ALSF AGGREGATE EXTRACTION AND THE GEOARCHAEOLOGICAL HERITAGE OF THE KIRKHAM MORAINE

Final Report

Oxford Archaeology North

Department of Geography

February 2008

English Heritage

Issue No: 2007-8/782
OAN Job No: L9870
NGR: SD 420 320 (centred)

Document Title: **ALSF AGGREGATE EXTRACTION AND THE GEOARCHAEOLOGICAL HERITAGE OF THE KIRKHAM MORAINE**

Document Type: **Final Report**

Client Name: English Heritage

Issue Number: 2007-8/782
OA Job Number: L9870
Site Code: n/a

National Grid Reference: SD 420 320 (centred)

Prepared by:	Joanne Cook	Neil Wearing
Position:	Project Officer	Project Officer
Date:	14th February 2008	
Checked by:	Jamie Quartermaine	Signed…….
Position:	Project Manager	
Date:	14th February 2008	
Approved by:	Rachel Newman	Signed…….
Position:	Director	
Date:	14th February 2008	
Receiving Museum	n/a	
Museum Accession No	n/a	

Oxford Archaeology North
Storey Institute
Meeting House Lane
Lancaster
LA1 1TF
t: (0044) 01524 848666
f: (0044) 01524 848606

w: www.oxfordarch.co.uk
e: info@oxfordarch.co.uk

Janus House
Osney Mead
Oxford
OX2 0EA
t: (0044) 01865 263800
f: (0044) 01865 793496

Oxford Archaeological Unit Limited is a Registered Charity No: 285627

CONTENTS

LIST OF TABLES

ACKNOWLEDGEMENTS

Oxford Archaeology North (OA North) and the University of Liverpool Geography Department would like to thank the staff of English Heritage for their considerable support for this project. In particular, we would like to thank Dr Jennie Stopford (English Heritage Ancient Monuments Inspector) and David Gander (English Heritage Ordnance Survey Liaison Officer).

We would particularly like to thank Peter D Iles (Specialist Advisor (Archaeology) Lancashire County Council Environment Directorate) for his support in the course of the project, for providing considerable amounts of digital data, and for the use of his offices for project meetings. Thanks are also due to the staff of the Lancashire Record Office, Preston. We are indebted to the staff of Preston and Lancaster Libraries for help in providing secondary sources, and to the staff of the National Monuments Record, Swindon.

At the University of Liverpool, Dr Richard Chiverrell was the Principal Investigator, examining the long-term (Quaternary) evolution and geoarchaeology of the Kirkham Moraine. Dr Gez Foster examined the long-term (Quaternary) evolution and geoarchaeology of the Kirkham Moraine and undertook much of the GIS analysis, fieldwork and modelling that underpinned the geomorphic research. Dr Geoff Thomas undertook the borehole archive research at the BGS and was integral to the interpretation of the glacial geology and Quaternary history.

At OA North, the data capture and GIS processing for the archaeological resource were undertaken by Neil Wearing and Jo Cook, and the palaeoenvironmental research was undertaken by Elizabeth Huckerby. Archaeological ground-truthing and fieldwork was by Neil Wearing. Neil Wearing, Jo Cook and Elizabeth Huckerby contributed to the report, which was edited by Jamie Quartermaine and Rachel Newman. Jamie Quartermaine managed the project.

SUMMARY

This report presents the results of the ALSF Aggregate Extraction and the Geoarchaeological Heritage of the Kirkham Moraine project, which was a study of the aggregate and archaeological potential of a study are centred on the Kirkham Moraine in Lancashire (SD 430 320 (centred)). The work was undertaken between April 2007 and January 2008 as a joint project between the University of Liverpool Geography Department and Oxford Archaeology North (OA North), and was funded by the Aggregates Levy Sustainability Fund (ALSF) under the overall management of English Heritage. The responsibility of the project was split such that the University of Liverpool undertook the geological and geomorphological elements of the project whilst OA North undertook the archaeological elements, and the palaeobotanical elements were undertaken jointly.

The geomorphological objectives of the project were to collate evidence on all past and present aggregate extraction, and to produce revised estimations and mapping of suitable resources for future extraction. The archaeological objectives were to collate evidence for all archaeological activity and, by the means of an exhaustive survey of LiDAR, aerial photography, field survey and other methods, find new archaeological sites and assess the potential for sites within areas of potential extraction. The data were assimilated into a GIS system, which was integral to the project, and the archaeological data and geomorphic data were subject to spatial analysis to provide an assessment of the areas of greatest potential for each element. A final objective was to integrate these two strands and assess the potential impact of aggregate extraction or geomorphological change on the archaeological resource.

The University of Liverpool has undertaken an extensive remapping of the available aggregate reserves and geology within the study area. This has led to an assessment demonstrating that substantial reserves are available, although some do have extensive overburden deposits, thereby reducing their economic viability. The principal sources of sand and gravel are glacially deposited inter-moraine sandur. Much of the Kirkham Moraine comprises workable aggregate in some manner or form, and 20 resource areas have been identified as having mineral present in both workable quantities and form. Thirteen of the blocks are landforms that have a history of extraction within the region, and these have been estimated as having potential deposit thicknesses of 10m, which is the practical extraction limit.

A survey of the archaeological resource using LiDAR and aerial photography was extremely successful, identifying new sites and improving classification of those already identified. Collating the enhanced resource and examining its location in relation to environmental and topographical factors, such as slope and distance to water, suggested considerable potential for buried archaeology within the study area. In particular, there is a significant potential for prehistoric remains, particularly on the sand islands, which are also potentially subject to aggregate extraction.

Recommendations have been made for further work within the region, following on from the discovery by the University of Liverpool of considerable mineral reserves in the Lune, Wyre, Northern Cumbria and Chorley areas, and the potential for the use of hard geological sources for aggregate in the Craven District of North Yorkshire.

1 INTRODUCTION

1.1 BACKGROUND

1.1.1 In April 2005, English Heritage (EH) commissioned Oxford Archaeology North (OA North) and the Department of Geography at the University of Liverpool to undertake a programme of investigation, funded by the *Aggregates Levy Sustainability Fund* (ALSF), into the potential impact of sand and gravel mineral extraction on the archaeological resource of the Ribble Valley in Lancashire and North Yorkshire (OA North and University of Liverpool 2007a). A key outcome of this project was the identification of two new areas of potential aggregate extraction, namely the Kirkham Moraine, between Kirkham, Poulton-le-Fylde and Longridge in Lancashire (Fig 1), and the Craven Lowlands in West Yorkshire.

1.1.2 As a result, in May 2007, OA North and the University of Liverpool were commissioned to undertake a related programme to assess the archaeology and the geomorphology of the Kirkham Moraine (OA North and University of Liverpool 2007b). The original Ribble Valley ALSF project had developed and tested a methodology for the combined study of the geomorphology and archaeology in areas of aggregate extraction, and this has been refined and reused in the current project. Furthermore, the earlier study had highlighted a need for outreach, targeting both industrial and lay audiences, along with better communication between the aggregates industry and archaeologists. The current project has sought to address this, with a programme of academic publication and a more generalised booklet for lay audiences.

1.1.3 ***Contract Background:*** the project design for the Kirkham Moraine ALSF project was prepared by OA North and University of Liverpool Department of Geography (2007b) following discussions with Peter Iles (Specialist Advisor (Archaeology) Lancashire County Council Environment Directorate), and Dr Susan Stallibrass, EH Scientific Advisor for the North West, with other EH personnel. It provided for an investigation of the geology and geomorphology of potential areas of sand and gravel, undertaken by the Department of Geography, University of Liverpool, and for an investigation of the archaeological resource of the area, undertaken by OA North. The project design was submitted in May 2007 and the project was commissioned in the same month.

1.2 THE KIRKHAM MORAINE STUDY AREA

1.2.1 The Kirkham Moraine is a ridge of low hills extending from the east of Preston to the coast north of Blackpool, centred approximately on Ordnance Survey grid reference NY 439 435 (Fig 1). It is an area of raised dry land edged by the wetlands of Fylde to the north, and has considerable archaeological potential. The present evidence (Middleton *et al* 1995) suggests that it has been an area of settlement since the early prehistoric period; it was subject to Roman military occupation and was subsequently further developed with the establishment of medieval towns.

1.2.2 Preliminary geomorphological mapping and evidence from boreholes and sections (Fig 2) shows that it is an ice marginal moraine ridge that comprises a significant

thickness of glacial sediment or diamict. Glaciofluvial sand and gravels thicken in the inter-moraine flow and reflect former outwash rivers. The ridges of the moraine demonstrate that the ice retreat was punctuated by oscillations of the ice margin, and in front of these successive ridges sandur deposits were formed, thicker in the major outwash channels at Skippool and Kirkham.

1.2.3 Towards the eastern end of the M55, the thick sequence of glaciolacustrine clays has precluded aggregate extraction, but to the west there are clearly thick sequences of glaciofluvial sands and gravels. Often these are buried by surface diamict that was laid down during oscillations of the ice margin, but these thin in the inter-moraine areas and can be no more than a shallow surface drape (1-3m) on the moraine ridges.

1.2.4 The study area was, therefore, defined on the basis of the geomorphological mapping and a series of Areas of Search identified in Lancashire County Council's *Minerals Plan* (Geoplan Ltd 2006). It covers an area of approximately 127 km^2, centred on Ordnance Survey grid reference NY 446 344 (Fig 1), and encompasses known sand and gravel extraction sites in the Kirkham Moraine, along with other more extensive areas that may have the potential to be exploited for aggregates.

1.3 AIMS OF THE PROJECT

1.3.1 The aims of this project, like those of the earlier Ribble Valley ALSF project (OA North and University of Liverpool 2007a), were 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 2005). The aims are:

- to produce data that contributes to the needs of both planners, the minerals industry, 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 archaeologists and other professionals.

1.4 OBJECTIVES

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

i) to collate, within a GIS, all available data on past, current and future aggregate extraction within the Kirkham Moraine area, including the Directory of Mines (BGS), Lancashire County Council (LCC) and Regional Aggregate Working Party (RAWP) sources;

ii) to map within a GIS the mineral resources within areas of search, drawing upon BGS maps, 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 databases, the *Historic Landscape Characterisation for Lancashire* (Ede and Darlington 2002), and the *Countryside Agency Joint Character Area Map* for the North West region (Countryside Agency 2005);

v) to undertake a comprehensive GIS-based survey of the late Quaternary 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 following this, an assessment of 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 and 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.

1.5 STRUCTURE OF THE REPORT

1.5.1 This report presents the results of the survey into the archaeology and geomorphology of the Kirkham Moraine. The spatial coverage for the geological and geomorphological research is, however, broader in scope so as to place the environmental history and the sand and gravel mineral resource within an appropriate regional context.

1.5.2 This report examines the geology and geomorphology of the areas in relation to its archaeological resource. It opens with a background section (*Section 2*) which presents the wider geological and geomorphological context of the Kirkham area and examines the archaeological and palaeoenvironmental context for the present study.

1.5.3 The methodology (*Section 3*) reports on the techniques that have been applied to examine the geomorphological development of the area and to identify and characterise the archaeological resource. This is based strongly on the

methodology developed in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, *Section 3*), but where appropriate for the archaeology and geomorphology within the area, some techniques were modified for this project.

1.5.4 The results of the study are presented in *Sections 4* and *5*. *Section 4* examines the glacial history of the area in the light of the present work. It also highlights the sand and gravel reserves that have the greatest potential for extraction, and therefore the areas that present the greatest threat to the archaeological resource. The following section (*Section 5*) examines the distribution of the archaeological resource and presents this distribution based on an enhanced Historic Landscape Characterisation (HLC), which highlights both the actual observed resource and the archaeological potential.

1.5.5 In *Section 6*, the threats resulting from aggregate extraction are considered in terms of areas of archaeological potential, examining the extent to which areas identified for potential extraction will have an impact on known archaeological sites, or areas of archaeological potential. Following on from this, *Section 7* makes recommendations for managing the risk to the archaeology, and highlights preferred options, including further research and mitigation, should extraction take place.

2 BACKGROUND

2.1 GEOLOGICAL BACKGROUND

2.1.1 ***The Kirkham Moraine:*** over the last two decades, the morphology, stratigraphy and sedimentology of a number of major moraine systems exposed around the coastal margin of the Irish Sea basin have received much attention. These moraines include the Screen Hills, Co Wexford, Ireland (Thomas and Summers 1983; 1984; Eyles and McCabe 1989; Evans and O´Cofaigh 2003), the 'Drumlin Readvance' moraines between Dundalk Bay and Killard Point in south-east Ulster (McCabe *et al* 1984; 1987; 2007), the Bride Moraine, Isle of Man (Thomas 1977; 1984; Thomas *et al* 1985; 2004), the moraines of the West Cumbrian coastal lowland (Huddart *et al* 1977; Merritt and Auton 2000; Williams *et al* 2001) and the moraines of the north-west coast of the Lleyn Peninsula in North Wales (Thomas and Chiverrell 2007). In each case, the moraines appear to have been associated with, and form a distinctive component of, complex episodes of multiple marginal oscillations, probably resulting from dynamic interaction between adjacent ice-streams during stages in the retreat of the Late Devensian Irish Sea Ice Sheet.

2.1.2 In this report, the focus is on the morphology and internal structure of a moraine system that borders the Lancashire coast of the Irish Sea. Originally identified as the 'Kirkham End Moraine' by Gresswell (1967a), it runs as a subdued set of low hills across the Fylde peninsula for some 25km from Broughton, north of Preston, westwards through Kirkham and north-west to Cleveleys, on the Irish Sea coast north of Blackpool (Fig 3). Lowland Lancashire received ice radiating out from centres in Scotland, the Lake District and the northern Pennines that coalesced and moved southwards. During the latter stages of the Devensian flood, as the ice-sheets reduced in extent, local ice source areas become increasingly important, moderating ice-streams within the main British and Irish Ice-sheet (BIS). The Kirkham area was affected by three significant ice-streams: first, an eastern Irish Sea Ice-stream (EISI) that crossed lowland south Lancashire, Cheshire and southwards towards Shropshire; second, an east Lake District Ice-stream (ELDI), radiating south out of the Lake District and passing across lowland Lancashire; and a third that radiated off the northern Pennines ice divide southwards and then bifurcated eastwards down Wharfedale and Airedale and south-westwards down Ribblesdale (Fig 3). Ice cover and penetration was extensive in the northern Pennines, but ceased at Burnley, south of which the Pennine hills formed a significant ice barrier and were as a result largely ice-free (Crofts 2005).

2.1.3 ***Drift distribution, thickness and bedrock relief:*** the earliest description and interpretation of the Pleistocene deposits of lowland Lancashire were undertaken in the late nineteenth century by Binney (1852) and De Rance (1875; 1877a), who utilised the, at the time, excellent coastal exposure at and north of Blackpool. All of the Fylde Peninsula is covered by glacial deposits, locally buried to the north, west and south by Holocene marine and estuarine sediments, and shows no exposed solid rock (Longworth 1985). The drift is underlain by Permo-Triassic sandstones and mudstones to the west of the M6 motorway and by Carboniferous sandstones and shales to the east. It is only to the east that bedrock is exposed at the surface as the Carboniferous rocks appear on the western escarpment of the Bowland Fells and the drift thins.

2.1.4 A reconstruction of the sub-drift surface from data in Wilson and Evans (1990) and Aitkenhead *et al* (1992) is shown in Figure 4. Little further data can be added however, because the BGS summary data, from which borehole records are selected, regrettably does not identify those boreholes that penetrate bedrock. Consequently, all boreholes, not just those identified as useful for characterising sediment-landform assemblages or constructing cross-sections, would have to be assessed, a wasteful effort given the small proportion in this area that descend to bedrock. Caution should be applied in the interpretation of reconstructed sub-drift surfaces. Firstly, few boreholes actually reach the rockhead, and secondly, many rural areas have very few boreholes, thus making interpretation and extrapolation very hazardous. Thirdly, the drilling method employed and the precision of description often makes it difficult to distinguish between clay-rich Irish Sea diamict and underlying Mercia Mudstone in the west of the area, and between glacial outwash sands and Sherwood Sandstone in the east. Consequently, the misidentification of sand or diamict units, or sandstone and mudstone units, commonly up to 20-30m in thickness, can raise or lower the rockhead by this amount.

2.1.5 West of the M6, the sub-drift surface forms a rough platform, 10-12km wide, at between -10m to -15m OD, and overlain by 20-35m of drift. West of Garstang, the platform is cut by a series of narrow channels floored at depths between - 36m and - 38m OD, one running beneath the modern Pilling Water and widening offshore to the north-west, another beneath the River Wyre and widening offshore to the west, and a third, north/south channel is floored to a depth of at least -22m OD, connecting the former two in their inner parts. To the south-west, around Blackpool, the rockhead falls rapidly away into a further channel running westwards to rockhead depths of at least -61m OD and overall drift thickness of up to 80m. Further south, along the northern and south shore of the Ribble estuary, boreholes are infrequent and shallow and no attempt has been made to determine the rockhead relief. More than 100 boreholes around Preesall, all drilled to prove the Permo-Triassic Preesall Salt Member, show very rapid variation in the rockhead over a short distance and identify a large depression caused, not by glacial erosion, but by probable solution and collapse of the salt. Further depressions in the rockhead surface occur north-west of Garstang (Fig 4), but their origin is unknown.

2.1.6 The origin of the channels cutting the rockhead surface are open to a number of interpretations but bear comparison to similar channels observed in the rockhead relief of the Merseyside area and elsewhere. The north/south channels are most likely to be of sub-glacial origin, either as large-scale basal erosional scours, as large tunnel valleys or, more likely, as sub-glacial meltwater channels following flow-line directed drainage at the base of an Irish Sea icesheet. The west or north-west directed channels, however, are unlikely to be sub-glacial and may be fortuitously preserved, though probably much glacially modified, non-glacial channels, formed by drainage from the western margin of the Bowland Fells during an unglaciated period of lowered sea-level, such as Oxygen Isotope Stage 3 or 4 of the Devensian Cold Stage (Aitkenhead *et al* 1992).

2.1.7 The deposits that comprise the Kirkham Moraine, in places show a Quaternary sediment fill of at least 30m, between +10m and -20m OD, with bedrock not reached in many boreholes. Typically, the sediment sequences comprise lower interbedded glacial diamict, outwash sands and laminated lake/marine muds. In terms of potential sand and gravel mineral, the outwash deposits within these sequences are the best candidate, and their distribution is affected by changing ice marginal positions,

minor advance and retreat episodes during the late Devensian deglaciation. Overlying the lower diamicts are thick (in places >10-15m) accumulations of outwash gravels, sands and waterlain silts and clays. The gravel and sand units are concentrated and thicker within broad channels and this upper sequence reflects pro-glacial deposition in the form of outwash sandar during passage northwards of the ice margin. Further complicating the sequence are, in the eastern parts of the moraine and the low-level plain to the north, thick (15-20m) units of waterlain silt and clay, which suggest a possible lacustrine basin, perhaps bordered and dammed by the Kirkham Moraine to the south and the retreating ice margin to the north.

2.1.8 ***Quaternary history of South Lancashire***: in south Lancashire, the earliest evidence for Pleistocene environments in the region is the basal diamict, a lodgement till smeared over the bedrock of the Lower Ribble. Borehole evidence shows the rockhead is some 20-25m below OD and the Pleistocene sediment fill in places is over 50-60m in thickness. This lodgement till was probably emplaced during the advance of the British Icesheet to limits in the English Midlands *c* 24,000 years ago (Longworth 1985). Much of the glacial geomorphic and sedimentary evidence relates to the sequence of environmental changes on retreat of the ice margins from that maximal limit. The Kirkham Moraine complex is an extensive feature of some magnitude, with no obvious parallels down-ice until the moraine ridges of south Cheshire are reached at Whitchurch, and little else in the up-ice direction until the Lake District. After the ice-marginal oscillations associated with the production of the Kirkham Moraine, the BIS appears to have gone into terminal decline, with rapid ice wastage and marginal retreat denoting the transition to the warm conditions of the late-Glacial interstadial, the Windermere Interstadial of Great Britain. In Lancashire, this is evidenced by the complete Windermere interstadial to Holocene stratigraphic sequences at Haweswater (Marshall *et al* 2002; Jones *et al* 2002) and in the kettleholes of the lowland Lake District, which show the region was ice-free by 15,500 years ago. Similar kettleholes diversify and occur throughout the Kirkham hills, typically formed by the melt out of buried ice within these ice front moraines. With climate warming, the buried ice melts, leaving depressions that have since formed a locus for organic sedimentation and are excellent repositories of the organic macro- and microfossils used to uncover vegetation histories.

2.2 TOPOGRAPHICAL BACKGROUND

2.2.1 ***Countryside Character Areas***: the former Countryside Agency (now Natural England) has divided England into 159 'Joint Character Areas', which represent zones of distinctively similar landscape character. Each area has a report that outlines the influences that determine the character of the landscape. The Kirkham Moraine study area is predominantly contained within the 'Lancashire and Amounderness Plain', with the exception of its most easterly tip, which crosses over into the 'Bowland Fringe and Pendle Hill area' (Fig 5; Countryside Agency 2005).

2.2.2 ***Bowland Fringe and Pendle Hill*:** this is a generally undulating landscape with local river valleys creating variations in topography, along with upland features including Longridge Fell, Beacon Fell and Pendle Hill. Limestone outcrops are common features of the Ribble and Hodder Valleys. Meandering rivers, commonly lined by trees, and dotted with oxbow lakes, are prominent in a predominantly pastoral landscape.

2.2.3 The land has undergone much in the way of improvement for dairy and livestock farming. Most grazing occurs in the lush fields of the river valley bottoms, with some grazing at higher altitudes. River bodies include the Calder, Ribble, Hodder, and the Wyre. There is semi-natural woodland, much of which is Designated Ancient Woodland, on the valley bottoms and ridges. The main settlement pattern is one of small villages, hamlets and scattered farmsteads interconnected by winding country lanes, often hedge-lined (Countryside Agency 2005).

2.2.4 ***Lancashire and Amounderness Plain:*** this is a relatively flat area of gently rolling lowlands punctuated by occasional isolated hills. It is a large-scale agricultural landscape with a patchwork of pasture and arable fields, with areas of woodland. It includes areas of reclaimed land, many of the fields having ponds, and drains and dykes are characteristic of the lands to the west, where there are also remnants of lowland mires and mosses. The river estuary heads are often areas of salt marsh. The pattern of lanes and tracks becomes more regular, and rectilinear, and there is a much lower occurrence of hedgeline or fencing along these transport routes in comparison with the Bowland Fringe area. The buildings are predominantly isolated brick farmsteads in the rural areas, with major settlements along the coasts, often comprising former Victorian seaside resorts.

2.3 PREHISTORIC ARCHAEOLOGICAL AND PALAEOENVIRONMENTAL BACKGROUND

2.3.1 ***Upper Palaeolithic Period (11,000-8000 BC):*** the 'Old Stone Age', the time of the earliest stone-tool-using cultures, spans the first settlement of Britain from the middle to the end of the Pleistocene era, between 500,000 and *c*8-10,000 years ago. During this period at least six glacial cycles occurred, until the end of the last great Ice Age, *c*10,000 years ago (Gresswell 1967b). Early human occupation of the North West was dependent upon the cycles of glaciation, and the region was essentially an unoccupied icy waste during each glacial period. As the ice retreated and the climate became warmer in the Late Devensian interstadial, the vegetation on the drier land was an open birch, juniper and willow scrub with a rich herbaceous flora. This was ultimately replaced by more open grassland, with less stable soil conditions as the climate became colder (Middleton *et al* 1995; Hodgson and Brennand 2006). The most complete pollen sequence near to the study area is that from the deposits at High Furlong (SD 331 387), Poulton-le-Fylde (Fig 6), in which the remains of an elk where discovered (Hallam *et al* 1973; Barnes 1975). The pollen diagram and plant macrofossil record from this site span the Late Devensian from the earliest climatic amelioration in Late-Devensian I, through the warmer Late-Devensian II interstadial to the return of colder conditions in Late-Devensian III. The upper and lower contacts of the Devensian II interstadial were dated (Barnes 1975) to 11,843-11,311 cal BC (11,665±140BP, Lab code unavailable) and 12,881-11,821 cal BC (12,220±160; Lab code unavailable). West of this site, there is a cluster of pollen sites from the Skitham/Eskham ridge, which record the vegetation in Late-Devensian II and III (Barnes 1975), at Skitham (SD 4334 4358), Crabtree Farm (SD 4411 4296), Curlew Farm (SD 4345 4302) and Eskham 1 (SD 4320 4367). At Skitham 1, the upper boundary was dated to 11,688-10,741 cal BC (11,160±260BP; Lab code unavailable).

2.3.2 The earliest evidence for human activity in the broad study area all falls into the late Upper Palaeolithic date range (*c*16,000-8000 BC). The most famous find from Lancashire was that of the elk at Poulton-le-Fylde in 1970 (Hallam *et al* 1973), in

peat, the body having flint points embedded in its leg and ribs, indicating that human hunting groups were present in the area. This has been dated to 13,417-11,769 cal BC (12,400±300BP; OxA-1500; Jacobi *et al* 1986), although it has been suggested that the sample was contaminated and that the date may be flawed. The pollen from the site was suggestive of a lightly wooded park tundra landscape (Middleton *et al* 1995). Elk have been found elsewhere in the area, at Carnforth quarry, North Lancashire, where extraction works revealed an antler of the *Megaloceros* or Giant Antlered Elk in 1973, a species that was known to be extinct by 8000 BC (Young 2002).

2.3.3 ***Mesolithic Period (8000-4000 BC):*** the transition from the Upper Palaeolithic to the Mesolithic period is marked by the landscape changing from an open birch and juniper scrub to a largely wooded one. This transition was dated at Skitham (Barnes 1975) to 10,675-9275 cal BC (10,160 ±210BP; Lab code unavailable) and at Rawcliffe to 10,396-8921 cal BC (9980±180BP; GU-5202, Middleton *et al* 1995). The early Holocene (Flandrian) open scrub woodland was replaced first by birch woods then by dense hazel woods with pine and birch and it was at this time that charcoal was first recorded in peat deposits at Skitham and Rawcliffe 1 (Barnes 1975; Middleton *et al* 1995, 193). Whether the charcoal is the result of anthropogenic activity or natural fires is debatable but the former can be neither confirmed nor disproved (Middleton *et al* 1995); it may, though, indicate an early Mesolithic presence in Over Wyre just north of the present study area. Further evidence of Mesolithic fires is recorded from south of the study area at Starr Hills (SD 3352 2747; Fig 6), where it is dated to 7597-7144 cal BC (8390±105BP; Hv-4343, Tooley 1978, 82). Charcoal continued to be recorded in the peat from the sites at Skitham, and Eskham (Barnes 1975) and from Rawcliffe (Barnes 1975; Middleton *et al* 1995) for most of the Mesolithic period.

2.3.4 The raised acid mires of the Fylde were initiated at this time, and marine conditions were present some kilometres from the present coastline (Tooley 1978). This transgression, Lytham 1, was the first of a series recorded by Tooley at a number of sites in the south-west Fylde, demonstrating a period of fluctuating sea-levels.

2.3.5 There was a rapid expansion of pine throughout the North West before it was replaced by oak, and at Skitham this was associated with charcoal. The Mesolithic landscape then became one of a mixed deciduous forest of oak, elm, hazel, and pine on the drier ground, with extensive areas of alder carr on wetter ground. The pine decline and oak rise was quickly followed by indications of possible small-scale clearances, with a slight reduction in oak pollen, and rises in birch and ash pollen and bracken spores in the pollen diagrams from the Fylde (Barnes 1975). Later in the Mesolithic period, a corpus of evidence for small-scale temporary clearances in this type of woodland in Lancashire is recorded in pollen diagrams (Hibbert *et al* 1971; Barnes 1975; Cowell and Innes 1994; Middleton *et al* 1995), which suggest that small-scale disturbance of the natural woodland cover was regionally widespread at that time.

2.3.6 Towards the end of the Mesolithic period, parts of the Fylde were submerged by the Lytham VI marine transgression. The regression that followed Lytham VI in the early Neolithic period has been dated at several sites in the south-west Fylde, perhaps the most significant, because of their proximity to the study area, being two sites at Lytham Common, and one each at Peel and Lytham Hall Park, where dates of 3946-3690 cal BC (5005±45BP; Hv-3845), 3947-3384 cal BC (4895±45BP; Hv-4344),

4038-3386 cal BC (4960±120BP; Hv-2919), and 3711-3372 cal BC (4800±75BP; HV-3933) have been recorded. At the height of Lytham VI, Blackpool and Lytham would have been islands, which would have had a significant impact on the location of late Mesolithic and Early Neolithic settlement in the Fylde.

2.3.7 The general understanding of settlement patterns and human society in Britain as a whole is reasonably well evidenced and understood at this time. However, there is a lack of physical remains and the record is dominated by either individual isolated artefacts or scatters of lithic material, of which the latter is taken as being the best indicator of activity and/or settlement (Middleton *et al* 1995). Evidence of Mesolithic activity has been recovered from lowland, coastal and estuarine sites in Lancashire over the last 20 years, as a result of systematic surveys (Cowell 1991; 1992; Cowell and Innes 1994; Middleton *et al* 1995). In addition, there has been a general increase in commercial archaeological projects, which have occasionally revealed Mesolithic material.

2.3.8 This pattern of small-scale Mesolithic clearance in the Fylde, possibly resulting from anthropogenic activity, is supported by finds made by the North West Wetlands Survey of typologically later Mesolithic flint in the Lytham Moss area (site LA71), around what is now Peel Hall Business Park (Middleton *et al* 1995). The assemblage contained Black Chert, which has so far only been found in deposits that have been securely dated to the period, including at Marles Wood in the Ribble Valley and Halton Park in the Lune Valley (Middleton 1993; OA North 2006). It would appear that the Mesolithic evidence within the study area, a combination of scatters and individual stray finds, indicates a significant amount of human activity, particularly in the western coastal section of the study area (Fig 7). Indeed, during the North West Wetlands Survey, the area around the northern edge of Lytham Moss, particularly around Peel, proved to be a key area of settlement from the late Mesolithic to the Bronze Age (Middleton *et al* 1995).

2.3.9 ***Neolithic Period (4000-2000 BC):*** the Neolithic period provides considerable evidence for significant changes in society in Britain, which includes the emergence of social stratification and the increase in the archaeological record of evidence for elite groups. Ceremonial monuments, henges, stone circles and mortuary structures all appear, and a gradual reduction in group mobility from the end of the Mesolithic period is evident, reflecting the gradual abandonment of a hunter-gatherer lifestyle and the establishment of more permanent settlements associated with the adoption of agriculture (Edmonds 1999).

2.3.10 Core areas of early human agricultural occupation are likely have been restricted by a combination of physical constraints and the need of early communities to utilise land best suited for growing crops (Winchester 2006). In the case of the Kirkham Moraine, the settlements would be constrained by the areas of lowland mosses and marshes, essentially avoiding excessive water, whilst the potential arable lands would be limited to the islands and ridges of till, which provide freely draining soils. This would suggest that the earliest settlement of the area would be necessarily dispersed and fragmented.

2.3.11 The first possible palaeoenvironmental indicator of anthropogenic activity is the extensive burning (indicated by charcoal) recorded in the raised mires of the Fylde. This is related to changes in the composition of the natural woodland, for example the expansion of pine, then oak and finally by alder. If the burning was anthropogenic, it extended back into the Mesolithic period and was perhaps related

to hunter-gatherer activities (Middleton *et al* 1995, 203). A more reliable indicator of settlement in the region is the appearance of cereal pollen in the palaeoecological record, and in Lancashire it is frequently present in pollen diagrams at the Mesolithic/Neolithic transition (eg Barnes 1975; Tooley 1978; Middleton *et al* 1995; Howard-Davis 1996, fig 9). Pollen diagrams demonstrate a regional pattern, of temporary episodes of woodland clearance followed by the regeneration of trees. Early cereal pollen, an indicator of arable cultivation, is consistently recorded in the pollen record throughout the region and was identified in the Fylde, for example at Fenton Cottage and Winmarleigh Moss, where it was associated with high values of grass pollen and microscopic charcoal (Middleton *et al* 1995); it becomes less frequent, however, in the later Neolithic record. Cereal pollen is absent from the Fenton Cottage diagram after 3312-2891 cal BC (4370±50BP; GU-5145) and from Winmarleigh Moss after 3515-2674 cal BC (4410±140BP; GU-5033), and it is recorded only sporadically until the late Iron Age and Romano-British periods.

2.3.12 Although there were higher drier areas in the Fylde that may have been suitable for agriculture, considerable areas of low-lying land, which had been inundated by the Lytham VI transgression, either directly by salt water or by the drainage becoming impeded, gradually became terrestrialised. As water levels fell, this terrestrialisation would have taken two forms, with plants tolerant of brackish conditions colonising the coastal areas, to be replaced by reedswamp. Away from the marine influences, this reedswamp replaced the obligate aquatic plants, before fen carr became established throughout the Fylde on the low-lying ground. The fen carr lasted for *c* 500-700 years, but ended suddenly around 2300 cal BC, with a widespread flooding horizon, clearly shown in mire stratigraphy, which was most prominent north of the Eskham-Skitham ridge (Middleton *et al* 1995). This flooding does not appear to be related to either a known marine transgression or to extensive forest clearance, but tephra from Hekla was recorded within it at Fenton Cottage (Middleton *et al* 1995; Wells *et al* 1997). The description of the excavation in 1950 of Kate's Pad, the prehistoric trackway across the mires of Over Wyre, suggests that it was constructed on this flooding horizon in the early Bronze Age (Middleton *et al* 1995).

2.3.13 This plant succession is recorded in both the plant macrofossil and pollen records from Fenton Cottage (Figs 8 and 9), Winmarleigh Moss, and Peel Park (Middleton *et al* 1995). Mixed deciduous woodland and areas of cultivation were found on the higher ground and, although this evidence comes from outside the study area, it is likely that this would also have been the case on the Kirkham Moraine and the low-lying hills around it.

2.3.14 The main artefactual evidence for Neolithic settlement in the region is lithic material, both scatters and individual flint finds. Prior to the North West Wetlands Survey, no records of early Neolithic sites had been recorded for the western part of the Fylde (Middleton *et al* 1995). One site was located during the survey, to the north of the current Moss House Farm (Fig 6), and was found to be a concentration of flint material, over an area of 50 x 40m, surrounded by less concentrated scattered finds across the surrounding field. The spread was thought to continue into the neighbouring field to the north (Middleton *et al* 1995).

2.3.15 At Friar's Hill, on Wyre, the same sand island provided evidence of activity in both the late Mesolithic and the early Neolithic periods (Middleton *et al* 1995, 204). A site at Pilling Moss produced an assemblage of flints on the eastern edge of the moss, on an area of well-drained gravel, surrounded by heavy boulder clay that was much less

suited to agricultural practices because of its inherently poor drainage. Indeed, the most likely places for the preservation of prehistoric material are within the areas of river gravels, where the geological history indicates that they will be buried beneath fluvial deposition episodes.

2.3.16 This can be demonstrated at the site of St Michaels, on the floodplain of the River Wyre (Fig 6), where Neolithic flints and pottery have been discovered. There, a peat lens was dated to 4325-3966 cal BC (5286±80BP; GX-17293) and 4316-3810 cal BC (5230±80BP; GX-17294; Middleton *et al* 1995, 58). Plant remains taken as indicators of settlement were buried beneath 2m of alluvium, including pollen and macrofossil evidence, the former suggesting small-scale clearance of the local carr vegetation. A tentative identification of possible cereal pollen towards the top of the peat suggested cereal cultivation. The macrofossil evidence contained high values of charcoal throughout the profile, suggesting *in situ* burning (*ibid*).

2.3.17 There is a distinct change in the nature of the artefacts during the period, in particular the appearance of single-piece leaf-shaped arrowheads and polished stone axes. The pattern of stone axe finds tends to result from a combination of casual loss and ritual deposition (Bradley and Edmonds 1993), and where thin-section analysis has been undertaken, the majority in Lancashire originate from Great Langdale in Cumbria (Clough and Cummins 1988). As Middleton states, 'the axes from Lancashire have a definite riverine and mossland distribution. It is now clear, however, that many of the axes must have been deposited deliberately and the rivers had a specific significance' (Middleton 1996, 38). A group of eight such polished axes were found at Pilling Moss, and a single axe was found south of the junction of the railway and the M55 at Weeton (KM0032), attributed a later Neolithic date (Middleton *et al* 1995).

2.3.18 The other significant change in the archaeological record is the first appearance of formal burial monuments, specifically long barrows and cairns. The evidence in Lancashire is sparse in comparison to neighbouring areas, but equally a systematic survey of monuments is lacking, particularly in upland areas (Howard-Davis 1996). Within the study area, there are two funerary sites which have been attributed a general prehistoric date: a barrow at Derby Hill Weeton road, Weeton (KM0606); and at Many Pits Wood, north of Lea Town (Fig 6), where there is a possible remnant ring barrow (KM0317).

2.3.19 ***Bronze Age (2000-800 BC):*** the Bronze Age was essentially a period of consolidation after the apparently revolutionary upheavals of the Neolithic period. There was an expansion of forest clearance, which extended onto the marginal uplands, such as Anglezarke and the Forest of Bowland. In these areas there is a substantial increase in the number of identified settlement remains (OA North in prep), in part reflecting the improved survival of archaeological remains within lands that have subsequently seen little exploitation.

2.3.20 There is a rich palaeoenvironmental record in the Fylde. There is, however, little in the pollen record to distinguish the vegetation of the Bronze Age from that of the Neolithic period, with a continuing pattern of temporary woodland clearance episodes followed by regeneration. The only difference is that these episodes were possibly more marked and cereal cultivation is less frequently recorded, perhaps reflecting a more pastoral economy. There were, however, major changes on the surfaces of the mires, which may have been caused by either local edaphic factors, climatic conditions or a combination of the two, when the lowlands of Over Wyre

became slow-growing mires of poor fen or 'wet heath'. The area was described by the North West Wetlands Survey as one of acid valley mires gradually becoming fused, leaving islands of birch wood on the sand hills (Middleton *et al* 1995). Burning episodes continue to be recorded in the mire stratigraphy throughout the Bronze Age.

2.3.21 In the later Bronze and early Iron Ages, a low but consistent level of interference with the vegetation is recorded in the pollen diagrams from Fenton Cottage and Winmarleigh Moss, Lancashire (Middleton *et al* 1995; Wells *et al* 1997; Wells and Hodgkinson 2001; Fig 9). The tree pollen recorded in these diagrams suggests that although woodland dominated the landscape it was of a secondary character, alder and hazel dominating rather than oak and elm. However, at Briarfield Nursery, Poulton-le-Fylde (SD 337 389), where a late Bronze Age human skull, dated to 1212-843 cal BC (2845±65BP; AA-28733), was discovered in peat, the pollen data suggest that there was a higher level of anthropogenic activity surrounding this site than at others in Lancashire (Huckerby 2001).

2.3.22 The evidence for Bronze Age activity within the region is well documented, one of the most distinctive features in Lancashire being the large numbers of stray finds (Middleton 1996). These are distributed across the region, with clusters in the river at Sawley (HER PRN 296), a group of three found at Longridge (HER PRN 2660, 147, 1789), and one at Broadgate, Preston (HER PRN 101). This would seem to point to the probable importance of the Lune and Ribble Valleys as natural corridors (Middleton 1996).

2.3.23 Within the Kirkham Moraine area, there are ten records which have been definitely attributed a Bronze Age date, of which five refer to funerary monuments and five are small finds (*Section 5.3*). The funerary monuments have almost all been discovered around the Weeton Lane Ends area, with the exceptions of a possible round barrow at Many Pits Wood (KM0317), and possible tumuli at Clifton Mill farm (KM0010) to the east of the study area. The stray finds again cluster around Weeton Lane Ends, with the exception of a fragment of a bronze flat axe found at Little Singleton, to the north west of the area, and a Palstave found at Salwick Hall Farm, Salwick (KM0197, KM0011).

2.3.24 In terms of settlement, the general pattern of finds and monuments suggests that a much wider use of the landscape was occurring. In particular, the uplands seem to have been exploited throughout the second millennium BC, a period when the pollen records from the Forest of Bowland and Anglezarke show that there was an increase in human impact on the natural environment (OA North in prep). Although the evidence of upland settlement is not as extensive and widespread as it is for Cumbria, there are nevertheless reliable indicators of Bronze Age land improvement and farming within this zone. At Nicky Nook, on the western slopes of the Forest of Bowland, a relatively sizable cairnfield on a gently sloping plateau has 57 randomly distributed clearance cairns (OA North in prep). There were no indicators of associated settlement, however, and it is probable that any domestic structures were wooden and have not survived as surface evidence.

2.3.25 At Anglezarke (Fig 6), there were also clearance cairns and a putative cairnfield on Stronstrey Bank, which is a very distinctive natural terrace, both elevated above the adjacent low-lying plain, and relatively flat (OA North in prep). The area is thus comparable to western Cumbria, where such terraces invariably were covered in cairnfields (Quartermaine and Leech forthcoming). These most often reflect Bronze

Age land improvement, and it is tempting to relate those at Anglezarke to a major clearance episode dated to the late Neolithic/early Bronze Age, identified at nearby Hurst Hill (Bain 1991; OA North in prep).

2.3.26 Settlement sites on the lowlands are again invariably defined by flint scatters, in part because the structural remains may not have been very substantial. At Bonds Farm, Pilling Moss (Fig 10), a Bronze Age artefact scatter was excavated (Edwards 1992), revealing a group of postholes and stakeholes, with no particularly discernible pattern. The implication is that this was a transient settlement, and the structures were little more than tents.

2.3.27 ***Bronze Age/Iron Age Transition:*** the end of the Bronze Age saw a change in the pattern of land use, and it seems that some of the upland areas were abandoned, with a move towards enclosed settlement (Fig 10). On the Ribble, there are two definite enclosed sites of this date (PRN 12914, Fishwick Allotments; PRN 1293, Frenchwood Knoll, east of the current Avenham Park) and four possible sites (PRN 15239, Mete House Wood, Fishwick; PRN 15240, Brockholes Wood; PRN 15241, Boilton Wood; and PRN 15242, Red Scar Wood). If these putative promontory forts are proved to be of later Bronze Age or early Iron Age date, then it would indicate concentrated occupation of the valley bottom during this transitional period.

2.3.28 Multi-proxy indicators from peat bogs throughout north-west England suggest that there was a sharp downturn in climatic conditions in the first millennium BC, with a significant expansion of the wetlands within the range of *c* 900-400 cal BC, both in the lowlands and the uplands (Middleton *et al* 1995, 196; OA North in prep; Bain 1991). This is also the date range for the *Grenzhorizont* of Weber (1926; Middleton *et al* 1995) and Granlund's RY4 (1932; Middleton *et al* 1995). This recurrence surface has been recorded in bog stratigraphy throughout Northern Europe and Turner (1981), in a review of the evidence, concluded that it was highly likely that climatic changes caused this horizon to form. The rapidly expanding mires would have severely restricted the area of land available for cultivation, perhaps causing a decrease in the population.

2.3.29 This climatic down-turn in the mid first millennium BC is when the conditions of the mires in the Fylde became much wetter and *Sphagnum imbricatum* rose to dominate the surface vegetation. This sudden expansion of wet mires in the Fylde also seems to be associated with peaks in macroscopic and microscopic charcoal in the peat stratigraphy and woodland clearance, at least in the vicinity of Fenton Cottage. However, although the evidence for anthropogenic activity being the causal agent of the increasing wetness is not strong (Middleton *et al* 1995), there are significant implications for settlement and agriculture north of the study area, perhaps leading to the Kirkham Moraine becoming more attractive, with more and larger areas of higher dry ground.

2.3.30 ***Iron Age:*** the climatic deterioration continued into the Iron Age. There was an abandonment of the upland settlements and clear evidence of woodland regeneration from the early Iron Age within the pollen sequences of the region, which is coupled with proxy climatic indicators, for example recurrence surfaces in peat bogs, that clearly indicate a deterioration in climatic conditions. However, there is also evidence in pollen diagrams of an improvement in climate, with drier and warmer conditions associated with extensive clearance in the later Iron Age; arable cultivation is clearly recorded in the pollen diagram from Fenton Cottage (Fig 10; Middleton *et al* 1995; Wells *et al* 1997).

2.3.31 The archaeological evidence for Iron Age activity in Lancashire is quite sparse, and even aerial surveys (Higham 1980) have located only a small number of sites. There are of course a few classic hillfort sites, presumably resulting from the increasing competition for agriculturally viable land that had diminished as a result of the climatic decline. The most notable hillfort, in the wider region, is that on Ingleborough, near the upper reaches of the River Ribble. This is a single vallate fort on the flat-topped summit of a 723m-high mountain in the Yorkshire Dales (Fig 10).

2.3.32 Much of the evidence for the Iron Age in the region derives from isolated finds, such as the dagger scabbard preserved in Pilling Moss (Haselgrove 1996). The deposition of human bodies in mosses and bogs is also known from the period, bodies having been recorded from Pilling Moss and Red Moss (Fig 10), and from further afield at Lindow Moss (Stead *et al* 1986; Middleton 1996).

2.3.33 There is an apparent contradiction between the dearth of confirmed Iron Age sites and palaeoenvironmental evidence, which indicates increased activity and forest clearance in the later Iron Age. In part, this reflects the dearth of reliably dated excavations on potential sites, and that there is a corresponding reliance on the typological dating of surface features. There is a now accepted realisation that in the North West (Quartermaine and Leech forthcoming) there was considerable continuity of settlement from the Iron Age into the Roman period, and sites that have the typical characteristics of a Romano-British settlement may in fact have Iron Age origins. For instance, a rectilinear, complex enclosed settlement at Ingleton, near to the northern reaches of the Ribble, morphologically was a classic Romano-British settlement, and the dates confirm that it was occupied during much of the Roman period; however, the earliest date (88 cal BC-cal AD 66 (2010 ± 28 BP; KIA 22910)) indicates that it had an Iron Age origin.

2.4 ROMANO-BRITISH ARCHAEOLOGY

2.4.1 The knowledge base and understanding of the Romano-British period is greater than that of any preceding period, reflecting in part the literary accounts of the peoples and places, ranging from 'histories' to inscriptions. A great deal of research in the North has focused on the Roman military and in particular the northern frontier system; the principal elements of this within the wider region of the study area are the sites of Kirkham, Ribchester and Walton-le-Dale (Howard-Davis and Buxton 2000; Buxton and Howard-Davis 2000; Gibbons *et al* forthcoming; Fig 11).

2.4.2 Within the study area there is physical evidence of a Roman road running from Kirkham, heading east, providing a communication route that linked to Walton-le-Dale and Ribchester (Margary 1973). The roads themselves have yielded a considerable amount of Roman coins, spanning the first to fourth centuries AD, as well as milestones and sculptures (Graystone 1996). At Elston Hall, on the Ribchester to Kirkham road, a hoard of *denarii* was found, at Fulwood and Ribbleton, coins of Nerva, and at Red Scar, Haslem Park and Clifton, third- and fourth-century coins have been found. This concentration of finds apparently contrasts with the lack of finds on the road between Ribchester and York (Graystone 1996; Shotter 1999).

2.4.3 West of Kirkham, the road is not visible in the landscape, but it is thought to follow a putative line curving north-west. The route is known as 'Dane's Pad' and has been described by the antiquary, the Rev W Thornber, who postulated that it was used by

Danish raiding parties to penetrate inland (Graystone 1996). This line is unusual in that it curves across the landscape, rather than etching a more customary straight line and indeed its very existence has been questioned (Middleton *et al* 1995). At Mythop Hall, however, an antiquarian report of an 'agger being up to 60ft wide at the base and 36ft wide at the top', was reported, but no physical remains can be seen today (Margary 1973).

2.4.4 Findspots of coins, pottery and metalworking run in a north-west curving line along the putative route from Kirkham to Todderstaffe Hall, north of Weeton. There the distribution of finds stop and the road running further north towards Poulton-le-Fylde and Thornton is increasingly speculative. The physical evidence of the road is slight across its course, with possibly the best remains being around Puddle House Farm to the north-east of the village of Hardhorn, south of Poulton-le-Fylde (Graystone 1996), though there is no corroborating record for this in the Lancashire HER.

2.4.5 One theory is that the road continued north to the estuary of the Wyre, with its northern terminus suggested as the postulated *Portus Setantiorum* or seaport of the Setantii, the local Iron Age tribe (Howard-Davis and Buxton 2000). This is mentioned by the ancient geographer Ptolemy (Berggren and Jones 2000) and perhaps lies somewhere along the lower reaches of the Wyre around present-day Fleetwood. A second stretch of Roman road between Preston crosses the study area through the village of Broughton and Lancaster; however, much of its route lies beneath the modern A6.

2.4.6 Kirkham was the focal point of Roman activity in the study area. At Dowbridge, a series of at least three temporary camps suggest that occupation may have begun as early as the governorship of Petilius Cerialis, *c*AD 71 (Howard-Davis and Buxton 2000). These were subsequently succeeded by a signal station or fortlet *(ibid*), which seems to have been incorporated into a more conventional fort, with a stone-fronted rampart and deep defensive ditch, probably in the early second century (*ibid*). The stone revetment was built from red sandstone, which was imported from areas further east (*op cit*, 27). The ditch was recut twice, and there appears to have been a fortified annexe to the east, also bounded by ditches. The interior of the fort was heavily disturbed and the stone had been robbed for later buildings in Kirkham, thereby limiting the evidence for structures (*op cit*, 36). The fortlet may have acted as a beacon, and the fort was clearly part of a system connecting the Fylde Coast to Ribchester, via the river and roads running along the north bank of the River Ribble (Shotter 2004). It appears, though, to have been abandoned by the middle of the second century AD (Howard-Davis and Buxton 2000).

2.4.7 The study area contains 40 definite Roman sites recorded in the HER, 16 of these in Kirkham, which are either associated with the fort at Dowbridge or are sections of the Roman road which runs through the town (Fig 11). The construction of the fort at Kirkham is likely to have been a stimulus to encourage the growth of settled communities in the area, providing a market for grain and meat production. This would mean that the remains of Romano-British field systems and farms should be dotted across the well-drained soils of the area. However, no substantial remains have yet been identified. This may reflect the fact that good agricultural land has remained in use and subsequent agricultural improvements may have removed traces of earlier field systems (Shotter and White 1995).

2.4.8 This suggestion is supported by the finding of 'a wide distribution of find spots of Roman coins in the Fylde area, even in places removed from the Roman roads and

settlement' (Graystone 1996, 84). Additionally, there are several HER records of findspots indicating wider settlement away from the roads, quernstones having been found at both Wharles and east of Esprick, and coins at Woodplumpton (PRN 2035, LA129 NWWS).

2.4.9 The evidence from the North West generally, and from Duttons Farm, Lathom (Cowell 2003), Barker House Farm, Lancaster (OA North 2004), and Broadwood, Ingleton (Johnson 2004; Fig 11) specifically, indicate that rural settlement was essentially of a native, Iron Age character. The houses were round and either stone founded or of timber, and often revealed little in the way of Roman material culture. The implication is that, although the native Britons may have traded with their Roman overlords, there was relatively little cultural interaction between them in the rural hinterlands of the Roman installations.

2.4.10 Palaeoenvironmental evidence shows that woodland clearance during the late Iron Age intensified during the Romano-British period. The extensive clearance activity recorded in the Late Iron Age at Fenton Cottage, Winmarleigh Moss, Cockerham, and Pilling Mosses in the Fylde (Oldfield and Statham 1965; Middleton *et al* 1995; Wells *et al* 1997), continued into the Roman period, with clear evidence of cereal cultivation. This clearance activity has been dated to between 365 cal BC-cal AD 77 (2080±90BP; GU-5159) and cal AD 349-583 (1590±50BP; GU-5144). Pollen evidence from this and other sites suggest both arable and pastoral farming in the Fylde, with heather (*Calluna vulgaris*) still an important component of the local vegetation. Burning still continued to be widespread, but this could have been used as a management tool to encourage new heather growth for animal fodder rather than for clearance *per se*. The dominance of *Sphagnum imbricatum* in the peat stratigraphy suggests that in general the mire surface was very wet, but it alternated with peaks of heather and cotton grass, suggesting temporary episodes of drier conditions.

2.4.11 ***Roman Decline:*** during the second century AD, the pacification and increasing stability of the area appears to have led to a scaling down of military activity. Evidence from Kirkham suggests abandonment, though the production site of Walton-le-Dale continued. Ribchester itself appears to have changed in function and become more of an administrative centre (Buxton and Shotter 1996).

2.4.12 The decline of Roman rule in Britain seems to have occurred not as an event but as an extended process over the latter part of the fourth century, the most obvious symptom of the administrative decline being the reduced supply of pottery and coinage. During this period, army units became in effect a local militia. From AD 402 there were no more supplies to pay the army (Shotter 2004, 153-74) and the ties with Rome were effectively cut, leaving the fort commanders as at least semi-autonomous leaders.

2.5 EARLY MEDIEVAL ARCHAEOLOGY

2.5.1 Following Rome's abandonment of the province, there appear to have been two phases of partial woodland regeneration, dated to cal AD 349-583 (1590±50BP; GU-5144) and cal AD 558-773 (1380±60BP; GU-5143) at Fenton Cottage, Lancashire (Fig 8); these phases were separated by increasing levels of grassland in the landscape (Middleton *et al* 1995, 152; Wells *et al* 1997; Fig 9). The earlier period of regeneration is contemporary on the mire surface with a change in dominance from

Sphagnum imbricatum to *S sect Acutifolia* at cal AD 349-583 (1590±50BP; GU-5144), suggesting a period of drier conditions at this time (Middleton *et al* 1995). There is extensive evidence for a drier period throughout the British Isles (Lamb 1977) and it seems likely therefore that the reduction in anthropogenic activity recorded was not caused by a deterioration in climatic conditions but by a genuine reduction in farming.

2.5.2 A great deal of the evidence for the period following the end of Roman governance comes from early historical sources, but any references to the North West are usually quite general, and often written with or for the purposes of a political agenda, or from a specific standpoint. Examples include the *Anglo-Saxon Chronicle* (Garmonsway 1967) and the writings of Bede (Colgrave and Mynors 1969).

2.5.3 The North West became part of the Anglo-Saxon kingdom of Northumbria in the seventh to ninth centuries, although there is limited archaeological evidence for this period across the area. It is likely that political instability existed throughout the tenth and eleventh centuries, and in this period, the most famous site known is the Cuerdale Hoard, the largest hoard of Viking hack silver and coins found outside Russia (Fig 12). It was discovered in the riverbank near Cuerdale, outside Preston, in 1840 (RM Newman 1996), and contained over 8600 items, including silver coins and bullion, contained in a lead box (Edwards 1998). The hoard contains over 7000 coins and between them they demonstrate very clearly the international scale of Viking activity, as well as providing evidence for the dating of the hoard. It is believed that it was buried between AD 903 and AD 910, at a time when the Ribble Valley was an important Viking route between the Irish Sea and York (Kenyon 1991).

2.5.4 The only surviving churches with obvious early medieval fabric in the region are St Patrick's Chapel and St Peter's Church, both at Heysham, and a small part of the church at Lancaster. The fabric of both the church and chapel at Heysham has been dated to the late eighth century (Potter and Andrews 1994). Given the amount of sculpture at both sites, and the juxtaposition of the two churches at Heysham, both of these, and Halton church, have been suggested as possible monastic sites (RM Newman 1996). These Lune Valley sites show a concentration of stone sculpture with both Northumbrian and Scandinavian attributes, at Heysham, Halton and Lancaster (Fig 13), which indicate Christian sites in the eighth to tenth centuries (*ibid*). These early church sites clearly continued to be in use into the tenth and eleventh centuries, as stone sculpture with Scandinavian attributes has been found at each. The Ribble Valley has both Northumbrian and Scandinavian motifs on stone crosses at Whalley, and there is possibly another piece, now at Anderton, but which may have derived from Preston (*ibid*).

2.5.5 At Lancaster, a hoard of stycas was also found at Vicarage Field (Penney 1981; Garstang 1906). Closer to the study area, a burial mound was opened in 1822 to the east of the study area, at Claughton Hall, near Garstang, which proved to be of immense significance. This revealed an urned cremation, an assemblage of ironwork that was of undoubted Norse origin, and two very ornate tortoise-shaped oval brooches (Edwards 1998, 14-17), suggesting reuse of an earlier burial place. A single HER record hints at early medieval activity within the study area; PRN 0074 records the find of a fragmented 'cinerary urn' during gravel extraction in 1889, at Crossmoor near Inskip. However, there was also a sword and a dagger that were thought to be Anglo-Saxon (Fishwick 1891). Again, this represents a later reuse of

an early burial mound, although the dating is not certain and the HER lists this find as 'uncertain' in date.

2.5.6 Despite the emergence of a distinct material culture from the eighth/ninth century onwards, evidence for the middle centuries of the early medieval period depends heavily on both place-names of Old English and Scandinavian origin. Groupings of both can be found on the good agricultural land of the North West's river valley floors (RM Newman 1996; Higham 2004), and also in coastal areas such as Kirkham (Kenyon 1991; Higham 2004).

2.5.7 The central Fylde contains some of the earliest surviving place-name evidence in the area, and 'settlement in the immediate Post-Roman period may be suggested by a series of 'British' place-names' (Middleton *et al 1*995, 113). The town of Kirkham is thought to have been in existence by approximately AD 700, as indicated by the 'ham' element of the name (Kenyon 1991). Inskip is thought to derive from the Old English 'Cype', which means an osier basket used for catching fish (Mills 1976, 99-100), and it is perhaps noteworthy that the village is situated on a rise that stands 20m above the low-lying reclaimed fields that surround it on three sides.

2.6 MEDIEVAL ARCHAEOLOGY

2.6.1 It was during the later medieval period that the landscape that we know today was largely created. The pattern of villages, with their irregular radial field systems, the scattered market towns, and the country road system had its origins largely in this period. The impetus for the nucleation of settlement was the intensification of lordship and manorialisation in the ninth and tenth centuries (Newman 1996). However, this process was impeded in the North West by the unstable political situation created by the expanding kingdoms of England and Scotland (Winchester 1987, 5) during the eleventh century. During the twelfth century, as the Norman rulers expanded their power up to the present Scottish border, a significant grouping of the characteristic Norman motte and bailey defensive earthworks developed along the line of the Lune. The indications are that for a period in the later eleventh century this river may have served as a border (*ibid*), whose defensive sites became centres of the feudal administration system introduced to England by William I (Higham 1991).

2.6.2 The system involved the division of the landscape into very large estates, each of which was given to the charge of a nobleman. These noblemen would collect taxes and would provide the king with troops; they were known as tenants-in-chief. Often these areas would be sub-divided amongst knights who would govern their own smaller estates, as sub-tenants (Barlow 1999). A general description of Kirkham and the Fylde is given in Porter's *History of Fylde* (1876). The study area was part of the Hundred of Amounderness and was given to Theobold Walter, a Norman noble. The document of conveyance is described at length by Porter: 'The Hundred of Amounderness was conveyed by the King on the 22nd of April, 1194, being the fifth year of his reign, to Theobald Walter the son of Hervens, a Norman who had accompanied the Conqueror. "Be it known" says the document, "that we give and confirm to Theobald Walter the whole of Amounderness with its appurtenances by the service of three Knights' fees, namely, all the domain thereto belonging, all the services of the Knights who hold of the fee of Amounderness by Knight's service, all the service of the Free-tenants of Amounderness, all the Forest of Amounderness,

with all the Venison, and all the Pleas of the Forest". His rights "are to be freely and quietly allowed", continues the deed, "in wood and plain, in meadows and pastures, in highways and footpaths, in waters and mills, in mill-ponds, in fish-ponds and fishings, in peat-lands, moors and marshes, in wreck of the sea, in fairs and markets, in advowsons and chapelries, and in all liberties and free customs"' (Porter 1876, 33).

2.6.3 The study area maintains an historic rural feel to the landscape, with areas of relict ridge and furrow cultivation preserved across the Fylde, many of which have been attributed a medieval date. Farmhouses at Woodplumpton, Haighton, and Elswick also have medieval origins. The field systems have headlands that indicate the use of horse or ox ploughing, as opposed to later steam ploughing, and as such suggest an early date. A strikingly well-preserved field system survives west of Catforth, where a series of long lanes extend out from the village. The small fields are orientated along these lanes and are almost identical to the pattern of fields that can be seen on the first edition Ordnance Survey map of 1844 (Fig 14). The field system runs for nearly 2km westwards to the parish boundary, where it stops abruptly, and stands in stark contrast to the regular larger fields to its west. It may suggest that the paths led out to the extent of usable land, perhaps with individual ownership of plots along them. The area has been classified by *The Lancashire Historic Landscape Characterisation programme* as 'Ancient Enclosure', which is defined as being 'land which has been enclosed prior to *c*. AD1600' (Ede and Darlington 2002, 92).

2.6.4 The areas of wetlands were seemingly attributed little value, and do not appear to have been exploited until the sixteenth century, when documentary evidence from court pleadings (Fishwick 1907) mentions disputes over the cutting of rushes for thatch and the blocking of drainage. This suggests that water management and some measure of reclamation was being undertaken in the landscape (*op cit*, 11-15). Further documentary evidence comes from Woodplumpton, where court records dated to 1542 record a protest by freeholders who lost their rights to pasture and 'turves' as a result of the lord of the manor enclosing certain lands (Middleton *et al* 1995).

2.6.5 The raised mires of the Fylde and North West in general have been extensively cut from at least the medieval period onwards. An exceptional resource is to be found at Fenton Cottage, where a rare fragment of 'top moss' remains, which curiously is still accumulating, despite being surrounded by ground several metres lower, where the mires have been extensively cut and drained. The surface of the mire is obviously drying and is gradually being colonised by birch, but pollen preservation is excellent and gives an unique record of vegetational changes in the Fylde, from the Neolithic to the present day (Middleton *et al* 1995).

2.6.6 In the late twelfth and thirteenth centuries, the North West began to see the development of what were to become the major towns of the region. Prior to the Norman Conquest, towns were not a feature of the landscape (White 1996, 125), and it is probable that the earliest were proto-urban defended sites, such as Lancaster and Penwortham (Fig 12), where the defended settlements grew into towns (Crosby 1994), though it has been postulated that Penwortham was actually a burh (a planted defended town) created under the rule of Edward the Elder (Higham 2006).

2.6.7 Settlements in the area mentioned in Domesday Book are Walton-le-Dale, Whalley, St Michael's on the Wyre, Poulton-le-Fylde, Kirkham, Ribchester and Ashton on Ribble (Morgan 1978; Faull and Stinson 1986). By the mid thirteenth century, the

principal boroughs of Lancashire were Lancaster, Preston, Liverpool, Manchester, Wigan and Warrington (Higham 2004). In addition to these, there were other smaller towns, tending to be situated at the favoured sites for settlement along the well-drained drier ridges and hillocks in between the extensive marshes. A distinct cluster of these can be seen in the Lower Ribble Valley, including Kirkham, Freckleton, Clifton, Penwortham (just south of the river), Longridge and Broughton (Newman 1996), all, for the most part, on the margins of the wetter lands.

2.6.8 There seem to have been only a few large parishes on the Fylde, principally Lytham, Preston, Kirkham, Poulton-le-Fylde and St Michael-on-Wyre. Both Poulton-le-Fylde and, St Michael-on-Wyre contained chapeleries, at Bispham and Woodplumpton respectively (Tupling 1957). The monastic cell at Lytham was created in the late twelfth century, the documents referring to its creation describing the landscape and including reference to mosslands (De Rance 1877b, 79). Lytham and Marton Mosses were described in the foundation charter for the Benedictine cell (a dependency of Durham Priory), written during the reign of Richard I (1189-99). The description lists meadows, pastures, moors, mosses, marshes, mills, millponds and fisheries (Middleton 1996, 100), and matches well the landscape description quoted by Porter (*Section 2.6.2*).

2.6.9 The written evidence for a church in Poulton is in the document of conveyance quoted by Porter (*Section 2.6.2*), which describes the presentation of the church in Poulton to the Abbey at Sees in Normandy (Porter 1876). This was accepted practice, and Poulton church, together with other churches in Amounderness, including the newly built church dedicated to St Mary at Lancaster, remained in the hold of the Norman Abbey until Henry IV dissolved the power of foreign abbeys to hold land in England.

2.6.10 Additionally, there are 12 crosses and/or cross bases, recorded in the HER for the study area, which have been dated to the medieval period, all in the southern half of the study area. Crosses are known to have been used as boundary markers between parishes (Middleton *et al* 1995).

2.7 POST-MEDIEVAL ARCHAEOLOGY

2.7.1 The study area contains 510 records HER assigned to the post-medieval period, of which the majority are features relating either to agricultural, domestic life, industrial or transport, which reflects the mixed economy of the area (Fig 15). The records include 118 listed buildings dotted throughout the towns and villages of the area. Post-medieval farming, to a substantial extent, was a continuation of medieval practices. However, there were several very significant changes, particularly the collapse of the peasant farming system. During the latter part of the medieval and the earlier post-medieval periods, the peasant farmers were acquiring the land they farmed (Taylor 1983) and there was a corresponding break-up of the open fields around nucleated settlements. This involved the enclosure of the aratral strip fields, their shape reflecting the oxen-ploughed ridge and furrow of the open fields. There was also, during the later medieval and post-medieval periods, pressure to reclaim lands that had previously been wetlands, and there was an increase of dispersed settlement on these outlying lands. This increase was compounded by the ultimate expression of land reorganisation, the parliamentary enclosure of the eighteenth and

early nineteenth centuries, which pushed this exploitation of newly won land-holdings (Whyte 2003).

2.7.2 In the medieval and post-medieval periods, from cal AD 1048-1268 (820±50BP; GU-5142) to the present, the landscape around Fenton Cottage has become progressively cleared and is now virtually treeless (Middleton *et al* 1995). Cereal cultivation was visible to a depth of 0.06m from the present ground surface (Fig 9), which is likely be historically very recent, as at a depth of 0.25-0.30m, peat was dated to cal AD 1435-1635 (390±50BP; GU-5141). The decline in cereal cultivation in recent times perhaps suggests changing agricultural regimes, away from subsistence farming, or reflects the fact that grain started to be imported from America after World War II (on what is likely to have been a marginal environment for cereal).

2.7.3 The effect of these changes was the expansion of the field systems, onto areas of previous waste, often with the characteristic straight lines of the parliamentary enclosures, as well as the rationalisation of nucleated settlements, and the loss of the former waste, be it woodland or moorland. The field patterns of the Fylde seen on the first edition Ordnance Survey mapping of 1844 show an increase in narrow yet regular fields, which are indicative of intensive drainage of land claimed back from mosses and marshes.

2.7.4 The villages and towns owe their growth to the expansion of eighteenth- and nineteenth-century industry; indeed, it was the growth and spread of industry which characterised the broader economic growth of the North West (Winchester 2006). At Thornton Cleveleys (Fig 15), a largely residential town developed between Blackpool and Fleetwood, during the late 1800s. The two original settlements of Thornton and Cleveleys became linked over a 100 years ago, when the railway station was named Thornton for Cleveleys because it served both communities (Kirkman and Van Zeller 1991). Cleveleys had developed as a resort, whilst Thornton has a more industrial background. The Marsh Mill at Thornton is a windmill dating back to 1794, standing 70ft (21m) high and is one of the largest mills in Europe. It is fully restored and is now a museum (Rothwell 1994). In 1889, land at Burn Naze, near the Wyre estuary, was acquired for building a salt works and The United Alkali Company's ammonia soda works started production in the early 1890s (*ibid*). In 1900, Thornton became an Urban District Council and remained so until 1974, when it was incorporated in Wyre Borough Council.

2.7.5 Poulton (Fig 15) had two ports, one on either bank of the River Wyre, on the south side at Skippool and on the north side at Wardleys in Hambleton. During the eighteenth century, this was an important trading facility, and Poulton had its own customs house, dealing in mahogany and flax with the Baltic ports, and coastal trade, with farm produce to Liverpool, Lancaster and Cumbria. The rise of Glasson Dock and Fleetwood ended Skippool's importance as a port (Poulton-le-Fylde Historical Society 2007).

2.7.6 By the post-medieval period, Kirkham appears generally to have been a successful local market centre. The Moot Hall was built in 1570 on the Market Place (Singleton 1980, 18). Additionally, Kirkham had acquired an industrial role in the post-medieval period, as a centre of flax processing and small-scale linen production, and it had a minor salt-making industry (Baines 1824). The Birley, Langton and Hornby families became established names in the town and built sailcloth mills supplying the Royal Navy, their success bringing workers into the town, increasing population and

creating a demand for housing and amenities such as public houses. Consequently, much of the old oxgang land (the land which a single farmer with a single ox could cultivate in a year, usually around 15 acres (Langdon 2002)) was used up, so joining Kirkham to the neighbouring village of Wesham, lying at the other side of the railway lines (Baines 1824, 658; Mannex 1851).

2.7.7 There are 22 mill sites in the study area recorded in the HER, including water- and wind-powered mills and later cotton and corn mills. One factor which certainly helped the development of all these industries was the coming of the railway to Kirkham in 1840. Its main purpose when constructed was to facilitate communications between the Lancashire manufacturers and Ireland by providing easy access to the River Wyre and the Port of Fleetwood. The Preston and Wyre Railway and Harbour Company was set up to construct the railway between Preston and the Wyre and plans were passed for this line in 1835 (Kirkman and Van Zeller 1991). The port, however, developed into a resort town and associated fishing industry rather than a centre of goods and cargo shipping.

3 METHODOLOGY

3.1 INTRODUCTION

3.1.1 This project continued to use the methodology established during the Ribble Valley ALSF project (OA North and University of Liverpool 2007a), bringing together geomorphological, palaeoenvironmental, and archaeological expertise, to produce an integrated model of the potential for archaeology and the suitability for aggregate extraction across the Kirkham Moraine study area (centred on SD 439 435). The techniques used have included traditional desk-based assessment, archaeological walkover survey, geological and palaeoenvironmental fieldwork, geostatistical and spatial analysis, and geospatial modelling.

3.1.2 During the Ribble Valley ALSF project, these techniques were assessed for their suitability and effectiveness, given the nature of the data available. For example, the distribution and quantity of archaeological sites within the study area favoured some techniques over others (*op cit*, *sections 4.1-3*). This process allowed the creation of a refined methodological toolkit, comprising techniques that could be applied as appropriate in other projects. Consequently, this section will not include an in-depth introduction or assessment of the techniques used, but will provide cross-references back to the original Ribble Valley ALSF report where necessary.

3.2 STRUCTURAL OVERVIEW OF THE GIS

3.2.1 Separate GIS systems were constructed for the data-gathering tasks that were undertaken by OA North and the University of Liverpool, but both were constructed in ArcGIS 9.2 format to ensure compatibility. In the analytical phase of the project, data were transferred freely between the two organisations in the form of a single geodatabase, compatible with Access 97. This allows the datasets, normally separated as shapefiles, to be distributed as a single file, and also allows both spatial and non-spatial interrogation of the datasets in both ArcGIS and Access.

3.2.2 ***Modern Mapping:*** the following modern map datasets were provided to form the basis of the GIS:

- Ordnance Survey Landform Profile 10m resolution digital elevation dataset;
- Ordnance Survey 1:10,000 digital raster mapping;
- Ordnance Survey 1:50,000 digital raster mapping.

3.2.3 ***Incorporation, processing and analysis of DEM datasets:*** due to licensing issues, hydrological data from the Environment Agency were not available for use in this project. Furthermore, the NextMAP Great Britain™ digital elevation dataset from Intermap Technologies was only available to the University of Liverpool under an existing academic licence, and could not be supplied to OA North. Consequently, a digital elevation model (DEM) for OA North that covered the entire study area could, therefore, only be created from the Ordnance Survey Landform Profile dataset (*Section 3.2.2*). This was of limited use for detailed analysis, given the resolution and accuracy, but was helpful in providing a broad model of the topography of the study area.

3.2.4 ***Light Distance and Ranging (LiDAR) data:*** this was supplied under licence for the duration of the project by the Environment Agency, although the whole study area has not been flown (Fig 16). Available coverage was supplied as ASCII files that were used to create georeferenced DEM for use in both the geomorphological and archaeological analyses.

3.2.5 ***Geomorphological mapping:*** in recent years geomorphological mapping has been revolutionised by the application of high-quality DEM, such as NEXTMAP and LiDAR, which has radically improved the quality of geomorphological mapping and considerably reduced its cost (Smith *et al* 2006; Chiverrell *et al* in press). For this project, geomorphological mapping of the whole of the Fylde was undertaken using a NEXTMAP bare ground model with a 5 x 5m spatial precision and a ~0.5m vertical resolution, with more detailed mapping undertaken for the Kirkham study area using the LiDAR data. Both datasets were manipulated to generate a light-dark-light colour gradation to highlight morphology within the altitudinal range of the moraine system, 1m contour intervals, variable aspect hillslope shading and slope angle surfaces. These images were then divided into 35 5 x 5km blocks, each equivalent to a conventional 1:10,000 scale quarter map sheet (eg SD44NE, SD44SE etc). Each sheet was overlain with a conventional non-generic symbol mapping system that includes basic break of slope symbols, together with symbols for primary landform geometries such as ridges, mounds and basins, and special symbols for channels, water bodies, flat ground, etc.

3.2.6 Despite the advantages of high-resolution DEMs, the morphological complexity of the landscape often imposes severe limitations on the interpretative capability of the remote sensing approach. Interpretative problems in DEM mapping may arise, for example, in differentiating between complex palaeochannel configurations and terrace levels, or between anthropogenically and naturally formed surface morphologies. Additional problems may arise where derived 'ground surface' DEMs involve elevation errors as a result of tree or building coverage. Therefore, field mapping surveys represent a necessary second stage of mapping in order to 'ground truth' and improve upon the results of the DEM desk-based study. Field mapping was carried out within the study area visiting key sites to verify the digital mapping. However, more complex examples of newly identified landforms were mapped using a hand-held GPS, particularly where the LiDAR coverage was lacking. All alterations compiled on the field maps formed the basis for editing the glacial landform (esker, delta, moraine ridge) and glacial line features (ridge crests, erosional channels, slope breaks) that comprise the geomorphological aspects of the geodatabase (Table 1).

3.2.7 ***Datasets produced:*** the datasets included in the geodatabase are outlined in Table 1. A flow diagram describing the tasks necessary to construct this geodatabase can be found in OA North and University of Liverpool 2007a, fig 28.

Feature class	Data type	Features included
Archaeological Events	Points	All archaeological interventions such as excavations, watching briefs and so on
Archaeological Events	Polygons	The actual extent of all archaeological interventions, where available
Archaeological Monuments	Points	All archaeological features within the study area
Archaeological Monuments	Polygons	The actual extent of all archaeological features, where available
Enhanced Historic Landscape Characterisation	Polygons	Quantity and density of archaeological events and monuments within each polygon
Potential for prehistoric activity	Polygons	Areas of high, medium and low potential for activity
Potential for Roman activity	Polygons	Areas of high, medium and low potential for activity
Potential for medieval activity	Polygons	Areas of high, medium and low potential for activity
Palaeoenvironmental Events	Points	All palaeoenvironmental work within the study area such as boreholes, coring and so on
Palaeoenvironmental Monuments	Points	Data resulting from palaeoenvironmental events, such as radiocarbon dates and so on
Glacial Landforms	Polygon	Moraine ridges, drumlins, deltas, kettle basins, sandur flats
Glacial Lines	Lines	Channels, ridge crests, ice-flow directions, ice divides
Boreholes	Points	Location of boreholes
Suitability for Aggregate Extraction	Polygons	

Table 1: Datasets included in the Ribble Valley ALSF project geodatabase

3.3 CHARACTERISING THE GEOLOGICAL AND GEOMORPHOLOGICAL RESOURCE

3.3.1 ***Introduction:*** some preliminary analysis and compilation of necessary datasets was achieved during the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, *sections 7.2.12-16*), but this needed to be built on to ensure comprehensive coverage. All data compilation was built upon the GIS framework described above (*Section 3.2*).

3.3.2 ***Collation and Analysis of Available Geological Data:*** the location, characteristics and age of all deposits potentially exploitable for aggregates within the study area were collated from a variety of sources. Evidence of usable aggregate sources was derived from the Lancashire Mineral Planning Authority record of current and old aggregate permissions, and the current *Lancashire Minerals and Waste Local Plan* (Geoplan Ltd 2006). Records of active, dormant and exhausted quarry workings were collated from the British Geological Survey (BGS) BritPits dataset, which records all quarry workings since 1835. Additional information on current and past workings was derived from the North West England Regional Aggregate Working Parties (RAWP), and the *Lancashire Minerals and Waste Local Plan*. BGS digital mapping was incorporated within the GIS as a first approximation for the sand and gravel (drift) aggregate. Lancashire County Council had 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 had been underpinned by a geomorphological and lithofacies-based analysis to

enhance understanding of the spatial pattern of deposits outside the outlines provided by BGS maps.

3.3.3 ***Borehole records and Quaternary stratigraphy:*** the BGS has legal right to logs of all boreholes drilled to depths greater than 10m, and encourages deposition of the logs of shallower boreholes. Numerous borehole records, mostly for shallow-depth site investigation, are also held by civil engineering, site investigation and quarry companies, public utilities, and highway and planning authorities. The BGS archive, held at the Keyworth office for England and Wales, now includes almost a million records, all scanned and available electronically in-house. Summary details of all boreholes are available externally, via the BGS Geoindex internet portal (http://www.bgs.ac.uk/scripts/GeoPortal/home.cfm), and these list borehole number, grid reference, availability and depth, amongst other information, for any user-defined geographical area. This permits the rapid downloading of data files that can be used for a first-order classification of borehole records of likely potential use.

3.3.4 For this work, summaries were obtained for the whole 875km^2 area geomorphologically mapped, yielding over 7000 borehole records. Boreholes less than 3m deep were excluded because of their limited use in determining stratigraphy, as were boreholes where no depth or location was recorded, amounting to a total of 13% of the records. Boreholes flagged as confidential were also excluded, as time constraints did not permit the request for retrospective permission from original contractors or clients, many no longer in existence. These boreholes numbered a further 29% of total records. Thus only 58% (3712 out of 6365) of records were potentially usable. Within these, 1861 were between 3m and 10m in depth, 1023 between 1m and 20m, 475 between 20m and 50m, and 354 over 50m.

3.3.5 Full log details of boreholes, held as a photocopy or a scan of the original, are not yet available from the BGS via the internet. Because of the number of boreholes that could potentially be used in this investigation (3712), and the number of man-days needed to assess them (some 40 days), it was necessary to sample for two different purposes. Firstly, in order to satisfy the definition of a sediment-landform assemblage, enough boreholes should be used to identify, where possible, a type sedimentary sequence underlying the principal sediment-landform assemblages, defined from the geomorphological mapping exercise (*Section 3.4*). The second purpose was for the construction of cross-sections. In this case, potential cross-section lines were identified on a GIS map of borehole locations, colour coded for depth, and boreholes selected on the basis of choosing those with the closest inter-hole distance and the greatest depth. A representative number of the deepest boreholes was also randomly selected in order to assist in the assessment of the overall stratigraphy of the area. In total, some 1400 borehole records were recorded (Fig 17).

3.3.6 A number of problems occur when interpreting borehole records, and these frequently determine whether the record can be used. Foremost is the unfortunate lack of any descriptive detail of the drift in many of the older, deeper and potentially more valuable boreholes. Further problems arise with older records through the use of very obscure local drilling terms that are difficult to resolve as a sediment or rock type. 'Crunchie', for example, was eventually found to refer to a coarse-grained diamict formed by the 'crunching up' of inferred bedrock beneath it by the passage of ice. Clastic sediments (sands and gravels) usually cause no problems, even with older records, though there is a plethora of terms used to denote size. Clays and silts

cause difficulty, even amongst the youngest records, as they often have no further description and could refer to massive lacustrine clay or, commonly, very clay-rich diamict.

3.3.7 ***Outline of Approach to the Geomorphic Analysis:*** the analysis of the geomorphology focused on two aspects:

- providing an enhanced assessment of the sand and gravel deposits;
- improving understanding of the glacial history.

3.3.8 The detailed methodology of providing an enhanced aggregate assessment is detailed in *Section 0*. The glacial history of lowland Lancashire has received scant attention over the last 50 years, and so the data compiled and reviewed in this project were analysed in the context of current thinking about the deglaciation of Britain at the end of the Devensian Ice Age. The analysis focused on the nature and timing of deglaciation, direct evidence for ice-marginal limits, ice-flow directions and the impacts of the differing ice-streams of the British and Irish Ice-sheets.

3.4 CHARACTERISING THE NATURAL LANDSCAPE AS A HERITAGE ASSET

3.4.1 The physical environment forms an important natural archive of past climatic and environmental change, and the geodiversity and biodiversity of this environment are both under threat from a multitude of sources: climate change; resource consumption; and land surface transformation (Ellis *et al* 2007). Geoconservation of our landscape heritage is an increasingly important component of the successful stewardship of the natural environment. The physical environment is currently protected under a number of statutory and non-statutory schemes, the main statutory scheme being the SSSI (Sites of Special Scientific Interest) scheme administered across the UK by Natural England (2007), Scottish National Heritage (SNH) and Countryside Council for Wales (CCW). The non-statutory conservation and management of sites is facilitated through the Regionally Important Geological/ Geomorphological Sites (RIGS) scheme devised by the former Nature Conservancy Council (NCC). The scheme is locally initiated through interest groups and supported by the Association of United Kingdom RIGS Groups (UKRIGS 2007), a national organisation formed in 1999, with the encouragement and support of the then English Nature, Countryside Council for Wales, Scottish Natural Heritage and the Royal Society for Nature Conservation (RSNC). UKRIGS represents the RIGS movement and the large number of independent RIGS groups across the UK. The Lancashire RIGS Group (2007) is a focus for activity within much of the Kirkham ALSF region.

3.4.2 The process of identifying what constitutes important scientific geological or geomorphological sites has been facilitated by the *Geological Conservation Review* (GCR), coordinated by the Joint Nature Conservation Committee (JNCC). The GCR selection process is underpinned by the highest scientific standards to identify systematically important sites that would reflect the range and diversity of Great Britain's Earth Heritage (Ellis *et al* 2007), and each GCR site must satisfy the legal requirements for notification as a Site of Special Scientific Interest by reason of its geology or geomorphology, which must be of international importance. International importance is conferred for a variety of reasons to include: sites that show time interval or boundary stratotypes; type localities for biozones (defined by fossil

content); and chronozone type localities for particular rock types, mineral or fossil species; historically important localities where rock or time units were first described, characterised, or linked to advances in geological theory; and where geological or geomorphological phenomena, concepts or theory were first recognised and described. Sites can also be listed because they have unique, rare or special features, with the intention that the highlights of British geology and geomorphology are conserved, and to ensure representative coverage of the essential features of Britain's Earth Heritage.

3.4.3 Given that academic research appears to be one of the precursors to designation and listing of sites for geological and geomorphological reasons, it is perhaps not surprising that there are few sites currently listed within the Kirkham Moraine ALSF area. Sites can be nominated for RIGS status through the site assessment process of the local RIGS groups and UKRIGS (2007). Sites can become SSSIs for geological and geomorphological criteria through the *Geological Conservation Review* series. The research undertaken during this project and the previous Ribble Valley ALSF project has assessed in some detailed the fluvial and glacial evolution, and, as a part of that work programme, the heritage value of the physical environment has been advanced. Sites that have contributed significantly to understanding the physical landscape, and the Quaternary and Holocene geomorphic history, are clearly now candidates for RIGS status and perhaps GCR nomination.

3.5 CHARACTERISING THE ARCHAEOLOGICAL RESOURCE

3.5.1 ***Database Structure:*** the structure of the database of archaeological and palaeoenvironmental events and monuments was taken directly from that used in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, *sections 3.9.1-3*), meeting the same national standards, and with the same distinction between events and monuments.

3.5.2 ***Historic Mapping:*** a range of historic maps for the study area was consulted, comprising:

- Ordnance Survey First Edition (6 inch to 1 mile) digital raster mapping;
- Ordnance Survey Second Edition (6 inch to 1 mile) digital raster mapping;
- Ordnance Survey Third Edition (6 inch to 1 mile) digital raster mapping;
- Ordnance Survey First Edition (25 inch to 1 mile) digital raster mapping;
- Saxton's *Survey of Northern England* (1577);
- Yates' *Map of Lancashire* (1786);
- Speed's *Map of Lancashire* (1610).

3.5.3 All the current and historic 1:10,560 (6 inch to 1 mile) Ordnance Survey maps were supplied georeferenced and incorporated within the GIS. The more detailed 1:2500 (25 inch to 1 mile) maps for Lancashire were acquired in PDF format from Digital Archives Association in Warrington. This precluded their use within the GIS due to the time required to convert the data into image files and properly georeference them.

3.5.4 Saxton (1577), Speed (1610) and Yates (1786) were found to be at too small a scale for use within the GIS. For example, entire villages were represented as a single

'blob' on the map. These, along with the Ordnance Survey 25 inch mapping, were consulted qualitatively outside of the GIS. Where new monuments were seen on these maps, an approximate location could be found by comparing them on screen with the GIS. The Ordnance Survey 25 inch maps were also used to provide greater detail for monuments than was shown on the six inch maps.

3.5.5 ***Archaeological and Palaeoenvironmental Data Capture:*** the GIS datasets were sourced from Lancashire County Council, whereas national repositories were utilised in the grey literature search, along with the archives of OA North, the County Record Office, and libraries at Kirkham, Preston, and Poulton-le-Fylde. Literature sources were also utilised to provide a broader context for the data.

3.5.6 Datasets provided by Lancashire County Council comprised:

- Historic Environment Records (HER);
- Roman roads;
- Portable Antiquities Scheme;
- Listed Buildings;
- Registered Parks and Gardens;
- Data derived from the North West Wetlands Survey (Middleton *et al* 1995);
- Scheduled Ancient Monuments;
- Data derived from the *Ribble Valley Catchment Archaeological Rapid Identification Survey* (LUAU 1997);
- Data derived from the Lancashire County Council Survey of the 1890 Ordnance Survey Map (Lancashire HER 2006).

3.5.7 National sources for the grey literature search comprised:

- Archaeological Investigations Project (AIP, Bournemouth University);
- National Monuments Record (NMR) Excavation Index for England;
- Archaeological Data Service (ADS).

3.5.8 Each dataset was opened in the GIS and subject to a process of data cleansing before any data entry work began. Location, spelling, field omissions and record duplications were addressed, and terminology was standardised to comply with ALGAO (FISH 2007) and the NMR thesauri for monument and event types (English Heritage 2007). To ensure compliance with Midas standards (English Heritage 2003), additional fields were added that were not originally included in the datasets, such as National Grid Reference (NGR) precision. An additional field was also added to the data to accommodate the National Monuments Broad Class (*ibid*) entry for each record. Once this process was completed, the records were entered into the project database via the appropriate data entry form.

3.5.9 ***Air Photographs:*** oblique and vertical aerial photographic coverage for the study area was obtained from the holdings of the Lancashire HER. This collection comprised historic RAF vertical photographs flown between the mid 1940s and mid 1950s (scanned by OA North), modern colour vertical air photographs provided as Multi-resolution Seamless Image Database (MRSID) format, and oblique air photographs ranging from the 1940s to the 1990s.

3.5.10 The oblique photographs were provided as hard copy and scanned as part of this project. The Lancashire HER provided shapefiles mapping the coverage of the photographs, allowing them to be analysed in conjunction with the other datasets. Features seen on the air photographs were then noted and cross-referenced against all other known archaeological monuments, and only when it was confirmed that there was no duplication were they added as new sites in the database. The distortion in the oblique photographs when attempting to draw up new monuments was resolved by direct comparison with available LiDAR data.

3.5.11 ***Secondary Sources:*** a selection of secondary sources was consulted, both relating to the study area and the wider landscape:

- *Historic Landscape Characterisation* (HLC) Project (Ede and Darlington 2002);
- Grey Literature from the archives of OA North/LUAU;
- Conservation Areas/SSSIs/Ramsar;
- Designated Ancient Woodland;
- Countryside Character Areas.

3.5.12 An initial scan of the secondary sources was undertaken to provide further evidence for the events and monuments already in the database and GIS. Where new events and monuments were identified during the study of the secondary sources, the primary source was sought and, where available, used as the basis for the record in the database and GIS.

3.5.13 However, the primary role of the secondary sources was to provide information about the broader landscape of the Fylde Coast, and to examine the development of the current character of the study area. The most useful sources for this were works undertaken by English Nature and the Countryside Agency (English Nature 1999a; 1999b; 1999c; Countryside Commission 1998) and the Lancashire HLC (Ede and Darlington 2002).

3.5.14 These datasets provided an understanding of the modern landscape types, a brief outline of historical influences on the region, and the location of particular designated areas such as Sites of Special Scientific interest (SSSI) or Designated Ancient Woodland. The Countryside Agency has created a map of character areas (Fig 5) that divide the landscape into 'packets' of similar character (Countryside Commission 1998 (*Section 2.1*)). The descriptions also relate how that character has developed and how it is changing; as such, they provide a context against which the archaeological development of the study area can be assessed. These were added to the GIS without any form of data cleansing and were added as external references to monuments as appropriate.

3.5.15 The Record Office and relevant libraries of Kirkham, Poulton-le-Fylde and Preston were visited and local history sections searched. The scope of the material was initially wider than the study area in order to determine whether the area matched patterns of development observable in other parts of north-west England, or whether it was unique. The approach taken for the secondary source information was to create a period-by-period description of the known archaeological and historical information from the region, but focusing on the Kirkham Moraine.

3.5.16 In addition, several publications were consulted at both a regional and site-specific level, including The North West Wetlands Survey 3: *The Wetlands of North Lancashire* (Middleton *et al* 1995), The Centre for North West Regional Studies volume, *Roman Forts in the Fylde: Excavations at Dowbridge, Kirkham* (Howard-Davis and Buxton 2000), and English Heritage's *English Landscapes* volume for the North West (Winchester 2006), and the *North West England Archaeological Research Framework, Archaeological Resource Assessment* (Brennand 2006).

3.5.17 ***Integration and analysis of aggregate, environment and heritage datasets:*** the initial archaeological dataset (*Sections 3.6.2-16*), along with the primary geological mapping and Lancashire County Council Areas of Search (*Sections 3.6.3*), were integrated in the GIS. A preliminary assessment of the distribution of archaeological monuments, geological types, and aggregate prospects was then undertaken in order to inform the later stages of enhancement, ground truthing and statistical analysis.

3.5.18 The methodology used was the KS Test (OA North and University of Liverpool 2007a, *section 3.1.25*). This allowed the comparison of geological type and aggregate prospect with the NMR Broad Class of each archaeological monument.

3.5.19 ***Enhancement of the archaeological record using LiDAR:*** the two main prospection techniques used were as for the Ribble Valley ALSF project: hillshade and slope models.

3.5.20 ***Hillshades:*** the hillshade function calculates the illumination values for each cell in a raster representing a surface, given a hypothetical light source in a specified position. It does this by setting a position for the light source and calculating the illumination values of each cell in relation to neighbouring cells. It can greatly enhance the visualisation of a surface for analysis or graphical display by highlighting subtle changes in the topographical surface (Chapman 2006, 81-2).

3.5.21 From the perspective of searching for archaeological monuments, the hillshade function simulates the effect of low-level aerial photography, in that the angle and azimuth of the sun can be selected to allow one to view the landscape as if from an aircraft. In this way landscape features stand out in the same way as they would under oblique photographic conditions.

3.5.22 Once a hillshade layer had been created in the GIS, it was overlaid onto the current vertical colour aerial photographic mapping to enhance the landscape, and this was systematically examined in transects across the study area. Any new archaeological monuments were recorded in the database and digitised within the GIS.

3.5.23 ***Slope Models*:** these were created using the height values attached to the LiDAR data. The slope model identifies the steepest gradient for a location on a surface (*op cit*, 82). For raster surfaces, this is the maximum rate of change in elevation between a cell and each of its nearest neighbours. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain.

3.5.24 Both slope and hillshade were manipulated in ArcScene, which allows a three-dimensional view of the data, and allowed the landscape to be examined from virtually any angle and with different orientation of light sources. Again, the landscape was systematically examined and any new monuments recorded on the GIS.

3.5.25 ***Ground-Truthing of the archaeological model:*** a limited programme of ground-truthing was undertaken during the course of the project, utilising OA North's *Level*

1 Identification Survey Methodology (OA North 2002), which covers walkover survey by visual assessment. This level of survey represents the minimum standard of record for field investigation, and is aimed at the rapid discovery of previously unrecorded archaeological monuments. Its objective is to record the existence, location, and extent of any monument using four elements: reconnaissance; mapping; description; and photography, and includes comments on character and condition. The focus was to cover areas that lacked LiDAR coverage. Records for new sites were then entered into the database.

3.6 ASSESSING THE MINERAL POTENTIAL

3.6.1 ***History of mineral extraction:*** the focus of the Kirkham ALSF project is upon land-based sand and gravel aggregates, for which previous and current extraction has targeted glacial, fluvioglacial and fluvial deposits. To assess the history of mineral extraction and future mineral planning, and to produce an inventory of current, past and future extraction of sand and gravel, information has been compiled from various sources. These were data held on existing extraction sites from the BGS, the reports of the Regional Aggregate Working Party (RAWP 1999-2006) for north-west England, and reports commissioned by LCC on the sand and gravel resource (Entec UK Ltd (2005) and the Geoplan Ltd (2006) reports). All these sources were constrained in that they focus on existing knowledge and predetermined study areas. All the sources were examined, however, and analysed to compile a database of sand and gravel mineral extraction activity within the study area. These data were used to compile a spatial geodatabase of current and past extraction sites, including both solid rock and sand and gravel aggregate quarries.

3.6.2 ***Current minerals planning, survey and knowledge:*** the main resources to inform minerals planning are:

- drift geology maps and digital databases of the BGS, particularly the five 1:50,000 sheets covering: Garstang (BGS 1990) and Preston (BGS 1982). The Preston sheet is currently under revision, and the present study is contributing to that process (BGS Preston sheet under revision);
- the Department of the Environment-commissioned report, *Sand and Gravel Resources of Lancashire,* by Allot and Lomax, which reported in 1990;
- the report, *Sand and Gravel Study Stage 1,* commissioned in November 2003 by Lancashire County Council from Entec UK Ltd (2005) in partnership with the British Geological Survey (BGS), http://www.lancashire.gov.uk/environment/lmwlp/;
- the report, *Sand and Gravel Study Stage 2*, commissioned in June 2005 by Lancashire County Council from Geoplan Ltd (2006), http://www.lancashire.gov.uk/environment/lmwlp/.

3.6.3 Boreholes clearly provide the ready means of confirming the nature of areas identified as having potential for sand and gravel extraction. The BGS holds copies of all deposited borehole records at their national headquarters, with summary data, including borehole number, location and depth, available from the BGS website. A list of potentially useful boreholes was collated (*Section 3.3.3*) and these were then compiled by examination and interpretation at the BGS archive at Keyworth. This data compilation exercise was undertaken for all areas identified as having potential

aggregate prospects from existing map and digital sources, and then repeated after the interrogation of the new geomorphological and Quaternary geological mapping, undertaken in the course of this study. This two-phase approach has proven necessary because the process of cataloguing borehole records demonstrated that, like the comparison of new geomorphic boundary data with BGS drift boundaries, BGS maps and the minerals plans based on the BGS mapping, especially older ones, are often inaccurate in their identification of the type of glacial sediment and depiction of boundary locations between them. This arises because the traditional basis of geological mapping, the identification of lithology at the surface, is inappropriate when mapping areas of thick glacial deposits, because of their inherent variability and rapid vertical and lateral transition between lithological units in glacial sediments. As a consequence of this, many boreholes identified as being in areas of non-aggregate mineral, such as till, show significant thicknesses of potential mineral hidden by thin surface tills.

3.6.4 All borehole locations were identified and the coordinates transferred into a Boreholes layer within the geodatabase. The following attribute data were attached to the layer:

- borehole identification code (text);
- borehole classification according to their usefulness;
- maximum depth;
- geomorphology associated with the borehole location;
- description of the sedimentology.

3.6.5 ***Producing an enhanced mineral assessment:*** to identify and characterize the mineral aggregates for the study area, it was necessary to identify a set of search criteria that define the type of mineral aggregate that is sought. It should be emphasised that the search criteria applied within the target areas may vary depending upon local circumstances. It must also be emphasized that an assessment of the criteria requires intervention by extraction, test pit or borehole; without these types of data, confidence in any assessment is reduced. Further, gleaning this type of information from the BGS borehole archive is often difficult, owing to the variable quality of the recording.

3.6.6 ***Lithology:*** examination of the mineral plans for Lancashire suggests that there is a need to identify new sand and gravel reserves and so there is no targeted preference for particular aggregate products. However, there is an additional focus on identifying high-grade sand in both the recent LCC commissioned sand and gravel studies (Entec UK Ltd 2005; Geoplan Ltd 2006).

3.6.7 ***Proportion of Fines:*** in order to minimise processing, potential resources need to be relatively free of silt and clay. In their regional mineral assessment reports, the BGS has traditionally used a maximum proportion of 40% fines (<0.0624mm) to differentiate between mineral and non-mineral. Consultation with the industry, however, suggests that this figure is too high and a figure of 15% is more appropriate.

3.6.8 ***Minimum thickness:*** the BGS uses an average minimum thickness of 1m to define an economically viable mineral resource. This is felt to be much too low and

consultation with the industry suggests an average minimum thickness of 3m is more appropriate.

3.6.9 ***Minimum ratio of overburden:*** 'overburden' is defined as the ratio of non-mineral overlying mineral in any potential resource. This ratio is important as higher ratios increase the cost of extraction. The BGS uses a ratio of not more than 3:1 but consultation with the industry suggests that a ratio of 1:1 is more appropriate.

3.6.10 ***Waste:*** 'waste' is defined as the ratio of mineral to non-mineral within any potential resource. This is important because many types of glacial deposit, especially those deposited in ice-marginal environments, contain rapidly varying, often discontinuous, sequences of sediment, that are usually diamict or laminated or massive mud, and which serve to contaminate the potential mineral and increase the cost of extraction. Consultation with the industry suggests that a minimum ratio of waste to mineral of 1:1, or 50% of a potential resource volume, is acceptable. In this project, diamict-dominated moraine ridges have been given a mineral waste rating of 90% waste, with 50% applied to sandur. Lower quantities of waste (25-40%) have been assigned to resource blocks with known higher quantities of sand.

3.6.11 ***Minimum quantity:*** consultation with the industry suggests that the minimum quantity of extractable mineral in any potential resource likely to be used for regional-scale supply should not be less than half a million tonnes. The Geoplan Ltd (2006) survey utilised a cut-off figure of one million tonnes, but recognised that it may be economic to extract quantities under that threshold.

3.6.12 ***Depth:*** in the industry, the normal maximum depth of extraction, below which technical difficulties and hence costs increase, is 20m. Potential resources located below this depth have therefore been excluded.

3.6.13 ***Working conditions:*** in general, resources located above the water table are significantly cheaper to extract than those below the water table. Extraction below the water table may also cause significant environmental problems due to contamination of ground-water, alteration of the ground-water circulation system, leakage of water used in processing into river systems, and disposal of water saturated with mud washed from the mineral removed.

3.6.14 ***Deleterious materials:*** deleterious materials are naturally occurring rocks, sediments or minerals, such as coal, shell beds, peat and alkali-silica reactive minerals, that reduce the quality of mineral aggregate or make them unsuitable for use by reducing their load-bearing or shear strength, or causing chemical reaction when mixed with cement in concrete production. This information may be difficult to gauge from the available data.

3.6.15 ***Methods for identifying potential resource areas*:** traditional approaches to the identification of workable sand and gravel (soft aggregate) reserves in the UK have varied from standard geological drift mapping, with borehole support, to more deductive use of sediment and landform relationships discerned through programmes of geomorphological mapping (Crimes *et al* 1992; 1994). This project has applied a sediment/landform approach and the integrated geomorphic and lithofacies models to identify and predict the distribution, quantity and quality of sand and gravel deposits (after Chiverrell *et al* in press). For glacial terrain like the Kirkham Moraine, economically extractable sand and gravel deposits are associated with certain sediment/landform assemblages, particularly sandur, pro-glacial alluvial and sub-aqueous fans, deltas, kames, eskers, and river terraces. Understanding the spatial

sedimentological relationships and geometries within the landform types allows construction of palaeogeographical models for different depositional settings. This sediment-landform assemblage approach provides a methodology for predicting the distribution, character and quality of sand and gravel reserves.

3.6.16 Investigations of how glacial systems behave in terms of transport and deposition of debris have resulted in the generation of models of landform-sediment relationships, which can be used to identify potential mineral aggregate resources. The basis of these models is the recognition that particular types of landform are associated with particular types of sediment, because the landform reflects the depositional process that created it. This leads to the concept of the sediment-landform assemblage, which is defined as an area in which relatively homogeneous geomorphological, stratigraphic and lithological characteristics occur. The identification of sediment-landform assemblages therefore provides a first approximation for potential mineral resources. Three major sediment-landform assemblage zones can be recognised within the glacial terrain of the British Isles that often provide deposits utilised as reserves of sand and gravel by the aggregate industry (Chiverrell *et al* in press), and all three are constituent members of the Kirkham Moraine complex.

3.6.17 ***Sub-glacial assemblage zone*:** this assemblage includes all landforms and sediments generated by the deposition of debris at the base of a glacier and is mostly associated with the outer, lowland portion of ice-sheets, where eroded materials are transported through the ice and redeposited further down the flow direction. This process often leads to thick accumulations of sub-glacial diamict, forming either low-amplitude diamict plains, or fields of ice-moulded drumlins. In either case, aggregate potential is low. An exception is eskers (Boothroyd and Ashley 1975; Warren and Ashley 1994), which represent former sub-glacial tunnels, preserved as a sand- and gravel-filled 'cast'. These can provide good local aggregate potential, as the characteristic ridge form is easily exploited.

3.6.18 ***Ice-marginal assemblage zone**:* this includes all landforms and sediments generated at the margin of, and in contact with, a glacier. Glacier velocity reduces to zero at the snout and the debris contained within and beneath it is consequently released. A wide variety of depositional environments are generated due to changes in the position of the ice margin, including ice-front alluvial fans, ice-front and ice-marginal sandur and lacustrine basins (Thomas 1985). Much deposition takes place over ice which, on melt, collapses, causing complex ice-disintegration topography, including classic kame-moraine systems and kettles holes. At the same time, other moraine ridges are generated by ice-front ablation and structural push. Together these processes create a very distinctive suite of individual landforms, each associated with a distinctive, though complex, sedimentary sequence (*ibid*). Consequently, they form potentially good sources of aggregate, easily identified, but often difficult to extract due to their rapid lateral and vertical variation, coarse calibre, and complex interdigitation with non-mineral deposits, such as diamict and lake-suspension mud.

3.6.19 ***Pro-glacial assemblage zone:*** this zone includes those landforms and sediments generated by glaciofluvial or glaciolacustrine processes beyond the margin of a glacier. At the snout, glacial meltwater is commonly discharged from exit tunnels into large braided streams that can carry exceptionally high sediment loads. These pass outwards, through the ice-marginal zone, to feed pro-glacial outwash sandur systems (Boothroyd and Ashley 1975) that act as major sediment sinks of potential

aggregate resource. Reflecting flow diffusion and the consequent decline in stream power, they generally fine in grain-size down-sandur from coarse gravels, through alternating finer gravel and sand, into fine sands and muds. Where sandur streams enter into lacustrine or marine basins, deltas form by rapid reduction in flow velocity. Most deltas show a classic Gilbert-style, three-fold internal structure (Thomas 1984; Lønne 1995), comprising topset gravels, formed by progradation of the sandur system across the delta surface; foreset gravels and sands, formed by avalanche down the delta slope; and bottomset muds, deposited across the lake floor by suspension. Where an ice margin is in contact with a water body, discharge from drowned-out exit tunnels generates complex sub-aqueous fan systems, characterised by rapid outward facies-shift from coarse gravel and intercalated diamict, through well-washed finer gravels and sands, into laminated and massive muds (Lønne 1995).

3.6.20 ***Identification and assessment of individual Resource Blocks:*** from the geomorphological maps generated for the Ribble, a filtering process was used to identify potential Resource Blocks. The first level of filtering was by the type of geomorphological feature. Thus, features identified as sandur, marginal sandur, ice-front alluvial fans, deltas, kames, kame terraces, eskers and river terraces were all included as, reflecting their depositional environments, they are likely to contain potential mineral. Features identified as diamict plains, drumlins, lake floors, push-moraines and ablation-moraines were excluded, as they are unlikely to contain potential mineral. The second level of filtering was done on the basis of pre-existing borehole information and section detail reported in the literature. Thus, if a pre-existing borehole provided confirmatory information of quality aggregate, it was included, otherwise unpromising prospects were excluded. Each resource block identified normally equates to an individual geomorphological feature, though in some cases several adjacent features of similar type are combined together.

3.6.21 ***Calculation of mineral volumes for prospects:*** one of the principal aims of geomorphology-based sand and gravel assessments is the accurate gauging of the volume of a deposit. Detailed accurate borehole information (provided by the BGS) characterises and describes the composition of the prospect, and without this information there is a great deal of uncertainty associated with sand and gravel assessments. It is in the volumetric assessment of landform geometry that DEMs and GIS come into their own, because the software allows the rapid calculation of the volumetric fill for a landform or shape, compared with another surface, typically the base of the deposit. Where possible, using a DEM-based approach represents a clear methodological improvement; however, it must be stressed that volumetric estimation of aggregate within Resource Blocks must take account of other areas of uncertainty, including product to waste ratios and overburden thickness, which need to be taken into consideration. Conversions from volumes (in m^3) to weight (in tonnes) were based on multiplying volumes by a factor of 1.6.

3.6.22 ***Reliability of volume and quality estimates:*** Resource Blocks have been classed into categories of reliability to reflect the sources of information available about each block and the method used for estimating volume and quality. These categories generally equate to the method of assessing volume and quality used in the Resource Blocks, but also takes into account uncertainties in landform identification, variations in the thickness of overburden, and waste.

- *High:* this is used where borehole information is available and is consistent in terms of thickness, broad grain-size and thickness of overburden. Some reliance may be placed on these estimates in the immediate vicinity of borehole locations, but should not be extrapolated to adjacent areas as glacial and fluvial deposits can vary considerably over short distances.
- *Medium:* this is used where there is no borehole information, but some sediment information is available from exposed sections. These estimates have a moderate margin of error but should be used with caution. A detailed drilling and sample testing programme should be undertaken before exploitation of blocks classed as of medium reliability is considered.
- *Low:* this is used where no borehole, sample or exposure information is available. Volume and grain-size distribution estimates are based on comparison with other blocks of similar geomorphological character and the general geological conditions in the area. Nevertheless, any estimates have a wide margin of error and should therefore be used with very considerable caution. A detailed drilling and sample testing programme should be undertaken, before exploitation is considered on blocks classed as of low reliability.

3.6.23 ***Environmental constraints*:** Resource Blocks have been classified according to the degree to which they are constrained by highway access, proximity to market, environmental designations and planning zonation. It should be noted that the significance of the latter factors can vary due to changes in planning policy or commercial conditions. Similarly, environmental constraints are rarely absolute and policy towards them often changes in the light of changed economic conditions.

3.6.24 Consequently, an assessment of any particular resource block as of high commercial potential should not be taken as a recommendation. The method of assessment used applies a ranking that takes into account the potential value of the prospect and offsets it against likely restrictions. The ranking of prospects in the Aggregate layer in the GIS follows an algorithm. Aggregate resource in tonnes was converted to a percentage of the average for the study area; this value provided a positive weighting, with the following constraints subtracted from that value. The key constraints were divided into: proximity to A roads; urban area; environmental site area (SSSI, SAC, SPA, RAMSAR and NNR); landscape areas (National Park, AONB and AONB Fringe); and the number of statutory historic sites (Scheduled Monuments and Listed Buildings). The area-based classes (urban, environmental and landscape) were expressed as percentage cover for each Resource Block. Distance to A roads was expressed as a percentage of 1500m. Numbers of Listed Buildings and Scheduled Monuments were expressed as percentages of a threshold of ten instances that was judged as representative of the study area. The eventual prospect score subtracts the five constraints from the mineral score, using a weighting of 2, 2, 1, 1, 1, 2 for Road, Urban area, Landscape, Historical, Environmental and Mineral indicators respectively.

3.7 ARCHAEOLOGICAL ANALYSIS AND ASSESSMENT OF POTENTIAL

3.7.1 ***Collation, analysis and enhancement of the archaeological data:*** as a result of the LiDAR study (*Sections 3.5.19*), and the limited ground-truthing programme (*Section 3.5.25*), an enhanced archaeological dataset was created.

3.7.2 ***Initial characterisation, risk, and archaeological value assessment using all datasets:*** during the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, s*ection 3.12.5-7*), a broad statistical analysis was undertaken of all broad classes and periods of archaeological monument, as an assessment of the method. However, the distribution and quantities of some classes and periods of monuments meant that it was not a statistically valid exercise. Consequently, it was anticipated that, for the current project, a more qualitative assessment of the archaeological distribution would be undertaken prior to performing the statistical analysis.

3.7.3 The factors selected for analysis included:

- prehistoric, Roman, and medieval monuments;
- prehistoric flint finds, both as isolated finds and scatters;
- NMR broad monument-type classes of domestic, industrial, agricultural and subsistence, and water supply and drainage.

3.7.4 Each of the selections was converted into a 10 x 10m presence-absence raster (see OA North and University of Liverpool 2007a, *section 3.12.2-4* for information) to match the resolution of the DEM created (*Section 3.2.3*).

3.7.5 The environmental and topographical factors selected for the comparison were aspect, elevation, geology, and slope. Distance to water was not included, for two reasons: firstly, unlike the Ribble Valley ALSF project, the study area did not include a significant river system; and secondly, hydrological data were not readily available for use.

3.7.6 Aspect was measured clockwise in degrees from 0° (due north) to 360° (again due north). The value of each cell in an aspect dataset indicates the direction of slope in which the cell faces. The individual values for each cell were grouped into 45° intervals and assigned the numbers 1-8. Flat areas with no downslope direction were assigned a value of -1. Elevation was measured in 10m intervals and slope was grouped into 5° intervals. The geological mapping (*Section 3.3.2*), was converted into a raster dataset, with each substrata-type assigned a value between 1 and 10.

3.7.7 Each dataset was combined using the raster calculator in ArcGIS, and the resulting tables exported into Excel. The Kolmogorov-Smirnov (KS) Goodness-of-Fit test (Kvamme 1990; OA North and University of Liverpool 2007a, *sections 3.12.6-7*) was then applied. The results were used to create weighted raster maps that indicate where the location of a particular archaeological type has been influenced by a particular environmental or topographical factor.

3.7.8 Kernel density mapping (*op cit*, *section 3.13.11*) was undertaken, with intervals of 250m, 500m and 1000m, for the prehistoric, Roman and medieval monuments. This produced a raster map that could be reclassified into intervals of low, medium and high density, representing low, medium and high potential.

3.7.9 Using the ArcGIS raster calculator, algebraic functions can be performed on single or multiple rasters on a cell-by-cell basis. In this way, the weighted raster maps (*Section 3.7.7*) and density maps (*Section 3.7.8*) were added together to produce maps of potential for the different periods of archaeology.

3.7.10 Using the methodology set out in the Ribble Valley ALSF project (*op cit*, *section 3.13.2*), the HLC land classifications were used to provide a measure of the amount

of below-ground disturbance in a locality. Landscape types that incur large amounts of below-ground disturbance will either already have had some level of archaeological investigation, or will probably have resulted in the destruction of any archaeological evidence. In either case, the potential for the discovery of new sites is likely to be low, whereas for more undisturbed landscape types, the potential for the discovery of new sites may be higher.

3.7.11 This process led to a reclassified set of HLC polygons within the study area that were converted into a raster and given the values one to three, with one representing high disturbance and three low. This raster was combined with the maps of potential (*Section 3.7.9*) to produce the final maps of potential for each period.

3.7.12 ***Refinement of characterisation of archaeological value:*** using the HLC polygons as the basic land division, an updated gazetteer for the study area was created, using the methodology devised during the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, *sections 3.12.11-15*). For each HLC polygon, information was collated on the number and density of archaeological events and monuments within it, along with the geomorphological classification, archaeological potential, an assessment of the level of below-ground disturbance indicated by the particular HLC landscape type, and a free-text description of the area.

3.7.13 ***Analysis and spatial patterning of archaeology against landscape taphonomy:*** preliminary analysis of the archaeological dataset (*Sections 3.5.17 and 3.7.2*) confirmed the decision to limit the selection of archaeological types to be used for the cell-based analysis. Additionally, the NMR broad classification of monument type was not felt to be fine-grained enough to take account of the more subtle distributions of monuments. For example, prehistoric flints are often classified as findspots, yet flint scatters may be the only evidence of prehistoric settlement. Consequently, a series of more subjective comparisons, using the KS Test methodology described above (*Section 3.7.7*), was undertaken in order to examine the archaeological development in the study area more closely.

3.7.14 The distribution of Roman monuments was compared to the known routes of Roman roads in the study area. This investigated the general pattern of Roman settlement within the area to see whether it was based entirely along the roads or was more widespread.

3.7.15 The distribution of ponds and marl pits was also investigated. Marl pits are associated with small-scale extraction of minerals for improving land for agriculture, and the HLC classifies them as being generally found on land of marginally higher elevation (Ede and Darlington 2002, 95). The presence of marl pits has two implications for this study: firstly, it is an indicator of agriculture; and secondly, it implies a degree of below-ground disturbance that may have brought to light evidence of prehistoric activity that had previously been buried.

3.7.16 Many ponds not shown on the modern mapping were identified from the LiDAR data (*Section 3.5.19*). In some cases these features could be seen on the historic mapping, but it was not possible to identify their function more closely. A comparison of the distribution of ponds and pond-like features against elevation and geology was therefore undertaken to try and identify the location of marl pits.

3.7.17 The distribution of flints and flint scatters was examined. Scatters of multiple flints are potentially indicators of increased prehistoric activity, such as settlement, whereas isolated finds may simply represent chance loss. However, flint scatters

were only recorded as such in the HER if they were all found at the same time, and many individual finds over time within a small area were not necessarily recognised as constituents of a 'scatter'. Consequently, it was necessary to examine the locations not only of the definitive flint scatters but also the areas where there was a higher density of individual flint finds. Kernel density calculations were used to identify clusters in the distribution of individual flints (OA North and University of Liverpool 2007a, *section 3.13.11*), with buffers set at 20m, 50m and 100m intervals.

3.7.18 ***Finalise risk/threat characterisation, incorporating geology and archaeology:*** using the ranked prospects data (*Section 3.6*), it was possible to create combined datasets showing the interaction between archaeological potential and suitability for aggregate extraction; this showed the correlation between the highest threat and the potential for archaeology. The overall rankings for prospects were grouped into intervals corresponding to low, medium and high suitability for aggregate extraction.

4 GEOMORPHOLOGICAL RESULTS

4.1 THE QUATERNARY PERIOD IN LOWLAND LANCASHIRE

4.1.1 ***Research during the nineteenth century:*** the Pleistocene deposits of lowland Lancashire were first investigated in the late nineteenth century by Binney (1852) and De Rance (1875; 1877a), who utilised the, at the time, excellent coastal exposure at and north of Blackpool. These investigations, reviewed by Wilson and Evans (1990), provide considerable detail on the composition of the Kirkham Moraine complex (Gresswell 1967a), which comprises an arc of low hills stretching from Preston to the coast at Blackpool. Binney (1852) and De Rance (1877a) devised a tripartite scheme to describe the glacial deposits of the Blackpool area. Although currently unfashionable, this scheme provides a useful summary of the overall sequence, but does not capture the complexity implicit in the history of ice retreat. The 'Lower Boulder Clay', hereafter the Lower Diamict, occurs at the base of the sequence overlying the bedrock, which lies up to some 20-30m below OD. Lithologically, this Lower Diamict is composed of materials that originated for the most part in the Lake District, with occasional chalk flints and Jurassic erratics. Overlying the Lower Diamict is a sequence of sands and gravels, 'The Middle Sands' of De Rance (1877a), varying in thickness by up to 25m. Sand tends to be considerably more dominant than gravel, although this balance varies at a local scale. These sands and gravels are glaciofluvial deposits lain down in a pro-glacial setting, probably during ice retreat. They are overlain by 'the Upper Boulder Clay', hereafter termed Upper Diamict, which varies spatially both in terms of thickness and inter-digitation with glaciofluvial sands and gravels, and reflects either small or larger-scale oscillation of the ice margin. The broad Lower Diamict / sands / Upper Diamict sequence occurs widely across the region.

4.1.2 ***Glacial geomorphology of the Fylde:*** the Fylde lowlands comprise a broad suite of landforms and sediments that were formed largely by sub- and pro-glacial processes. Large areas of the lowlands are of low relief, and form a relatively featureless sub-glacial diamict plain, formed by basal deposition under relatively thick ice conditions when the ice margin was some distance south of the region. The most substantial ice-marginal landforms in the region are the extensive array of elongated low ridges that extend from the foothills of the Bowland Fells, east of Preston, to the coast north of Blackpool. These ridges, collectively termed the Kirkham Moraine by Gresswell (1967a), were remapped during this project and comprise a sequence of parallel ridge forms with amplitudes of relief of 15-35m, extending over some 10km north to south (Fig 18).

4.1.3 ***Geomorphology of the Kirkham Moraine:*** investigation of major moraine systems (Chadwick *et al* 2001; Thomas *et al* 2004; Thomas 1999; Thomas and Chiverrell 2007) shows that they display a number of characteristic sediment-landform assemblages that are a response to the major glacial depositional environments active during their formation. In this context, a sediment-landform assemblage is defined as a mappable unit in which relatively homogeneous morphological, lithological and stratigraphic characteristics occur (Thomas 1989; Thomas *et al* 2004; Thomas and Chiverrell 2007). The main sediment-landform assemblages identified in the area are mapped in Figure 18 and a summary list of their characteristics is given (Table 2). These assemblages ignore the extensive, thick

sequences of Holocene coastal, peatland, lacustrine and alluvial deposits which drape, and in place cover, the glacial terrain.

Sediment landform assemblage	Description of main characteristics
1. Drumlin fields	Areas of thick diamict showing characteristic 'basket of eggs' topography, consisting of elongated, smooth ridges on a scale of up to 1km in length. Represent areas of basal lodgement till that have been moulded by the fast advance of thick ice.
2. Sub-glacial Diamict floor	Areas of low amplitude, subdued topography, underlain by thick diamict. Represent areas of basal lodgement till deposition under thick, advancing active ice.
3. Ice-marginal moraine ridges	Often prominent linear ridges occurring singly or as an en-echelon complex. They form at the margin of active glaciers and are composed of complex sequences of diamict and sands and gravels. They are often tectonically deformed by the repeated movement of the ice margin. These ridges represent ice-marginal sedimentation and subsequent deformation during still-stand and varying scales of ice-marginal oscillation.
4. Ice-disintegration zones	Areas of disorganised topography, including small-scale ridges, mounds and basins, many water filled, often occurring in wide linear belts. Underlain by complex sequences of diamict and fluvioglacial sediment. They represent the disintegration of ice-marginal topography by the melt of buried ice at the margin.
5. Sandur systems	Flat to low-angle topography sloping away from normal ice-marginal moraine systems, or wide, flat channels or troughs running parallel to ice-marginal moraine systems. Underlain by fluvioglacial sand and gravel sequences, they are sediment depocentres draining directly away from tunnels in the ice-margin or outwash sandur directed parallel to the ice-margin by the occurrence of large, abandoned moraines forward of the ice-margin. Local sandur surfaces can have a pitted form, fretted with hollows formed through the meltout of dead-ice buried within the sandur.
6. Kame terraces	Relatively flat but often uneven terraces or benches formed on the lateral margins of glaciers between the glacier and adjacent hillslopes. Surfaces of kames are often locally diversified by higher relief, reflecting bedrock outcrop, moraine ridges and debris features. They comprise complex sequences of diamict, debris flow, alluvial fan, fluvioglacial and glaciolacustrine sediment.
7. Major drainage distributaries	Fretting and dissecting ice-marginal moraine complexes, are often incised channels. These channels are often flat floored, incised and breach the moraine, with current drainage that is clearly a misfit. They reflect the location of major drainage exits from the ice-margin. The floors comprise often thin sequences of sand and gravel close to the ice-margin that thicken and fine in a distal direction.

Table 2: Sediment landform assemblages of the Kirkham Moraine and Fylde deglacial terrain

4.1.4 The main sub-glacial landforms are the *drumlin fields* (Assemblage 1) flanking the River Wyre south of Fleetwood (Fig 18) and on either side of the River Lune extending south from Lancaster. The drumlin field adjacent to the River Lune is part of a more extensive field extending from Kendal in the south Lake District to 5km north of Garstang (Fig 3). The orientation of these drumlin fields confirms a north to south ice-flow out from the eastern Lake District. Relatively little exposure has been seen but Wilson and Evans (1990) describe a section near the mouth of

the Wyre that comprised glacial diamict containing an erratic suite of Lake District-derived lithologies. Further drumlins occur in the upper Ribble, on the interfluve between the Ribble and the head of Airedale, between Hellifield and Skipton (Rose 1985), the orientation of which indicates two directions of ice movement: south-eastwards down the Ribble Valley; and east and south-east into Airedale (Fig 3). Adjacent to these drumlin fields and south of the Kirkham Moraine is a lower amplitude topography underlain by thick accumulations of diamict (Fig 18). This *diamict plain* (Assemblage 2) represents an area where basal lodgement tills were deposited under conditions of thick advancing ice.

4.1.5 The most substantial landforms in the region are *ice-marginal moraine ridges* (Assemblage 3), which occur as an extensive array of elongated low ridges extending from the foothills of the Bowland Fells east of Preston to the coast north of Blackpool. Further arcuate bands of ridges can be identified further north, with the mostly clearly identified bands to the north and south of the River Wyre. These lineations of moraine ridges reflect former ice-marginal positions during the retreat of Devensian ice in lowland Lancashire. Diversifying the morphology of Assemblage 3 are numerous depressions and water-filled basins identified as kettleholes (Fig 18; Wilson and Evans 1990). These are formed by disintegration and melt of marginal dead-ice and are identified as *ice-disintegration zones* (Assemblage 4; Fig 18). This assemblage is restricted to inter-ridge areas and typically is up-ice of the maximum southwards extent of the Kirkham Moraine. Ice-disintegration topography is particularly well displayed on the outskirts of Blackpool, between the moraine ridge crests around Kirkham, and in the moraine ridges north of the River Wyre extending west from Garstang.

4.1.6 The ridges of Assemblage 3 are often separated by narrow, flat-floored channels (Fig 18), which represent former ice-marginal *sandur systems* or outwash plains (Assemblage 5). They typically run parallel to moraine crests and are formed by the deposition of sands and gravels in marginal sandur troughs constrained by the moraine ridges. Sandur flats and troughs are widespread throughout the moraine complex, but are more extensive in the lower terrain between the three major belts of moraine ridge: Kirkham, South Wyre and North Wyre (Fig 18). To the north of the region (Fig 18), flanking the western fringe of the Bowland Fells, are a number of uneven but extensive flats identified as *kame terraces* (Assemblage 6). These hillslope benches comprise a mixture of glacial diamict and outwash sands and gravels.

4.1.7 Crossing and dissecting the Kirkham Moraine are several major drainage distributary channels (Assemblage 7). These are differentiated from the more numerous minor drainage channels, in that they run broadly north / south across the moraine, extend over 10-15km and are 200-500m in width. The channels are typically flat-floored and were formed by the incision of glacial meltwaters that have subsequently aggraded relatively thin sequences of fluvioglacial sand and gravel. The most substantial of these features are the Skippool channel, immediately east of Blackpool, and the Kirkham channel (Fig 18), further to the east. They both cut through the moraine complex and probably represent fixed-position drainage outlets from the retreating margins of the icesheet.

4.1.8 ***Interpretation of the Geomorphology:*** the regional distribution and relationships between these assemblages display some consistent patterns, with the ice-marginal moraine ridges, ice disintegration zones and sandur forming three discrete bands

across the Fylde lowlands. These lineations are a function of the staged retreat of the east Lake District ice-stream during deglaciation, as seen elsewhere around the Irish Sea basin in Wexford, Ireland (Thomas and Summers 1984), the Isle of Man (Thomas *et al* 2004) and in north-west Wales (Thomas and Chiverrell 2007). Diamict plains are restricted to zones in advance of these limits, or around the drumlin field, where perhaps materials were lacking for deformation into drumlinoid features, and instead relatively flat but ice-moulded terrains of lodgement till were produced. The drumlin fields themselves are 20-30km up-ice from marked ice-marginal positions, which is a similar relationship to that encountered between the Anglesey drumlin field and ice-marginal retreat moraines on the Lleyn peninsula (Thomas and Chiverrell 2007) and associated with the drumlin re-advance moraines in Ireland (McCabe *et al* 1984; 1987; 2007). Intriguingly, for the Kirkham area morphological evidence for pro-glacial outwash landforms is lacking, and perhaps has mostly been buried or has been removed by the subsequent erosion of the Ribble. Sediments of this nature possibly include a thick sandur floor underlying the estuary of the Ribble, or lake or even shallow water glaciomarine sedimentation in advance of the Kirkham Moraine.

4.1.9 South of the post-glacial erosional cut of the current Ribble Valley, there appears to be a large fan at the exit of the more enclosed reach of the lower Ribble Valley. Morphologically, it appears to be either a large ice-front alluvial fan or a sub-aqueous fan that must entirely reflect deposition in front of a Ribble glacier or ice stream (Fig 18). Immediately to the west of this fan there is what appears to be a north/south aligned asymmetric moraine ridge with a fronting sediment apron to the west (Fig 18). This interpretation explains the steep asymmetry of the ridge, with the eastern steep slope the ice-contact surface of an ice-lobe issuing from the Ribble Valley. This feature is very similar in form to a de Greer moraine (cf Eyles and McCabe 1989). This geomorphology appears to reflect the actions of three major ice-streams that coalesced in the Kirkham area, with the bulk of the end moraine structure reflective of an ice-stream issuing from the east Lake District, and a south Pennines ice-stream extending down the Ribble Valley at least as far as Preston (Johnson 1985). These two ice-streams are, however, dwarfed by the eastern Irish Sea ice-stream that extended southwards from the Solway Firth and western Lake District, east of the Isle of Man, and eventually southwards across south Lancashire into Cheshire (Crofts 2005). The interplay between these three ice-streams is critical in explaining the glacial geomorphology and geology, with the north/south aspect of the lineation of the Kirkham Moraine marking the most probable boundary between the eastern Irish Sea basin and east Lake District ice-streams.

4.1.10 ***Stratigraphy and internal structure:*** formerly very well exposed in a coastal cliff section (Binney 1852; De Rance 1877a; Fig 2), but now almost completely obscured by coastal land reclamation and sea defences, the Kirkham Moraine provided much of the basis for formulating the original 'tripartite' glacial drift classification of lowland north-west England. This classification divided the glacial deposits into a Lower Boulder Clay, a Middle Sands, and an Upper Boulder Clay, and, although unfashionable and heavily criticised by Longworth (1985) in his detailed account of the glaciation of the Lancashire Plain, it remains a useful local descriptive classification. The scheme is not one to be taken to imply strict contemporaneity with similarly named deposit sequences from elsewhere (Wilson and Evans 1990). Its use also implies that the Upper and Lower Boulders Clays can

be distinguished one from the other lithologically, and may therefore be properly identified in section or borehole log in the absence of the other. This implication is used in the account of the Blackpool area by Wilson and Evans (1990) but is not used a few years later in the account of the adjacent Garstang area by Aitkenhead *et al* (1992).

4.1.11 In addition, borehole records have been used to construct a series of cross-sections through the Kirkham Moraine, with the aim of identifying its stratigraphy and internal structure. Ideally, these cross-sections would comprise two sets of section lines, one drawn parallel to the assumed ice-flow direction, from north-east to south-west, the other drawn parallel to the strike of the moraine ridges, from north-west to south-east, together providing the basis for constructing a three-dimensional model of the moraine. In reality, the identification of lines was constrained by major spatial variation in borehole density and location, and complications arising from the lobate form of the ice-margin. Most boreholes are either clustered somewhat randomly in major urban areas or spread out in lines along major highway or pipeline routes, with many intervening rural areas almost devoid of boreholes. Despite these limitations, several major lines were established (Fig 19 (inset)). They include a set (lines 1-6) in the west of the area and, further east, another set (lines 8-12; Figs 20, 21a and 22), all running normal to the strike of the moraine ridge. To these were added a re-analysis of borehole cross-section lines parallel to the strike of the moraine (line 7) following the M55 motorway (Fig 21b), previously described by Longworth (1985), Aitkenhead *et al* (1992), and Wilson and Evans (1990). The cross-sections (Figs 19-22) are only as good as the borehole data that provided the information, and these are affected by problems of limited or vague lithostratigraphic description. The identification of glacigenic lithologies has been restricted in this report to sands, sand and gravel, silt/clay, laminated muds, and diamict, because these are more reliably assigned. Furthermore, boreholes where the descriptions were ambiguous or unclear have been excluded. The boreholes have been located as precisely as possible using the BGS catalogue grid reference, but the ground elevations of the sections are shown as a continuous profile and were derived from the Nextmap DEM and cross-checked against elevations recorded in the borehole logs.

4.1.12 ***Blackpool and northwards:*** Blackpool and the surroundings are well served in borehole coverage and six section lines (Fig 19) have been compiled progressing north to south, which complement the recorded but now obscured coastal cliff sections (Fig 2; Binney 1852; De Rance 1877a). Line 1, farthest north from the flat low terrain north of the Kirkham Moraine, shows a Pleistocene sediment fill of at least 30m, between +10m and -20m OD, with bedrock not reached throughout most of the section. Two broad sequences are shown, with the lower comprising at least 30m of interbedded glacial diamict, outwash sands and laminated lake/marine muds. These appear to be stacked and bifurcating diamict units separated by outwash deposits, which probably reflect changing ice-marginal positions, minor advance and retreat episodes during the late Devensian deglaciation. Overlying the lower sequence are thick (in places >10-15m) accumulations of outwash gravels, sands and waterlain silts and clays. The gravel and sand units are concentrated and thicker within broad channels and this upper sequence reflects pro-glacial deposition in the form of outwash sandar during the northwards passage of the ice margin. The eastward part of line 2 (Fig 19) further reveals the character of the low-level plain to the north of the Kirkham Moraine, with a thick (15-20m)

sequence of waterlain silt and clay burying glacial diamict, which suggests a possible lacustrine basin border that was dammed by the Kirkham Moraine to the south and the retreating ice-margin to the north.

4.1.13 The western end of line 2 and, proceeding southwards, lines 3 to 6 traverse the repeated crests and troughs of the Kirkham Moraine. The bedrock surface is at considerable, but variable, depth, and for the most part was not reached; however, locally it rises to within 20m of the surface (line 3). Further to the south, the Pleistocene sequence reaches thicknesses in excess of 70m. These sections reveal complicated sequences dominated by glacial diamict, but with interbedded outwash sands, gravels and occasional laminated muds. Lines 3, 4 and 5 show relative highs and thickening of diamict at the three major ridge lineations (Fig 19), suggesting a link between the morphology and stratigraphy. The sequence does not show the 'classical' tripartite scheme of diamict, sand and gravel and then diamict. Instead, the diamicts vary in thickness, bifurcate and laterally pinch-out, with wedges of outwash sand and gravel interbedded and laterally variable across the sections. The stratigraphy probably reflects minor advance and retreat episodes (Thomas and Chiverrell 2007), either at the margin of an ELD (Eastern Lake District) ice-stream or in a complicated sediment depocentre along the suture between the ELD and EIS (Eastern Irish Sea) ice-streams. Both these models provide settings for the deposition of laminated lacustrine muds in either moraine-dammed ice-marginal lakes or as inter-ice-stream sub-glacial or surfical lakes along these marginal sutures. The surface of the Kirkham Moraine is diversified by a series of peat- and lacustrine mud-filled hollows (lines 4-5), and a depth of 5-6m of probable late glacial and Holocene deposit have accumulated within these kettleholes.

4.1.14 Line 6 extends from the centre of the southernmost moraine lineation southwards across a diamict plain into the pro-glacial zone. At depth (-40m OD), a basal diamict is buried by a thick (>30m) off-lapping southwards wedge of outwash gravels and sands, that is interbedded with diamict units. A surface, and probable re-advance, diamict extends southwards of the Kirkham Moraine, forming a relatively gently undulating diamict plain immediately south of the moraine ridges. This diamict is then buried by a thick (15-20m) off-lapping wedge of pro-glacial outwash sands and gravel south of the moraine complex (lines 5 and 6).

4.1.15 The coastal sections (Fig 2) at Blackpool run parallel to the strike of the Kirkham Moraine (line 7), and to some extent reveal a less complex stratigraphy than that shown in strike normal sections, because they represent a snapshot along a moraine crest rather than a retreat/advance timeline. The sequence comprises the 'classic' tripartite scheme with upper and lower diamict separated by outwash sands and gravel. This lateral exposure of the sand and gravel reveals spatial variations in dominant grain size, with gravels focused in distinct higher energy channels and the more widespread sands typical of the wider sandur environment. The strike normal sections (Fig 19; *Sections 4.1.12-4.1.14*) show this sequence to be a simplification, with the repeated and stacked diamicts lain down during repeated oscillations of the ice-marginal position.

4.1.16 ***Kirkham to Preston:*** further east, between Kirkham and the rise towards the Bowland Fells, the borehole coverage is more intermittent, but four section lines have been compiled, each aligned north/south (lines 9-12; Figs 21 and 22). They complement line 8, which runs parallel to the M55, and which has been enhanced and reinterpreted with additional borehole information. Eastern tracts of line 8 run

parallel to the strike of the Kirkham Moraine, whereas the curvature of the ridge in the western lines forms a strike normal section (Fig 22 (lower)). In contrast to sections near Blackpool, the terrain in this area is higher, with the moraine crests rising to *c*30m OD, which in part reflects the rockhead rising locally to 10-15m above OD. Bedrock is also more consistently present and reached throughout most of the lines. Throughout, the sections are more diamict-dominated than those around Blackpool. The northern tracts of lines 9-12 cross obliquely a series of lateral moraines abutted against the bedrock rise of the Bowland Fells. The deposits thicken westwards away from the Bowland Fells, and, in lines 9-12, units of gravel, sand and laminated mud are more abundant, forming wedges between diamict units (Fig 22). Further south, stacked and bifurcating sequences of diamict dominate but are locally separated by outwash sands and gravels. These patterns are confirmed and amplified by the M55 borehole section (line 8; Fig 21), which shows thicker glaciolacustrine deposits towards the east. What is also apparent is that the thickness of surface diamict varies considerably, with greater thickness of near-surface sands around Preston and Kirkham.

4.1.17 The whole sequence probably reflects minor advance and retreat episodes and the stratigraphy broadly supports the geomorphology, with diamict at the surface of ridge crests. Outwash sand and gravel tend to thicken rapidly and then pinch out in a down-ice direction, but are buried by later diamict, reflecting either over-ride by ice or flow-diamict off an advancing and proximal ice-margin. Lines 8 and 6 show the thickest sequence of outwash deposits, which has, towards the southern reaches, in excess of 15m of sand and gravels, but these also inter-digitate with diamict, and off-lap the moraine ridge to the south. Also more abundant in these eastern sections are laminated and probable glaciolacustrine (no recorded fauna) muds, which are laterally continuous over 1-2km and over 10m in thickness. These deposits are also interbedded with the mixture of diamict and outwash deposits, but are more prevalent in the eastern and southern parts of these transects.

4.1.18 ***Summary stratigraphic succession:*** the Quaternary stratigraphic succession in Lancashire comprises Devensian glacial deposits overlain by thick sequences of lacustrine, alluvial, peatland and estuarine deposits (Thomas 1999). The regional stratigraphy was first defined by Hull (1864) as the classic three-fold division into 'Lower Boulder Clay', a 'Middle Sands', and an 'Upper Boulder Clay', and in recent revisions to the British Quaternary Stratigraphy these are all incorporated within the Kirkham Formation (Thomas 1999). The variable nature of the Quaternary succession led Gresswell (1967a) to question the value of the tripartite scheme in his treatment of the Kirkham Moraine, and the wider conceptual view of this scheme was further challenged by Johnson (1985). Longworth (1985) expounded on this theme in detailed stratigraphic research on the Lancashire plain, identifying multiple till or diamict sequences that seldom conformed to the tripartite scheme, although the M55 borehole series does in part conform to this idealised model. In this report, further strike parallel sections confirm the complexity of the glacigenic succession. The entire Quaternary succession relates to the late Devensian, and incorporates lower diamicts that reflect the advance of ice well to the south of the region, probably towards maximal limits in Cheshire/Shropshire, which are buried by a series of retreat-stage outwash deposits and further diamicts, of both flow and lodgement types (Longworth 1985). As with other regions, for example the Isle of Man and Lleyn Peninsula (Thomas *et al* 2004; Thomas and Chiverrell 2007), the upper diamicts and outwash deposits can

be attributed to multiple and variable-scale marginal oscillations of the ice-margin during the retreat of the late Devensian ice-streams of the British Isles. From a perspective of stratigraphic nomenclature, the entire glacigenic succession is properly defined as the Kirkham Formation, with further formal subdivision unwarranted, although clearly it does comprise a number of distinct sediment-landform assemblages: outwash sand and gravels, diamicts and glaciolacustrine muds.

4.1.19 ***Event sequence - the Pleistocene Evolution of the Ribble Valley:*** the earliest evidence for Pleistocene environments in the region is the basal diamict, a lodgement till smeared over the bedrock of the Lower Ribble Valley. Borehole evidence shows that the rockhead is some 20-25m below OD and the Pleistocene sediment fill in places is over 50-60m in thickness. This lodgement till was probably emplaced during the advance of the British Icesheet to limits in the English Midlands *c* 24,000 years ago. Much of the glacial geomorphic and sedimentary evidence relates to the sequence of environmental changes on the retreat of the ice margins from that maximal limit. The Kirkham Moraine complex is an extensive feature of some magnitude, with no obvious parallels down-ice until the moraine ridges of south Cheshire are reached at Whitchurch, and little else in the up-ice direction until the Lake District (Longworth 1985). After the ice-marginal oscillations associated with the production of the Kirkham Moraine, the British Icesheet (BIS) appears to have gone into terminal decline, with rapid ice wastage and marginal retreat denoting the transition to the warm conditions of the late-Glacial Windermere Interstadial of Great Britain. In Lancashire, this is evidenced by the complete Windermere interstadial to Holocene stratigraphic sequences at Haweswater (Marshall *et al* 2002; Jones *et al* 2002) and in the kettleholes of the lowland Lake District, which show that the region was ice-free by 15,500 years ago.

4.1.20 The geomorphology and limited stratigraphic data suggest that the Kirkham Moraines were the product of repeated ice-marginal oscillation, with tills over-riding the glaciolacustrine deposits east of Preston. The probable sub-glacial deformation in the lower diamict, the number of moraine ridges, and stratigraphy tentatively identified from the borehole and previously described section exposures (De Rance 1877b), can all be interpreted as reflecting marginal oscillations during a re-advance episode. In the Lower Ribble Valley, there is borehole and exposure evidence for lacustrine environments that extends from just east of Preston, upstream in the Lower Ribble and Calder, in the Vale of Chipping, and throughout much of the Hodder. That the Lower Ribble Valley comprised a large ice-dammed lake during deglaciation is beyond question; the implications of this are that the Ribble glacier was in a state of retreat earlier than the ELD and EIS ice-streams issuing from the Lake District and Scotland. This may reflect the comparatively low altitude and small ice source area of the southern section of the Pennine ice-field north of Settle. This lake may have varied considerably both in size and water depth throughout its existence, with the key controlling feature being the damming mechanism across the Lower Ribble Valley east of Preston and the western edge of the Vale of Chipping (Fig 3). The Kirkham Moraine formed the northern shoreline to this lake for part of its history and the overriding of lake sediments by glacial diamict implies ice advance into the lake basin.

4.1.21 There is no information about the timing of this sequence of events, but, given that glaciolacustrine deposits appear to underlie much of the Lower Ribble Valley and

up into the Hodder catchment, it does appear that the Bowland Fells had become ice-free and the Ribble glacier was substantially in retreat whilst the EIS and ELD ice-streams may still have been in comparatively advanced positions, at least as far south as the rock-ridge that extends west to Skelmersdale. The eventual northwards retreat of the EIS and ELD ice-fronts would have allowed the drainage of this lake system, and perhaps encouraged some of the incision, that produced the reach that the contemporary Ribble occupies. It is suggested that the margins of the ELD ice-stream were at, or near, the Kirkham Moraine complex during the existence of the Ribble ice-dammed lake, with the larger dominant EIS ice-stream providing the damming mechanism. In this context, the curvature of the Kirkham Moraine and the north/south aligned moraine ridge to the south of the Ribble mark the join between two ice-streams. As such, the Kirkham Moraine is at least, for part of its length, an example of an inter-ice-stream moraine complex, as is the continuation of the moraine ridge from south of the Ribble towards Skelmersdale. The diamict drape over glaciolacustrine deposits east of Preston can then be explained as debris flows off the ice-margin over bottom-set laminated clays. It would also explain some of the inter-digitation between the glaciolacustrine clays and sand and gravel units, with outwash sands and gravels from the nearby ice-margin impinging upon the lake.

4.1.22 Retreat and submission rapid advances by the ELD ice-stream were probably responsible for the sub-glacial deformation and production of the Lancashire drumlin fields. A corollary of this rapid ice advance could be the advances to Heinrich event 1 (H1) limits identified in north-east Ireland and on the Isle of Man (Bowen *et al* 2002). This theory is largely underpinned by an attempt to link the retreat sequence to major ice-advance episodes, which is not necessary because the pulsed process of ice-margin retreat is more than capable of producing substantial recessional moraine complexes. However, the curvature of the Kirkham Moraine does encourage the determination of the ELD ice-stream as the dominant ice source area. Unfortunately, much of the geomorphology required to assess the westward continuation of these ice-marginal moraine limits is currently on the seabed of the Irish Sea.

4.2 ASSESSMENT OF THE SAND AND GRAVEL POTENTIAL

4.2.1 ***The Kirkham Moraine Complex:*** the focus on the Kirkham Moraine was driven for the most part by the fact that it is arguably one of the best prospects for finding significant quantities of sand and gravel in Lancashire. Stratigraphic information on the mineral potential of this region, compiled in this report, draws on new and previously discussed borehole series (Wilson and Evans 1990; Aitkenhead *et al* 1992). The detailed mapping of the geomorphology and the borehole and section evidence show that the glaciofluvial sands and gravels thicken in the inter-moraine areas and that there are thick units of sand and sand/gravel buried within the moraine complex. These deposits provide the best prospect for mineral extraction. The ice-front sandur appear wider and comprise thicker deposits near the major through-moraine outwash channels: the Skippool and the Kirkham Channels. Towards the eastern end of the M55, borehole sequences, the surface diamicts, and the thick sequence of glaciolacustrine laminated clays preclude aggregate extraction, but to the west there are clearly thick sequences of glaciofluvial sands and gravels. The surface diamict laid down during the ice-marginal oscillations

responsible for the ridges often buries these glaciofluvial sands and gravels, but the diamict of variable thickness drapes the moraines.

4.2.2 Further data on the mineral reserves within the Kirkham Moraine are available from past, current and planned mineral extraction sites: at Chain Lane; Bradley's Sand Pit; Higher Hill House Farm; Myerscough; and Sharples Quarry (Geoplan Ltd 2006; Fig 23). All previous mineral extraction in the Kirkham Moraine complex has targeted the inter-moraine areas. The database of Resource Block reports by Geoplan Ltd (*ibid*) assists scrutiny of the potential mineral resource, Resource Blocks 4C, 4D, 4E and 3H highlighting the potential resource within the Kirkham Moraine, with 8m-thick sand and gravel deposits present (*ibid*). Higher Hill House Farm (Fig 23) was refused planning permission for mineral extraction in 1983 and the limited information within the Geoplan Ltd report (*ibid*) suggests that a fairly limited deposit of glaciofluvial sand and gravel was the target mineral, with a predominance of sand at *c*72%. The setting is one of an inter-moraine sandur flat, and so is a zone with a high potential for glaciofluvial sands and gravel. Further confirmation of ice-marginal sandur-style deposits associated with this flat, that are commercially extractable, is gained from mineral reports from nearby exhausted workings at Myerscough (*ibid*).

4.2.3 Bradley's Sand Pit to the south-east (Fig 23) is also within an inter-moraine area, and the mineral reported is some 25m in thickness, buried by 4-4.5m of diamict/clay. The reports for Resource Block 4E (*ibid*) around Bradley's Sand Pit confirm this interpretation, that mineral is present but is laterally variable. The geomorphological setting is intriguing, because the nature of the deposits and inter-moraine setting suggests a sandur depositional environment, but the sandur would have been very restricted in extent between the flanking ridges. However, the total thickness of deposit may relate to the phase of ice retreat formed as pro-glacial outwash, with ridge-forms created by later ice-marginal advance. The M55 borehole series around the M55-A585 interchange shows the thickest sand deposits, potentially 15-20m in thickness, that lie in this inter-moraine sandur associated with the Kirkham Channel. Further to the west, at Chain Lane, a restored gravel pit worked glaciofluvial deposits during the 1950s, and again the geomorphic setting is in an inter-moraine flat.

4.2.4 ***Sand and gravel potential of the Kirkham Moraine:*** much of the Kirkham Moraine comprises workable aggregate in some manner or form. Areas underlying a substantial kettlehole have been excluded from consideration owing to the potential thick, saturated overburden. Twenty resource areas are identified as having mineral present in both workable quantities and form (Fig 24; Table 3). These 20 areas are also the least constrained of the potential Resource Blocks within the Kirkham study area. Thirteen of the blocks are inter-moraine sandur, landforms that have a history of extraction within the region, and these have been given potential deposit thicknesses of 10m, which is the practical extraction limit. This estimate, derived from the history of extraction and mineral reports (*ibid*), is probably an over-estimate, however, and is offset by the more conservative waste estimates of 40% attached to these deposits. The remainder of the Resource Blocks are moraine ridges, which have been included based on borehole evidence that suggests the presence of significant quantities of sand. With these prospects, the thicknesses have again been set at 10m, but waste is significantly higher, possibly as much as 90%. These waste values are estimates, and the actual values are likely to be much lower and spatially variable. It is crucial, however, that these estimates

are subsequently validated and supported by field-derived borehole and exposure data, together with appropriate sediment sampling and laboratory analysis. Two prospects have been handled differently: sandur prospect K19 has previously sustained extraction in Bradley's Sand Pit and has been assessed as having a waste of 25%, with a deposit thickness of 20m. Moraine prospect K66 appears to be the largest aggregate resource, and borehole evidence shows this to have in excess of 20m of sand. Taking consideration of the hill morphology and potential quality of the deposit, a deposit thickness of 20m and a waste of 40% has been used. Admittedly, though, some of these volumes are locked beneath roads and settlements, and so provide broadly indicative maximal estimates. According to our reliability index, with the exception of sub-Resource Blocks where exposures are available and so have a high reliability, the remainder are inferred resources and the reliability of the assessment is medium to low. Prior to any extraction, a comprehensive survey must be undertaken to prove the nature of the deposits, and the predicted aggregate quantities must be regarded as indicative estimates.

4.2.5 In terms of constraints (Table 4), the majority of the resource blocks appear largely free. K18 borders the Forest of Bowland AONB and is within the AONB fringe zone. K34 and K13 are poorly connected in terms of transport network. Historic constraints within current understanding are negligible, owing to the absence of Schedule Monuments (*Section 5*), and all Listed Buildings are within Urban areas and thus accounted for in the Urban category. Urban cover does not prohibit extraction within the Resource Blocks outside the settlement limit. In summary, combining the information on the quantity of mineral available with limitations to use by constraint produces a relative viability index (Fig 25), which shows that most of the Resource Blocks are of reasonable viability for future use.

Resource Block	Feature	Depth (m)	Volume (m^3)	Waste (%)	Estimated Workable Deposit (m^3)	Reliability	Usable
K10	Sandur flat	10	20620700	40	19795900	Medium	Y
K13	Sandur flat	10	18466600	40	17727900	Medium	Y
K18	Moraine ridge	10	70838300	90	11334100	Medium	Y
K19	Sandur flat	20	11213700	25	13456400	High	Y
K20	Sandur flat	10	12616900	40	12112200	Medium	Y
K24	Moraine ridge	10	60219800	90	9635170	Medium	Y
K25	Sandur flat	10	34188500	40	32821000	Medium	Y
K26	Moraine ridge	10	47955600	90	7672900	Medium	Y
K28	Sandur flat	10	11429200	40	10972000	Low	Y
K29	Moraine ridge	10	23564300	90	3770290	Medium	Y
K34	Sandur flat	10	40813700	40	39181200	Medium	Y
K42	Sandur flat	10	9795610	40	9403790	Low	Y
K43	Sandur flat	10	56316400	40	54063700	Medium	Y
K56	Sandur flat	10	11115500	40	10670900	Low	Y
K66	Moraine ridge	15	124742000	40	79834900	Medium	Y
K67	Sandur flat	10	18632100	40	17886800	Medium	Y
K68	Sandur flat	10	26568500	40	25505800	Medium	Y
K69	Moraine ridge	10	78697500	90	12591600	Medium	Y
K7	Sandur flat	10	11125000	40	10680000	Medium	Y
K74	Moraine ridge	10	27134800	90	4341570	Low	Y

Table 3: Mineral volumes expressed as total estimated sand and gravel for the workable Resource Blocks identified on Figure 24. Workable Resource Blocks have to exceed 1,000,000mt usable mineral.

Resource	Road (m)	Road Name	Urban (%)	Environment (%)	Landscape	Historic	Ranking
K10	1197	A6	0	0	0	120	8
K13	2774	A6	9	0	0	0	20
K18	0	A6	1	2	100	100	19
K19	0	A6	30	0	0	20	9
K20	657	A6	0	0	0	0	18
K24	0	A583	16	0	0	160	13
K25	516	A583	19	0	0	140	5
K26	0	A583	16	0	0	80	14
K28	0	A583	0	0	0	0	7
K29	0	A583	12	0	0	0	12
K34	2235	A583	9	0	0	80	4
K42	698	A585(T)	0	0	0	0	15
K43	0	A585(T)	10	0	0	40	3
K56	0	A585(T)	0	0	0	0	10
K66	0	A585	11	0	0	100	1
K67	0	A583	49	0	0	0	6
K68	73	A585	5	0	0	0	2
K69	1295	A585	9	0	0	60	16
K7	0	A6	30	0	0	20	17
K74	0	A586	2	1	0	40	11

Table 4: Environmental constraints for the workable Resource Blocks identified on Figure 24. Workable Resource Block have to exceed 500,000mt usable mineral. Connectivity to the road network is based on distance in metres to the nearest A-road. Urban refers to the % of urban area in the resource block, with equivalent % area calculations for environmental designated sites (SSSI, NNR, SAC, SPA, Ramsar). Listed buildings and Scheduled Monuments form the Historic category (see Section 3.6.24 for methodology).

5 ARCHAEOLOGICAL RESOURCE: RESULTS

5.1 INTRODUCTION

5.1.1 The analysis of the archaeological resource was conducted in three phases. Firstly, a desk-based study examined the sources and collated the events and monuments arising from those (*Section 5.2*). Secondly, a quantitative and qualitative analysis was undertaken of their distribution throughout the landscape (*Sections 5.3-5.5*), and, thirdly, the threat from possible future aggregate extraction on both known monuments and potential new monuments was considered (*Sections 5.6-5.7*).

5.1.2 As a result of this study, 203 new monuments were recorded, in addition to the 768 already known. Throughout this report, monuments will be referred to by the reference number assigned to them in the database for this project, and will be prefixed 'KM'.

5.2 RESULTS OF THE DESK-BASED STUDY

5.2.1 ***Historic Mapping:*** all the map sources consulted for the general historic background were examined (*Section 3.5.2*), but only those sources that identified monuments within the study area are listed below (Table 5).

Map Source	Period	Count
First edition 6 inch to 1 Mile (1844-52)	Post-medieval	83
	Unclassified	12
First edition 25 inch to 1 mile (1893)	Post-medieval	42
Second edition 6 inch to 1 Mile (1898)	Post-medieval	15
	Total	**152**

Table 5: Breakdown of new monuments sourced from historic maps

5.2.2 ***Lancashire Historic Environment Records (HER):*** there were 521 monuments listed in the Lancashire HER (Table 6). There were also 118 Listed Buildings recorded on the HER within the study area (Table 7), and 124 records made during the North West Wetlands Survey (Table 8; Middleton *et al* 1995). In addition, eight sites recorded by the Ribble Catchment Rapid Identification Survey (LUAU 1997; Table 9) had been entered into the HER, making a total of 768 records in all. Significantly, there were no Scheduled Monuments or Registered Parks and Gardens within the area.

Period	Count
Early Neolithic	1
Neolithic	1
Bronze Age	10
Prehistoric (Unspecified)	2
Roman	40
Medieval	49
Post-medieval	271
Modern	7
Unclassified	140
Total	**521**

Table 6: Breakdown of HER Monument records by period

Period	Count
Post-medieval	93
Modern	25
Total	**118**

Table 7: Breakdown of Listed Building records by period

Period	Count
Neolithic	1
Prehistoric (Unspecified)	47
Roman	1
Medieval	55
Post-medieval	5
Unclassified	15
Total	**124**

Table 8: Breakdown of North West Wetlands Survey records by period

Period	Count
Roman	3
Medieval	2
Post-medieval	3
Total	**8**

Table 9: Breakdown of Ribble Valley Rapid Identification Survey records by period

5.2.3 ***Grey Literature Search:*** this examined unpublished reports of archaeological events that had occurred in the study area, which may have generated new monuments. The Excavation Index for England (NMR), the Archaeological Investigations Project (Bournemouth University), and the archives of OA North were all consulted. It also served, however, to establish an archaeological and historical context for the study area. Those records that fell within the study area were compared to both the events and monuments data supplied by the HER, to ensure that there were no omissions. The grey literature search identified 42 records in the study area and a further 158 records for the wider region (Table 10). Of those, it was established that the related monuments within the study area had already been accessioned into the HER, and did not require the creation of any additional monument records.

Event Type	Count
Archaeological assessment	20
Archaeological assessment and walkover survey	1
Archaeological building survey	38
Archaeological evaluation	45
Desk-based assessment	1
Environmental sampling	2
Geophysical survey	2
Test pit excavation	1
Topographic survey	2
Unspecified	60
Walkover survey	4
Watching brief	24
Total	**200**

Table 10: Breakdown of Grey Literature Search records by Type

5.2.4 ***Aerial Photographs:*** nine sites were identified from aerial photographs and their mapping, of which two have been listed as 'Unclassified', and the rest were ascribed a 'post-medieval' date (Table 11).

5.2.5 ***LiDAR****:* in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a), LiDAR proved to be an invaluable resource in terms of determining new sites. In this project, 87 of the 203 new sites were discovered by the use of LiDAR techniques alone (*Sections 3.5.19–24*). A further 111 new sites were identified by combining information derived from LiDAR with that from historic maps, oblique and vertical aerial photographs (OAP/VAP). Therefore, only five new sites were not visible on the LiDAR, or were found in areas where there was no coverage.

Source	Period	Count
Aerial Photography Only	Post-medieval	1
	Unclassified	2
Sub-total		*2*
LiDAR Only	Post-medieval	30
	Unclassified	55
	Modern	2
Sub-total		*87*
LiDAR and Second Edition OS maps	Post-medieval	14
Sub-total		*14*
LiDAR and First Edition OS maps	Post-medieval	80
	Unclassified	12
Sub-total		*92*
LiDAR, OAP/VAP	Post-medieval	2
Sub-total		*2*
LiDAR, First Edition OS maps, OAP	Post-medieval	3
Sub-total		*3*
Total		**198**

Table 11: Breakdown of monuments sourced from LiDAR, aerial photographic mapping and historic maps, by period

5.2.6 ***Compilation:*** all the datasets were subject to a process of data cleansing and checking, the main focus of which was to ensure that there was no duplication of monument records and to check the accuracy of their location. The monuments were classified by class and period using the standard terminology used in the NMR Thesauri (English Heritage 2007, Table 12). The term 'Monument <by form> is used to classify monuments of unknown class.

Period	**NMR Class**	**Count**
Neolithic	MONUMENT <BY FORM>	2
Sub-total		*2*
Bronze Age	MONUMENT <BY FORM>	6
	RELIGIOUS RITUAL AND FUNERARY	4
Sub-total		*10*
Prehistoric	MONUMENT <BY FORM>	47
	RELIGIOUS RITUAL AND FUNERARY	2
Sub-total		*49*
Roman	DEFENCE	1
	MONUMENT <BY FORM>	24
	RELIGIOUS RITUAL AND FUNERARY	1
	TRANSPORT	12
	UNASSIGNED	2
Sub-total		*40*
Medieval	AGRICULTURE AND SUBSISTENCE	40
	CIVIL	3
	DOMESTIC	27
	GARDENS PARKS AND URBAN SPACES	2
	INDUSTRIAL	4
	MONUMENT <BY FORM>	27
	RELIGIOUS RITUAL AND FUNERARY	20
	TRANSPORT	3
	WATER SUPPLY AND DRAINAGE	1
Sub-total		*127*
Post-medieval	AGRICULTURE AND SUBSISTENCE	65
	CIVIL	8
	COMMERCIAL	18
	COMMEMORATIVE	1
	COMMUNICATION	8
	DEFENCE	1
	DOMESTIC	60
	EDUCATION	15
	GARDENS PARKS AND URBAN SPACES	5
	HEALTH AND WELFARE	5
	INDUSTRIAL	92
	MONUMENT <BY FORM>	41
	RECREATIONAL	6
	RELIGIOUS RITUAL AND FUNERARY	32
	TRANSPORT	48
	UNASSIGNED	8
	WATER SUPPLY AND DRAINAGE	97
Sub-total		*510*
Modern	AGRICULTURE AND SUBSISTENCE	2
	MONUMENT <BY FORM>	5
	UNASSIGNED	2
Sub-total		*9*
Unclassified	AGRICULTURE AND SUBSISTENCE	29
	DOMESTIC	6

Period	NMR Class	Count
	INDUSTRIAL	2
	MONUMENT <BY FORM>	128
	RELIGIOUS RITUAL AND FUNERARY	1
	TRANSPORT	6
	UNASSIGNED	8
	WATER SUPPLY AND DRAINAGE	32
Sub-total		*212*
Total		**959**

Table 12: Breakdown of all monuments by period and NMR Class

5.3 THE DISTRIBUTION OF MONUMENTS IN THE KIRKHAM STUDY AREA

5.3.1 The range and quantity of monuments in the study area was essentially similar to that in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a), in that the more recent periods had the greatest number of monuments. There were, however, more recorded sites of prehistoric date than there were from the Roman period, perhaps because this had been inflated by the results of the North West Wetlands Survey. This survey had substantially increased the number of Mesolithic sites within the area between the Ribble and the Lune (Middleton *et al* 1995, 202), for example, and highlights that areas outside their survey area will have a correspondingly lower density of similar monuments.

5.3.2 ***Prehistoric period:*** the earliest evidence of prehistoric activity in the study area comes from the flint and stone tools of the Neolithic period. Flints were generally found on land below 35m Ordnance Datum (OD), with broad clusters between 25m and 35m OD and between 10m and 15m OD. Broadly speaking, the monuments fell into two broad swathes of sites sitting on moraine ridges (Fig 26), one of which runs from the west of Kirkham, and extends north-north-west towards the village of Singleton. The other runs north of Kirkham towards the Skippool valley, and curves back north-east towards the village of Inskip.

5.3.3 Within the latter cluster, there is a substantial concentration of sites between Weeton and Westby reservoirs, around Whitprick Hill (Fig 27), comprising both scatters and individual flint finds. This concentration, however, may be a result of a bias in the North West Wetlands Survey (Middleton *et al* 1995). The quality of the agricultural land in this area is a direct result of the area having free-draining gravels, mixed with the boulder clay, and this drainage may have attracted occupation during the prehistoric past. This may, however, be the result of intensive fieldwork in this area by the North West Wetlands Survey (Middleton *et al* 1995), as good-quality arable land is frequently ploughed.

5.3.4 In addition to the flint finds, there are five records (KM0002–KM0006, *Appendix*1) attesting to the discovery, north of Weeton Road, near Stanley House Farm, of urns containing *'bones and ashes and broken pottery of rude workmanship in an extensive barrow in Lim'd Hall, Moorfield*' (Thornber 1837, 12-13). In 1850, Thornber referred to a possible second cairn in a field called Moor Hey, which, when robbed, *'yielded many rude urns and black earth*' (Thornber 1850, 120). A possible grass-covered, circular barrow, 18m in diameter and *c* 2.5m high, was located in a small pasture field to the north of Derby Hill Farm (KM0606). In combination with the distribution of flint finds, the burial

remains appear to suggest that the Whitprick Hill area may have been a focus for settlement in prehistory.

5.3.5 A second concentration of flint was identified east of the village of Hardhorn, in the district of Staining (Fig 24). The area is riddled with drains and ponds and has a substantial drain running through it. LiDAR reveals a wide sunken, curving linear feature, seemingly a palaeochannel, and the prehistoric distribution closely mirrors this (Fig 28). It would suggest that the raised, well-drained floodplains on the edges of watercourses were favoured for prehistoric activity.

5.3.6 A second swath of prehistoric flint finds runs north of Salwick Bridge Farm, curving north west towards Roseacre, and then curving back north-east towards Inskip. At this time, no funerary remains have been found in this area. East of Salwick Hall, however, a possible ditched bowl barrow has been recorded in Many Pits Wood (KM0317; Fig 29). Several tumuli have also been recorded on the line of the Roman road from Kirkham to Preston (KM0010, Fig 29), some 40m south of the projected line of the Roman road. No evidence of later prehistoric activity has been recovered in the study area. Indeed, the only hint of Iron Age occupation comes from a piece of possibly locally made pottery from the fort site at Dowbridge (Howard-Davis and Buxton 2000; *Section 2.4.2*).

5.3.7 ***Roman period:*** the main Roman site in the area is the fort at Dowbridge, Kirkham (KM0015), which was built at the point where the Pennine route via the Ribble Valley would have met the coast (Howard-Davis and Buxton 2000). Together with the fort at Ribchester (Buxton and Howard-Davis 2000), and the apparently industrial complex at Walton-le-Dale (Gibbons *et al* forthcoming), this demonstrated a heightened level of military activity in the area, presumably because of the ease of access into the Ribble estuary. The largest concentration of Roman monuments was to be found around Kirkham, with 18 monuments recorded (Fig 30). Only a further ten are known within the rest of the study area (Fig 31). There are several dispersed findspots across the area, mainly representing coins and pottery, with the exceptions of a quernstone found at Wharles (KM0087) and a beehive quern found north of Carr Wood in the district of Medlar (KM0534, Fig 32). South of Salwick Station, an altar (KM0025) was found, which is now in the church of St John, near Clifton Mill Farm, used as a font. Whilst this distribution is not particularly informative, it would suggest some dispersed settlement in the period across the Kirkham Moraine.

5.3.8 ***Early medieval period:*** the only record of activity from the early medieval period is a cinerary urn from Crossmoor in Inskip (KM0016), which was associated with sword and dagger fragments, discovered by workmen in 1889 (HER PRN 74). The urn was attributed a 'Saxon' (ie early medieval) date on the basis of the metalwork.

5.3.9 ***Medieval period:*** much of the evidence for the medieval period comes from documentary sources, but there is also a broad range of archaeological monuments (127 monuments within the study area) ascribed to the period (Fig 33). There is a concentration of 20 findspots of pottery around the village of Crossmoor (*Section 2.6.6*, Fig 34), and there are Deserted Medieval Villages (DMV) sites postulated at Medlar, Bartle, Haighton, Westby, and Greenhalgh (Fig 35).

5.3.10 There are medieval 'Ritual Religious and Funerary' sites recorded in a line along the southern edge of the study area (Fig 36). These include crosses, chapels and

churches, and it would appear that early settlement was concentrated around these southern margins. Ten moated sites are also recorded in the area, which again cluster to the south, and are for the most part close to the religious sites. Medieval domestic sites, such as houses, halls, cottages and farmhouses (Fig 37), are also more predominantly located on the better drained ground in the southern part of the study area, and similarly, the six findspots classified as medieval are located around the margins of the area (Fig 38). The rest of the study area was evidently farmed, however, as there are remains of broad ridge and furrow, and other field systems, clustered towards the centre and westwards, but generally not in the south where the settlement remains predominate (Fig 39). However, these do not provide a particularly reliable diagnostic indicator of medieval activity, as they can often be of post-medieval date. Given the paucity of medieval farmhouses surviving in the central area, it is possible either that these sites have disappeared or that much of this ridge and furrow is of post-medieval date.

5.3.11 Only four records in the HER refer to industrial monuments of the medieval period (Fig 40). There is a horse engine at Kirkham, which is first mentioned in 1337 (KM0044), and is thought to have been a corn mill. There are also two windmills, one at Carr Hill (KM0045), and 'Clifton Windmill' (KM0659) on Clifton Lane, Clifton, again both for grinding corn. At Inskip, an outbuilding, presently being used for storage, is considered to be a former wheelwright's shop of medieval date (KM0667).

5.3.12 ***Post-medieval period:*** there are 510 post-medieval monuments within the study area (Table 13), which reflect a marked increase over earlier periods. Many of these are new sites identified by the present project. Most are buildings and standing structures such as houses, banks, bridges, and stables.

NMR Class	**Count**
AGRICULTURE AND SUBSISTENCE	65
CIVIL	8
COMMERCIAL	18
COMMEMORATIVE	1
COMMUNICATION	8
DEFENCE	1
DOMESTIC	60
EDUCATION	15
GARDENS PARKS AND URBAN SPACES	5
HEALTH AND WELFARE	5
INDUSTRIAL	92
MONUMENT <BY FORM>	41
RECREATIONAL	6
RELIGIOUS, RITUAL AND FUNERARY	32
TRANSPORT	48
UNASSIGNED	8
WATER SUPPLY AND DRAINAGE	97
Total	**510**

Table 13: Breakdown of post-medieval monuments by Class

5.3.13 The distribution of monuments (Fig 41) shows that farmhouses were located throughout the study area, including the central area, indicating that much wider agricultural exploitation was undertaken across the Central Fylde at this time (Fig 42). There was clearly increased reclamation of mosses and wetlands at this time, which can be seen in the changing patterns of field boundaries and enclosure. The most striking example of this (*Section 2.6.5*, Fig 14) is shown on the Ordnance Survey first edition map of 1850 around the village of Catforth, where a series of parallel lanes extends out to the former moss edge, presumably to provide access for turbary there. The former moss edge is now marked by a change to regular rectangular fields, which is often an indicator of reclaimed ground, although elsewhere rectangular fields are indicative of Parliamentary Enclosure (Whyte 2003). There were also substantial numbers of ponds in the area, which are likely to be water-filled marl pits, reflecting improvement of the reclaimed ground. In total, 90 were recorded during the survey, all of which were shown on the first edition Ordnance Survey maps (1844-52), but none of these are present on the modern Ordnance Survey mapping. Most, though, were still evident as earthworks on the LiDAR data.

5.3.14 ***Industrial Monuments:*** there is a huge increase in the number of industrial monuments dated to the post-medieval period (Fig 43). In particular, there are many clay pits, sand pits, and gravel pits, indicating a substantial increase in the level of extraction (Fig 44). This was occurring at a time of intensive land reclamation and parliamentary enclosure, and many of the clay pits and ponds may have been marl pits, created to improve the agricultural land. Given the absence of limestone to burn for agricultural land improvement, the practice of marling was widespread in the region for improving productivity. The reason for this was that the low-lying areas of the Fylde were inundated during marine transgressions and the primary colonisation of the drying land in the Neolithic period was by vegetation which eventually produced raised acid mires (*Section 2.3.4*). These areas were then drained and reclaimed in the later medieval and post-medieval periods, producing land with very acidic soils. The effect of marling was to reduce the acidity of the soil, and improve the land in a way similar to the practice of putting lime on the fields.

5.3.15 The industrial sand pits and gravel pits are predominantly found in the southern half of the study area (Fig 44), and may indicate a concentration in areas of geological resource on the Kirkham Moraine. Kirkham itself developed as a centre for flax and linen production, particularly during the late seventeenth and eighteenth centuries (Singleton 1980). This is reflected in the standing remains of weaving and sailcloth factories, and the associated workers' housing.

5.3.16 The development of the canal and, later on, the railways, has left a lasting mark on the study area. Most of these are now redundant, but their cuttings and embankments survive, and also many of the associated buildings and other furniture. There are records of signal boxes and posts, various bridges, toll gates and goods sheds, all associated with the network of different types of communication that developed in the post-medieval period.

5.4 PRELIMINARY ANALYSIS AND ENHANCEMENT OF ARCHAEOLOGICAL DATASET

5.4.1 The monument selections used for the initial analysis were based upon the observations made during the integration and analysis of aggregate, environment and heritage datasets (*Section 3.5.17*). This involved an examination of the coincidence of known (pre-enhancement) archaeological monuments, the Lancashire County Council principal areas of search suitable for aggregates extraction, topography, and existing geological mapping (*Section 3.5.18*).

5.4.2 Rather than analysing monuments of all periods and types in conjunction with the chosen parameters, a qualitative selection was made of those monument classes or periods thought to be most vulnerable to risk from aggregate extraction within the study area. The resulting selections were:

- 'Prehistoric'- all monuments that were dated to any prehistoric period;
- 'Flint'- all flint finds including both individual stray finds and scatters;
- 'Roman'- all monuments dated to the Roman period irrespective of type;
- 'Medieval' - all monuments dated to the medieval period;
- 'Findspot' – all monuments classed as 'Findspots';
- 'Agriculture and Subsistence' class;
- 'Domestic' class;
- 'Industrial' class;
- 'Monument <by form>' class.

5.4.3 All categories were combined with four variables, namely Slope, Aspect, Elevation, and existing BGS geological mapping. There was, however, a very limited correlation between the monument datasets and any of the test variables (Table 14).

Monument Selection	Total Number of Monuments	Slope	Aspect	Elevation	Geology
Prehistoric	61	No	No	No	No
Roman	28	No	No	No	**Yes**
Medieval	127	No	No	No	**Yes**
Agriculture and Subsistence	117	No	No	No	No
Domestic	93	No	No	**Yes**	No
Industrial	88	No	No	No	No
Monument <By Form>	235	No	No	No	No
Water Supply and Drainage	33	No	No	No	No
Findspots	45	No	No	No	No
Flints	46	No	No	No	No

Table 14: Results of KS tests of monuments and variables

5.4.4 The only correlations occurred between both Roman and medieval monuments and geology, and between domestic monuments and elevation. The analysis of the domestic monuments shows that 69 of the 93 monuments are between 10m and 30m OD.

5.4.5 Both the Roman and medieval selections correlate with the geology variable, with the majority of the Roman monuments being on Devensian Till (Fig 45), unsurprisingly clustered around Kirkham, with a distribution along the line of the Roman road to the east. The medieval monuments again mainly fall on the Devensian Till, with a cluster of pottery finds around Crossmoor, Inskip and Elswick (Fig 46).

5.4.6 The limited correlations shown in these tests provide little extra knowledge about the distribution of the monuments, but do serve to substantiate the assumptions one would make about the geology and general topography of the study area. The Fylde is essentially flat and low-lying, and the tests show that, of the 127.41km^2 of the study area, some 98.07km^2 (76%) falls between 10m and 30m OD. Also, 117km^2 (92%) of the area lies on a slope of 0-5°. Furthermore, the study area has large areas of similar geological substrata (*Section 4.1.2*), and the tests show that, indeed, 88km^2 (89%) of the area is classified by the BGS as Diamicton (Devensian Till). Essentially, the landscape exhibits little demonstrable variation in slope, aspect, elevation or underlying geology.

5.5 ENHANCEMENT OF THE HLC

5.5.1 A similar process of enhancement was undertaken to that in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a). The 278 HLC polygons in the study area were enhanced to enable comparisons between the landscape types and the monuments/events (*Section 3.7.10*). These included the total counts (Table 15), counts per period, overall density, and density per period, of archaeological monuments. The number of events per polygon, geomorphological classification, level of ground disturbance, and geological prospect ranking were also attached to each polygon.

5.5.2 Out of the total (278), 112 polygons contained no monuments (Table 16), and of the remaining 166, the average was 5.77 monuments per polygon. Polygons containing no monuments were evenly distributed throughout the study area, indicating that there is little or no spatial clustering of monuments overall. Polygons containing no monuments are also distributed evenly across almost all landscape types, accounting for 15 of the 17 possible types within the study area. The exceptions are 'Modern Ornamental' and 'Ancient and Post-medieval Woodland'. This would appear to indicate that *lacunae* in the distribution of monuments are not related to landscape type.

5.5.3 The HLC landscape type with the lowest number of polygons containing no monuments, as a proportion of the total number, was 'Modern Enclosure' (Table 16). This landscape type is the most recent, indicating that the land has been subject to substantial change in modern times, and, therefore, is more likely to have been subject to some level of archaeological or antiquarian investigation. This 'Modern Enclosure' landscape type refers to fields that are likely to have been subject to deep ploughing, which would bring artefacts to the surface, and landscape features, such as ridge and furrow, may have been noted prior to later land improvements.

HLC Broad Type	Number of Polygons	Total Number of Monuments	Average number of Monuments
Ancient and post-medieval Ornamental	10	18	1.8
Ancient and post-medieval Settlement	29	116	4
Ancient and post-medieval Woodland	4	6	1.5
Ancient Enclosure	76	253	3.3
Lowland Moss and Grassland	1	0	0
Modern Communication	3	0	0
Modern Enclosure	32	177	6.5
Modern Industry	3	2	0.6
Modern Military	6	7	1.16
Modern Ornamental	1	1	1.0
Modern Recreation	1	1	1.0
Modern Settlement	23	81	3.52
Modern Woodland	4	0	0
Post-medieval Enclosure	79	295	3.7
Salt Marsh	1	0	0
Sand and Mudflats	2	0	0
Water	3	2	0.6
Total	**278**	**959**	**1.59**

Table 15: HLC landscape types, showing the total and average number of monuments per polygon

HLC Broad Type	Total Number of Polygons	Number of Polygons with no monuments
Ancient and post-medieval Ornamental	10	5
Ancient and post-medieval Settlement	29	9
Ancient and post-medieval Woodland	4	0
Ancient Enclosure	76	29
Lowland Moss and Grassland	1	1
Modern Communication	3	3
Modern Enclosure	32	6
Modern Industry	3	1
Modern Military	6	3
Modern Ornamental	1	0
Modern Recreation	1	1
Modern Settlement	23	12
Modern Woodland	4	4
Post-medieval Enclosure	79	34
Salt Marsh	1	1
Sand and Mudflats	2	2
Water	3	1
Total	**278**	**112**

Table 16: HLC landscape types, showing numbers of polygons containing no monuments

5.5.4 Polygon-based density maps were created for the total count of all monuments, and for the monument count per period for the prehistoric, Roman, and medieval periods. The polygon representing the Ancient and Post-medieval Settlement of

Kirkham (HLC 3276), representing the historic core of the town, was found, not unsurprisingly, to contain the highest density (though not the highest number) of monuments within the study area (Fig 47). The most monuments and most events, however, have been recorded in the polygon defining the 'Modern Settlement' of Kirkham, which represents the modern expansion around the historic core. Rather than assuming that there is some archaeological significance to this high density, it is perhaps more likely to be a result of later building work occurring under development-control conditions, and hence an increased level of archaeological recording, producing larger numbers of monuments within the suburbs.

5.5.5 The polygon with the highest density of prehistoric monuments is that around Whitprick Hill (HLC 2877, Fig 48), whilst that with the highest density of Roman monuments is the historic settlement core of Kirkham (HLC 3276, Fig 49), which has been subject to several archaeological events. The polygon with the highest density of medieval monuments is that representing the core of the village of Little Plumpton (HLC 2914, Fig 50); however, this is a result of the small size of the polygon, comprising only the village core. It has been recorded as a shrunken medieval village (KM0064) and contains a correspondingly large number of individual monuments.

5.5.6 Interestingly, only four polygons (HLC 3271, 2879, 2873, 2918) contain monuments dated to all periods (prehistoric, Roman, and medieval). These are all in the south-western corner of the study area (Fig 51) and form a distinct group of three, with a single outlier. Only two of these contain events, however, and the polygon with the least events contains the highest number of monuments. This highlights a problem, in that events may sometimes be difficult to quantify in relation to monuments. The landscape represented by this polygon saw intensive fieldwalking as part of the North West Wetlands Survey (Middleton *et al* 1995), and as such shows as one event, but this led to multiple finds. It does, however, demonstrate the effectiveness of systematic fieldwalking for artefact recovery.

5.5.7 The polygon representing the modern settlement of Kirkham contains no prehistoric monuments, implying that it was not a settled area before the Roman period. This could have been because the land was not suitable for settlement, which seems unlikely, given that there are monuments for both the town and the surrounding area representing settlement and agricultural activity from the Roman period to the present day (Figs 11, 12, 15). However, alternative explanations include the possibility that the later Roman activity destroyed all traces of prehistoric settlement, or that the archaeological techniques used in the interventions within the polygon concentrated on finding Roman and medieval evidence, and were targeted accordingly; it would therefore have been a matter of chance if prehistoric sites were in the same precise locations as the later Roman and medieval sites.

5.5.8 ***Survivability:*** it was suggested in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a) that in areas of below-ground disturbance, either archaeological intervention would have taken place and uncovered buried monuments, or that no archaeological intervention would have occurred, but the level of disturbance would have destroyed any monuments. The HLC polygons were classified in terms of the amount of disturbance that their landscape type would have caused (Fig 52, *Section 3.7.10*). Modern land uses that require considerable landscaping or excavation were classified as bad, whilst ancient land

use types were considered to have less impact, and were classified as either medium or good (Table 17).

HLC Landscape Type	Disturbance Level	Count of Polygons
Ancient and post-medieval Settlement	Good	29
Ancient and post-medieval Ornamental	Medium	10
Ancient and post-medieval Wood	Good	4
Ancient Enclosure	Good	76
Lowland Moss and Grassland	Medium	1
Modern Communications	Bad	3
Modern Enclosure	Medium	32
Modern Industry	Bad	3
Modern Military	Medium	6
Modern Ornamental	Bad	1
Modern Recreation	Medium	1
Modern Settlement	Bad	23
Modern Woodland	Bad	4
Post-Medieval Enclosure	Good	79
Saltmarsh	Medium	1
Sand and Mudflats	Medium	2
Water	Medium	3

Table 17: HLC landscape types, showing disturbance classification

5.5.9 The levels of disturbance were then combined with the density maps for each period, to create basic maps of archaeological potential for each polygon. This was later combined with the potential for aggregate extraction allocated to each polygon, to create threat maps for the study area (*Section 5.7.1*).

5.6 ANALYSIS AND SPATIAL PATTERNING OF ARCHAEOLOGY

5.6.1 Following on from the initial tests, it was recognised that there was a need to examine the patterns for specific monument types. Large numbers of ponds were identified during the survey, and this category was correspondingly selected for further tests. It was also decided to examine the flint finds further, by separating out the scatters from individual finds. Roman roads and finds were also separated, and the distance of finds from the roads was examined. KS Tests were run again on these new selections and also kernel density calculations were made for:

- 'Prehistoric'- all monuments dated to any prehistoric period irrespective of type;
- 'Flint'- all flint finds, including both individual stray finds and scatters;
- 'Roman'- all monuments dated to the Roman period irrespective of type, but **not** including records referring to Roman roads;
- 'Medieval' - all monuments dated to the medieval period irrespective of type.

5.6.2 Of the many ponds noted both on the current and historic maps, those seen only on LiDAR or historic mapping, but now no longer mapped, were recorded as new

sites. The ponds were combined with the four variables used for initial analysis, and were subjected to KS testing; however, there proved to be no statistical correlation between the landscape variables and these ponds. The largest numbers of ponds were, however, found between heights of 20m and 40m OD and concentrated on areas classed as Diamicton geology, and again this may simply be a reflection of the limited landscape variation across the study area.

5.6.3 There would appear to be a considerable need for drainage within the study area, as a substantial proportion has been reclaimed from former marshes; correspondingly, there are large numbers of watercourses and drains. While the large number of ponds may now be water management features providing water for stock, they are likely to have originally been marl pits. The effect of marling was to reduce the acidity of the soil, and improve the land in a way similar to the practice of putting lime on the fields. The effect of this was to bring buried materials, including finds, from the marl pits and scatter them across the fields.

5.6.4 Scatters of flint finds are concentrated on areas classed as Diamicton, as are the isolated flint finds, and they cluster between 10m and 35m OD. However, there were no statistical correlations between the flint finds or scatters as recorded in the HER, and the four landscape variables. When the proximity of isolated flint finds was compared, to identify whether they were part of clusters (*Section 3.7.17*), they were found to be at least 100m apart, which was considerably greater than any given in the descriptions of known scatters within the HER. While this would suggest that the isolated flints were not components of individual scatters, the existence of a single surface find can be an indicator of a much larger site if excavated (Cowell and Innes 1994).

5.6.5 Records specifically relating to the Roman roads (or parts thereof) were removed from the Roman monument dataset to examine the proximity of other types of Roman monument to the roads (*Section 3.7.14*). Of the remaining 28 Roman monuments, 20 were within 500m of the roads, which would support the supposition that the Roman activity in the study area was, for the most part, related to the known communications network. The eight sites located 500m or more away from the road (Fig 53) included two finds of quernstones, one at Wharles (KM0087) and one near Treales (KM0534). This limited evidence could be suggestive of settlement in the wider area beyond Kirkham and the road leading to it.

5.7 CHARACTERISATION AND INCORPORATION OF GEOMORPHOLOGY

5.7.1 The University of Liverpool provided the finalised geomorphological mapping, which was used as a fifth variable against which the monument selections used in both the initial and the refined stages (*Sections 5.4.2, 5.6.1*) could be combined. The only positive correlation to emerge from this set of KS tests was with flint finds (both scatters and individual finds).

5.7.2 The initial selections with positive correlations (*Section 5.4.3*), and the flint finds from the second round of tests, were then weighted according to the same scoring system used in the Ribble Valley ALSF (OA North and University of Liverpool 2007a), which resulted in a series of maps that were classed as areas of low, medium and high archaeological potential. Each in turn was then added to the raster for ground disturbance that had been created for the HLC enhancement stage;

combined, these resulted in the maps of archaeological potential for each of the monument selections.

5.7.3 ***Flint Potential:*** the correlation between the distribution of flint sites and the geomorphology bears out a simple broad pattern of land use. The geomorphological type 'Moraine Ridge' contains the highest concentration of flints, and statistically is proven to constrain the pattern of flint distribution. This geomorphological type is widespread across the area and therefore it can be concluded that the area has, in general, a high potential for prehistoric flints (Fig 54).

5.7.4 Additionally, there is a distinct spatial relationship between the topography of the study area, and the distribution of all prehistoric monuments. This is, however, not a statistical correlation, but the subjective evidence of coincidence is strong. This pattern shows clearly that within the areas of moraine ridges there are variations in the topography, which create islands of sand and gravel. It is on these islands that the known prehistoric monuments occur, almost without exception (Middleton *et al* 1995, 202). This would seems to suggest that prehistoric activity has been concentrated on the better drained islands; however, it may also reflect a bias of site visibility, in that the lower, poorly drained land often still retains peat cover which has the potential to restrict discovery of finds during fieldwalking (*op cit*, 200).

5.7.5 ***Roman Potential:*** there was no particular correlation between Roman monuments and any specific geomorphological types, and it seems the geomorphology does not specifically constrain the distribution of Roman monuments. The correlation between Roman monuments and the geological type known as 'Devensian Till' is clear (*Section 5.4.4*), and the conditions in which Roman finds occur are widely seen within the study area. It is likely, therefore, that the area generally has a high potential for Roman archaeology (Fig 55).

5.7.6 ***Medieval Potential:*** there was no particular correlation between medieval sites and any specific geomorphological types, and therefore the geomorphology does not specifically constrain the medieval site distribution. The correlation between medieval monuments and geological type known as 'Devensian Till' is again clear (*Section 5.4.4*), and again, such conditions in which medieval finds occur are widely spread across the study area. The area, therefore, generally has a high potential for medieval archaeology (Fig 56).

5.7.7 ***Domestic Potential:*** there was no particular correlation between domestic sites and any specific geomorphological types, largely because diamict covers most of the study area. The correlation between domestic monuments and elevation is again clear (*Section 5.4.3*), providing conditions in which domestic monuments occur widely across the study area. The area generally has a high potential for domestic monuments (Fig 57).

5.7.8 ***Archaeological Threat:*** all four aggregated maps demonstrated that the same areas had the highest coincidence of threat and potential for archaeology. The area of Whitprick Hill and Weeton, and between Singleton and Wesham, represent a large zone of considerable threat, and the threat is also high around the areas of Lea Town, Blackleach and Moorside to the east (Fig 58).

5.8 CONCLUSIONS

5.8.1 Generally, the landscape contains dispersed ancient settlement and relatively regular field systems, which have predominantly come into being through a slow process of marshland reclamation. The KS test results show that the geological, geomorphological and topographical characteristics of the study area have exerted a limited influence on the distribution of archaeological monuments. Slope and aspect had no correlations with any selection of archaeological monuments, although elevation influenced the siting of domestic monuments of all periods, with activity being concentrated on the higher, better-drained ground. The distribution of Roman, medieval and flint finds have been influenced by the form of the geomorphology; where there is coincidence, however, it has been across wide areas, and is largely indicative of the low level of variations within the landscape, rather than being a reliable diagnostic indicator. This again indicates that the moraine ridges have, in general, been the focus of settlement and activity in the Fylde since prehistory.

5.8.2 This concept was first raised by the North West Wetlands Survey, which suggested that the areas adjacent to rivers and coasts offered the best range of resources, both from the rivers and sea, and from the hinterland. Indeed, it was in these areas that most of the prehistoric sites were found (Middleton *et al* 1995). This pattern of sites exists from the Late Mesolithic period and into the Bronze Age, with a preference for well-drained soils on moss edges and the coast *(ibid).* In the current project, the comparison of distribution with topography has provided a statistical support for the findings of the North West Wetlands Survey, clearly demonstrating the coincidence of prehistoric monuments and elevation, showing a distinct pattern of clustering at 25-35m OD and again at 10–15m OD (*Section 5.3.2*) on the moraine ridges.

5.8.3 There are distinct islands of sand and gravel within the moraine ridge, which rise slightly higher than the surrounding landscape. When the elevation is classified with a suitable colour stretch, and exaggerating the topography slightly, the coincidence of prehistoric monument distribution and landform is striking (Fig 59). The sea level fluctuations of the Lytham VI marine transgression, in the later Mesolithic and Neolithic periods (*Section 2.3.6*), inundated much of the low-lying Fylde, and Lytham and Blackpool were likely to have been islands (Tooley 1978). This reduced the extent of potentially habitable land, making the sand islands even more valuable and thus increasing the potential for prehistoric material to be found on them.

5.8.4 There are areas of sand islands in the study area which have as yet yielded no evidence of prehistoric activity (Fig 59), but these must be considered as having considerable potential for prehistoric activity, despite the lack of positive correlation in the statistical analysis.

5.8.5 If the visibility of prehistoric activity is biased, as a result of farming practices bringing finds to the surface, the lack of prehistoric evidence in the areas of reclaimed mosses and wetlands would seem unusual. Not only were these areas subject to ploughing, but poorer quality land required marling, which was primarily to neutralise the acidity of soils (Mathew 1993). The effect of marling was to distribute soil extracted from marl pits and redistribute it across the fields, thereby bringing any buried finds to the surface.

5.8.6 In order to test this theory, a series of buffers were made around the 90 ponds recorded from the OS first edition map (but not shown on the current OS mapping) which were considered to have been former marl pits, but in the event only one flint fell within 100m of any pond. Given these increased levels of disturbance, coupled with a lack of finds, this affords more weight to the potential that the sand islands were preferred areas of prehistoric activity.

5.8.7 There is limited evidence of Roman activity away from Kirkham and the line of the Roman road; however, the lack of finds in the central parts of the study area is striking. It was not until the later medieval and post-medieval periods that the distribution of monuments in the study area significantly changes, and the central parts began to be exploited.

5.8.8 This project has shown that the geomorphology, geology, palaeoenvironmental history, agricultural history, and archaeological survey work undertaken in the study area can be drawn together to demonstrate that the moraine ridges were the principal focus of human activity, and that those sand islands which have not yet yielded archaeological remains represent, in the light of all available evidence to date, the areas of greatest potential for further archaeological discovery.

6 AGGREGATE PROSPECT AND ARCHAEOLOGICAL POTENTIAL

6.1 AGGREGATE PROSPECTS

6.1.1 The Kirkham Moraine has proved to contain workable aggregate reserves across much of the area, and this assessment argues that it is one of the best prospects for the extraction of significant quantities of sand and gravel in Lancashire (*Section 4.2.1*). Equally, it has also been shown that the area has a substantial number of known archaeological monuments, and a considerable potential for, as yet, undiscovered archaeological remains; in particular, there is a high potential for the discovery of new prehistoric monuments. The areas of highest archaeological potential, coupled with those of greatest viable aggregate prospect, have been drawn together and subjected to assessment (*Section 5.8.8*).

6.1.2 The geomorphological mapping has shown that the inter-moraine areas have thick areas of buried sands and gravel within the moraine complex, and that the thickest deposits are within the Skippool and Kirkham outwash channels (*Section 4.2.1*). As such, these areas provide the best prospect for aggregate extraction, represented by Resource Blocks K25, K34, K43, K66 and K68 (Fig 60).

6.1.3 The highest areas of archaeological potential are shown on Figure 61; the largest area is in the western half of the study area, centred on the village of Greenhalgh, and extends south to Kirkham and north to the village of Singleton, covering an area of 15.29km^2. A second area to the east includes the settlements of Swillbrook and Blackleach, and is smaller, at 1.9km^2. The third general area of potential comprises a group of smaller blocks, of which the largest is around Sudell's Farm, at Lea Town (0.8km^2). Two smaller areas are at Bartle Hall (0.25km^2), and around Clock House Farm, on the outskirts of Preston (0.4km^2). In total, 107 known monuments fall within these broad areas of highest potential (Fig 59). When combined with the areas of greatest aggregate potential, these produce a map highlighting the areas of greatest potential impact to the archaeological resource (Fig 61).

6.2 ARCHAEOLOGICAL POTENTIAL

6.2.1 ***The Moraine ridge between Kirkham and Singleton:*** this large area is dominated by resource blocks K66, which is an area of moraine ridge, and also by K68 and K43, which are both sandur flats (Fig 60). These overlap the largest area of overall archaeological potential, around Whitprick Hill and south of Weeton (*Section 5.7.9*, Table 18). Within these Resource Blocks are 108 known monuments, representing all periods, which include 12 of the 17 NMR broad classes that are represented within the study area. Some 49 are post-medieval sites within the area, which are considered to be of less concern for future management, as any resource of this period is more likely to be visible, and therefore can be addressed reasonably easily as part of the planning process.

Period	Number of Monuments
Prehistoric	11
Bronze Age	5
Roman	2
Medieval	17
Post-medieval	49
Unassigned	24

Table 18: Monuments contained within Resource Blocks K66, K68 and K43, by period

6.2.2 ***Prehistoric Sites:*** the known prehistoric sites under threat from extraction (KM0525-KM0531, KM0541, KM0551, KM0556 and KM0606) represent both individual flint finds and scatters, and are seen as being the most diagnostic indicator of prehistoric occupation / settlement in the absence of structural remains (Middleton *et al* 1995). The exception to this type of site is KM0606, which is a putative cairn in the field immediately north of Derby Hill Farm (Fig 60).

6.2.3 The five Bronze Age monuments (KM0002-KM0006) within the K66 resource block (Fig 60) represent 50% of the total number of Bronze Age monuments within the entire study area. All are funerary remains, and all were reported by antiquarians, either exposed by ploughing or stone was robbed from cairns, resulting in the discovery of cinerary urns. Of particular interest to this project is that at least one of the monuments was discovered during gravel extraction (KM0005), between Derby Hill Farm and Westby Wood, around 700m west of Whitprick Hill. When combined with the flint evidence, this area, south of the current M55 in the southern half of the K66 Resource Block, contains the strongest evidence for prehistoric activity. Given the number of sites discovered either by chance or fieldwalking, there is considerable potential for further discovery of flint artefacts and funerary structures that have been disturbed or hidden by later activity. The distribution of known monuments suggests that this area was a focus of activity during the prehistoric period, particularly since in the North West individual finds should be taken as potential indicators of larger, but buried, sites within the immediate environs (*Section 5.6.4;* Cowell and Innes 1994). Prehistoric activity in the area of Whitprick Hill is indicated by the presence of mortuary structures, although the evidence for settlements is as yet elusive. This is, perhaps, not surprising, as it is known that prehistoric communities typically endowed structures for the dead with more permanency than those of the living (Parker Pearson 1999); the physical remains of settlement are therefore expected to be less durable and less likely to survive in the archaeological record, without careful excavation. The concentrations of prehistoric remains in the Whitprick Hill area must, however, be treated as a reasonable indicator of further buried prehistoric remains.

6.2.4 ***Roman Sites:*** only two Roman monuments would be directly affected by any extraction in these resource blocks: KM0008, a findspot of a glass bead; and KM0022, a findspot of a metal 'Medal' (Fig 60). These were both discovered in the field to the south of the village of Weeton, *c*110m east of Knowsley Crescent. The findspots are 750m east of the projected line of the Roman road, and, given this line is not certain, there is little possibility that they reflect casual losses from traffic.

They should therefore be regarded as being potential indicators of Roman occupation or activity within in the Weeton area.

6.2.5 The finds themselves were in close proximity to modern residential housing, and, while they may potentially be threatened by any expansion of that settlement, the presence of the housing will serve to discourage mineral extraction. As such, these sites would not appear to be under great threat within the context of the present study. It must, however, be noted that any extraction within this Resource Block may impact upon the remains of the Roman road, should this indeed exist, as it is projected to pass within 150m of K66.

6.2.6 ***Medieval Sites:*** there are 17 medieval monuments within these Resource Blocks (Fig 60; KM0001, KM0009, KM017, KM0034, KM0068, KM0069, KM0170, KM0319, KM0523, KM0548, KM0549, KM0550, KM0557, KM0558, KM0698, KM0742). Two were finds of horseshoes which have been attributed a medieval date by the HER (KM0001 and KM0009), but monuments KM0017 and KM0550 are both related to a moated site shown on the OS current map, although the latter refers to an area of ridge and furrow within the moated area. Bradkirk Hall (KM0034) is an occupied standing building and as such is unlikely to be under direct threat from mineral extraction. There is also a possible moat (KM0319) at Bradkirk Hall, as evidenced by earthworks to the north and south, but given the proximity to the hall, these features are unlikely to be under direct threat.

6.2.7 A cruck barn at Weeton (KM0742) stands at the entrance to a horticultural nursery and is in the centre of the village; again, this means that it is not under direct threat. Within the areas of Greenhalgh and Medlar (Fig 60), the most significant threat from extraction is posed to the potential Deserted Medieval Villages (DMV) (KM0068 and KM0069). The fields around these sites have largely been unaltered since the OS first edition map (1844-52), and there is still considerable potential for the buried remains from these, which would include field systems / earthworks, building foundations, and associated finds. Any surviving medieval fabric within the buildings of Weeton are not likely to be under direct threat from mineral extraction, as they stand within a residential area. The outlying fields which are classified within the HLC as 'Ancient Enclosure', are, however, more likely to be under threat.

6.2.8 ***Unassigned Sites:*** in addition to the dated monuments, there are 24 others within the Resource Blocks that have not been assigned a date by the HER; five of these are watercourses and/or palaeochannels (KM0134, KM0136, KM0138, KM0156, and KM0607) and may have potential to contain palaeoenvironmental remains. A further 11 monuments (KM0096 KM0110, KM0148, KM0149, KM0150, KM0151, KM0159, KM0169, KM0285, KM0297 and KM0511) are sites identified from aerial photography, either as cropmarks or earthworks. There is also a section of trackway (KM0283), two earthworks (KM0175, KM0934), two ponds (KM0819, KM0961), two putative moats (KM00179, KM0609) and a field system (KM0284). These are all potentially significant and would require further investigation should a threat from extraction be realised.

6.2.9 ***Swillbrook sandur flat:*** this flat has a good extraction prospect, located some 4km east of Kirkham, and comprises Resource Block K34. It contains 19 known monuments, comprising one prehistoric, three medieval, nine post-medieval, and six unassigned monuments. A single prehistoric flint was found on the south side of the road at Pepper Hill (KM0559), while three medieval monuments, in the same

area, comprise a milestone (KM0726) on 'Six Mile Bridge' (Salwick Bridge Farm), and two areas of ridge and furrow (KM0560 and KM0561) to the north-east of Pinfold Farm, Salwick. The unassigned monuments comprise four sites that have been identified from aerial photography as cropmarks and earthworks. The remaining two unassigned sites are earthworks. KM0287, to the west of Swillbrook Lodge, is a rectilinear earthwork, cut by ridge and furrow. KM0933 is an oval earthwork to the east of Swillbrook Bridge. No interpretation has been made of these features, and they would clearly require further investigation prior to any extraction.

6.2.10 ***Lea Town Sandur Flat:*** the Lea Town area is a sandur flat located north of Clifton, on the western urban fringe of Preston (Resource Block K25). This contains 26 monuments, comprising one Roman, four medieval, 20 post-medieval, and one unassigned site. The line of the Roman road is perhaps indicated by a hollow way (KM0363), although this is over 500m from the projected line of the Roman road ('classed as certain') in the Lancashire HER (Fig 62). A crucifix was found in a field east of the town, and north of what is now the Millennium Ribble Link (KM0088), and a cross base stands near the roundabout at Clock House Farm, Cottam. In the residential area of Lea Town is a further cross base (KM0658), and on its southern outskirts is a standing farmhouse (KM0677); both are unlikely to be affected by extraction, being close to residential areas. Overall, the main threat from any extraction in the area would be to the route of the Roman road, and by association, any contemporary roadside structures.

7 RECOMMENDATIONS

7.1 INTRODUCTION

7.1.1 ***Resource Blocks:*** the prime Resource Blocks for future sand and gravel mineral aggregate extraction in the study area are zones of pro-glacial and ice-marginal sandur within the Kirkham Moraine. There are substantial thicknesses of sand and gravel, and well-sorted sands, in particular, within the areas of the moraine. However, the ice-marginal oscillations complicate the stratigraphy and in places surface diamicton overburden is sufficiently thick to preclude extraction. Nevertheless, in the inter-moraine ridge zones, and on the flanks of some ridges, the thickness of sand deposits is large, and the quantity of mineral is extremely large. In terms of extraction, Resource Blocks within the Kirkham Moraine make considerably more economic sense than the small, and environmentally problematic, river-side permissions in the Lower Ribble Valley (OA North and University of Liverpool 2007a). The dating for the Kirkham Moraine is generally uncertain, but it is clearly of late Devensian age, post-dating the advance to the last glacial maximum (LGM) limits near Wolverhampton, 30-22 ka (30,000-22,000bp) (Longworth 1985). In terms of ice source area, the Kirkham ridge is an ice-marginal feature produced by ice issuing from east and central Cumbria, and reflects a fairly substantial marginal position of that ice-stream during the retreat from the LGM position. Interplay between the Eastern Lake District (ELD) ice-stream and the main eastern Irish Sea (EIS) ice-stream, extending southwards from Scotland through the Cheshire lowlands to the English Midlands, may also be responsible for the shape and form of the Kirkham Moraine.

7.1.2 In the instance of any extraction of glacial deposits in the Kirkham Moraine, any potential archaeological remains will overlie the target mineral. The present assessment of archaeological potential should therefore inform the strategies employed by the extractive industries at the planning and development stage. This information also provides a framework for the mitigation and monitoring programme necessary to characterise and record the archaeological and geological heritage in advance of mineral extraction.

7.1.3 ***Archaeological Potential:*** the archaeological study has demonstrated that there is a significant archaeological resource within the prime Resource Blocks. In particular, the K66 Resource Block, in the western part of the study area, has considerable potential for prehistoric remains, in the form of both flint scatters and Bronze Age funerary remains. Previous investigations as part of the North West Wetlands Survey in Merseyside (Cowell and Innes 1994) have demonstrated that very small surface scatters (of only two or three flints) can be an indicator of considerably larger scatters, which would potentially indicate prehistoric activity centres. On this basis, there is considerable potential for buried, and as yet undiscovered, archaeological remains. The distribution of monuments would indeed appear to reinforce the supposition, postulated during the North West Wetlands Survey of North Lancashire (Middleton *et al* 1995), that prehistoric activity was concentrated on the sand islands around and within the wetlands of the Fylde. This potential therefore inevitably coincides with the areas of sand and gravel resource that may be selected for future mineral extraction, and there is clearly a need for more

detailed archaeological investigation in advance of establishing new sand and gravel works.

7.1.4 Resource Blocks K25 and K34 are at the eastern margins of the study area, and have a reduced potential for prehistoric and medieval remains by comparison with K66, but nevertheless have considerable potential for post-medieval remains. These later monuments are more likely to be visible on the surface and, because they are known sites, they can be more easily addressed by the planning process when establishing new mineral extraction sites.

7.2 FURTHER WORK ON THE SAND AND GRAVEL RESOURCES

7.2.1 The Regional Aggregate Working Party (North West Region) reports (RAWP 1999-2006) show that regional and individual Authority landbank levels across the region are generally well above the guideline levels in MPG6 (DoE 1994). This healthy landbank has been achieved largely through the success of MPG6's policy framework in delivering an adequate supply, and partly because of a downturn in annual production between 2002 and 2006, thereby enhancing reserves.

7.2.2 The North West, though, displays marked imbalances in the quantities available and the usage of crushed rock, and sand and gravel mineral aggregates between the constituent counties (Table 19). In terms of sand and gravel, both Cumbria and Cheshire possess extensive permitted reserves, whereas for Lancashire the landbank is much smaller. A result of this is that there has been investment by Lancashire County Council in several recent sand and gravel surveys. In addition, it has been a motivating factor behind both the present study and previous ALSF-funded projects commissioned and supported by English Heritage in the last few years (OA North and University of Liverpool 2007a). In these projects, two key aggregate provinces have received re-evaluation – the Ribble Valley, with one extant and one restored workings, and the Kirkham Moraine, with one exhausted and two restored workings. This report focuses on the Kirkham area, but the findings must be considered in the context of the wider resource within Lancashire and the North West RAWP.

	Rock Landbank (years)	**Sand/gravel Landbank (years)**	**Permitted reserves (million tonnes) 2005**		**Sales 2005 (million tonnes)**	
			Rock	**Sand and Gravel**	**Rock**	**Sand and Gravel**
Cumbria	38.2	13.1	157	9.18	3.7	0.7
Lancashire	25.0	8.8	115	4.4	3.7	0.38
Cheshire	41.5	10.42	5.4	20.53	0.03	1.58
Metropolitan	14.36	34.3	23.69	8.91	1.2	0.4
Total			300	43.02	8.63	3.06

Table 19: Mineral aggregate statistics from the 2005-6 RAWP report issued in 2007 (RAWP 2006)

7.2.3 Geomorphological interpretation, alongside the available borehole and section evidence, has improved our understanding of the distribution of mineral within the moraine complex. Clearly, the Kirkham Moraine is an area that contains

considerable quantities of mineral aggregate. In terms of sand and gravel mineral aggregates, little future research is needed on the potential of the glacial landforms of the Kirkham Moraine. The aggregate inventory (*Section 4.2*) improves our understanding of the distribution of sand and gravel reserves, and will be of benefit to the extractive industries. In addition, the improved understanding of the deglacial history of the area (*Section 4.1*) should be used to inform future sand and gravel investigation within the wider county. However, prior to any proposed extraction, a comprehensive survey should be undertaken to confirm the aggregate resource in any particular locale.

7.2.4 ***Leyland / Chorley Area:*** elsewhere in lowland Lancashire, the evaluation of the deglacial history has highlighted other areas that may also have potential for sand and gravel mineral. The first of these was identified in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a), to the south of the Ribble. It comprises a large fan-shaped landform that extends out from the area of the Ribble Valley (Fig 63). There is currently mineral extraction within this area, near Leyland, and the Geoplan Ltd (2006) report shows that mineral is present, but 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.

7.2.5 ***The Lune and Wyre Valleys:*** further north in Lancashire, potential resources of sand and gravel mineral are associated with the fluvial deposits of the Wyre and Lune systems, and the flanking glacial terrain. In these systems, as in the Ribble Valley, the older river terraces date to the deglacial period and early Holocene, and are potential sources of mineral aggregate. The Wyre and environs encompasses five areas of search utilised in the recent sand and gravel surveys produced for Lancashire County Council (LCC) (Geoplan Ltd 2006; Allot and Lomax 1990). In the last 100 years, there have been three sand and gravel pits within the Wyre area. The lower Lune and Keer have attracted no attention in the studies by LCC, but have considerable potential in terms of the resource, owing to substantial river terraces and associated deposits. The Keer in particular has sustained two sand and gravel workings in recent years, which are now dormant or restored. The lower Lune and Keer are, however, heavily constrained, being surrounded by the Lake District and Yorkshire Dales National Parks, and the Forest of Bowland and Arnside and Silverdale AONBs; indeed, part of the highlighted tract is AONB fringe (Fig 63).

7.2.6 ***Cumbria:*** in the wider North West RAWP region, zones of aggregate extraction in Cumbria are under some pressure and the County Council is keen to extend extraction into new areas. The pattern of aggregate extraction has focused upon the glacial deposits in a lowland belt extending along the Solway / northern part of the West coast and then across lowland Cumbria. These were lain down during deglaciation from the late glacial maximum of the last ice age (Devensian), and reflect the pattern of decoupling of an active ice-margin between Scottish ice and Lake District ice, together with locally passive ice wastage during the latter stages of deglaciation (Huddart 1994). As such, this belt forms a coherent area for assessing the deglacial geomorphology, geology, palaeoenvironments and chronology, which will help improve an understanding of both the glacial heritage and the aggregate potential. This area incorporates both the Brampton kames and

the Abbeytown ridge, which would be key sites for extraction, but which also have considerable archaeological potential (*Section 7.4.15*). The river systems of Cumbria have also been utilised for aggregate extraction, but, compared to other rivers in northern England, such as the Ribble, Wear, North and South Tyne, Tees, Swale, Ure and Wharf, there has been relatively little research on the lowland alluvial geomorphology of Cumbria. This gap is unfortunate, because Holocene river terraces are an important archive of climatic and human history. The fluvial deposits of the Eden drainage basin form a coherent area for assessment of the aggregate potential, the research for which would address geomorphology, geology, environmental history and archaeology.

7.2.7 ***Craven District, North Yorkshire:*** the Craven District has been highlighted as an area of concern (OA North and University of Liverpool 2007a) and remains an area requiring further investigation as part of the overall ALSF programme. In the course of the earlier study (*ibid*), it became evident, following consultation with the North Yorkshire County Council Minerals Officer (Chris Jarvis), that the *Minerals Plan* for North Yorkshire County Council (NYCC 1997) included an area of search for aggregates that needed further investigation beyond the remit of that study. This reflected the fact that, in Craven District and the Yorkshire Dales National Park, the main source of aggregate is limestone rather than the soft geology. At present, the worked sources of aggregate are all limestone quarries within the Yorkshire Dales National Park, but it is North Yorkshire County Council's and the Yorkshire Dales National Park Authority's policy to discourage further extraction within these. Any applications for new quarries or extensions to existing quarries within the National Park will therefore be rejected. There is a need for extended research to include all areas of potential aggregate extraction, including hard rock geology resources, and this was the subject of a variation proposal during the Ribble Valley ALSF project (OA North and University of Liverpool 2007a) and a further proposal following completion of the project (OA North and University of Liverpool 2007c). In the event, the funding for a variation was not available in 2006/7 or 2007/8.

7.3 FUTURE ENVIRONMENTAL AND GEOMORPHOLOGICAL RESEARCH

7.3.1 ***Glacial and deglacial heritage of lowland Lancashire:*** the landscape of Lancashire reflects the cumulative impacts of overriding ice, with the subsequent retreat clearly punctuated by the repeated oscillation of the ice margin, and possibly a substantial ice advance episode associated with the Kirkham Moraine complex, which is the most substantial glacigenic landform in lowland Lancashire. During deglaciation, there was a period when the decoupling of different ice-streams produced ice-free conditions in the Lower Ribble, Loud and Hodder valleys, with an extensive ice-dammed lake to the east of Preston, fed by waters draining from the retreating Ribble glacier. The work undertaken in this project has produced detailed information on the deglacial history of lowland Lancashire, providing research of some significance, given the current academic focus on ice-stream behaviour during deglaciation from the last glacial episode, and in particular the interplay between Eastern Lake District (ELD), Eastern Irish Sea (EIS) and Ribble ice-streams. The current work highlights two key avenues for further research.

7.3.2 ***Late glacial palaeoenvironmental change*:** the morphology of the Kirkham Moraine comprises ridges, inter-moraine sandur and depressions that are former kettlehole basins. Kettleholes form as the margins of glaciers retreated, leaving

stagnant blocks of dead-ice within moraine ridges or buried by outwash sediment. Eventually, these dead-ice blocks melt and the ground collapses, leaving water-filled hollows called kettleholes. These are common features of the ice disintegration topography of the Kirkham Moraine. These kettlehole basins have attracted little attention from palaeoecologists, but, as the volume of research undertaken at Haweswater in the Silverdale area of north Lancashire (Marshall *et al* 2002) shows, they are of tremendous palaeoclimatic and palaeoenvironmental significance. At Haweswater, the oxygen isotope, pollen, and Chironomid techniques, amongst others, have been used to reconstruct the climate and environmental history for the last 15,000 years.

7.3.3 ***The deglacial chronology in lowland Lancashire:*** whilst the geomorphology and sedimentology of lowland Lancashire has become increasingly well resolved, there is no information about the timing of this sequence of events. The broad sequence shows that the Bowland Fells became ice-free relatively early, and the Ribble glacier, with its reduced source areas, was in a state of retreat, whilst the EIS and ELD ice-streams were still in comparatively advanced positions. The Kirkham Moraine is either a marginal position for the ELD ice-stream after the drainage of Lake Ribble, or a moraine marking the join between the two ice-streams. Our understanding of the timing of events is entirely underpinned by linking the retreat sequence to major ice-advance episodes, whereas a comprehensive programme of geochronological research is needed. Obtaining chronology for former ice-front positions is challenging, due to the scarcity of organic remains within glacigenic sediments, and thus radiocarbon dating has only limited applicability.

7.3.4 Optical Stimulated Luminescence (OSL) techniques circumvent this problem, in that the target quartz grains are readily available. OSL dating of glaciofluvial deposits in the British Isles has proven problematic, however, as a result of heterogeneous bleaching during glaciofluvial transport, and poor quartz luminescence properties. Recent advances in optical dating, such as the Single-Aliquot Regenerative-dose (SAR) protocol (Murray and Wintle 2000), the ability to use very small aliquots (~30 quartz grains), and the use of statistical models such as the Minimum Age Model (MAM) (Galbraith and Laslett 1993), enable the equivalent dose (De) to be calculated based on a positively skewed distribution, and has allowed the earlier problems to be overcome. Researchers at the University of Liverpool have generated results from former ice-marginal sandar at Orrisdale, Isle of Man (Thomas *et al* 2004), Wexford, south-east Ireland (Thomas and Kerr 1987) and Nefyn, north-west Wales (Thomas and Chiverrell 2007). This is the first time that a direct OSL chronology has been applied to sediments deposited as a result of the retreat of the Irish Sea Ice-Stream (ISIS). The optical ages of these sediments show a retreat sequence of the Irish Sea Ice-Stream ranging from the oldest samples from Wexford in the south of Ireland, coincident with a retreat from the LGM advance *c*21-26 ka (21,000 - 26,000bp), to the youngest samples from Orrisdale, thought to be broadly equivalent to the Heinrich Event 1 re-advance *c*15-17 ka, which produced dates of 13-17 ka.

7.3.5 Contrary to previous attempts to age quartz in northern Britain, this research has been successful. Each site has been dated and an age obtained, so overcoming the problems of poor quartz luminescence characteristics and heterogeneous bleaching that often plagues glaciofluvial sediments. The reasons for these successful applications of OSL, in contrast to the situation during the Ribble Valley ALSF

project dating (OA North and University of Liverpool 2007a), is that a protocol has been developed for ascertaining likely success of OSL determination prior to lengthy and expensive analyses. The approach also targeted sites dominated by Permo-Triassic sandstone source areas and selected lithofacies subject to maximum sub-aerial exposure of the quartz during deposition. A significantly greater number of aliquots are analysed under this approach, and the greater volume of data appears to overcome problems of poor bleaching.

7.3.6 In parallel to further OSL research, more precision as to the timing of deglaciation in the British Isles is being secured by cosmogenic dating of rock-scour, transported boulders, and sediments. For this to be successful, the age since the last exposure of materials (erosion) is calculated by analysing the cosmogenic ^{10}Be and ^{36}Cl accumulation to determine exposure age. This approach has some potential for securing the deglacial chronology in Lancashire, by targeting glacially scoured bedrock and surface boulders, though admittedly both of these need careful analysis to be certain of the erosion history, and analysis of surface sediments. The use of these cosmogenic isotopes will be able to improve our knowledge of the history of deglaciation in the British Isles.

7.4 ARCHAEOLOGICAL INVESTIGATION

7.4.1 The present project has highlighted the degree to which known archaeological monuments coincided with the most economically exploitable reserves of aggregate, and has also demonstrated that selective areas have a high potential for significant buried archaeological remains. In particular, there is considerable potential for prehistoric remains on the well-drained sand islands of the western Resource Blocks (K43 and K66, Fig 61) which were favoured occupation / activity areas during these periods. As such, the project has provided valuable information that could be used to target future aggregate exploitation away from significant archaeological resources and has also considered the methodologies needed to assess the archaeological impact accurately in any particular area.

7.4.2 The project has also highlighted areas beyond the limited extent of the Kirkham Moraine study area, such as the Lune / Wyre Valleys and the Craven Gap, where there are economically viable sources of aggregate, and there is thus a need both to explore the potential of these reserves and to investigate the archaeological resource that may suffer adverse impact should the reserves be exploited.

7.4.3 ***Further Investigation within the context of the Regional Research Agenda:*** the *North West Archaeological Research Framework* (Brennand 2007) has identified a series of *lacunae* in archaeological knowledge within the North West. In particular, archaeological knowledge in Lancashire is perceived to be weak, for particular periods and for particular themes and subjects. Any future work within the county will have the potential to address many current research issues, and allow the formulation of appropriate mitigation strategies and methodologies. The Kirkham Moraine is an area of well-drained, good agricultural land surrounded by poorly drained bogland. As such, it has provided a focus for settlement and activity from the Mesolithic period through to the present. Prehistoric remains abound on its sand islands and the southern side of the morainal ridge has provided an arterial east/west communication route, established to serve the Roman fort at Kirkham, and has subsequently linked medieval settlements that exploited the same terrain.

The archaeological deposits on, and adjacent to, the moraine have the potential to contain evidence for multi-period episodes of occupation and landscape change, with significant potential for organic and palaeoenvironmental preservation.

7.4.4 The deposits within the Kirkham Moraine, and indeed, across north Lancashire, contain a significant palaeoenvironmental resource, especially for later prehistory and the historic period, where it has been widely acknowledged that 'considerable further work needs to be undertaken on environmental analyses, especially on lowland and later deposits that have not been truncated' (Chitty and Brennand 2007, 22). Analyses could build on the work of the North West Wetlands survey programme and examine the palynological relationship between lowland wetlands and the nearby better drained morainal landscape. Kettleholes have considerable environmental potential, not only from a geomorphological perspective (*Section 7.3.2*) but also from an archaeological one, and should be considered a priority for examining the impact of early man, climate change and sea level change (Hodgson and Brennand 2007, 35). In particular, kettleholes can provide extended palaeoenvironmental sequences that date back to the early Holocene, and as such have the potential to provide an important insight into man's earliest exploitation of the landscape.

7.4.5 ***Prehistory:*** period-specific studies have the potential to address the apparent changes in the type of evidence between Cumbria and Cheshire, for both prehistoric and historic periods. In particular, knowledge of Neolithic and Bronze Age religious / burial practices is predominantly reflected in monumental construction, which is not as evident in Lancashire as those areas to the north and south (Hodgson and Brennand 2007). Within Resource Block K66, a significant number of lowland Bronze Age burial monuments have been discovered, although they are only known from antiquarian reports. These appear to correspond to the form of 'flat cemeteries'; which have little or no above ground expression and is a class of monument that has seen little modern-day investigation, but which would undoubtedly warrant it (*op cit*, 45).

7.4.6 ***Roman Period:*** an improved understanding of the system of communications between sites at Walton-le-Dale, Kirkham, Ribchester, and Lancaster on the Lune, would have far-reaching implications for the study of military traffic, trade, taxation and policing. In particular, the extent and character of the Roman presence within the Fylde is still very uncertain. The elusive *Portus Setantiorum*, reported by Ptolemy (Berggren and Jones 2000) is purported by some to be in the Fylde (eg Dixon 1949), and a road between the area and the fort at Kirkham has been conjectured (Margary 1957), but not confirmed. The reality is that the existence of a western port, and associated infrastructure and communications in the Fylde, are uncertain, and the wider aspects have been highlighted as warranting further research (Philpott and Brennand 2007, 71).

7.4.7 ***Early Medieval and Medieval Periods:*** during the early medieval period, the Ribble and the Wyre estuaries would have provided access between the study area and the Irish Sea, then a busy and vibrant artery of communications for the western seaboard of Britain, Ireland and beyond; the potential significance of this marine routeway is highlighted by the discovery of the Cuerdale hoard beside the Ribble, to the east of the present study area. Added to this, the Ribble may once have operated as the southern boundary of the kingdom of Northumbria, with both differing styles of

stone sculpture and language or dialect on either side of the river (Newman and Brennand 2007).

7.4.8 The early medieval occupation of the Kirkham Moraine is still uncertain; while Kirkham seems to have existed in some form by the seventh century (Singleton 1980), the potential for continued occupation in the area from the Roman period can only be conjectured. Continuity of occupation, if only as a favoured place, is an aspect that has been highlighted as warranting further investigation (Newman and Brennand 2007).

7.4.9 The origins and growth of the medieval market towns of Kirkham, Freckleton and Clifton during the medieval period are key to the development of the Fylde; however, there are considerable uncertainties as to the relationships between the origins of the market places and the towns, and the corresponding relationship between the towns and surrounding settlement (Newman and Newman 2007). In particular, the present project has highlighted that there are uncertainties surrounding the extent and character of medieval rural settlement away from the southern part of the study area, and also as to the broad date at which there was an expansion onto the poorer drained lands to the north of the moraine.

7.4.10 ***Other Areas of Potential Extraction - Chorley and Leyland:*** there is a significant prehistoric resource within the area south of the Ribble, which includes scatters of Mesolithic flints, located during the North West Wetlands Survey (Middleton *et al* forthcoming), along the boulder clay ridge extending from Hesketh Bank to Banks, and burial evidence from Astley Hall, Chorley and Winter Hill (Howard-Davis 1996). Roman activity is reflected in a Roman coin hoard from Chorley (Hallam 1980) and the line of a possible Roman road that crosses the area at Bamber Bridge (Graystone 1996). Moated sites at Broughton, Clayton-le-Woods and Farington testify to activity in the medieval period (LUAU 2000). The general character of the resource is that the area has been occupied from an early period and that there is potentially far more evidence to recover.

7.4.11 ***Lower Lune Valley (Fig 63):*** prehistoric activity has been recorded within the Lune Valley, indicated by Neolithic pottery found in Lancaster (Shotter and White 1990), flints found on the river terraces at Caton and Halton (Williams 1998; OA North 2006), and the possible Iron Age sites at Eller Beck, Kirkby Lonsdale and Castle Hill, Leck (Haselgrove 1996). The Lune Valley served as a garrisoned communications artery in the Roman period, represented by the line of forts from Lancaster, through Burrow in Lonsdale, and Low Borrowbridge to Brougham. The presence of a road along both the north and south banks of the Lune, to connect Lancaster to Nether Burrow, has also been postulated (Lancashire HER).

7.4.12 A line of medieval castles was built along the River Lune, which would appear to have formed the border between Norman England and the politically unstable lands to the north, at least for a short period (Higham 1991). These survive at Lancaster, Halton, Arkholme, Whittington, Kirkby Lonsdale, Melling and Hornby. Indeed, this valley has the greatest density of Norman castles outside of the Welsh border (Ede and Darlington 2002).

7.4.13 ***Wyre Valley:*** the area of Over Wyre has a good potential for prehistoric archaeology, with sites such as St Michael-on-Wyre and Rawcliffe Moss, which have revealed significant Neolithic and Mesolithic flint assemblages, and Winmarleigh Moss has yielded prehistoric metalwork. In addition, human remains

have been recovered from Pilling Moss and from close to Poulton (Middleton *et al* 1995; Wells and Hodgkinson 2001). There is also evidence of Roman activity in the form of a putative Roman settlement at Poplar Grove Farm, on the edge of Rawcliffe Moss (A Plummer pers comm), and the Roman road from Preston to Lancaster runs through this area (Graystone 1996). A burial within a supposedly Bronze Age tumulus at Claughton Hall has revealed several weapons and a pair of 'tortoise' brooches, which are of Scandinavian origin, clearly from a secondary burial (Edwards 1998).

7.4.14 ***River Keer:*** the Carnforth Levels, west of the River Keer, are a perimarine zone – a belt of land lying between the tidal flat and lagoonal zone to seaward and the rising till surfaces to landward, which was directly affected by marine transgressions (Tooley 1978, 142). The area contains prehistoric remains, such as a barrow and a possible stone circle near Yealand Conyers (North and Spence 1936), and flint scatters and stone and bronze implements from a limestone quarry at Webber (OA North 2003). At Manor Farm, Borwick, a Bronze Age cairn was excavated in 1982, which contained two primary inhumation burials, with associated high-status metalwork (Olivier 1987). The area is noted for having one of the larger Iron Age promontory hillforts within the region at Warton Crag (Hodgson and Brennand 2006).

7.4.15 At Tewitfield Farm, the 'Carnforth Viking Treasure' (White 1999) was discovered by two local metal detectorists, comprising two silver ingots, two bracelet fragments and three Kufic dirhems (coins). This is remarkably similar in character to material from the Cuerdale hoard (White 1999) which has been dated to AD 905 (Archibald 1992). Overall, the area has a rich archaeological resource, which is in need of further systematic investigation.

7.4.16 ***North Cumbria (north-west coastal plain and Eden Valley):*** the areas that seemingly have the greatest potential in Cumbria to contain aggregate suitable for extraction, the north-western coastal plain and the Eden Valley, also have a considerable potential for archaeological remains. The North Cumbrian coastal plain has been settled since at least the Mesolithic period, and settlements such as Ewanrigg and Plasketlands (Bewley 1994), identified from aerial photography, have been found to have a long development history through the later prehistoric period. The defensive system beyond Hadrian's Wall extends along the Solway coast to at least Maryport (Breeze 2006), and there is considerable Roman infrastructure associated with the frontier zone (Shotter 2004).

7.4.17 The Eden Valley contains some of the more significant prehistoric monuments of Cumbria, such as Long Meg and her Daughters stone circle, and the King Arthur's Round Table and Mayburgh henge monuments (Higham 1986). Some of the highest grade agricultural land in Cumbria is in the Eden Valley, and as such the valley bottom land has been extensively farmed, obscuring and degrading the remains of earlier activity. Significantly, most of the significant prehistoric remains surviving on the surface are on the marginal lands just above the valley bottom, suggesting that the archaeological resource within the valley is as rich, but buried.

7.4.18 The Eden Valley was followed by the major arterial Roman road linking Carlisle and York, which utilised one of the few, but very well travelled, natural crossings of the Pennines over Stainmore (Margary 1973). Such a route would have attracted settlement, and also military infrastructure from the Roman and subsequent periods. The Eden Valley was within a very disputed border region for much of the early

medieval and medieval periods, and a major defensive line extends down the valley, including the castles of Bewcastle, Naworth, Appleby, Brougham, Brough, Hartley, and Pendragon (Jackson 1990). Given the considerable and ancient activity within the valley, the area has a correspondingly high archaeological potential.

7.4.19 ***Craven District, North Yorkshire:*** the Craven area in North Yorkshire has also been highlighted as an area suitable for the extraction of hard rock aggregate (*Section 7.2.7*). This area is rich in palaeoenvironmental and archaeological remains (Bartley *et al* 1990) and is a candidate for combined geomorphological and archaeological investigation similar to that undertaken on the Kirkham Moraine. It is therefore recommended that when any permission is sought for extraction, it should be accompanied by a programme of investigation.

7.4.20 ***Mitigation Strategy*****:** a programme of archaeological investigation would be needed to characterise and map these areas using a GIS, the County's Historic Environment Record, in relation to areas of past, present and potentially future extraction of sand and gravel. Through this mechanism, the County's capacity to manage the impact of aggregate extraction on the historic environment would be improved. Such work should include:

- the validation and enhancement of the HER in relation to areas of sand and gravel extraction;
- enhancement of an understanding of the palaeoenvironment in areas that are likely to be affected by aggregate working;
- definition of the threat to geoarchaeology and historic landscapes and the modelling of risk from aggregate extraction;
- use of the baseline data to map the historic environment's sensitivity to change from aggregate extraction.

7.4.21 The methodology employed to achieve such outcomes should largely follow that developed in the Ribble Valley ALSF project (OA North and University of Liverpool 2007a, *section 3*) and refined in the present project (*Section 3*), as this has proven to be a cost-effective way of collating and analysing data. GIS techniques are clearly integral to any such strategy, allowing the integration and analysis of a wide spectrum of data sources (documents, maps, HER, aerial photographs, LiDAR and limited ground-truthing). HLC enhancement should also result, where available, in providing a management tool for future planning.

7.4.22 This project has highlighted the success of a combined qualitative and statistical approach to analysing the data, and it is recommended that this approach be followed in any future projects. As in this project, the analysis should concentrate on the more sensitive, fragile and less-visible monuments rather than extant, robust, well-documented sites. In actuality, this would mean concentrating less on post-medieval sites, that are much more likely to be known and visible, and more on sites of earlier periods; however, it is anticipated that the exact nature of the analysis would only be decided after an initial assessment of the known archaeological resource had been undertaken.

7.5 MANAGEMENT RECOMMENDATIONS

7.5.1 If the areas highlighted by the present study within the Kirkham Moraine (*Section 6*) should be subject to aggregate extraction, it is clear that the potential for disturbance of archaeological remains would be substantial, and that a programme of archaeological investigation would be required to establish the character of the resource and the extent to which it would be impacted on by extraction. A programme of test-pits and field assessment should be undertaken that could operate in parallel with pre-extraction testing undertaken by the aggregate company. However, while this would determine the character and depth of any deposits, it would not provide a comprehensive assessment of any archaeological remains at this stage.

7.5.2 A further programme of archaeological evaluation should be undertaken prior to the application of planning permission, and preferably before the location of the extraction site had been finalised. The archaeological deposits will clearly overlie the target mineral deposits in the Kirkham Moraine area, and will not be at a great depth, minimising any difficulties in identifying them in the course of the archaeological evaluation. However, any remains, particularly of the prehistoric period, may be localised and of an insubstantial character. This would mean that a substantial proportion (at least *c*5%) of the area of the proposed development should be subject to trial trenching.

7.5.3 Where such pre-extraction evaluation has identified important archaeological, palaeoecological and geomorphological sites, a pre-defined programme of investigation may be necessary as part of the mitigation strategy, including palaeoecology, radiocarbon dating, and, if necessary, the *in-situ* preservation of archaeological remains. During the extraction process, a programme of field monitoring should be undertaken during site preparation and removal of overburden, as this may identify further archaeological remains.

8 BIBLIOGRAPHY

CARTOGRAPHIC SOURCES

BGS, 1982 Preston (E75) 1:50,000 Solid Geological Map

BGS, 1990 Garstang (E67) 1:50,000 Solid with Drift Geological Map

Ordnance Survey, 1844-1852 First Edition 6" to 1 mile maps

Ordnance Survey, 1893 First Edition 25” to 1 mile maps

Ordnance Survey, 1898 Second Edition 6” to 1 mile maps

Ordnance Survey, 1925 Third Edition 6” to 1 mile maps

Saxton, C, 1577 Survey of Northern England

Speed, J, 1610 Map of Lancashire

Yates, W, 1786 Map of Lancashire

SECONDARY SOURCES

Aitkenhead, N, Bridge, D McC, Riley, NJ, and Kimbell, SF, 1992 Geology of the country around Garstang, British Geol Surv Memoir, sheet 67, London

Allot and Lomax Ltd, 1990 *Sand and Gravel Resources of Lancashire*, unpubl rep

Archibald, MM, 1992 Dating Cuerdale: the Evidence of the Coins, in J Graham-Campbell (ed), *Viking treasure from the North West: the Cuerdale hoard in its context: selected papers from the Vikings of the Irish Sea conference, Liverpool, 18-20 May 1990*, National Museums and Galleries on Merseyside, Liverpool, 15-20

Bain, MG, 1991 *Palaeoecological studies in the Rivington Anglezarke Uplands Lancashire*, Unpubl PhD thesis, Univ Salford

Baines, E, 1824 *History, Directory and Gazetteer of the County Palatine of Lancaster*, **2**, London

Barnes, B, 1975 *Palaeoecological studies of the late Quaternary period in the North West Lancashire lowlands*, unpubl PhD thesis, Univ Lancaster

Barlow, F, 1999 *The Feudal Kingdom of England 1042-1216*, London

Bartley, DD, Jones, IP, and Smith, RT, 1990 Studies in the Flandrian History of the Craven District of the Yorkshire Lowlands, *J Ecol*, **78**, 611-32

Berggren, JL, and Jones, A, 2000 *Ptolemy's Geography: An Annotated Translation of the Theoretical Chapters*, Princeton and Oxford

Bewley, RH, 1994 Prehistoric and Romano-British Settlement in the Solway Plain Cumbria, *Oxbow Monog, **36**, Oxford*

Binney, EW, 1852 Notes on the drift deposits found near Blackpool, *Lit Phil Soc Manchester*, **10**, 121-35

Boothroyd, JC, and Ashley, GM, 1975 Process, bar morphology and sedimentary structure on braided outwash fans, northeast Gulf of Alaska, in AV Jopling, and BC Walker (eds),

Glaciofluvial and glaciolacustrine sedimentation, SEPM Special paper, **23**, New York, 193–222

Bowen, DQ, Phillips, FM, McCabe, AM, Kuntz, PC, and Sykes, GA, 2002 New data for the last Glacial Maximum in Great Britain and Ireland, *Quaternary Sci Rev*, **21**, 89-101

Bradley, R, and Edmonds, M, 1993 *Interpreting the Axe Trade: Production and Exchange in Neolithic Britain*, Cambridge

Breeze, DJ, 2006 *John Collingwood Bruce's Handbook to the Roman Wall*, 14th edn, Newcastle Upon Tyne

Brennand, M (ed), 2006 *The Archaeology of North West England: An Archaeological Research Framework for North West England: Volume 1, Resource Assessment*, Archaeology North West, **8**, Manchester

Brennand, M (ed), 2007 *Research and Archaeology in North West England: An Archaeological Research Framework for North West England: Volume 2, Resource Agenda and Strategy*, Archaeology North West, **9**, Manchester

Buxton, K, and Howard-Davis, CLE, 2000 *Bremetenacum: Excavations at Roman Ribchester, 1980, 1989-90*, Lancaster Imprints, **9**, Lancaster

Buxton, K, and Shotter, DCA, 1996 The Roman Period, in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 75-91

Chadwick, RA, Jackson, DI, Barnes, RP, Kimbell, GS, Johnson, H, Chiverrell, RC, Thomas, GSP, Jones, NS, Riley, NJ, Pickett, EA, Young, B, Holliday, DW, Ball, DF, Molyneux, SG, Long, D, Power, GM, and Roberts, DH, 2001 Geology of the Isle of Man and its offshore area, *Brit Geol Surv Res Rep*, **RR/01/06**, Keyworth

Chapman, H, 2006, *Landscape Archaeology and GIS*, Brimscombe

Chitty, G, and Brennand, M, 2007 An archaeological research framework for the North West Region: Research Agenda Introduction, in Brennand 2007, 7-30

Chiverrell, RC, Thomas, GSP, and Foster, GC, in press Sediment–landform assemblages and digital elevation data: an improved methodology for the assessment of sand and gravel aggregate reserves, *Engineering Geology*

Clough, T, and Cummins, WA (eds), 1988 *Stone Axe Studies Vol 2: The Petrology of Prehistoric Stone Implements from the British Isles*, CBA Res Rep, **67**, London

Colgrave, B, and Mynors, RAB, 1969 *Bede's ecclesiastical history of the English People*, Oxford

Countryside Commission, 1998 *Countryside Character: the Character of England's Natural and Manmade Landscape, vol 2: the North West*, Cheltenham

Countryside Agency, 2005 Countryside Character Areas: North West Region, http://www.countryside.gov.uk/LivingLandscape/countryside_character/north_west/index.asp

Cowell, RW, 1991 The Prehistory of Merseyside, in The Archaeology of Merseyside, *J Merseyside Archaeol Soc*, **7**, 21-61

Cowell, RW, 1992 Wetland survey in Merseyside: Winter 1990/91, in R Middleton (ed), *North West Wetlands Survey Annual Report*, **2**, Lancaster, 13-20

Cowell, RW, 2003 *Prehistoric and Romano-British Excavations at Duttons Farm, Lathom, West Lancashire: Third interim report: 1999-2002*, Liverpool Museum unpubl rep

Cowell, RW, and Innes, JB, 1994 *The Wetlands of Merseyside*, Lancaster Imprints, **2**, Lancaster

Crimes, TP, Chester, DK, Hunt, NC, Lucas, GR, Mussett, AE, Thomas, GSP, and Thompson, A, 1994 Techniques used in aggregate resource analysis of four areas in the UK, *Engineering Geol*, **37**, 165-92

Crimes, TP, Chester, DK, and Thomas, DSP, 1992 Exploration of sand and gravel resources by geomorphological analysis in the glacial sediments of eastern Lleyn Peninsula, Gywnedd, North Wales, *Engineering Geol*, **32**, 137-56

Crofts, RG (ed), 2005 *Quaternary of Rossendale Forest and Greater Manchester, a field guide, Quaternary Res Assoc*, London

Crosby, A, 1994 The Towns of Medieval Lancashire: An Overview, *Lancaster University Centre for North-West Regional Studies Regional Bull*, n ser, **8**, Lancaster, 7-18

De Rance, CE, 1875 The geology of the country around Blackpool, Poulton and Fleetwood, *Mem Geol Surv England and Wales*, London

De Rance, CE, 1877a On the glacial phenomena of western Lancashire and Cheshire, *Quart J Geol Soc London*, **26**, 641-5

De Rance, CE, 1877b The superficial geology of the country adjoining the coasts of South West Lancashire, *Mem Geol Surv England and Wales*, London

Department of the Environment (DoE), 1994 *Minerals Planning Guidance 6, Guidelines for aggregate provision in England*, London

Dixon, A, 1949 *Portus Setantiorum*, unpubl doc, Fleetwood

Ede, J, and Darlington, J, 2002 *Lancashire Historic Landscape Characterisation Programme*, Preston

Edmonds, M, 1999 *Ancestral geographies of the Neolithic: Landscapes, monuments and memory*, London

Edwards, BJN, 1992 Bond's Farm, Pilling, Lancashire, in R Middleton (ed), *North West Wetlands Survey Ann Rep*, Lancaster, 42-3

Edwards, BJN, 1998 *Vikings in North West England – The artifacts*, Centre for North-West Regional Studies, Lancaster

Ellis, NV, Bowen, DQ, Campbell, S, Knill, JL, McKidy, AP, Prosser, CD, Vincent, MA, and Wilson, RCL, 2007 *Contents of an Introduction to the Geological Conservation review*, Joint Nature Conservation Committee (http://www.jncc.gov.uk/page-2965)

English Heritage, 2003 *MIDAS: a Manual and Data Standard for Monument Inventories*, Swindon

English Heritage, 2005 *English Heritage ALSF Programme: River Valleys*, http://www.english-heritage.org.uk/FileStore/archaeology/ALSF/River valley guidance draft2.doc

English Heritage, 2007 NMR thesauri for monument and event types, http://thesaurus.english-heritge.or.uk/thesaurus.asp?thes_no=1

English Nature, 1999a *Cumbria Fells and Dales Natural Area Profile*, unpubl rep

English Nature, 1999b *Lancashire Plain and Valleys Natural Area Profile*, unpubl rep

English Nature, 1999c *Urban Mersey Basin Natural Area Profile*, unpubl rep

Entec UK Ltd, 2005 Lancashire Minerals and Waste Local Plan Sand and Gravel Study, unpubl rep, http://www.lancashire.gov.uk/environment/lmwlp/sand1.asp

Evans, DJA, and Ó Cofaigh, C, 2003 Depositional evidence for marginal oscillations of the Irish Sea ice stream in southeast Ireland during the last glaciation, *Boreas*, **32**, 76–101

Eyles, N, and McCabe, AM, 1989 The Late Devensian (<22000BP) Irish Sea basin: The Sedimentary Record of a Collapsed Ice margin, *Quaternary Sci Rev*, **8 (4)**, 307-51

Faull, ML, and Stinson, M (eds), 1986 The Domesday Survey of Yorkshire, in J Morris (ed), *Domesday Book*, **30**, Chichester

FISH, 2007 Forum on Information standards in Heritage, http://www.fish-forum.info/

Fishwick, H, 1891 *The history of the parish of St Michael-on-Wyre in the county of Lancaster*, Chetham Soc, n ser, **25**, Manchester

Fishwick, H, 1907 *The history of the parish of Lytham in the county of Lancaster*, Chetham Soc, n ser, **60**, Manchester

Galbraith, RF, and Laslett, GM, 1993 Statistical models for mixed fission track ages, *Nuclear Tracks and Radiation Measurements*, **21(4)**, 459-70

Garmonsway, GN, 1967 *Anglo-Saxon Chronicle*, London

Garstang, J, 1906 Anglo-Saxon remains, in W Farrer and J Brownbill (eds), *Victoria history of the counties of England, Lancashire*, **1**, London, 257-68

Geoplan Ltd, 2006 *Sand and Gravel Study - Stage 2*, unpubl rep, http://www.lancashire.gov.uk/environment/lmwlp/sand2.asp

Gibbons, P, Howard-Davis, C, Garner, D, and Miller, I, forthcoming *Excavations at Walton-le-Dale, 1981-3*, 1996-7

Granlund, E, 1932 De svenska Hogmossarnas geologi, *Sver Geol Unders*, **26**, 1-93

Graystone, P, 1996 *Walking Roman Roads in the Fylde and the Ribble Valley*, Lancaster

Gresswell, RK, 1967a, The geomorphology of the Fylde, in RW Stell and R Lawton (eds), *Liverpool essays in geography: a Jubilee Collection*, London, 25-42

Gresswell, RK, 1967b *Physical Geography*, Hong Kong

Hallam, J, 1980 *Archaeology in the Central Lancashire New Town - Report on the Surveys and Excavations 1975-79*, Unpubl rep

Hallam, J, Edwards, BJN, Barnes, B, and Stuart, AJ, 1973 The remains of late Glacial Elk associated with barbed points, from High Furlong, near Blackpool, Lancashire, *Proc Prehist Soc*, **39**, 100-28

Haselgrove, C, 1996 The Iron Age, in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 61-74

Hibbert, FA, Switsur, VR, and West, RG, 1971 Radiocarbon dating of Flandrian pollen zones at Red Moss, Lancashire, *Proc Roy Soc London*, **B 177**, 161-76

Higham, MC, 1991 The mottes of North Lancashire, Lonsdale and South Cumbria, *Trans Cumberland Westmorland Antiq Archaeol Soc*, n ser, **91**, 79-90

Higham, NJ, 1980 Native settlements west of the Pennines, in K Brannigan (ed), *Rome and the Brigantes*, Sheffield, 41-7

Higham, NJ, 1986 *The Northern Counties to AD 1000*, London

Higham, NJ, 2004 *A frontier landscape: the North West in the Middle Ages,* Bollington

Higham, NJ, 2006 Northumbria's southern frontier: a review, *Early Medieval Europe,* **14 (4)**, 391-418

Hodgson, J, and Brennand, M, 2006 Prehistoric Period Resource Assessment, in Brennand 2006, 23-58

Hodgson, J, and Brennand, M, 2007 The Prehistoric Period Research Agenda, in Brennand 2007, 31-54

Howard-Davis, C, 1996 Seeing the sites: Survey and excavation on the Anglezarke Uplands Lancashire, *Proc Prehist Soc,* **61**, 133-66

Howard-Davis, C, and Buxton, K, 2000 *Roman Forts in the Fylde: Excavations at Dowbridge, Kirkham,* Lancaster University Centre for North West Regional Studies, Lancaster

Huckerby, E, 2001 Palynological assessment, in Wells and Hodgkinson 2001, 167-8

Huddart, D, 1994 The Late Quaternary Glacigenic Sequence: Landforms and Environments in Coastal Cumbria, in J Boardman and J Walden (eds), *Cumbria Field Guide,* Quaternary Res Assoc, Oxford, 59-77

Huddart, D, Tooley, MJ, and Carter, PA, 1977 The coasts of North-West England, in C Kidson and MJ Tooley (eds), The Quaternary history of the Irish Sea, *Geol J Spec Issue,* **7**, Liverpool, 119-54

Hull, E, 1864 Geology of the country around Oldham, including Manchester and its suburbs, *Mem Geol Survey Great Britain*, London

Jackson, MJ, 1990 *Castles of Cumbria*, Carlisle

Jacobi, RM, Gowlett, JAJ, Hedges, REM, and Gillespie, R, 1986 Accelerator Mass Spectrometry dating of Upper Palaeolithic finds with the Poulton elk as an example, in D Roe (ed), *Studies in the Upper Palaeolithic of Britain and Northwest Europe*, Brit Archaeol Rep, Int Ser, **296**, Oxford, 121-8

Johnson, D, 2004 *Excavation of Broadwood Enclosure, Thornton in Lonsdale, North Yorkshire: Report on the excavation of a Romano-British enclosure and 17th-century lime kiln*, Ingleton

Johnson, RH, 1985 The imprint of glaciation on the West Pennine Uplands, in RH Johnson (ed), *The geomorphology of north-west England*, Manchester, 237-62

Jones, RT, Marshall, JD, and Crowley, SF, 2002 A high resolution, multiproxy Late-glacial record of climate change and intrasystem responses in North West England, *J Quaternary Sci*, **17 (4)**, 329-40

Kenyon, D, 1991 *The Origins of Lancashire*, Manchester

Kirkman, R, and Van Zeller, P, 1991 *Rails to the Lancashire Coast*, Clapham, Lancaster

Kvamme, KL, 1990 One-sample Tests in Regional Archaeological Analysis: New possibilities through Computer Technology, *American Antiq*, **55.2**, 367-81

Lamb, HH, 1977 *Climate, past, present and future. 2: climatic history and the modern world*, Cambridge

Lancashire HER, 2006 *Documentary Survey of 1890s mapping*, unpubl rep

Lancaster University Archaeological Unit (LUAU), 1997 *River Ribble Catchment Lancashire and North Yorkshire Archaeological Rapid Identification Survey*, unpubl rep

Lancaster University Archaeological Unit (LUAU), 2000 *Clayton Hall, Clayton-le-Woods, Lancashire, Archaeological Evaluation Report*, unpubl rep

Langdon, J, 2002 *Horses, Oxen and Technological Innovation: The Use of Draught Animals in English Farming from 1066-1500*, Cambridge

Longworth, D, 1985 The Quaternary history of the Lancashire Plain, in RH Johnson (ed), *The geomorphology of north-west England*, Manchester,178-200

Lønne, I, 1995 Sedimentary facies and depositional architecture of ice-contact glaciomarine systems, in SK Chough and GJ Orton (eds), Fan deltas: Depositional Styles and Controls, *Sedimentary Geol*, **98**, 13-43

McCabe, AM, Clark, PU, Clark, J, and Dunlop, P, 2007 Radiocarbon constraints on readvances of the British-Irish Ice Sheet in the northern Irish Sea Basin during the last deglaciation, *Quaternary Sci Rev*, **26 (9-10)**, 1204-11

McCabe, AM, Dardis, GF, and Hanvey, PM, 1984 Sedimentology of a Late Pleistocene submarine-moraine complex, County Down, Northern Ireland, *J Sedimentary Petrol*, **54 (3)**, 716-30

McCabe, AM, Dardis, GF, and Hanvey, P, 1987 Sedimentation at the margins of a late Pleistocene ice-lobe terminating in shallow marine environments, *Sedimentol*, **34,** 473–93

Mannex, PJ, 1851 *History, topography, and directory, of Westmorland; and of the hundreds of Lonsdale and Amounderness in Lancashire ... by Mannex & Co*, Beverley

Margary, ID, 1957 *Roman roads in Britain, Vol II, North of the Foss Way - British Channel (inc Wales and Scotland)*, London

Margary, ID 1973 Roman Roads in Britain, 3rd edn, London

Marshall, JD, Jones, RT, Crowley, SF, Oldfield, F, Nash, S, and Bedford, A, 2002 A high resolution Late-Glacial isotopic record from Haweswater, Northwest England, Climatic oscillations and comparison of palaeotemperature proxies, *Palaeogeog Paleoclimatol Palaeoecol*, **185**, 25-40

Mathew, WM, 1993 Marling in British Agriculture: a Case of Partial Identity, *Ag Hist Rev*, **41, 2**, 97-110

Merritt, JW, and Auton, CA, 2000 An outline of the lithostratigraphy and depositional history of Quaternary deposits in the Sellafield district, west Cumbria, *Proc Yorkshire Geol Soc*, **53**, 129–54

Middleton, R, 1993 Landscape Archaeology in the North West and the definition of surface lithic scatter sites, in R Middleton (ed), *North West Wetlands Survey Annual Report 1993*, Lancaster, 1-8

Middleton, R, 1996 The Neolithic and Bronze Age, in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 35-59

Middleton, R, Wells, C, and Huckerby, E, 1995 *The Wetlands of North Lancashire, Lancaster Imprints*, **4**, Lancaster

Middleton, R, Tooley, M, and Innes, JB, forthcoming *The Wetlands of South West Lancashire*, Lancaster Imprints, Lancaster

Mills, D, 1976 *The place-names of Lancashire*, London

Morgan, P, 1978 The Domesday survey of Cheshire, in J Morris (ed), *Domesday Book*, **26**, Chichester

Murray, AS, and Wintle, AG, 2000 Luminescence dating of quartz using an improved single-aliquot regenerative-dose protocol, *Radiation Measurements*, **32**, 57-73

Natural England, 2007 Sites of Special Scientific Interest: New Notifications, http://www.english-nature.org.uk/special/sssi/notification.asp

Newman, R, 1996 Medieval Rural Settlement in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 109-24

Newman, RM, 1996 The Dark Ages, in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 93-108

Newman, RM, and Brennand, M, 2007 The Early Medieval Period Research Agenda, in Brennand 2007, 74-94

Newman, C, and Newman, R, 2007 The Medieval Period Research Agenda, in Brennand 2007, 95-114

North, OH, and Spence, JE, 1936 Stone Circle, Summerhouse hill, Yealand Conyers, *Trans Cumberland Westmorland Antiq Archaeol Soc*, n ser, **36**, 69-70

North Yorkshire County Council (NYCC), 1997 *North Yorkshire Minerals Local Plan*, unpubl rep

OA North, 2002 *Survey Levels*, unpubl doc

OA North 2003 *Tewitfield Marina, Priest Hutton, Lancashire: Archaeological Desk-Based Assessment* unpubl rep

OA North, 2004 *South West Campus, Lancaster University, Lancaster: Excavation Assessment Report*, unpubl rep

OA North, 2006 *The Caton River Terrace, Lancashire: Archaeological Excavation Assessment Report*, unpubl rep

OA North, in prep The Upland Peats of the North West, unpubl doc

OA North and University of Liverpool, 2007a *Aggregate extraction in the Lower Ribble Valley: Final Report*, unpubl doc

OA North and University of Liverpool, 2007b *ALSF Aggregate Extraction in the Kirkham Area: Project Design*, unpubl doc

OA North and University of Liverpool, 2007c *ALSF Aggregate Extraction in the Craven Lowland and Kirkham Areas: Project Design*, unpubl doc

Oldfield, F, and Statham, DC, 1965 Stratigraphy and pollen analysis on Cockerham and Pilling Moses, North Lancashire, *Mem Proc Manchester Lit Phil Soc*, **107**, 70-85

Olivier, ACH, 1987 Excavations of a Bronze Age Funerary Cairn at Manor Farm, Near Borwick, North Lancashire, *Proc Prehist Soc*, **53**, 129-86

Parker Pearson, M, 1999 *The Archaeology of Death and Burial*, Stroud

Penney, SH, 1981 *Lancaster: the evolution of its townscape to 1800*, Centre for North-West Regional Studies Occ Pap, **9**, Lancaster

Philpott, R, and Brennand, M, 2007 The Romano-British period Research Agenda, in Brennand 2007, 55-73

Porter, J, 1876 *The History of the Fylde of Lancashire*, repr 1968, Fleetwood and Blackpool

Potter, TW, and Andrews, RD, 1994 Excavation and survey at St Patrick's Chapel and St Peter's Church, Heysham, 1977-8, *Antiq J*, **74**, 55-134

Poulton-le-Fylde Historical and Civic Society, 2007 *A Brief History of Poulton*, http://www.poulton-le-fylde-hcs.co.uk/html/body_brief_history.html (retrieved December 2007)

Quartermaine, J, and Leech, R, forthcoming *The later prehistory of the Lake District, the results of recent surveys*, Lancaster Imprints

Regional Aggregate Working Party (RAWP), 1999-2006 *Regional Aggregate Reports*, http://www.communities.gov.uk/

Rose, J, 1985 The Dimlington Stadial/Dimlington Chronozone: a proposal for naming the main glacial episode of the Late Devensian in Britain, *Boreas*, **14 (3)**, 225-30

Rothwell, C, 1994 *Around Kirkham in Old Photographs*, Stroud

Shotter, DCA, 1999 Cerialis, Agricola and the Conquest of Northern Britain, *Contrebis*, **24**, 3-8

Shotter, DCA, 2004 *Romans and Britons in North West England*, 2nd rev, Lancaster

Shotter, DCA, and White, A, 1990 *The Roman Fort and Town and Lancaster*, Lancaster

Shotter, DCA, and White, A, 1995 *The Romans in Lunesdale*, Lancaster

Singleton, FJ, 1980 *Kirkham – A Short History*, Lytham St Annes

Smith, MJ, Rose, J, and Booth, S, 2006 Geomorphological mapping of glacial landforms from remotely sensed data: An evaluation of the principal data sources and an assessment of their quality, *Geomorphol*, **6(1-2)**, 145-65

Stead, IM, Bourke, JB, and Brothwell, D (eds), 1986 *Lindow Man: the Body in the Bog*, London

Taylor, C, 1983 *Village and Farmstead: A History of Rural Settlement in England*, London

Thomas, GSP, 1977 The Quaternary of the Isle of Man, in C Kidson and MJ Tooley (eds), *The Quaternary of the Irish Sea*, Geol J special issue, **7**, Liverpool, 155–79

Thomas, GSP, 1984 A Late Devensian glaciolacustrine fan-delta at Rhosesmor, Clwyd, North Wales, *Geol J*, **19**,125–41

Thomas, GSP, 1985 The Quaternary of the northern Irish Sea Basin, in RH Johnson (ed), *The geomorphology of north-west England*, 143-58

Thomas, GSP, 1989 The Late Devensian glaciation along the western margin of the Cheshire-Shropshire lowland, *J Quaternary Sci*, **4**, 167-81

Thomas, GSP, 1999 Northern England, in DQ Bowen, AM McCabe, DG Sutherland, DR Bridgland, TDJ Cameron, PL Gibbard, R Holmes, SG Lewis, D Maddy, RC Preece and GSP Thomas, *Correlation of Quaternary deposits in the British Isles*, Geol Soc, Spec Rep **4**, London, 179-93

Thomas, GSP, Chiverrell, RC, and Huddart, D, 2004 Ice-marginal depositional responses to probable Heinrich events in the Devensian deglaciation of the Isle of Man, *Quaternary Sci Rev*, **23 (1–2)**, 85–106

Thomas, GSP, and Chiverrell, RC, 2007 Structural and depositional evidence for repeated ice-marginal oscillation along the eastern margin of the Late Devensian Irish Sea Ice Stream, *Quaternary Sci Rev*, **26 (19-21)**, 2375-405

Thomas, GSP, Connaughton, M, and Dackombe, RV, 1985 Facies variation in a supraglacial outwash sandur from the Isle of Man, *Geol J*, **20**, 193–213

Thomas, GSP, and Kerr, P, 1987 The stratigraphy, sedimentology and palaeontology of the Pleistocene Knocknasilloge Member, Co Wexford, Ireland, *Geol J*, **22 (2)**, 67-82

Thomas, GSP, and Summers, AJ, 1983 The Quaternary stratigraphy between Blackwater Harbour and Tinnaberna, Co Wexford, *J Earth Sci*, **5**, 121–34

Thomas, GSP, and Summers, AJ, 1984 Glacio-dynamic structures from the Blackwater Formation, Co Wexford, Ireland, *Boreas*, **13**, 5–12

Thornber, W, 1837 *An historical and descriptive account of Blackpool and its neighbourhood*, Poulton

Thornber, W, 1850 *Remarks on the Roman occupation in the Fylde District*, Trans Hist Soc Lancashire Cheshire, **3**, 116-26

Tooley, MJ, 1978 *Sea-level changes in north west England during the Flandrian Stage*, Oxford

Tupling, GH, 1957 The pre-Reformation parishes and chapeleries of Lancashire, *Trans Lancashire Cheshire Antiq Soc*, **67**, 78-89

Turner, J, 1981 The Iron Age, in I Simmons and MJ Tooley (eds), *The environment and prehistory*, London, 250-81

UKRIGS, 2007 http://www.ukrigs.org.uk/html/ukrigs.php

Warren, WP, and Ashley, GM, 1994 Origins of the ice-contact stratified ridges (eskers) of Ireland, *J Sedimentary Res*, **A 64**, 433–49

Weber, CA, 1926 Grenhorizont und Klimaschwankungen, *Abh Nat Bremen*, **28**, **H1**, 57-65

Wells, CE, and Hodgkinson, D, 2001 A late Bronze Age human skull and associated worked wood from a Lancashire Wetland, *Proc Prehist Soc*, **67**, 163-74

Wells, C, Huckerby, E, and Hall, V, 1997 Mid- and Late- Holocene vegetation history and tephra studies at Fenton Cottage, Lancashire, UK, *Vegetation Hist and Archaeobot*, **6(34)**, 153-66

White, AJ, 1996 Medieval Towns, in R Newman (ed), *The Archaeology of Lancashire: Present State and Future Priorities*, Lancaster, 125-38

White, AJ, 1999 Carnforth Viking Treasure, *Contrebis*, **29**, 12-14

Whyte, ID, 2003 *Transforming Fell and Valley: Landscape and parliamentary enclosure in North West England*, Lancaster

Williams, GD, Brabham, PJ, Eaton, GP, and Harris, C, 2001 Late Devensian glaciotectonic deformation at St Bees, Cumbria: a critical wedge model, *J Geol Soc London*, **158**, 125–35

Williams, R, 1998 A conjectural mesolithic Scatter Site on the River Lune at Halton *Contrebis,* **23,** 12-4

Wilson, AA, and Evans, WB, 1990, Geology of the country around Blackpool, *British Geol Surv Memoir*, sheet 66, London

Winchester, AJL, 1987 *Landscape and Society in Medieval Cumbria,* Edinburgh

Winchester, AJL (ed), 2006 *England's Landscape, The North West*, London

Young, R, 2002 The Palaeolithic and Mesolithic Periods in Northern England: An Overview, in C Brooks, R Daniels, and A Harding (eds), *Past Present and Future, The Archaeology of Northern England,* Architect Archaeol Soc Durham Northumberland, Res Rep, **5**, Durham, 19-27

APPENDIX 1: SUMMARY GAZETTEER OF PROJECT DATABASE

Database Reference Number	Site Name	Monument Type	Period
KM0001	Weeton horseshoe	Findspot: Horseshoe	Medieval
KM0002	Weeton Lane Ends	Findspot: Cinerary Urn	Bronze Age
KM0003	Weeton Lane Heads Round Cairn	Cairn	Bronze Age
KM0004	Weeton Lane Heads, Moor Hey Field Cairn	Barrow	Bronze Age
KM0005	Weeton Lane Heads, Moor Hey Field Gravel Pit	Findspot: Cinerary Urn	Bronze Age
KM0006	Weeton Lane Heads Lim'd Hall, Moorfield,	Barrow	Bronze Age
KM0007	Weeton palstave	Findspot: Palstave	Bronze Age
KM0008	Weeton, South of Kirkham Road, bead	Findspot: Bead	Roman
KM0009	Weeton: horseshoe	Findspot: Horseshoe	Medieval
KM0010	Moss Side Farm, Salwick	Barrow	Bronze Age
KM0011	Salwick Hall, Salwick	Findspot: Palstave	Bronze Age
KM0012	Church House Farm, Woodplumpton	Findspot: Coin	Roman
KM0013	Kirkgate Street (north), Kirkham	Findspot: Pottery	Roman
KM0014	Kirkham	Findspot: Coin	Roman
KM0015	Dowbridge, Kirkham	Fort	Roman
KM0016	Crossmoor, Inskip	Findspot: Cinerary Urn	Unknown
KM0017	Pasture Barn, Medlar, Wesham	Moat	Medieval
KM0018	Friary Close, Dowbridge, Kirkham	Building	Roman
KM0019	Nan's Flats, Dowbridge Road	Findspot	Roman
KM0020	St Michaels Road	Findspot: Shield Boss	Roman
KM0021	Walton Hall, Wrongway Brook, Kirkham	House	Post-medieval
KM0022	Weeton	Findspot: Metal	Roman
KM0023	Weeton	Findspot: Coin	Roman
KM0024	St Michael's Church, Kirkham	Gravestone	Roman
KM0025	St Johns Church near Kirkham	Findspot: Altar Stone	Roman
KM0026	Todderstaffe Hall, Fairfield Road, Poulton-le-Fylde	House	Medieval
KM0027	Preese Hall, built 1732 on site of cottages	Great Hall	Post-medieval
KM0028	Cock Sod	Cockpit	Post-medieval
KM0029	Green Ridges, Great Plumpton	Cross	Medieval
KM0030	Westby Hall and Chapel, Westby	Chapel	Medieval
KM0031	Weeton with Preese	Manor House	Medieval
KM0032	Weeton	Findspot: Stone axe	Neolithic
KM0033	Catforth Hall, Woodplumpton	Great Hall	Post-medieval
KM0034	Bradkirk Hall	House	Medieval
KM0035	Mowbeck Hall, Medlar with Wesham	Great Hall	Post-medieval
KM0036	Thatched House Tavern, Weeton Road, Wesham	Inn	Post-medieval
KM0037	Wrangway Bridge	Bridge	Post-medieval
KM0038	Parsonage, Kirkham	Vicarage	Medieval
KM0039	Free Grammar School, Kirkham	School	Post-medieval
KM0040	Carr Lane Bridge, Kirkham	Bridge	Post-medieval
KM0041	Moor Street, Kirkham	Pound	Post-medieval
KM0042	Kirkgate, Kirkham	Findspot: Coin	Roman
KM0043	The Moot Hall, Kirkham	Moot	Medieval
KM0044	Preston Street, Kirkham	Horse Engine	Medieval
KM0045	Windmill, Carr Hill, sometimes 'Glebe Mill', Kirkham Mill'	Windmill	Medieval
KM0046	Ribby Hall	Fishpond	Post-medieval
KM0047	Dowbridge	Bridge	Medieval
KM0048	Dowbridge Cross	Cross	Medieval
KM0049	Headless Cross	Cross	Medieval
KM0050	Freckleton	Cross	Medieval

Database Reference Number	Site Name	Monument Type	Period
KM0051	Dow Bridge	Findspot: Pottery	Roman
KM0052	Myrtle Drive, Carr Hill, Kirkham	Findspot: Pottery	Roman
KM0053	The Old Schoolhouse, Woodplumpton	School	Post-medieval
KM0054	Moor Hall, Bartle, Woodplumpton	Great Hall	Medieval
KM0055	Salwick Hall	Moat	Medieval
KM0056	Clock House Farm, Lea	Cross	Medieval
KM0057	Ward`s House	House	Post-medieval
KM0058	Lund Cross	Cross	Medieval
KM0059	St John`s Church	Private Chapel	Medieval
KM0060	Danes Pad	Farmhouse	Post-medieval
KM0061	Westleigh Cottage	Farmhouse	Post-medieval
KM0062	Treales	Hermitage	Medieval
KM0063	Pudding Pie Nook, Wrea Green	Cruck House	Post-medieval
KM0064	Little Plumpton	Shrunken Village	Medieval
KM0065	Mythop	Shrunken Village	Medieval
KM0066	Westby	Deserted Settlement	Medieval
KM0067	Near Slack House	Findspot: Axe	Bronze Age
KM0068	Medlar DMV	Deserted Settlement	Medieval
KM0069	Greenhalgh DMV	Deserted Settlement	Medieval
KM0070	Adjacent to Moorside Villa	Tithe Barn	Post-medieval
KM0071	Tarnbrick Cross	Cross	Medieval
KM0072	Bartle DMV	Deserted Settlement	Medieval
KM0073	Daniel's Cross	Cross	Medieval
KM0074	Duxen Dean	Cross	Medieval
KM0075	Newsham Hall	Great Hall	Post-medieval
KM0076	Old Hall (Broughton Hall or Row), Broughton	Great Hall	Post-medieval
KM0077	Roman Catholic Chapel, near Dean House, Whittingham	Chapel	Post-medieval
KM0078	Brabiner House Farm, formerly Braboner's House	House	Post-medieval
KM0079	Haighton DMV	Deserted Settlement	Medieval
KM0080	Broughton Churchyard Cross	Cross	Medieval
KM0081	Oak Bank Farm Cross	Cross	Medieval
KM0082	Free Grammar School, Broughton	School	Post-medieval
KM0083	Haighton Green Cross	Cross	Post-medieval
KM0084	Gerard Hall Farm, formerly Old Gerard Hall, Haighton	Farmhouse	Post-medieval
KM0085	Broughton Churchyard	Findspot: Metal	Roman
KM0086	Bickerstaffe	Findspot: Coin	Roman
KM0087	Wharles	Findspot: Quernstone	Roman
KM0088	Lea, near Preston	Findspot: Crucifix	Medieval
KM0089	1, Myrtle Drive, Carrhill, Kirkham	Findspot: Multiple	Roman
KM0090	Carr Hill, Kirkham	Findspot: Pottery	Roman
KM0091	Carr Hill, Kirkham	Findspot: Textile	Roman
KM0092	Pennine View, Kirkham	Findspot: Pottery	Roman
KM0093	Roots Bridge and Intack Farm	Ridge and Furrow	Unknown
KM0094	Locking Stoops	Soil Marks	Unknown
KM0095	Wrea Green	Cropmarks	Unknown
KM0096	Whitprick Hill	Soil Marks	Unknown
KM0097	Mythop	Earthwork	Unknown
KM0098	Main Dyke, Mythop	Cropmarks	Unknown
KM0099	North of Haighton Hall	Soil Marks	Unknown
KM0100	South-west of Salwick Hall	Earthwork	Unknown
KM0101	Preston New Road, Westby-with-Plumpton	Field Boundaries	Unknown
KM0102	Woodplumpton	Earthwork	Unknown
KM0103	Cardwells Farm, Treales, aerial photographic site	Earthwork	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0104	Earthworks, Moss Lane West, Treales	Earthworks	Unknown
KM0105	Town Head Farm, Thistleton	Field Boundaries	Unknown
KM0106	Town Head Farm	Trackway	Unknown
KM0107	Singleton	Earthworks	Unknown
KM0108	Manor Farm and area	Earthworks	Unknown
KM0109	Pool Foot Lane, Singleton	Field Boundaries	Unknown
KM0110	Swarbrick Hall	Earthworks	Unknown
KM0111	Carr Lane, Singleton	Hollow Way	Unknown
KM0112	Singleton	Hollow Way	Unknown
KM0113	Kirkham i'th' Fields	Earthwork	Unknown
KM0114	South of Blackleach	Cropmark	Unknown
KM0115	Blue Moor, aerial photographic site	Ridge and Furrow	Unknown
KM0116	Toplands Farm	Cropmark	Unknown
KM0117	Boyse's Farm	Earthworks	Unknown
KM0118	Broughton	Earthwork	Unknown
KM0119	Main Dyke, Mythop Bridge - Garstang Road, Poulton-le-Fylde	Peat deposit	Unknown
KM0120	Puddle House Wood (East)	Peat deposit	Unknown
KM0121	Poultry Houses, Hall's House Farm	Peat deposit	Unknown
KM0122	Preese Hall (South)	Site: Unknown	Unknown
KM0123	16 Myrtle Drive, Kirkham	Findspot: Pottery	Roman
KM0124	Singleton Windmill	Post Mill	Post-medieval
KM0125	Great Plumpton	Spa	Post-medieval
KM0126	Broughton Church Lane	Holy Well	Medieval
KM0127	Main Dyke (South), Mythop	Ridge and Furrow	Unknown
KM0128	Mythop Hall	Ridge and Furrow	Unknown
KM0129	Clinkum Wood (North)	Ridge and Furrow	Unknown
KM0130	Carr Wood	Ridge and Furrow	Unknown
KM0131	Carr Wood, Poulton-le-Fylde	Ridge and Furrow	Unknown
KM0132	Greenacres (South), Poulton-le-Fylde	Ridge and Furrow	Unknown
KM0133	Brakinscale	Ridge and Furrow	Unknown
KM0134	Kirby's Farm	Ridge and Furrow	Unknown
KM0135	Lucas Flash Wood	Ridge and Furrow	Unknown
KM0136	Whitmoor Farm (West)	Watercourse	Unknown
KM0137	Mythop Road, Weeton	Watercourse	Unknown
KM0138	Whitprick Hill (North)	Watercourse	Unknown
KM0139	Moss Wood (North)	Ridge and Furrow	Unknown
KM0140	West Lynn (South)	Ridge and Furrow	Unknown
KM0141	Madeline Cottage (North-west)	Ridge and Furrow	Unknown
KM0142	Weeton Road	Watercourse	Unknown
KM0143	Moss Farm	Watercourse	Unknown
KM0144	Moss Cottage (West)	Watercourse	Unknown
KM0145	Hale Hall	Watercourse	Unknown
KM0146	Roseacre Farm	Watercourse	Unknown
KM0147	Spring Plantation	Watercourse	Unknown
KM0148	Moor Hey (North)	Watercourse	Unknown
KM0149	Leeming Nursery (North)	Watercourse	Unknown
KM0150	Beech View	Watercourse	Unknown
KM0151	Whin Wood	Watercourse	Unknown
KM0152	White Carr Farm	Watercourse	Unknown
KM0153	Moss House Farm	Watercourse	Unknown
KM0154	Dingle Farm (North)	Watercourse	Unknown
KM0155	New Bridge	Watercourse	Unknown
KM0156	Bradkirk Hall (North)	Ridge and Furrow	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0157	Rose Villas	Ridge and Furrow	Unknown
KM0158	Scholar Brook	Ridge and Furrow	Unknown
KM0159	School House Farm	Ridge and Furrow	Unknown
KM0160	Bolton Houses	Ridge and Furrow	Unknown
KM0161	White Hall	Watercourse	Unknown
KM0162	Freshfield Farm	Ridge and Furrow	Unknown
KM0163	Tarnbrick Farm	Ridge and Furrow	Unknown
KM0164	Blundel Brook	Ridge and Furrow	Unknown
KM0165	Greenhalgh	Kettleholes	Unknown
KM0166	Westfield Cottages, Weeton with Preese	Site:multiple	Unknown
KM0167	Mythop Moss, Weeton with Preese	Enclosure	Unknown
KM0168	Mythop Moss, Weeton with Preese	Site:multiple	Unknown
KM0169	Medlar with Wesham	Ridge and Furrow	Unknown
KM0170	Pasture Barn, Medlar	Moat	Medieval
KM0171	Treales etc	Site:multiple	Unknown
KM0172	North Greenfield, Medlar with Wesham	Site:multiple	Unknown
KM0173	Treales etc	Ridge and Furrow	Unknown
KM0174	Inskip Lodge	Site:multiple	Unknown
KM0175	Windmill Farm	Earthwork	Unknown
KM0176	Barnfield Street, Kirkham	Weaving Shed	Post-medieval
KM0177	14 Myrtle Drive, Kirkham	Building	Roman
KM0178	Boyse's Farm, Broughton	Site:multiple	Unknown
KM0179	Pasture Barn, Medlar	Moat	Unknown
KM0180	Inskip Lodge	Earthwork	Unknown
KM0181	Bracken Strip Wood	Site:multiple	Unknown
KM0182	Wrea Green, West	Possible Quarry	Unknown
KM0183	Haighton Hall	Site:unknown	Unknown
KM0184	Haighton Manor	Site:multiple	Unknown
KM0185	Blundel Brook	Site:multiple	Unknown
KM0186	Avenham Wood	Cropmark	Unknown
KM0187	Pinfold Farm	Cropmarks	Unknown
KM0188	Salwick Bridge Farm	Track	Unknown
KM0189	Grange Cottage, Treales	Site:multiple	Unknown
KM0190	Salwick Hall Farm	Earthworks	Unknown
KM0191	Salwick Station	Cropmarks	Unknown
KM0192	Newton Grange	Ridge and Furrow	Unknown
KM0193	Carr Wood	Cropmarks	Unknown
KM0194	Pop Hall Farm	Cropmarks	Unknown
KM0195	Wharles	Cropmarks	Unknown
KM0196	Keeps Barn Farm, Cross Moor, Inskip with Sowerby	Findspot: Axe	Prehistoric
KM0197	Little Singleton	Findspot: Flat Axe	Bronze Age
KM0198	The Butts, Treales	Cruck House	Post-medieval
KM0199	Eagle and Child Inn, Weeton	House	Post-medieval
KM0200	Jolly's Farm, Mythop	Farmhouse	Post-medieval
KM0201	Christ Church near Moorside	School	Post-medieval
KM0202	Near Ferdys' Wood	House	Post-medieval
KM0203	Wharles	Blacksmiths' Workshop	Post-medieval
KM0204	Wharles	Well	Post-medieval
KM0205	Roseacre	Well	Post-medieval
KM0206	Over Scholar Brook	Bridge	Post-medieval
KM0207	Corner Row Farm, Fleetwood Road	Well	Post-medieval
KM0208	Swillbrook Police Station	Police Station	Post-medieval
KM0209	Inskip	Well	Post-medieval
KM0210	Next to Tynewold Cottage, Catforth	Blacksmiths' Workshop	Post-medieval
KM0211	Moor Side	Chapel	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0212	Moor Side, Woodplumpton	Workhouse	Post-medieval
KM0213	Cuddy Hill, near Tanyard Farm	Tannery	Post-medieval
KM0214	Inskip	Chapel	Post-medieval
KM0215	School House, Inskip	School	Post-medieval
KM0216	Inskip Mill	Water Mill	Post-medieval
KM0217	Derby Arms Hotel	Stocks	Post-medieval
KM0218	Lowther Hill Farm	Well	Post-medieval
KM0219	Woodplumpton	Corn Mill	Post-medieval
KM0220	Lancaster Canal	Canal	Post-medieval
KM0221	Plumpton Lane	Cross	Post-medieval
KM0222	On Woodplumpton Brook, south-east of Woodplumpton	Corn Mill	Post-medieval
KM0223	Puddle House, Hardham	House	Post-medieval
KM0224	Summerer House, Singleton	House	Post-medieval
KM0225	Moss House, Weeton	House	Post-medieval
KM0226	Swarbrick Hall, Weeton	House	Post-medieval
KM0227	Hill House, Weeton	House	Post-medieval
KM0228	Singleton Grange and Farm, Singleton	House	Post-medieval
KM0229	Singleton Lodge	House	Post-medieval
KM0230	Bankfield House, Little Singleton	House	Post-medieval
KM0231	Old Bankfield, Little Singleton	House	Post-medieval
KM0232	Pointer House, Little Singleton	House	Post-medieval
KM0233	Mythop Road, Weeton	Gravel Pit	Post-medieval
KM0234	Weeton	School	Post-medieval
KM0235	Greenhalgh with Thistleton, near crossroads	Sign Post	Post-medieval
KM0236	Grange Farm, Fleetwood Road, Greenhalgh with Thistleton	House	Post-medieval
KM0237	Greenhalgh with Thistleton	House	Post-medieval
KM0238	Barton	Farmstead	Post-medieval
KM0239	Broughton Bridge, near Church Farm	Blacksmiths' Workshop	Post-medieval
KM0240	Brabiner House Farm	Well	Post-medieval
KM0241	Lawton House, Bartle	House	Post-medieval
KM0242	Bartle Hall, Bartle	Great Hall	Post-medieval
KM0243	Saddle Inn, Sidgreaves Lane, Bartle	Inn	Post-medieval
KM0244	Gravel Pit, Newton with Clifton	Gravel Pit	Post-medieval
KM0245	Near Salwick Station	Watch House	Post-medieval
KM0246	Moss House, Great Plumpton	House	Post-medieval
KM0247	Sandpit, Great Plumpton	Sand Pit	Post-medieval
KM0248	Westby Windmill, and corn kiln near Whinbrick	Windmill	Post-medieval
KM0249	Wrea Green Station, Preston and Wyre railway	Railway Station	Post-medieval
KM0250	Wrea Green Windmill, Mill Lane	Windmill	Post-medieval
KM0251	Roman Road, called Danes Pad, Kirkham	Road	Roman
KM0252	Manor House, Blackburns Farm, Ribby with Wrea	House	Post-medieval
KM0253	Browns House, Browns Lane, Ribby with Wrea	House	Post-medieval
KM0254	Walton House Farm, Hill Farm, Ribby with Wrea	House	Post-medieval
KM0255	Lightfoot Green Farm, Woodplumpton	House	Post-medieval
KM0256	Parsonage, Lower Bartle, Preston	Vicarage	Post-medieval
KM0257	Spa Cottages, formerly Murton Row, Lower Bartle, Preston	House	Post-medieval
KM0258	Smithy, near Sitting Goose inn, Lower Bartle	Blacksmiths' Workshop	Post-medieval
KM0259	Lea Free school, Lea Road, Sidgreaves Lane	School	Post-medieval
KM0260	Quaker Lodge, Lea	House	Post-medieval
KM0261	Malt Kiln, near Danes Pad Farm	Malt Kiln	Post-medieval
KM0262	Lund Vicarage, Vicarage Lane	Vicarage	Post-medieval
KM0263	Grace Mire House, near Salwick bridge	House	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0264	Chapel, school and burial ground	Church	Post-medieval
KM0265	Pear Tree House, Deepdale Lane	House	Post-medieval
KM0266	Kirkham and Wesham station	Railway Station	Post-medieval
KM0267	Kirkham Linen Mill	Linen Mill	Post-medieval
KM0268	Gasometer, just north of Kirkham linen mill	Gas Works	Post-medieval
KM0269	Fylde Union Workhouse, Kirkham	Workhouse	Post-medieval
KM0270	Freckleton Street, Kirkham	Chapel	Post-medieval
KM0271	Gas works, Moor Street and Poulton Street	Gas Works	Post-medieval
KM0272	Warehouse and houses, Mill Street, Kirkham	Warehouse	Post-medieval
KM0273	Gravel Pit, near Dowbridge House	Gravel Pit	Post-medieval
KM0274	Wesham Hall, Medlar with Wesham	House	Post-medieval
KM0275	Gravel Pit, Treales, Roseacre and Wharles	Gravel Pit	Post-medieval
KM0276	Smiths Mill Windmill, Medlar with Wesham	Windmill	Post-medieval
KM0277	Bolton Houses, Treales	House	Post-medieval
KM0278	Highgate Inn, Blackpool Road	Inn	Post-medieval
KM0279	Sand Pit, near Church Street, Kirkham	Sand Pit	Post-medieval
KM0280	New Hey Farm	Site:unknown	Unknown
KM0281	Sidings Farm, Dowbridge	Earthworks	Unknown
KM0282	Central Kirkham	Church	Unknown
KM0283	Wesham	Trackway	Unknown
KM0284	Bradshaw Farm	Field System	Unknown
KM0285	Grange Wood	Cropmarks	Unknown
KM0286	Stanley Grange	Field Boundaries	Unknown
KM0287	Swillbrook Lodge	Earthwork	Unknown
KM0288	Weeton Windmill, Weeton Lane Head	Windmill	Post-medieval
KM0289	Newton with Clifton	Canal	Post-medieval
KM0290	Woodplumpton	Canal	Post-medieval
KM0291	Lodge House, Mill Street, Kirkham	House	Post-medieval
KM0292	Moss House Farm	Ridge and Furrow	Unknown
KM0293	Isaac Ball's Workshop, Wharles	Works	Post-medieval
KM0294	Near Mains Hall, off Mains Lane, Singleton	Dovecote	Post-medieval
KM0295	Moss House Farm, Treales	Site: unknown	Unknown
KM0296	New Bridge	Enclosure	Unknown
KM0297	Pedders House, Weeton with Preese	Site: unknown	Unknown
KM0298	Mythop	Ridge and Furrow	Medieval
KM0299	86-94 Poulton Street, Kirkham	Well	Post-medieval
KM0300	Church of St John the Evangelist, Lund	Church	Post-medieval
KM0301	Weeton with Preese	Findspot: Coin	Post-medieval
KM0302	Weeton with Preese	Findspot: Coin	Post-medieval
KM0303	Weeton with Preese	Findspot: Coin	Post-medieval
KM0304	Singleton	Findspot: Seal	Medieval
KM0305	Kirkham	Findspot: Token	Post-medieval
KM0306	Weeton with Preese	Findspot: Coin	Roman
KM0307	Weeton with Preese	Findspot: Buckle	Post-medieval
KM0308	Weeton with Preese	Findspot: Spindle Whorl	Medieval
KM0309	Kirkham	Findspot: Coin	Medieval
KM0310	Kirkham	Findspot: Coin	Post-medieval
KM0311	Leyland Hall, Medlar	Findspot: 'Horn Book'	Post-medieval
KM0312	Bradshaw Lane, Greenhalgh	Earthwork	Unknown
KM0313	Staining	Moat	Unknown
KM0314	Mains Hall	Jetty	Unknown
KM0315	River Wyre near Pool Foot Farm	Jetty	Unknown
KM0316	Earth Mounds north of Mythop Hall	Earthwork	Unknown
KM0317	Many Pits Wood	Barrow	Prehistoric
KM0318	Ferndale Farm	Mound	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0319	Bradkirk Hall Farm	Moat	Medieval
KM0320	Harbour Farm, Salwick	Moat	Unknown
KM0321	Lund church to New Hay Lane, Newton	Road	Roman
KM0322	Church Farm, formerly D'Urton Lane End, Broughton	Farmstead	Post-medieval
KM0323	D'Urton Lane, Broughton	Road	Post-medieval
KM0324	D'Urton Lane, Broughton	Marl Pit	Post-medieval
KM0325	Off D'Urton Lane, Broughton	Trackway	Post-medieval
KM0326	near Church Hill Farm, Broughton	Ridge and Furrow	Post-medieval
KM0327	Brooklands Park, Broughton	Park	Post-medieval
KM0328	Brooklands, Broughton	Ridge and Furrow	Post-medieval
KM0329	Near Brooklands, Broughton	Field Boundary	Post-medieval
KM0330	Near Broughton Park, Broughton	Trackway	Post-medieval
KM0331	Near Broughton Park, Broughton	Pond	Post-medieval
KM0332	Near Broughton Park, Broughton	Field Boundary	Post-medieval
KM0333	Near Broughton Park, Broughton	Pond	Post-medieval
KM0334	Near Broughton Park, Broughton	Field Boundary	Post-medieval
KM0335	Near Broughton Park, Broughton	Pond	Post-medieval
KM0336	Near Broughton Park, Broughton	Pond	Post-medieval
KM0337	Near Broughton Park, Broughton	Marl Pit	Post-medieval
KM0338	Near Broughton Park, Broughton	Trackway	Post-medieval
KM0339	Near Broughton Park, Broughton	Pond	Post-medieval
KM0340	Near Broughton Park, Broughton	Pond	Post-medieval
KM0341	Near Broughton Park, Broughton	Field Boundary	Post-medieval
KM0342	Near Broughton Park, Broughton	Pond	Post-medieval
KM0343	Whittingham Lane, Broughton	Road	Post-medieval
KM0344	Off Whittingham Lane, Broughton	Trackway	Post-medieval
KM0345	Near Whittingham Lane, Broughton	Pond	Post-medieval
KM0346	Near Hoole's Farm, Broughton	Pond	Post-medieval
KM0347	Near Barton Park, Barton	Marl Pit	Post-medieval
KM0348	Barton Park, Barton	Park	Post-medieval
KM0349	Barton Park, Barton	Marl Pit	Post-medieval
KM0350	Barton Park, Barton	Field Boundary	Post-medieval
KM0351	Barton Park, Barton	Marl Pit	Post-medieval
KM0352	Garstang Road, Barton	Road	Post-medieval
KM0353	Old Hall Farm, Broughton	Fishpond	Medieval
KM0354	Old Hall Farm, Broughton	Garden	Medieval
KM0355	South-east of Old Hall Farm, Broughton	Earthwork	Medieval
KM0356	The Mere, east of Little Plumpton	Moat	Medieval
KM0357	South-west of The Mere, Little Plumpton	Moat	Medieval
KM0358	South-west of The Mere, Little Plumpton	Moat	Medieval
KM0359	North-west of The Mere, Little Plumpton	Lake	Unknown
KM0360	North-west of The Mere, Little Plumpton	Kiln	Unknown
KM0361	'Muskett' (field name) north of The Mere, Little Plumpton	Lake	Unknown
KM0362	Bailey's Bridge, Woodplumpton	Moat	Medieval
KM0363	Wadebridgegate, Darkinsons Lane	Road	Roman
KM0364	Weeton	Bear Pit	Post-medieval
KM0365	Chain Lane, Staining	Findspot: Coin	Roman
KM0366	Ribchester to Poulton-le-Fylde Roman Road (Margary 703)	Road	Roman
KM0367	Ribchester to Poulton-le-Fylde Roman Road (Margary 703)	Road	Roman
KM0368	Ribchester to Poulton-le-Fylde Roman Road (Margary 703)	Road	Roman

Database Reference Number	Site Name	Monument Type	Period
KM0369	Ribchester to Poulton-le-Fylde Roman Road (Margary 703)	Road	Roman
KM0370	Danes Pad, Poulton-le-Fylde	Road	Roman
KM0371	Preston to Lancaster Roman Road (Margary 70d)	Road	Roman
KM0372	1 Carr Lane, Kirkham	Findspot: Bracelet	Roman
KM0373	Dowbridge	Wall	Unknown
KM0374	Railway Goods Shed, Kirkham	Goods Shed	Post-medieval
KM0375	Kirkham North Junction	Signal Box	Post-medieval
KM0376	Barton	Swing Bridge	Post-medieval
KM0377	Roots Bridge	Canal Bridge	Post-medieval
KM0378	Swillbrook Bridge	Canal Bridge	Post-medieval
KM0379	Stone Chimneys Bridge	Canal Bridge	Post-medieval
KM0380	Gornall's Mill, Whitworth Street	Corn Mill	Post-medieval
KM0381	Hall Cross	Weaving Shed	Post-medieval
KM0382	Singleton	Gas Works	Post-medieval
KM0383	Windmill, Town End, Kirkham	Windmill	Post-medieval
KM0384	Worsicks Farm, The Village, Singleton	Barn	Post-medieval
KM0385	Barn at Highfield Farm, Lea Lane, Lea	Barn	Post-medieval
KM0386	Old Hall Farm, Whittington	Wall	Unknown
KM0387	Old Clay Pit, east of A585 Fleetwood Road, north-east of Wesham House	Clay Pit	Post-medieval
KM0388	Thatched House Tavern, 31 Weeton Road, Wesham	Public House	Post-medieval
KM0389	School, A585 Garstang Road North (opposite nos 10-20), Wesham	School	Post-medieval
KM0390	School, site of present St Joseph's RC School, Fleetwood Road, Wesham	School	Post-medieval
KM0391	St Joseph's Church, Fleetwood Road, Wesham	Church	Post-medieval
KM0392	Presbytery, west of 2-4 Mowbreck Lane, off Fleetwood Road, Wesham	Priest's House	Post-medieval
KM0393	Lecture Hall, Porter Street East, off Garstang Road South, Wesham	Lecture Theatre	Post-medieval
KM0394	Post Office, 20 Station Road, Wesham	Post Office	Post-medieval
KM0395	Signal Box, Kirkham and Wesham Station, Station Road, Kirkham	Signal Box	Post-medieval
KM0396	Cattle Pens, north side of railway line west of Kirkham and Wesham Street	Cattle Pen	Post-medieval
KM0397	Coal Yard, north of railway line, to rear of 2-4 Segar Street, off Station Road, Medlar	Yard	Post-medieval
KM0398	Milepost, adjacent to the railway line to rear of works, Richard's Street, Medlar	Milepost	Post-medieval
KM0399	Crane, to rear of factory off Foxwood Drive, off A585 Fleetwood Road, Kirkham	Crane	Post-medieval
KM0400	Wesham Mill, site of present depot, west side of junction of Brook Street, Medlar	Cotton Mill	Post-medieval
KM0401	Brook Mill, Brook Street, off Richard's Street, Kirkham	Cotton Mill	Post-medieval
KM0402	Bone Mill, 11-17 Marquis Street, off Station Road, Kirkham	Bone Mill	Post-medieval
KM0403	Signal Box, adjacent to railway line near Carr Farm, off Church Street, Kirkham	Signal Box	Post-medieval
KM0404	Signal Box, north of railway line at Sidings Farm, Carr Lane, Kirkham	Signal Box	Post-medieval
KM0405	Milepost, south of railway line, west of Sidings Farm, Carr Lane, Kirkham	Milepost	Post-medieval
KM0406	East Lodge, Mowbreck Lane, Wesham	Lodge	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0407	Old Clay Pit, south of Mowbreck Lane, to south-east of East Lodge, Wesham	Clay Pit	Post-medieval
KM0408	Old Clay Pit, south of Mowbreck Manor, Mowbreck Lane, Wesham	Clay Pit	Post-medieval
KM0409	Old Clay Pit, east of Ravenglass Close, off Park Lane, Wesham	Clay Pit	Post-medieval
KM0410	Lodge, north of Mowbreck Lane at junction with Pine Way, Wesham	Lodge	Post-medieval
KM0411	Old Clay Pit, Grange Wood, north of Mowbreck Lane near Wesham Hall, Wesham	Clay Pit	Post-medieval
KM0412	Old Clay Pit, Grange Wood, north of Mowbreck Lane near Wesham Hall, Wesham	Clay Pit	Post-medieval
KM0413	Old Clay Pit, south-west of Ash Tree Farm, Moorside, near Wesham	Clay Pit	Post-medieval
KM0414	Well, 'Northwood', south side of junction of Kirkham Road with Lower Lane	Well	Post-medieval
KM0415	Football Ground, Kirkham Bypass, rear of 29-37 Southlands and Gleneagles Court	Football Ground	Post-medieval
KM0416	Old Sand Pit, A583 Blackpool Road, south of 4 Cherry Close, Kirkham	Sand Pit	Post-medieval
KM0417	School, 85b Ribby Road and 1 Bryning Fern Lane, Kirkham	School	Post-medieval
KM0418	Cricket Ground, off Woodlands Avenue, to rear of Mellor Road, Kirkham	Cricket Ground	Post-medieval
KM0419	Methodist Chapel, Woodlands Avenue, off Mellor Road, Kirkham	Wesleyan Methodist Chapel	Post-medieval
KM0420	Gasometer, 9-11 Milton Crescent, Kirkham	Gas Holder	Post-medieval
KM0421	Fire Engine Station, opposite 44 Station Road, Kirkham	Workhouse	Post-medieval
KM0422	Gun Tavern, adjacent to 17 Station Road, Kirkham	Public House	Post-medieval
KM0423	Inn, 106-108 Poulton Street, Kirkham	Inn	Post-medieval
KM0424	Inn, site of present Swan Hotel, junction of Poulton Street with Orders Lane	Inn	Post-medieval
KM0425	Presbytery, Willows Lane, off Ribby Road, Kirkham	Priest's House	Post-medieval
KM0426	Cotton Mill, Greenacres Avenue, Kirkham	Cotton Mill	Post-medieval
KM0427	Local Board Office, near 10 Station Road, Kirkham	Office	Post-medieval
KM0428	Fylde Union Workhouse, site of present Pear Tree School, Holmeswood	Workhouse	Post-medieval
KM0429	Inn, site of present church adjacent to 82 Poulton Street, Kirkham	Inn	Post-medieval
KM0430	Inn, 38 Marsden Street, Kirkham	Inn	Post-medieval
KM0431	Bank, St Theresa's Court, off Marsden Street, Kirkham	Bank (Financial)	Post-medieval
KM0432	Inn, site of present public house adjacent to 16 Freckleton Street, Kirkham	Inn	Post-medieval
KM0433	Post Office, 25 Poulton Street, Kirkham	Post Office	Post-medieval
KM0434	Inn, 19-21 Poulton Street, Kirkham	Inn	Post-medieval
KM0435	Drill Hall, site of present Community Centre, Birley Street, off Poulton Street, Kirkham	Drill Hall	Post-medieval
KM0436	Zion Chapel, near 72-74 Marsden Street, Kirkham	Congregational Chapel	Post-medieval
KM0437	Police station, north of present police station, Freckleton Road, Kirkham	Police Station	Post-medieval
KM0438	Cotton Mill, Old Row, off Freckleton Street, Kirkham	Cotton Mill	Post-medieval
KM0439	Inn, 25 Preston Street, Kirkham	Inn	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0440	Black Horse Hotel, 29 Preston Street, Kirkham	Hotel	Post-medieval
KM0441	Vicarage, site of present Glebe House, School Lane, off Church Street, Kirkham	Vicarage	Post-medieval
KM0442	Kennels, off Carr Lane, south of Sidings Farm, Kirkham	Kennels	Post-medieval
KM0443	Rifle Range, south of Carr Lane near Sidings Farm, Kirkham	Firing Range	Post-medieval
KM0444	Tile and Drain Pipe Works, south of Carr Lane near Sidings Farm, Kirkham	Tile Works	Post-medieval
KM0445	Clay Pit, south of Carr Lane near Sidings Farm	Clay Pit	Post-medieval
KM0446	Old Clay Pit, north of Cemetery, Garstang Road East, Poulton-le-Fylde	Clay Pit	Post-medieval
KM0447	Well, north of Fairfield Road, west of junction with Puddle House Lane, Hardhorn	Well	Post-medieval
KM0448	Old Clay Pit, Puddle House Lane near Puddle House Nurseries, Hardhorn	Clay Pit	Post-medieval
KM0449	Old Clay Pit, north of junction between Fairfield Road and Station Road	Clay Pit	Post-medieval
KM0450	Old Clay Pits, north of Fairfield Farm, Fairfield Road, Hardhorn	Clay Pit	Post-medieval
KM0451	Milepost, north-east of Fairfield Farm, Fairfield Road, Hardhorn	Milepost	Post-medieval
KM0452	Old Clay Pit, north-east of Puddle House Farm, Puddle House Lane, Hardhorn	Clay Pit	Post-medieval
KM0453	Sand Pit, south-east of Shire Farm, Oldfield Carr Lane, Poulton-le-Fylde	Sand Pit	Post-medieval
KM0454	Signal Box, east of railway line to south-east of Posh Paws Cattery	Signal Box	Post-medieval
KM0455	Well, Heights Farm, Moorside, near Kirkham	Well	Post-medieval
KM0456	Brickfield, east of Brookfield and Greylands, off A583 Kirkham Bypass, Kirkham	Brickfield	Post-medieval
KM0457	Singleton Hall, Lodge Lane, Singleton	House	Post-medieval
KM0458	Old Clay Pit, south-east of Saddle Inn Public House, Sidgreave Lane, near Cottam	Clay Pit	Post-medieval
KM0459	Old Clay Pit, east of Crow Lady Farm, Lea Lane	Clay Pit	Post-medieval
KM0460	Old Clay Pit, east of Adamson Farm, Rosemary Lane, near Cottam	Clay Pit	Post-medieval
KM0461	Birley Arms, site of present Sitting Goose Inn, Lea Lane, near Cottam	Public House	Post-medieval
KM0462	Old Clay Pit, east of Stott's Farm and south-east of Bridge House, Tabley Lane	Clay Pit	Post-medieval
KM0463	Old Clay Pit, east of Bridge House and north-east of Stott's Farm, Tabley Lane	Clay Pit	Post-medieval
KM0464	Old Clay Pit, north of M55 Motorway near Houghton House Farm and Lightfoot Farm	Clay Pit	Post-medieval
KM0465	Old Clay Pit, beneath M55 Motorway to south-west of Tabley Farm, Tabley Lane	Clay Pit	Post-medieval
KM0466	Old Clay Pit, north of Darkinson Lane and south of railway line, to west of Halsall's Farm	Clay Pit	Post-medieval
KM0467	Old Clay Pit, south-west of Quaker's Bridge, Darkinson Lane-Sidgreaves Lane, Lea	Clay Pit	Post-medieval
KM0468	Old Clay Pits, south-west of Earl's Farm, Sidgreaves Lane, Lea	Clay Pit	Post-medieval
KM0469	Tabley Arms, site of present Bridge House, Tabley Lane, Higher Bartle	Public House	Post-medieval
KM0470	Old Clay Pit, east of Tabley Farm, Tabley Lane,	Clay Pit	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
	Higher Bartle		
KM0471	14 Myrtle Drive, Kirkham	Site:multiple	Unknown
KM0472	Bankfield Street, Kirkham	Site:multiple	Unknown
KM0473	Lodge House, Mill Street, Kirkham	Site:multiple	Unknown
KM0474	Poulton Street, Kirkham	Site:multiple	Unknown
KM0475	Poulton Street, Kirkham	Site:multiple	Unknown
KM0476	Freckleton Street, Kirkham	Site:unknown	Unknown
KM0477	Worsick's Farm, Singleton	Farm	Unknown
KM0478	St John's Church, Lund	Site:multiple	Unknown
KM0479	Petroleum Exploration Site, Mythop	Site:multiple	Unknown
KM0480	Dowbridge, Kirkham	Site:multiple	Unknown
KM0481	Barn at Highfield Farm, Lea Lane, Lea, Preston	Barn	Unknown
KM0482	Broughton Bypass, Preston	Site:multiple	Unknown
KM0483	Land at Mythop Hall Farm	Site:multiple	Modern
KM0484	49 Dowbridge, Kirkham	Site:unknown	Modern
KM0485	Land south of Mythop Road, Weeton	Site:multiple	Unknown
KM0486	South of Grange Cottages, Mythop	Artefact Scatter	Neolithic
KM0487	Cuckoo House and Lane, Mythop	House	Post-medieval
KM0488	Mythop Windmill, Weeton	Windmill	Post-medieval
KM0489	77 Dowbridge, Kirkham	Site:multiple	Unknown
KM0490	73 Dowbridge, Kirkham	Site:unknown	Unknown
KM0491	36 Dowbridge Close, Kirkham	Site:multiple	Unknown
KM0492	Proposed Golf Course at Dover Lodge Farm, Chain Lane, Staining, Blackpool	Site:multiple	Unknown
KM0493	Gateposts on Chain Lane, Staining	Gate Pier	Post-medieval
KM0494	Gateposts on Chain Lane, Staining	Gate Pier	Modern
KM0495	Gateposts 235m east of Chain Lane, Staining	Gate Pier	Modern
KM0496	Danes Pad Roman Road (RR 703)	Road	Roman
KM0497	Old Clay Pits	Clay Pit	Post-medieval
KM0498	Dains's Path Carr	Field	Unknown
KM0499	'Pit Carr' south-west of Hall's House Farm	Marl Pit	Post-medieval
KM0500	Former wind-pump near Hall House Farm	Wind Pump	Post-medieval
KM0501	'Stable Farm' near Hall's House Farm	Stable	Post-medieval
KM0502	'Kiln Field' near Dover Lodge Farm	Kiln	Post-medieval
KM0503	'Kiln Field' north of Dover Lodge Farm	Kiln	Post-medieval
KM0504	Well near Main Dyke	Well	Post-medieval
KM0505	Former structure west of Hall's House Farm	Building	Post-medieval
KM0506	Mythorp Toll Gate	Toll Gate	Post-medieval
KM0507	Thatchpat Bridge	Suspension Bridge	Post-medieval
KM0508	Main Dyke foot stick	Footbridge	Post-medieval
KM0509	Possible evidence for Dane's Pad north of Main Dyke	Road	Roman
KM0510	Roman Road 703 Ribchester - Poulton-le-Fylde	Road	Roman
KM0511	Mythop Road, Weeton	Site:multiple	Unknown
KM0512	North of Mythop Road, Weeton	Building	Post-medieval
KM0513	Hornby's sailcloth factory, Orders Lane, Kirkham	Textile Factory	Post-medieval
KM0514	34 Roman Way, Kirkham	Site:multiple	Modern
KM0515	High Bank Farm, Fairfield Road, Hardhorn, Poulton-le-Fylde	Site:multiple	Modern
KM0516	Building 1, High Bank Farm, Fairfield Road, Hardhorn	Stable	Post-medieval
KM0517	Building 2, High Bank Farm, Fairfield Road, Hardhorn	Barn	Post-medieval
KM0518	Playing Fields Site, Singleton CE Primary School, Singleton	Site:multiple	Modern

Database Reference Number	Site Name	Monument Type	Period
KM0519	Diffuse scatter of flint, Singleton	Stone: Flint	Prehistoric
KM0520	Duplicate entry	-	-
KM0521	South side of small stream, Singleton	Stone: Flint Tool	Prehistoric
KM0522	Singleton	Ridge and Furrow	Medieval
KM0523	Singleton	Ridge and Furrow	Medieval
KM0524	Trackway, headlands, and associated traces of ridge and furrow, Weeton-with-Preese	Field System	Medieval
KM0525	Weeton-with-Preese	Stone: Flint	Prehistoric
KM0526	Weeton-with-Preese	Stone: Flint	Prehistoric
KM0527	South of Stanley House Farm, Weeton-with-Preese	Stone: Flint	Prehistoric
KM0528	Weeton-with-Preese	Stone: Flint Blade	Prehistoric
KM0529	Weeton-with-Preese	Stone: Flint	Prehistoric
KM0530	Weeton-with-Preese	Stone: Flint	Prehistoric
KM0531	Medlar-with-Wesham	Stone: Flint	Prehistoric
KM0532	Small ridge, Medlar-with-Wesham	Stone: Flint Scraper	Prehistoric
KM0533	Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0534	Treales, Roseacre and Wharles	Stone: Beehive quern	Roman
KM0535	Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0536	Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0537	Treales, Roseacre and Wharles	Ridge and Furrow	Medieval
KM0538	Westby-with-Plumptons	Stone: Flint	Prehistoric
KM0539	Westby-with-Plumptons	Stone: Flint	Prehistoric
KM0540	Boulder-clay ridge, Westby-with-Plumptons	Ridge and Furrow	Medieval
KM0541	Immediately West of Wesham	Stone: Flint Scraper	Prehistoric
KM0542	Westby-with-Plumptons	Stone: Flint	Prehistoric
KM0543	Flint finds, Westby-with-Plumptons	Stone: Gun Flint	Post-medieval
KM0544	East of Great Plumpton	Stone: Flint	Prehistoric
KM0545	Small flint scatter, Westby-with-Plumptons	Stone: Flint	Prehistoric
KM0546	Cross Hill, unworked flint nearby	Stone: Flint Tool	Prehistoric
KM0547	Treales, Roseacre and Wharles	Ridge and Furrow	Medieval
KM0548	Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0549	Denuded ridge and furrow, Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0550	South-west of Pasture Barn, Medlar-with-Wesham (SMR 0075)	Moat	Medieval
KM0551	Greenhalgh-with-Thistleton with some raw material	Stone: Flint	Prehistoric
KM0552	Single burnt flake, Kirkham	Stone: Flint	Prehistoric
KM0553	Moss Side Farm	Stone: Flint	Prehistoric
KM0554	Moss Side Farm	Stone: Flint Flake	Prehistoric
KM0555	Medlar-with-Wesham	Ceramic: Pottery	Medieval
KM0556	South of Mowbreck Hall	Stone: Flint Tool	Prehistoric
KM0557	Medlar-with-Wesham, with unworked flints	Ceramic: Pottery	Medieval
KM0558	Medlar-with-Wesham	Ridge and Furrow	Medieval
KM0559	North-west of Pepper Hill Farm	Stone: Flint	Prehistoric
KM0560	Newton-with-Clifton	Ridge and Furrow	Medieval
KM0561	Two areas south of Pepper Hill	Ridge and Furrow	Medieval
KM0562	Treales, Roseacre and Wharles	Ceramic: Pottery	Medieval
KM0563	Grit-tempered pottery, Treales, Roseacre and Wharles	Ceramic: Pottery	Medieval
KM0564	Treales, Roseacre and Wharles	Ceramic: Pottery	Medieval
KM0565	Treales, Roseacre and Wharles	Ceramic: Pottery	Medieval
KM0566	Treales, Roseacre and Wharles	Ridge and Furrow	Medieval
KM0567	Treales, Roseacre and Wharles	Ridge and Furrow	Medieval
KM0568	Treales, Roseacre and Wharles	Stone: Flint Tool	Prehistoric
KM0569	Treales, Roseacre and Wharles	Field System	Medieval
KM0570	Treales, Roseacre and Wharles	Ridge and Furrow	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0571	North-west of Post Farm	Ceramic: Pottery	Medieval
KM0572	North-west of Post Farm	Stone: Flint	Prehistoric
KM0573	North-east of Boundary Farm	Stone: Flint	Prehistoric
KM0574	North of Pea Nook	Stone: Flint	Prehistoric
KM0575	West of Elswick Lodge	Ridge and Furrow	Medieval
KM0576	South-west of Salwick House	Ridge and Furrow	Medieval
KM0577	South of Grange Road, Elswick, three areas	Ridge and Furrow	Medieval
KM0578	North-east of Elswick Grange Farm	Ridge and Furrow	Medieval
KM0579	Inskip-with-Sowerby, unretouched flint	Stone: Flint Tool	Prehistoric
KM0580	South-west of Chesham House, narrow ridges	Ridge and Furrow	Medieval
KM0581	Inskip-with-Sowerby, large spread	Ceramic: Pottery	Medieval
KM0582	Inskip-with-Sowerby, large spread	Ceramic: Pottery	Medieval
KM0583	Inskip-with-Sowerby, large spread	Ceramic: Pottery	Medieval
KM0584	Coarse, gritty ware, Inskip-with-Sowerby	Ceramic: Pottery	Medieval
KM0585	Inskip-with-Sowerby, large spread	Ceramic: Pottery	Medieval
KM0586	Treales, Roseacre and Wharles, two large fields	Ridge and Furrow	Medieval
KM0587	Between Gorst Farm and Elswick Hospital, three fields	Ridge and Furrow	Medieval
KM0588	Ridge and furrow, relict field boundaries, east of Carr House Farm	Ridge and Furrow	Medieval
KM0589	East of Hodgkinson Farm	Ridge and Furrow	Medieval
KM0590	East of Inkskip CE School	Ceramic: Pottery	Medieval
KM0591	Greenhalgh-with-Thistleton	Ceramic: Pottery	Medieval
KM0592	Greenhalgh-with-Thistleton	Ceramic: Pottery	Medieval
KM0593	Greenhalgh-with-Thistleton	Ceramic: Pottery	Medieval
KM0594	Greenhalgh-with-Thistleton, probably locally made	Ceramic: Jug	Medieval
KM0595	Greenhalgh-with-Thistleton	Ceramic: Cooking pot	Medieval
KM0596	North and East of Walker House Farm	Ridge and Furrow	Medieval
KM0597	North-east and South of Higham Side, possibly drainage	Ridge and Furrow	Medieval
KM0598	South-west of the Derby Arms Hotel	Ridge and Furrow	Medieval
KM0599	East of Inskip Lodge	Ceramic: Pottery	Medieval
KM0600	East of Inskip Lodge	Stone: Flint Tool	Prehistoric
KM0601	East of Inskip Lodge	Stone: Flint Tool	Prehistoric
KM0602	East of Inskip Lodge	Ceramic: Pottery	Medieval
KM0603	East of Pad End Farm	Stone: Flint Tool	Prehistoric
KM0604	West of Moor House Farm, narrow ridges	Ridge and Furrow	Medieval
KM0605	North-west of Moor House Farm	Stone: Flint Scraper	Prehistoric
KM0606	North of Derby Hill Farm, grass-covered, unconfirmed	Barrow	Prehistoric
KM0607	Cropmark, Weeton-with-Preese	Watercourse	Unknown
KM0608	Cropmarks, Medlar-with-Wesham	Watercourse	Unknown
KM0609	Moat, field boundaries, and drainage, Medlar-with-Wesham	Moat	Unknown
KM0610	Duplicate entry	-	-
KM0611	Elswick Manor	Ridge and Furrow	Post-medieval
KM0612	Inskip-with-Sowerby, probably agricultural	Enclosure	Unknown
KM0613	Treales, Roseacre and Wharles	Enclosure	Unknown
KM0614	Duplicate entry	-	-
KM0615	Duplicate entry	-	-
KM0616	Treales, Roseacre and Wharles, with watercourses and narrow ridge and furrow	Field Boundary	Unknown
KM0617	Duplicate entry	-	-
KM0618	Treales, Roseacre and Wharles, with watercourses and narrow ridge and furrow	Field Boundary	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0619	Treales, Roseacre and Wharles	Field System	Unknown
KM0620	Duplicate entry	-	-
KM0621	Duplicate entry	-	-
KM0622	Newton-with-Clifton, with watercourses	Field Boundary	Unknown
KM0623	Woodplumpton	Ridge and Furrow	Post-medieval
KM0624	Inskip-with-Sowerby, with narrow ridge and furrow	Field Boundary	Post-medieval
KM0625	Inskip-with-Sowerby	Watercourse	Unknown
KM0626	Adjacent to former Weeton Moss	Stone: Flint Tool	Prehistoric
KM0627	Duplicate entry	-	-
KM0628	Rise above Lytham-Skippool Valley	Stone: Flint	Prehistoric
KM0629	Weeton-with-Preese	Stone: Flint Tool	Prehistoric
KM0630	Small rise within Lytham-Skippool Valley	Stone: Flint Tool	Prehistoric
KM0631	Isolated flint near Clinkum Wood	Stone: Flint	Prehistoric
KM0632	Near Clinkum Wood	Stone: Flint	Prehistoric
KM0633	Staining	Stone: Flint Scraper	Prehistoric
KM0634	Staining	Stone: Flint Scraper	Prehistoric
KM0635	South of Fairfield Cottages, Staining	Stone: Flint	Prehistoric
KM0636	Staining, respected by surviving boundaries	Ridge and Furrow	Medieval
KM0637	Find of a 'large horn' in the 1980s, Staining	Organic: Animal Horn	Prehistoric
KM0638	Duplicate entry	-	-
KM0639	South of Mythop Grange	Ridge and Furrow	Medieval
KM0640	Weeton-with-Preese	Stone: Flint	Prehistoric
KM0641	Singleton, scatter	Stone: Flint	Prehistoric
KM0642	Singleton, crudely worked lump	Stone: Flint	Prehistoric
KM0643	Singleton, with medieval pottery	Stone: Flint	Prehistoric
KM0644	Features relating to Lancaster Canal, Singleton	Canal	Post-medieval
KM0645	The Old Cottage, Fairfield Road, Hardhorn	House	Post-medieval
KM0646	St Mary's Chapel and St Anne's Church, Singleton	Chapel	Medieval
KM0647	Fox Lane Ends Cross, Wrea Green, Westby-with-Plumptons	Cross	Post-medieval
KM0648	Canal Bridge, Lea Road, Lea	Canal Bridge	Post-medieval
KM0649	Quaker's Bridge, Darkinson Lane, Lea	Canal Bridge	Post-medieval
KM0650	Ambrose Hall, Woodplumpton	Hall	Post-medieval
KM0651	Treales Windmill	Windmill	Post-medieval
KM0652	St Michael's Church, Kirkham	Church	Medieval
KM0653	Kirkham Market Cross and fish stones	Cross	Post-medieval
KM0654	St Anne's Church, Woodplumpton	Chapel	Medieval
KM0655	Church of St Anne, Plumpton Road, Woodplumpton	Sundial	Post-medieval
KM0656	Church of St Anne, Plumpton Lane, Woodplumpton	Gate Pier	Post-medieval
KM0657	Fernyhalgh Lane, Broughton	School	Post-medieval
KM0658	Darkinson Lane, Lea	Cross	Medieval
KM0659	Clifton Windmill, Clifton Lane, Clifton	Windmill	Medieval
KM0660	South of Church of St John the Baptist, Broughton	Sundial	Post-medieval
KM0661	Church of St John the Baptist, Broughton	Mounting Block	Post-medieval
KM0662	Church Cottage, off Garstang Road, Broughton	House	Medieval
KM0663	Barn, approximately 15m south of Catforth Hall, Woodplumpton	Cowhouse	Medieval
KM0664	Mill House, B5269, Inskip	House	Post-medieval
KM0665	Church of St Peter, Inskip	Church	Post-medieval
KM0666	Whitehouse Farmhouse, B5269, Inskip	Farmhouse	Post-medieval
KM0667	Outbuilding south-east of Brook House, Lewth Lane, Inskip	Wheelwrights' Workshop	Medieval
KM0668	Haighton Hall, Haighton	Farmhouse	Post-medieval
KM0669	Bank Hall, Broughton	Hall	Post-medieval
KM0670	St John the Baptist's Church, Broughton	Church	Medieval

Database Reference Number	Site Name	Monument Type	Period
KM0671	Broughton Primary School, Broughton	School	Post-medieval
KM0672	The Stone House, Whittingham Lane, Broughton	House	Post-medieval
KM0673	Haighton Manor (Haighton House), Haighton Green Lane	Manor House	Post-medieval
KM0674	Haighton House, Cow Hill, Haighton	House	Medieval
KM0675	Haighton Top Farmhouse, Haighton Green Lane, Haighton	Farmhouse	Post-medieval
KM0676	Seamark Farmhouse, Haighton	Farmhouse	Post-medieval
KM0677	Raikes Farmhouse, Lea Lane, Lea	Farmhouse	Medieval
KM0678	Clock House, Lea Road, Lea	House	Post-medieval
KM0679	Back Lane Farm, Whittingham	Farmhouse	Post-medieval
KM0680	Pudding Pie Nook, Whittingham	Farmhouse	Post-medieval
KM0681	Eaves Cottage and Farmhouse, Eaves, Woodplumpton	Farmhouse	Post-medieval
KM0682	Anderton House, Bartle	Farmhouse	Post-medieval
KM0683	Wearden House, Bartle	Farmhouse	Post-medieval
KM0684	Hollowforth Hall, Woodplumpton	House	Post-medieval
KM0685	South View, Woodplumpton	Farmhouse	Post-medieval
KM0686	Cuckstool Farmhouse, Woodplumpton	Farmhouse	Medieval
KM0687	Church House Farmhouse, Woodplumpton	Farmhouse	Post-medieval
KM0688	St Anne's Church, Woodplumpton	Mounting Block	Medieval
KM0689	Chapel Farmhouse, Back Lane, Elswick	Cruck Barn	Medieval
KM0690	Forest Farmhouse, High Street	Farmhouse	Medieval
KM0691	Old Congregational Chapel, Lodge Lane	Gravestone	Post-medieval
KM0692	Elswick Manor, Watery Gate Lane	Manor House	Post-medieval
KM0693	Elswick Manor, Watery Gate Lane	Stable	Post-medieval
KM0694	Elswick Manor, Watery Gate Lane	Gate Lodge	Post-medieval
KM0695	Elswick Lodge Farmhouse, Watery Gate Lane	Farmhouse	Post-medieval
KM0696	Hall Cross Farmhouse, Kirkham Road, Freckleton	Farmhouse	Post-medieval
KM0697	'By-the-Way', Fleetwood Road	House	Post-medieval
KM0698	Guild Farmhouse, Fleetwood Road	Barn	Medieval
KM0699	Plane Tree Farmhouse, Thistleton	Farmhouse	Post-medieval
KM0700	Malt Kiln Farmhouse, Thistleton	Farmhouse	Post-medieval
KM0701	Ivy House, Thistleton	Farmhouse	Post-medieval
KM0702	Ash Tree House, 2 Church Street, Kirkham	House	Post-medieval
KM0703	4 Church Street, Kirkham	House	Post-medieval
KM0704	Sundial at Church of St Michael, Church Street, Kirkham	Sundial	Medieval
KM0705	Tomb of E and E Birley, Church of St Michael, Church Street, Kirkham	Chest Tomb	Post-medieval
KM0706	Tomb of W Birley, Church of St Michael, Church Street, Kirkham	Tomb	Post-medieval
KM0707	King tomb, Church of St Michael, Church Street, Kirkham	Chest Tomb	Post-medieval
KM0708	4 and 6, Freckleton Street	Inn	Post-medieval
KM0709	32 Poulton Street, Kirkham	House	Post-medieval
KM0710	Trustee Savings Bank, Poulton Street	Charity School	Post-medieval
KM0711	Poulton Street, Kirkham	Telephone Box	Post-medieval
KM0712	14 Preston Street, Kirkham	House	Post-medieval
KM0713	48 Hillside, Preston Street, Kirkham	House	Post-medieval
KM0714	Church of St John the Evangelist, Ribby Road, Kirkham	Wall	Post-medieval
KM0715	Grammar School, Ribby Road, Kirkham	Grammar School	Post-medieval
KM0716	Railway Hotel, Station Road, Kirkham	Hotel	Post-medieval
KM0717	Christ Church, Fleetwood Road, Wesham	Church	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0718	War Memorial, Garstang Road, Wesham	War memorial	Post-medieval
KM0719	Bradkirk Hall Farmhouse, Weeton Road, Wesham	Farmhouse	Post-medieval
KM0720	Canal bridge No 22, Lea Town	Canal Bridge	Post-medieval
KM0721	Ward's House Bridge (No 23), Lea Town	Canal Bridge	Post-medieval
KM0722	Salwick Hall Bridge (No 24), Salwick	Canal Bridge	Post-medieval
KM0723	Wilsons Bridge (No 25), Salwick	Canal Bridge	Post-medieval
KM0724	Salwick Bridge (No 26), Salwick	Canal Bridge	Post-medieval
KM0725	Six Mile Bridge (No 27), Salwick	Canal Bridge	Post-medieval
KM0726	Six Mile Bridge, Salwick	Milestone	Medieval
KM0727	New Bridge, Salwick	Canal Bridge	Post-medieval
KM0728	Kellets Bridge (No 29), Blackleach	Canal Bridge	Post-medieval
KM0729	Ribby Hall, Ribby Road, Ribby	House	Post-medieval
KM0730	Church of St Nicholas, Wrea Green	Church	Post-medieval
KM0731	Church Grove House, 2 Ribby Road, Wrea Green	House	Post-medieval
KM0732	Hawthorn House, 27 Ribby Road, Wrea Green	Farmhouse	Post-medieval
KM0733	Church of St Anne, Church Road, Singleton	Lych Gate	Post-medieval
KM0734	Church Road and Miller Road, Singleton	Fire Engine House	Post-medieval
KM0735	Treales CE Primary School, Church Road, Treales	School	Post-medieval
KM0736	Derby Arms Inn, Church Road, Treales	Farmhouse	Post-medieval
KM0737	Rhododendron Cottage, Cross Lane, Moorside, Treales	Cruck House	Medieval
KM0738	Pointer House, Higham Road, Wharles	Farmhouse	Post-medieval
KM0739	Ivy Dene Farm, Moorside Lane, Moorside, Treales	Farmhouse	Post-medieval
KM0740	Smithy Farmhouse, Kirkham Road, Treales	Farmhouse	Post-medieval
KM0741	Church of St Michael, Church Road, Weeton	Church	Post-medieval
KM0742	Barn (Crooke Barn) approximately 50m west of Church Road End Farmhouse, Mythop Road, Weeton	Cruck Barn	Medieval
KM0743	Willow Cottage, Ballam Road, Wrea Green	House	Medieval
KM0744	Westby House, Ballam Road, Westby	Barn	Medieval
KM0745	Church of St Anne, Weeton Road, Great Plumpton	Church	Post-medieval
KM0746	Moon's Bridge (No 36), Hollowforth Lane	Canal Bridge	Post-medieval
KM0747	Bell Fold Bridge (No 35), Plumpton Lane, Woodplumpton	Canal Bridge	Post-medieval
KM0748	Whinnyfield Bridge (No 34) Woodplumpton	Canal Bridge	Post-medieval
KM0749	Singleton Hall, Lodge Lane, Singleton	Icehouse	Post-medieval
KM0750	Milestone approximately 50 m North of Helm's Farm	Milestone	Post-medieval
KM0751	St Anne's Church, Woodplumpton	Stocks	Medieval
KM0752	Broughton Churchyard	Stocks	Medieval
KM0753	Adamsons Farm, Eaves	Farmhouse	Post-medieval
KM0754	Fox's Farm, Hardhorn	Farmhouse	Post-medieval
KM0755	Knowsley Farmhouse, Weeton	Farmhouse	Post-medieval
KM0756	Moons Farm, Hollowforth	Farmhouse	Post-medieval
KM0757	Elswick, Church and Sunday school	Chapel	Post-medieval
KM0758	Mains Hall, Mains Lane, Little Singleton	House	Post-medieval
KM0759	Near Keyfold, Broughton	Pound	Medieval
KM0760	Church of St Mary, Fernyhalgh Lane, Broughton	Church	Post-medieval
KM0761	Church of St John the Evangelist, Ribby Road, Kirkham	Church	Post-medieval
KM0762	Brook Mill Pond, Kirkham, Lancashire	Mill Pond	Post-medieval
KM0763	Brook Farm, Dowbridge	Well	Post-medieval
KM0764	Book Mill, Cotton Mill, Kirkham	Mill	Post-medieval
KM0765	Wesham Cotton Mill	Mill	Post-medieval
KM0766	Moss House Farm, Peel Hill, Weeton-with-Preese	Bank	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0767	Mythop Hall Cottages, Mythop, Weeton with Preese	Earthwork	Post-medieval
KM0768	Mythop Hall, Mythop	Ridge and Furrow	Post-medieval
KM0769	Mythop Hall, Weeton-with-Preese	Palaeochannel	Unknown
KM0770	Halls House Farm, Staining	Pond	Post-medieval
KM0771	Hawes House Farm, Newton	Pond	Post-medieval
KM0772	Hawes House Farm, Newton	Trackway	Post-medieval
KM0773	Todderstall Hall, Newton	Pond	Post-medieval
KM0774	Todderstall Hall, Staining	Pond	Post-medieval
KM0775	Todderstaffe Hall, Staining	Pond	Post-medieval
KM0776	Hawes House Farm, Staining	Pond	Post-medieval
KM0777	Todderstaffe Woods, Newton	Watercourse	Unknown
KM0778	Fairfield cottages to Todderstaffe Wood, Newton	Unassigned	Unknown
KM0779	Todderstaffe Hall, Staining	Earthwork	Post-medieval
KM0780	Todderstaffe Hall	Pond	Post-medieval
KM0781	Garstang Road, Little Singleton	Ridge and Furrow	Post-medieval
KM0782	Greenways Nursery, Little Singleton	Ridge and Furrow	Unknown
KM0783	Singleton Park, Singleton	Pond	Post-medieval
KM0784	Rogue Wood, Singleton	Sand Pit	Post-medieval
KM0785	Rouge Wood, Singleton	Ridge and Furrow	Unknown
KM0786	Little Singleton	Pond	Post-medieval
KM0787	Little Singleton	Pond	Post-medieval
KM0788	Plough Marks, Kennel Woods, Singleton	Ridge and Furrow	Post-medieval
KM0789	Game Farm, Station Road, Singleton	Pond	Post-medieval
KM0790	Game Farm, Station Road, Singleton	Clay Pit	Post-medieval
KM0791	Avenham Wood, Station Road, Singleton	Trackway	Post-medieval
KM0792	Avenham Wood, Singleton	Pond	Post-medieval
KM0793	Knowle Hill Wood, Singleton	Trackway	Post-medieval
KM0794	Singleton Lodge, Singleton	Ridge and Furrow	Post-medieval
KM0795	Swarbrick Hall, Weeton camp, Weeton-with-Preese	Pond	Post-medieval
KM0796	Swarbrick Hall, Weeton camp, Weeton	Pond	Post-medieval
KM0797	Stanley Bank, Weeton	Ridge and Furrow	Post-medieval
KM0798	Little Tarnbrick Farm, Kirkham	Pond	Post-medieval
KM0799	Parkwood Nurseries, Wrea Green	Pond	Post-medieval
KM0800	Parkwood Nurseries, Wrea Green	Pond	Post-medieval
KM0801	Prospect Farm, Ribby With Wrea	Pond	Post-medieval
KM0802	Fishers Slack Wood, Singleton	Earthwork	Unknown
KM0803	Fishers Slack Wood, Singleton	Pond	Post-medieval
KM0804	Kirkham i'th' Fields Farm, Singleton	Field Boundary	Post-medieval
KM0805	Fisher's Slack Wood, Singleton	Pond	Post-medieval
KM0806	Fisher's Slack Cottage, Singleton	Ridge and Furrow	Post-medieval
KM0807	East of Round Wood, Singleton	Pond	Post-medieval
KM0808	Duplicate entry	-	-
KM0809	Tile Croft Wood, Thistleton	Ridge and Furrow	Post-medieval
KM0810	Copthorn Wood /Rogue Wood, Singleton	Earthwork	Unknown
KM0811	Brackenscales Farm, Singleton	Pond	Post-medieval
KM0812	Brackenscales Farm, Singleton	Pond	Post-medieval
KM0813	Thistleton House, Thistleton	Road	Post-medieval
KM0814	Thistleton Lodge, Thistleton	Earthwork	Unknown
KM0815	Thistleton House, Thistleton	Earthwork	Unknown
KM0816	Thistleton Lodge, Thistleton	Clay Pit	Post-medieval
KM0817	Thistleton Lodge, Thistleton	Field Boundary	Post-medieval
KM0818	Bracken Scales Farm, Greenhalgh	Pond	Post-medieval
KM0819	Moss House Farm, Weeton	Pond	Unknown
KM0820	Manor Farm, Singleton	Earthwork	Unknown

Database Reference Number	Site Name	Monument Type	Period
KM0821	Kirkham i'th' Fields Farm, Thistleton	Pond	Post-medieval
KM0822	Fisher's Slack Woods, Thistleton	Pond	Post-medieval
KM0823	Kineton Lodge, Weeton	Earthwork	Post-medieval
KM0824	Derby Hill, Weeton	Pond	Post-medieval
KM0825	Duplicate entry	-	-
KM0826	Slack Wood, Weeton	Clay Pit	Post-medieval
KM0827	Stanley House Farm, Weeton	Pit	Post-medieval
KM0828	Hill House, Weeton	Pond	Post-medieval
KM0829	Westby Wood, Weeton	Earthwork	Unknown
KM0830	North of Westby Reservoir, Great Plumpton	Clay Pit	Post-medieval
KM0831	North of Westby Reservoir, Great Plumpton	Brick Works	Post-medieval
KM0832	North of Westby Reservoir, Great Plumpton	Palaeochannel	Unknown
KM0833	Inglenook Farm, Kirkham	Earthwork	Post-medieval
KM0834	Prospect Farm, Wrea Green	Pond	Post-medieval
KM0835	Copper house Farm, Kirkham	Pond	Post-medieval
KM0836	Swimza Butts Farm, Freckleton	Earthwork	Unknown
KM0837	Crooks Plantation, Kirkham	Ridge and Furrow	Modern
KM0838	Crooks Plantation, Kirkham	Ridge and Furrow	Modern
KM0839	Lund Vicarage, Newton with Scales	Pond	Post-medieval
KM0840	Clifton Mill Farm, Clifton	Palaeochannel	Post-medieval
KM0841	East of Cardwells Farm, Treales	Gravel Pit	Unknown
KM0842	Molly's Plantation, Clifton	Bank	Unknown
KM0843	Grange Farm, Clifton	Earthwork	Unknown
KM0844	Bucks Moss Wood, Clifton	Field Boundary	Post-medieval
KM0845	Bucks Moss Wood, Clifton	Earthwork	Unknown
KM0846	Moss Side Farm, Treales	Pond	Post-medieval
KM0847	Kays Farm, Dagger Road, Woodplumpton	Earthwork	Unknown
KM0848	Locking Stoops, Kellets Bridge, Black Leach	Earthwork	Unknown
KM0849	Locking Stoops, Kellets Bridge, Black Leach	Pond	Post-medieval
KM0850	Locking Stoops, Kellets Bridge, Black Leach	Field Boundary	Post-medieval
KM0851	Locking Stoops, Kellets Bridge, Black Leach	Road	Post-medieval
KM0852	Locking Stoops, Kellets Bridge, Black Leach	Pond	Post-medieval
KM0853	Locking Stoops, Kellets Bridge, Black Leach	Pond	Post-medieval
KM0854	Stanley Bridge	Earthwork	Unknown
KM0855	Hale Hall, Wharles	Earthwork	Post-medieval
KM0856	Stanley Lodge, Wharles	Pond	Unknown
KM0857	Hale Hall, Wharles	Field Boundary	Post-medieval
KM0858	East of Stanley Lodge, Wharles	Pond	Post-medieval
KM0859	East of Stanley Lodge, Wharles	Pond	Post-medieval
KM0860	East of Stanley Lodge, Wharles	Field Boundary	Post-medieval
KM0861	Willacy Lane End, Catforth	Field Boundary	Post-medieval
KM0862	Mellings Farm, Catforth	Trackway	Post-medieval
KM0863	Mellings Farm, Catforth	Field Boundary	Post-medieval
KM0864	Mellings Farm, Catforth	Field Boundary	Post-medieval
KM0865	Moss House	Pond	Post-medieval
KM0866	Moss House Lane, Catforth	Palaeochannel	Post-medieval
KM0867	Wolf Farm, Catforth	Palaeochannel	Unknown
KM0868	Higham Grange, Inskip	Earthwork	Post-medieval
KM0869	Higham Grange, Inskip	Field Boundary	Post-medieval
KM0870	Higham Grange, Inskip	Pond	Post-medieval
KM0871	Walker House Farm, Inskip	Earthwork	Unknown
KM0872	Higham Grange, Inskip	Earthwork	Unknown
KM0873	Higham Grange, Inskip	Pond	Post-medieval
KM0874	Two Shoots Plantation, Inskip	Earthwork	Unknown
KM0875	Woodsfold Bridge, Lewth	Field Boundary	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0876	New Woodsfold Farm, Lewth	Palaeochannel	Unknown
KM0877	Lyndale Fields, Lewth	Earthwork	Unknown
KM0878	Lyndale Fields, Lewth	Earthwork	Post-medieval
KM0879	New Mill Brook, west of Hankinson House, Lewth	Palaeochannel	Unknown
KM0880	Cuddy Hill, Lewth	Pond	Post-medieval
KM0881	Higham Nook (Airfield), Lewth	Earthwork	Post-medieval
KM0882	Higham Nook (Airfield), Lewth	Pond	Post-medieval
KM0883	Stanley Farm, Roseacre	Pond	Post-medieval
KM0884	Nigget Wood, Stanley Farm, Roseacre	Pond	Post-medieval
KM0885	Higher Slip Inn Farm, Inskip	Field Boundary	Post-medieval
KM0886	Hodgkinson's Farm, Inskip	Pond	Post-medieval
KM0887	Walker House Farm, Inskip	Pond	Post-medieval
KM0888	Walker House Farm, Inskip	Earthwork	Unknown
KM0889	Porters Farm, Inskip	Palaeochannel	Unknown
KM0890	Grove House, Inskip	Ridge and Furrow	Post-medieval
KM0891	Toplands Farm, Woodplumpton	Pond	Unknown
KM0892	Threllfalls Farm, Broughton	Earthwork	Unknown
KM0893	West of Bridge Bridge, Broughton	Earthwork	Unknown
KM0894	Crow Hall, Broughton	Earthwork	Unknown
KM0895	Barton Park	Pond	Unknown
KM0896	Bank Hall Farm	Field Boundary	Unknown
KM0897	War Memorial, Garstang Road, Broughton	Pond	Post-medieval
KM0898	Bank Hall Farm Broughton	Pond	Unknown
KM0899	Broughton House, Broughton	Earthwork	Unknown
KM0900	Yates's Farm, Broughton	Pond	Unknown
KM0901	Old Hall Park, Broughton	Pond	Unknown
KM0902	Orchard Farm	Pond	Post-medieval
KM0903	New Chingle Hall, Haighton Green	Earthwork	Post-medieval
KM0904	New Chingle Hall, Haighton Green	Ridge and Furrow	Post-medieval
KM0905	New Chingle Hall, Haighton Green	Pond	Post-medieval
KM0906	New Chingle Hall, Haighton Green	Field Boundary	Post-medieval
KM0907	New Chingle Hall, Haighton Green	Pond	Post-medieval
KM0908	New Chingle Hall, Haighton Green	Field Boundary	Post-medieval
KM0909	Beesley House Farm	Pond	Unknown
KM0910	South of Whitehead Farm, Whittington	Pond	Unknown
KM0911	Primrose Farm, Haighton	Building	Unknown
KM0912	Primrose Farm, Haighton	Pond	Unknown
KM0913	Simpson House Farm, Haighton Top	Pond	Unknown
KM0914	Edmondson's Farm, Haighton Top	Pond	Unknown
KM0915	Rose Acre Wood	Pond	Unknown
KM0916	Dean House, Broughton	Pond	Post-medieval
KM0917	Dean House, Goosnargh	Pond	Unknown
KM0918	Cockshoot Wood, Preston	Pond	Post-medieval
KM0919	'Sea Mark' Haighton Top	Ridge and Furrow	Post-medieval
KM0920	'Sea Mark' Haighton Top	Pond	Post-medieval
KM0921	South of Whitehead Farm, Haighton top	Ridge and Furrow	Post-medieval
KM0922	Whitehead Farm, Lea Town	Ridge and Furrow	Post-medieval
KM0923	Hallsall's Farm	Ridge and Furrow	Post-medieval
KM0924	Quakers Bridge, Lea Town	Pond	Post-medieval
KM0925	Earles Farm, Lea Town	Pond	Post-medieval
KM0926	Earles Farm, Lea Town	Palaeochannel	Unknown
KM0927	Moor Hall Farm, Tanterton	Pond	Unknown
KM0928	Lawton House, Lower Bartle	Earthwork	Post-medieval
KM0929	Brookfield Farm, Higher Bartle	Field Boundary	Post-medieval

Database Reference Number	Site Name	Monument Type	Period
KM0930	Haydock Farm, Nog Tow	Pond	Unknown
KM0931	East of Adamson Farm	Earthwork	Unknown
KM0932	Swillbrook Grange, Swillbrook	Field Boundary	Post-medieval
KM0933	Swillbrook Grange, Swillbrook	Earthwork	Unknown
KM0934	Carrot Wood, Wesham	Earthwork	Unknown
KM0935	Mee Farm, Treales	Sand Pit	Post-medieval
KM0936	Hall Cross Farm, Freckleton	Pond	Post-medieval
KM0937	Newfold Farm, Kirkham	Pond	Post-medieval
KM0938	Dale Farm, Kirkham	Field Boundary	Post-medieval
KM0939	Dale Farm, Kirkham	Pond	Post-medieval
KM0940	Fairfield Farm, Kirkham	Pond	Post-medieval
KM0941	Windtop Farm, Ribby-with-Wrea	Pond	Post-medieval
KM0942	Wood View Farm, Woodplumpton	Field Boundary	Post-medieval
KM0943	Wood View Farm, Woodplumpton	Pond	Post-medieval
KM0944	Inglenook Farm, Kirkham	Pond	Post-medieval
KM0945	Westby Wood, Woodplumpton	Pond	Post-medieval
KM0946	Westby Wood, Woodplumpton	Trackway	Post-medieval
KM0947	Westby Wood, Woodplumpton	Pond	Post-medieval
KM0948	Westby Wood, Woodplumpton	Ridge and Furrow	Post-medieval
KM0949	Fox Lane Farm, Wrea Green	Pond	Post-medieval
KM0950	Willows Farm, Wrea Green	Ridge and Furrow	Post-medieval
KM0951	Willows Farm, Wrea Green	Pond	Post-medieval
KM0952	Fox Lane Ends Farm, Wrea Green	Pond	Post-medieval
KM0953	Corner Farm, Great Plumpton	Pond	Post-medieval
KM0954	Wood View Farm, Great Plumpton	Earthwork	Post-medieval
KM0955	Ream Hills Farm, Mythop Bridge, Weeton-with-Preese	Earthwork	Unknown
KM0956	Ream Hills Farm, Mythop Bridge, Weeton-with-Preese	Clay Pit	Post-medieval
KM0957	Knowle Hill Wood, Singleton	Pond	Post-medieval
KM0958	Singleton Carr, Singleton	Pond	Unknown
KM0959	Gamekeeper's cottages, Mile Road, Singleton	Pond	Unknown
KM0960	Thistleton House, Thistleton	Pond	Unknown
KM0961	Medlar Fall Farm	Pond	Unknown
KM0962	Bell Fold, Wood Plumpton	Pond	Unknown
KM0963	Catforth Hall, Catforth, Woodplumpton	Pond	Post-medieval
KM0964	Mowbreck Hall Park, Caravan Park, Kirkham	Ridge and Furrow	Post-medieval
KM0965	Mowbreck Hall Park, Caravan Park, Kirkham	Field System	Post-medieval
KM0966	Mowbreck Hall Park, Caravan Park, Kirkham	Ridge and Furrow	Post-medieval
KM0967	Many Pits Woods, Highfield Farm, Lea Town	Pond	Post-medieval
KM0968	Harbour Farm, Lea Town	Gravel Pit	Post-medieval
KM0969	Kellets Bridge, Black Leach, Woodplumpton	Drain	Post-medieval
KM0970	Woodfield House, Woodplumpton	Pond	Post-medieval

FIGURES

27. Flints and funerary monuments/urns found in the area of Whitprick Hill
28. Distribution of prehistoric monuments along palaeochannel north of Hardhorn Village, with additional topographic detail from available LiDAR coverage
29. Finds in the area of Salwick Hall
30. Roman monuments around Kirkham
31. Distribution of Roman monuments within the study area
32. Roman quernstone findspots near Wharles
33. Distribution of medieval monuments within the study area
34. Concentration of medieval ceramic findspots near Crossmoor
35. Distribution of deserted medieval villages within the study area
36. Distribution of medieval 'religious, ritual and funerary' monuments within the study area
37. Distribution of medieval domestic sites within the study area
38. Distribution of medieval findspots within the study area
39. Distribution of medieval field systems, ridge and furrow, and farmhouses within the study area
40. Distribution of medieval industrial monuments within the study area
41. Distribution of post-medieval monuments within the study area
42. Distribution of post-medieval farmhouses within the study area
43. Distribution of post-medieval industrial monuments within the study area
44. Distribution of post-medieval extraction pits within the study area
45. Distribution of Roman monuments superimposed onto geology mapped by the British Geological Survey (BGS)
46. Distribution of medieval monuments superimposed onto geology mapped by the BGS
47. HLC polygons within the study area, classified by the overall density of monuments per polygon
48. HLC polygons within the study area, classified by density of prehistoric monuments
49. HLC polygons within the study area, classified by density of Roman monuments
50. HLC polygons within the study area, classified by density of medieval monuments
51. HLC polygons containing prehistoric, Roman, and medieval monuments
52. HLC polygons within the study area, classified by level of below-ground disturbance
53. Distribution of Roman monuments, compared to the line of the Roman roads
54. Potential for prehistoric flint finds and scatters within the study area
55. Potential for Roman monuments within the study area
56. Potential for medieval monuments within the study area
57. Potential for domestic monuments within the study area
58. Areas of overall threat to monuments of all periods