 the North West Wetlands Survey.

As Director, a particular area of responsibility is quality management, and she is the series editor for the Lancaster Imprints series. She is also consultant to Hadrian's Wall Heritage Ltd in their ongoing management of the Hadrian's Wall Path National Trail and managed a series of minor archaeological interventions along the Wall resulting from the planning of the trail's route.

Joanne Cook, BA Hons Mlitt AIFA MBCS (OA North IT Coordinator)

Jo is an archaeologist with a particular interest in the setup of IT systems and their support, database design and administration, and GIS. She has constructed databases for archaeological excavations and archiving, and designed and used Geographic Information Systems (GIS) for a number of major projects (compatible with national data standards) including the Carlisle UAD, Carlisle Archives Project, the A1 Road Improvement Scheme between Darrington and Dishforth, and our continuing work at Chavasse Park in Liverpool. She has also completed a GIS-based project to map the course of the River Eden through Carlisle from prehistoric to modern times, involving the coordination of many disparate types of evidence, such as documentary sources, historic mapping, and topographic data. During the Upland Peats Project she gained experience in geospatial and statistical techniques for the analysis of archaeological and environmental datasets. She is particularly experienced in the use of the Arcview software packages, but also has experience of other GIS packages such as MapInfo. Jo oversaw the GIS system for the Ribble ALSF project.

Neil Wearing BA Hons (Project Officer)

Neil specialises in landscape archaeology, historic landscape characterisation of both an urban and rural environment, and the use of Geographic Information Systems (GIS) in archaeology (ArcGIS and MapInfo). He has been primarily involved in the

data gathering and landscape analysis of GIS-based projects, undertaking landscape and survey orientated fieldwork, documentary studies and historic map regression. He undertook much of the project work for the first phase of the Ribble Valley ALSF Project.

In between spells at OA North, Neil was the Project Officer for the English Heritage-funded Merseyside Historic Characterisation Project (MHCP), which was undertaken by the Merseyside Archaeological Service, part of the National Museums on Merseyside. The project required the creation of a GIS based historic Character map of the five Unitary Authorities of Merseyside (Liverpool, Knowsley, Sefton, St Helens and Wirral).

Elizabeth Huckerby BA Hons MSc MIFA (Senior Palaeoenvironmentalist)

Elizabeth is the OA North Senior Environmental Archaeologist with responsibility for the co-ordination and management of environmental sampling, processing and post-excavation analysis, analysis of pollen, and charred and waterlogged plant remains. She joined OA North in 1990 when she worked as palynologist on the North West Wetlands Survey (NWS). She specialises in palynology and collaborated in what was one of the first successful isolations of Icelandic tephra from a lowland raised mire in England. Since the completion of the NWS she has been involved in many projects both as a palynologist and archaeobotanist, on prehistoric, Roman, medieval and historic sites in both the north and south of England. Her work includes palynological studies on two Bronze Age burnt mounds in Cumbria, at Drigg and Sparrowmire, and she has worked on environmental remains from Roman and medieval sites in Lancaster, Carlisle, Kirkby Thore, Cumbria, Berwick and Gateshead.

Her main skills are archaeobotany, pollen and plant macrofossil identification, and she has extensive knowledge of the palaeoecology of north west England. She has considerable experience of selecting and submitting samples for radiocarbon dating, and she has co-authored countless books, papers and client reports. Elizabeth undertook the palaeoenvironmental work for the Ribble ALSF project.

4.1.3 ***Department of Geography, Liverpool University:*** the Liverpool team is drawn from the Physical Geography and Environmental and Ecosystem Management research clusters. They have a strong track record in the various aspects of this proposal.

4.1.4 ***Liverpool University Project Team:***

Dr Richard Chiverrell (Lecturer in Geography)

Richard has particular research interests in Geographical Information Systems, Geomorphology and Quaternary Geology. He recently produced the Quaternary Geology information for the new BGS 1:50,000 sheet for the Isle of Man Government, and two Sand and Gravel Resource Assessment and Environmental Capacity Surveys for Wales (Welsh Assembly Government), with Dr Geoff Thomas. He has researched the upland geomorphology of the British Isles, focusing upon episodes of hillslope instability in the late Holocene, and has worked on the Holocene and late Quaternary palaeoecology and in particular the pollen, plant macrofossil and testate amoebae (Protozoa) profiles within peat and lacustrine sediments. The Holocene evolution of the Isle of Man is also an interest, focusing upon linkages

between the palaeoecological and archaeological records, and he has produced a GIS of Bronze Age finds on the Isle of Man for the Centre for Manx Studies and Manx National Heritage.

He has considerable GIS experience from aggregate consultancy and geological mapping contracts, numerous applications of spatial analysis in geomorphic, palaeoecological and process-based research and running the GIS curriculum at the Geography Department, Liverpool University. He has experience in the hydrogeomorphic modelling of lowland floodplain responses to climate change, socio-economic decision-making and river basin management.

Dr Geoff Thomas (Senior Lecturer in Geography)

Geoff's interests are quaternary stratigraphy, glacial geomorphology, glacial sedimentology and the assessment of sand and gravel aggregate resources. Current areas of specialisation include the Quaternary stratigraphy of the Irish Sea basin, north Wales and the Cheshire-Shropshire lowlands; morphology of ice-marginal and ice-contact depositional systems; and the sedimentology and sedimentary architecture of glaciolacustrine and glaciomarine deltas and subaqueous fan systems in Wales, western Ireland and Norway. He recently produced the Quaternary geology of the revised 1:50,000 BGS geological map of the Isle of Man for the Manx Government and a survey of the aggregate resources of north-west Wales and an Environmental Capacity Survey of Wales for the Welsh Assembly Government, with Dr Richard Chiverrell.

4.2 TIMETABLE

4.2.1 See task list (*Appendix 1*) and gantt chart (*Appendix 2*).

4.3 OTHER MATTERS

4.3.1 **Access:** establishing ownership will be in consultation with the Land Registry Record Office, Lancashire County Council. The land owners and tenants will be contacted to request access.

4.3.2 **Health and Safety:** full regard will, of course, be given to all constraints (services) during the survey, as well as to all Health and Safety considerations. All site procedures are undertaken in accordance with the guidance set out in the *Health and Safety Manual* compiled by the Standing Conference of Archaeological Unit Managers (1991, rev 1993). Risk assessments will also be undertaken as a matter of course, and these will anticipate the potential hazards arising from the project. Copies of OA North's health and safety policy are lodged with English Heritage.

4.3.3 **Insurance:** the insurance in respect of claims for personal injury to or the death of any person under a contract of service with OA North and arising in the course of such person's employment shall comply with the employers' liability (Compulsory Insurance) Act 1969 and any statutory orders made thereunder. For all other claims to cover the liability of OA North in respect of personal injury or damage to property by negligence of OA North or any of its employees, there applies insurance cover of £10m for any one occurrence or series of occurrences arising out of one event.

4.3.4 **Working Hours:** survey will be undertaken on the basis of a five day week, within daylight hours only.

5. FINANCIAL RESOURCES

5.1 TOTAL BUDGET

TOTAL COSTS

OA NORTH	£ 48,048.75
LIVERPOOL	£ 51,870.00

Combined Total **£ 99,918.75**

5.2 OA NORTH BUDGET

Unit Staff	Grade	Per day	Days	Cost
RMN	Director	282	4	1128.00
JQ	Project Manager	191	22	4202.00
EH	project Officer	115	16	1840.00
JC	Project Officer	115	83	9545.00
NW	Project Officer	115	92	10580.00
Tba	Project Supervisor	93	69	6417.00
Tba	Research Assistant	83	19	1577.00

Total salary costs **35,289.00**

Non-staff costs

Travel and Accommodation	900.00
HER / Historic mapping costs	250.00
Printing Costs for booklet	2000.00
TOTAL NON-STAFF COSTS	3150.00

Overheads at 25% 9609.75

Total Costs **48,048.75 (ex vat)**

Notes:

- Salaries and wages inclusive of NI and Superannuation
- Costs are 2007/2008 rates.
- VAT will not be charged

5.3 LIVERPOOL UNIVERSITY BUDGET

Staff	Role	Per day	Days	Cost
RCC	LU Manager	340	66	21,080.00
GF	GIS	/ 159	103	15,900.00
GSPT	Geomorphology Geology / Glacial Expert	356	30	10,680.00
Total salary Costs				47,660.00

Non staff costs

Item	Cost
Nextmap DTM data	1344
CartoGraphic services	750
Travel mileage fieldwork	100
Travel meetings Preston	58
Travel meetings Lancaster	108
Fieldwork accommodation (pppd)	500
BGS Access borehole archive	250
BGS Travel Liv-Nottingham	100
BGS accommodation	250
Data storage 12 months 20 gb	180
Photocopy / printing costs	350
Scanning and digitisation	220
Total	4210.00
Total Costs	51,870.00

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APPENDIX 1 TASK LIST

TASK NO	TASK	RESPONSIBILITY	OA North		Liverpool	
			Staff Member	Days	Staff Member	Days
1	Project manager	OA North	JQ	6		
2	Liverpool co-ordination, supervision and management	LU			RCC	4
3	Project liaison LU/OA North	OA North/ LU	JQ JC NW PS	2 4 3 1	PDRA RCC GSPT	4 3 2
4	Steering Group meetings	OA North/ LU	JQ	3	RCC	3
5	GIS Preparation	OA North/ LU	JC NW	2 1	RCC	1
6	Modern mapping, Conservation, HLC data	OA North	JC NW PS	1 2 2		
7	Collation, incorp geological data	LU			PDRA	3
8	Identify, obtain, boreholes data from BGS and Highways Authority archives	LU			GSPT	8
9	Historic mapping	OA North	JC NW PS	1 2 2		
10	Aerial Photographs	OA North	JC NW PS	2 5 6		
11	HER/archaeological data capture	OA North	JC NW PS PA	2 4 4 3		
12	Integration and analysis of aggregate, environment and heritage datasets	OA North/ LU	JC NW PS	2 4 4	PDRA RCC	1 3
13	Compilation and incorporation of AP and DEM datasets (LiDAR and Nextmap)	OA North/ LU	JC NW PS	2 9 3	PDRA	4
14	Comprehensive geomorphological analysis and mapping using the LiDAR and Nextmap datasets	LU			PDRA RCC	12 2
15	Enhancement of archaeological record using AP and Lidar data	OA North	JC NW PS	2 4 8		

16	Initial characterisation, risk and archaeological value assessment	OA North	JC NW PA	3 6 5		
17	Collation, analysis and enhancement of the HER data	OA North	JC NW PS	3 5 6		
18	Ground truthing of the archaeological model	OA North	NW PA	4 4		
19	Refinement of characterisation of archaeological value	OA North	JC NW PS	6 5 5		
20	Analysis and enhancement of Geological datasets	LU			RCC	2
21	Geomorphology: fieldwork truth mapping and sections/quarries	LU/ OA North	EH	4	PDRA RCC GSPT	6 2 2
22	BGS / Highways Authority boreholes: analysis	LU			GSPT	6
23	Analysis, spatial patterning of archaeology and palaeobotany against landscape taphonomy	OA North	JC NW PS	6 3 6	PDRA RCC	5 2
24	Analysis of geological datasets	LU			PDRA RCC GSPT	6 2 2
25	Finalise risk/threat characterisation incorporating geology and archaeology	OA North/ LU	JC NW	5 6	PDRA RCC	5 2
26	Gazetteer and palaeobotanical Research	OA North	JC NW PS PA	4 3 8 5		
27	Produce illustrated project report - both archaeological, geomorphic evolution and aggregates - all areas	OA North/ LU	JQ JC/EH NW PA	4 24 14 2	PDRA RCC	5 10
28	Produce and deliver hardcopy maps and ARCGIS layers to EH, NY and LCC and archive within ADS, NMR for all areas	OA North/ LU	JC NW	2 2	PDRA RCC	2 2
29	Presentations as appropriate to relevant stakeholders via the appropriate media ~ RAWP meetings, EH WiP meetings	OA North/ LU	JQ JC NW	2 4 5	RCC	3
30	Publications (Liverpool)					
	Paper 1	LU			RCC GSPT	2 3
	Paper 2	LU			RCC GSPT PDRA	2 5 5
	Paper 3	LU			RCC PDRA	4 6
	Paper 4	LU			RCC PDRA	4 6

	Paper 5	LU			RCC GSPT PDRA	4 2 6
	Paper 6	LU			RCC PDRA	2 6
	Paper 7	LU			RCC PDRA	2 6
	Paper 8	OA North			JQ EH JC NW	2 3 2 2
	Paper 9	OA North			JQ JC NW	1 4 2
31	Compilation of popular publication for a lay audience	OA North/ LU	RMN JQ JC PS	2 1 14 10	PDRA RCC	12 4
32	Revision of popular publication	OA North/ LU	RMN NW JC	1 1 1	PDRA	2
33	Printing	OA North/ LU	JQ JC	1 1	RCC	0.5
34	Distribution	OA North/ LU	NW	2	PDRA	1

Tasks in White will be undertaken jointly by Liverpool University and OA North

Tasks in Yellow will be undertaken by OA North

Tasks in Green will be undertaken by Liverpool University

APPENDIX 2
GANTT CHART

FIGURES

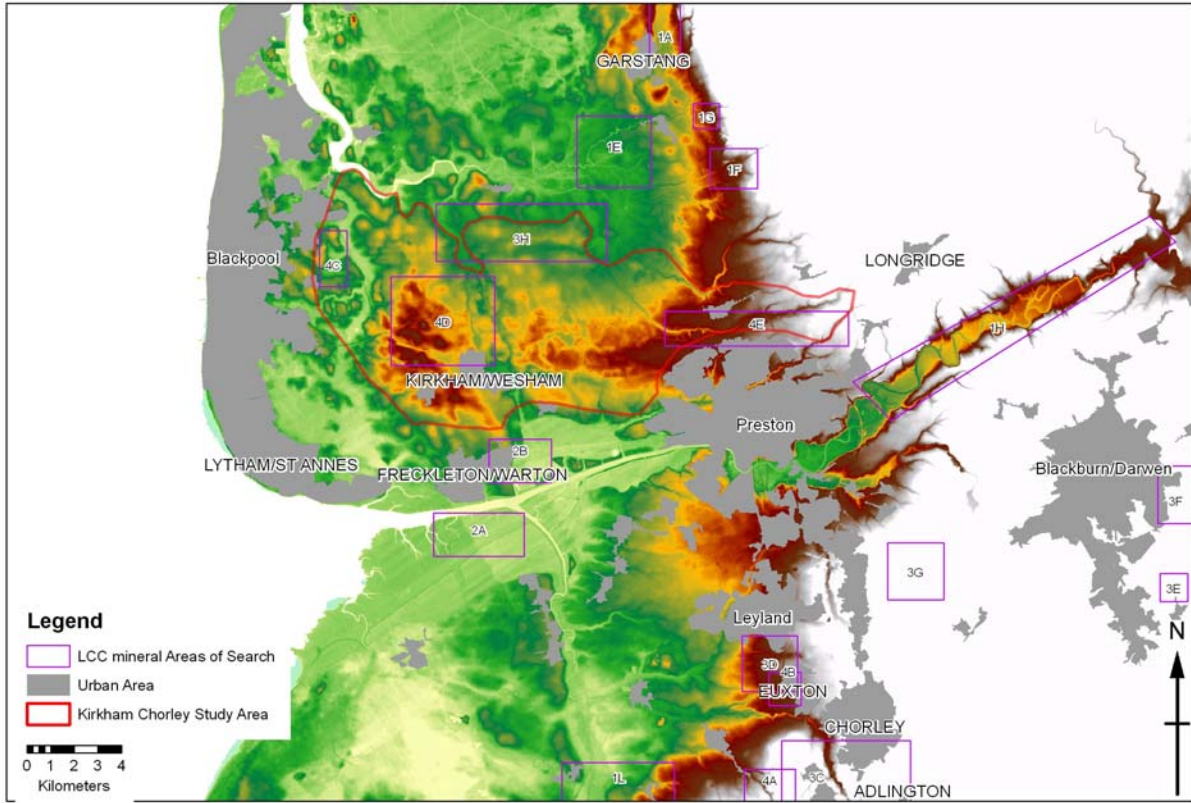


Figure 1 The Kirkham study area is identified as the red outlined area. The purple outline boxes are the areas of search identified by Lancashire County Council

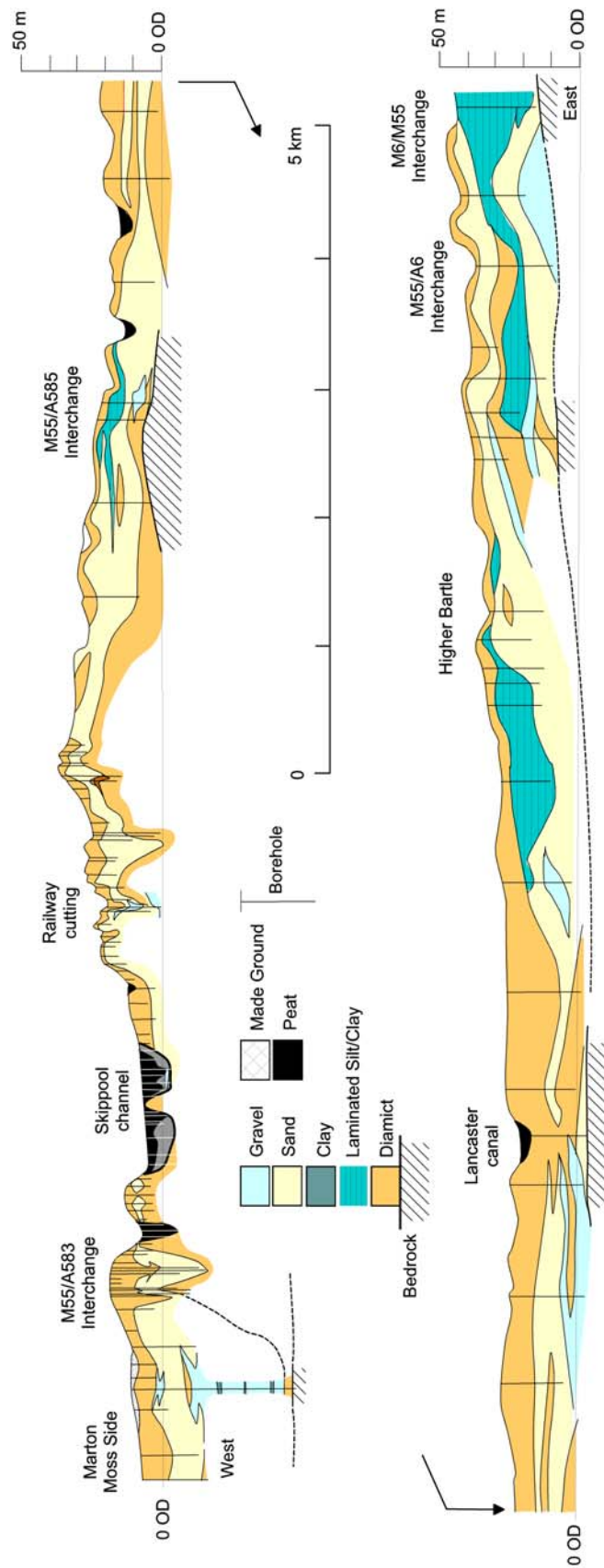


Figure 2 The M55 borehole series plotted against a topography derived from the NextMAP DEM

GANTT CHART
