ALSF AGGREGATE EXTRACTION IN THE RIBBLE VALLEY

Preliminary Report
Stage 1

Oxford Archaeology North

THE UNIVERSITY of LIVERPOOL

Department of Geography

August 2005

English Heritage

NGR: SD 586306

CONTENTS

1. INTRODUCTION

1.1 CONTRACT BACKGROUND

1.1.1 This report presents the preliminary results of Stage 1 of the ALSF Ribble Valley Aggregate Extraction project. The work was undertaken as a joint project between University of Liverpool and Oxford Archaeology North (OA North), and was funded by the Aggregates Levy Sustainability Fund and under the overall management of English Heritage. The responsibility of the project was split such that the geological and geomorphological elements of the project were undertaken by Liverpool University and the archaeological elements were undertaken by OA North; the palaeobotanic work was split between both organisations.

1.1.2 The programme of work is as defined within a project design (March 2003) submitted by University of Liverpool and OA North. Stage 1 represents the primary data capture part of the project, and entailed the setting up of the project, the GIS and the winning of geological / geomorphological, archaeological and palaeoenvironmental data.

2. RIBBLE AGGREGATE EXTRACTION PRELIMINARY ASSESSMENT

2.1 CURRENT AND PROJECTED AGGREGATE EXTRACTION

2.1.1 The Ribble catchment falls within the remit of two of the Regional Aggregates Working Parties (RAWP's): (1) North-west of England and (2) Yorkshire and Humberside. The 2003/2004 Report of the North-west England Regional Aggregate Working Party (RAWP) shows that within Lancashire the primary aggregates are derived from crushed rock sources (88%) (Carboniferous limestone and sandstone), with lesser amounts derived from sand and gravel (10%), and marine aggregates (2%) (Table 1).

	(AM 92)	(AM 93)	(AM 94)	(AM 95)	(AM 96)	(AM 97)	(AM 98)	(AM 99)	(AM OO)	(AM 01)	(AM 02)	(AM 03)
1. LIMESTONE[11,]												
Cumbria	4.2	4.1	4.8	3.8	3.2	3.5	3.2	3.4	3.4	3.0	2.9	2.6
Lancashire	3.8	3.7	4.3	3.5	2.9	3.0	2.7	2.6	2.7	2.6	2.7	2.6
TOTAL - LIMESTONE	8.0	7.8	9.1	7.3	6.1	6.5	5.9	6.0	6.1	5.6	5.6	5.2
2. SANDSTONE & IGNEOUS												
Cumbria[(2)]	0.7	0.6	0.8	0.8	0.7	0.7	0.8	0.8	1.0	1.1	1.1	1.1
Lancashire	1.6	2.3	2.7	2.8	2.63	2.17	2.1	1.8	1.7	1.9	2.2	1.6
Cheshire [(3)(4)]	0.3	0.6	1.0	0.6	0.44	0.29	0.1	0.1	0.1	0.1	0.01	0.02
GM/M'side/Halton/Warrington[(5)]	1.6	2.0	1.8	1.8	1.6	1.9	1.9	1.8	1.4	1.4	1.3	1.4
TOTAL - SANDSTONE & IGNEOUS ROCK	4.2	5.5	6.3	6.0	5.37	5.06	4.85	4.58	4.2	4.5	4.6	4.12
TOTAL - CRUSHED ROCK	12.2	13.3	15.4	13.3					10.3	10.1	10.2	9.32
3. SAND & GRAVEL												
Cumbria [(2)]	0.8	0.9	1.1	0.9	0.8	0.8	0.9	0.9	0.8	0.7	0.9	1.0
Lancashire	0.8	0.8	0.77	0.8	0.8	0.91	0.66	0.48	0.34	0.47	0.5	0.46
Cheshire [(3) and (4)]	2.6	2.6	3.2	2.9	2.65	2.56	2.3	2.48	2.33	1.7	1.4	1.4
GM/M'side/Halton/Warrington[(5)]	0.45	0.28	0.48	0.33	0.26	0.45	0.3	0.24	0.31	0.23	0.4	0.5
4. TOTAL - LAND WON SAND & GRAVEL	4.65	4.58	5.55	4.93	4.51	4.72	4.16	4.1	3.78	3.1	3.2	3.36
5. MARINE DREDGED												
Cumbria	-	-	-	-	-	-	-	-	-	0.03		0.043
Lancashire	-	-	-	-	-	-	-	0.05	0.07	0.18	0.04	0.11
GM/M'side/Halton/Warrington	0.25	0.22	0.22	0.22	0.25	0.25	0.23	0.24	0.22	0.25	2	0.32
TOTALMARINE SAND & GRAVEL	0.25	0.22	0.22	0.22	0.25	0.25	0.23	0.29	0.29	0.46	0.50	0.47
6. HARBOUR AUTHORITIES SAND AND GRAVEL												
Cumbria											0.05	0.03
TOTAL SAND & GRAVEL	4.9	4.8	5.77	5.15	4.76	4.97	4.39	4.34	4.07	3.56	3.8	3.86
TOTAL AGGREGATE PRODUCTION	17.1	18.1	21.17	18.45	16.23	16.53	15.14	14.92	14.37	13.66	14.0	13.18

(1) Excludes Limestone used for non-aggregate purposes

(2) Cumbria figures includes the Lake District National Park

(3) Prior to 1999 figures included Peak Park within Cheshire

(4) Prior to 1998 figures include Halton/Warrington

(5) Prior to 1998 figures exclude Halton/Warrington

Table 1 - Monitoring of Primary Aggregate Production/Sales: Northwest Region 1992-2003 (million tonnes) (Northwest of England RAWP 2004)

2.1.2 The 2003/2004 Report of the Yorkshire and Humber RAWP shows that aggregate production comprises crushed rock 14.7 Mt (75%), and sand and gravel at 4.8 Mt (25%)

(Table 2 and 3). In the Yorkshire and Humber RAWP region a number of different rock types are worked for aggregate. Of relevance for the Ribble catchment, the oldest of these rock types are the Lower Palaeozoic greywackes ("gritstones") which occur beneath Carboniferous strata in the Yorkshire Dales and are worked to produce high specification aggregate for road surfacing. Also in the region are the Carboniferous Limestone and sandstones of the Pennines which are worked for both aggregate and building stone. Data from the Yorkshire and Humber RAWP show that about a quarter of all primary aggregate sales in the region are from sites in national parks, predominantly from the Yorkshire Dales, and that just under a third of sales come from National Parks and AONBs. Furthermore, over the period from 1997, the proportion of primary aggregate sales from national parks and AONB's shows very little change. Aggregate exploitation within AONB and National Parks is not explicitly stated for the North-west of England RAWP.

	1998	**1999**	**2000**	**2001**	**2002**	**2003**
North Yorkshire	2.6	2.6	2.6	2.6	2.5	2.5
South Yorkshire	1.3	1.1	1.0	1.4	1.4	1.1
West Yorkshire						
East Riding and North Lincolnshire	0.9	0.9	0.8	0.9	0.8	1.0
Marine (Hull)*A	0.4	0.3	0.3	0.3	0.2	0.3*B
TOTAL	**5.2**	**5.0**	**4.7**	**5.2**	**5.0**	**4.8**

Table 2 - Sand and Gravel Aggregate And Non-Aggregate Sales 1998-2003 (million tonnes)

	1998	**1999**	**2000**	**2001**	**2002**	**2003**
- Yorkshire Dales NP	(4.4)	(4.0)	(3.9)	(4.0)	(4.0)	(4.0)
- North York Moors NP	(0.2)	(0.3)	(0.2)	(0.3)	(0.3)	(0.3)
North Yorkshire CC	(4.1)	(4.5)	(3.8)	(3.9)	(4.1)	(3.7)
North Yorkshire	8.7	8.7	7.9	8.2	8.4	8.0
South Yorkshire	3.8	3.1	3.1	3.4	3.2	3.1
West Yorkshire	1.2	1.2	1.0	1.2	1.1	1.2
E Riding	2.7	0.6	0.5	0.5	0.6	0.5
North Lincolnshire		2.6	2.3	2.4	2.5	1.9
TOTAL	**16.3**	**16.1**	**14.9**	**15.8**	**15.8**	**14.7**

Table 3 - Crushed Rock: Aggregate and Non-Aggregate Sales 1998-2003 (million tonnes)

2.1.3 In terms of the reserves within each region this balance between crushed rock and sand and gravel aggregates is maintained. In Yorkshire and Humberside there are adequate permitted reserves of crushed rock in the region and there is limited scope to seek a progressive reduction in the proportion and amount of aggregate production from national parks and AONBs (current and future production is detailed in Table 4). Table 5 gives details of permitted reserves and landbanks of aggregate for the Northwest of England, with again for Lancashire the sand and gravel reserve a fraction of the listed crushed rock reserve. In terms of the Ribble crushed rock appears to be the primary aggregate of choice, with the exception of the lower Ribble around Preston. Furthermore aggregate production includes a large number of active sites within the Forest of Bowland AONB and the Yorkshire Dales National Park.

	Land-won sand and gravel	**Land-won crushed rock**
North Yorkshire **- North Yorkshire CC** **- Yorkshire Dales NP** **- North York Moors NP**	42.1 (42.1) - -	140.8 (74.0) (66.0) (0.8)
South Yorkshire	13.0	53.5
West Yorkshire	5.5	17.8
East Riding	8.3	5.3
North Lincolnshire	4.1	2.6
TOTAL	**73.0**	**220.0**

Table 4 - Sub-Regional Apportionment in the Yorkshire and the Humber Region of the National and Regional Guidelines for Aggregates Provision, 2001 to 2016 (Million Tonnes)

	(AM 92)	(AM 93)	(AM 94)	(AM 95)	(AM 96)	(AM 97)	(AM 98)	(AM 99)	(AM OO)	(AM 01)	(AM 02)	(AM OS)
1. LIMESTONE[1]												
Cumbria [2]	157.6 102.0	169.0	177.6	143.9	111.7	121.9	91.7[3]	111.8	116.7	106.0	102.0	99.2
Lancashire [4]		103.8	93.3	65.9	63.8	63.5	59.4	56.8	54.1	53.9	59.3	57.5
TOTAL - LIMESTONE	259.6	272.8	270.9	209.5	175.5	185.4	151.1	168.6	170.8	159.9	161.3	156.7
2. SANDSTONE and IGNEOUS ROCK												
Cumbria[2]	63.4 73.0	76.1	77.1	76.3	69.6	67.7	66.8	67.5	66.5	65.0	63.0	62.0
Lancashire	2.9 33.6	146.4	151.8	125.0	112.7	105.7	86.0	84.0	73.5	71.1	70.3	68.7
Cheshire [5][6]		8.2 9.8	9.8	9.4	10.2	9.6	8.52	8.4	8.36	6.5	5.6	5.6
GM/M'side/Halton/Warrington[7][8]			27.9	34.9	35.5	32.4	35.33	32.0	30.9	30.2	27.7	22.6
TOTAL - SANDSTONE & IGNEOUS ROCK	172.9	266.2	266.6	245.6	228.0	215.4	196.7	191.9	179.3	172.8	166.6	158.9
TOTAL - CRUSHED ROCK	432.5	539.0	553.7	444.4	403.5	400.8	347.75	360.5	350.1	332.7	327.9	315.6
7. SAND & GRAVEL												
Cumbria [2]	18.7	17.3	15.2	14.1	12.2	13.5	12.2	12.3	11.8	12.0	12.1	11.4
Lancashire	7.0	9.4	9.0	9.5	9.2	8.6	7.38	7.0	6.4	4.6	4.0	3.54
Cheshire[6]	27.5	27.4	29.3	28.3	25.9	24.1	21.7	19.3	17.9	24.6	23.5	19.7*
GM/M'side/Halton/Warrington[7][8]	2.8	4.0	3.2	4.1	3.8	3.5	5.36	7.67	7.1	6.7	7.7	6.7**
TOTAL - SAND and GRAVEL	56.1	58.1	56.7	56.0	51.1	49.7	46.64	46.27	43.2	47.9	47.3	41.34
TOTAL AGGREGATE RESERVES	544.7	597.1	610.4	500.4	454.6	450.5	394.4	406.8	393.3	380.6	375.2	356.9

(1) Excludes Limestone used for non-aggregate purposes

(2) Cumbria includes the Lake District National Park

(3) Nil Return for one site

(4) Data up to and including AM94 includes reserves for non-aggregate purposes, including cement.

(5) Prior to 1998 figures include Peak Park within Cheshire.

(6) Prior to 1998 figures include Halton/Warrington.

(7) Prior to 1998 figures exclude Halton/Warrington.

(8) Data combined to preserve confidentiality

Table 5- Monitoring of Primary Aggregate Permitted Reserves - North West Region 1992-2003 (million tonnes)

2.2 CURRENT WORKINGS WITHIN THE RIBBLE

2.2.1 Aggregate extraction within the Ribble catchment is predominantly of the crushed rock type (Figures 1 and 2). The only sand and gravel site is at Higher Brockholes and targets the Ribble river terrace gravels. Solid rock quarries producing aggregates target Carboniferous sandstones and limestones in the headwaters of the Ribble (Garsdale Limestone Formation), Calder (Old Lawrence Rock) and Darwen (Millstone Grit Group), and in the Forest of Bowland AONB (Pendle Grit Member). Lower Palaeozoic greywackes of the Horton Formation, for high quality road stone, are also used for aggregates in the Upper Ribble. The brief of the current project does not include solid rock reserves used for aggregates.

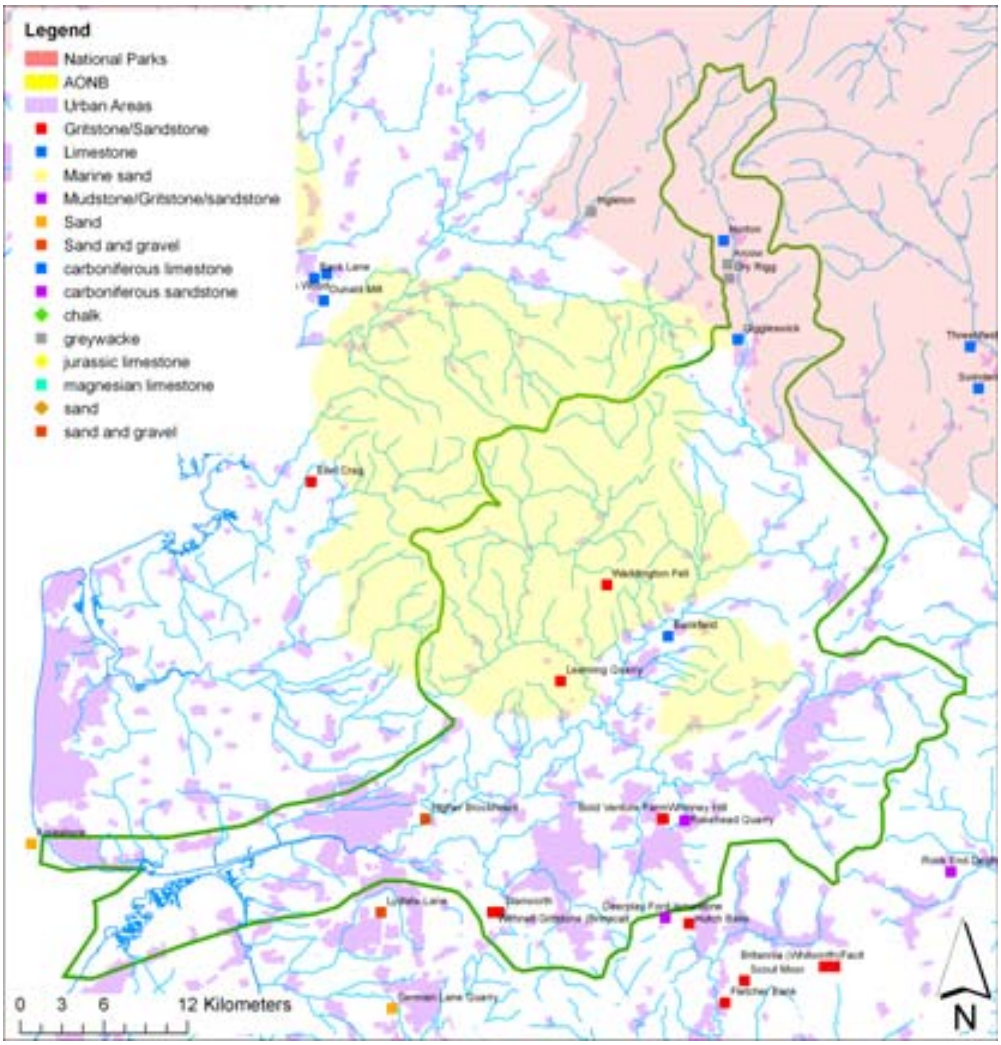

Figure 1 Current aggregate extraction sites within the Ribble

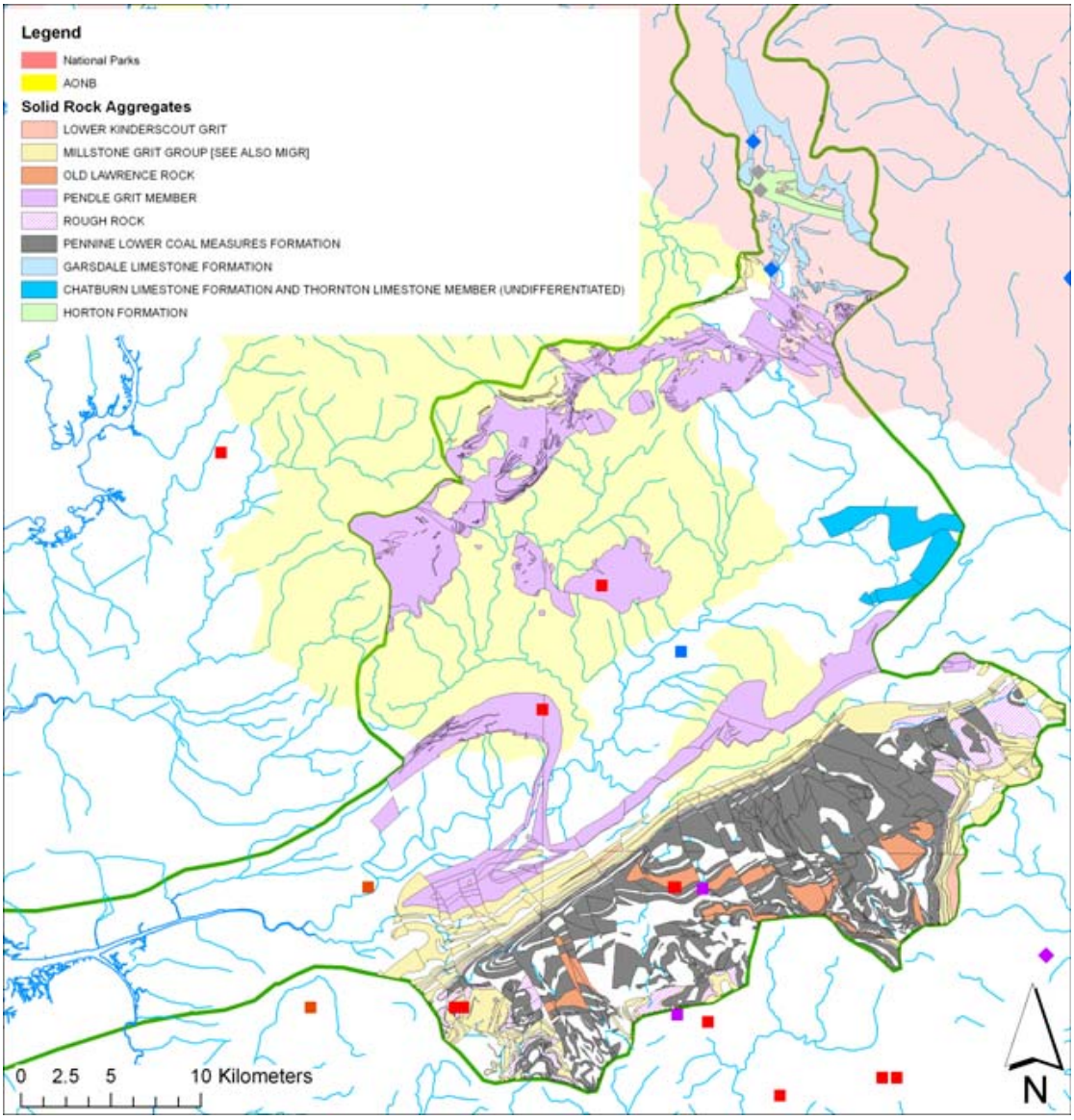

Figure 2 Lithologies currently used for aggregate within the Ribble catchment (BGS,

2.3 SAND AND GRAVEL RESERVES WITHIN THE RIBBLE

2.3.1 Current knowledge of the sand and gravel reserves within Lancashire is based upon two reports commissioned by Lancashire County Council (LCC) Minerals and Waste Group. The first study Department of the Environment Commissioned report "Sand and Gravel Resources of Lancashire" by Allot and Lomax reported in 1990 and the second was by Entec UK Ltd in partnership with the British Geological Survey (BGS). The general consensus (LCC and Minerals Operators) was that the Study by Entec UK Ltd. represents a helpful start and provided a better identification of potential targets for high-grade sand and gravel deposits than the previous Allot and Lomax report. A number of limitations and reservations have been raised about the Entec report including:- concern that the implication is that the areas identified are economic to exploit whereas this is not necessarily the case; the areas identified by the BGS in the Study have not been assessed using borehole investigations to test the quality of the resource available and have only been identified based on the available data; and clearly there is a paucity of high quality published information relating to Lancashire's sand and gravel geology and resources. LCC have

commissioned a more targeted and detailed investigation to be undertaken in stage 2 of the Study, which is intended to assist in providing more information to quantify the initially identified sand and gravel deposits from stage 1. However at present the findings of the Entec report are the best available assessment of sand and gravel aggregate reserves within Lancashire. Sand and gravel extraction is not currently or predicted in the future to be a feature of aggregate extraction in the area of North Yorkshire within the Ribble catchment (pers. comm. North Yorkshire Minerals Planning Officer).

2.4 THE ENTEC REPORT

2.4.1 The Entec Report utilised the BGS's baseline geological data, but was further refined by the BGS to identify those sand and gravel deposits that represented "high quality" material. This was achieved by investigating and interrogating all boreholes within the target polygons, BGS 1:10 000 field slips and Allot and Lomax report (1990). The principal outcomes of the Entec Report were to identify areas (Figure 3) of potential high quality sand and gravel that might warrant further investigation, which divide into the following categories:

- River Valley Sand and Gravel (11 areas);
- Estuary and Foreshore Sand and Gravel (2 areas);
- Fluvio-Glacial and Glacial Sand and Gravel (10 areas);
- Concealed Glacial / Fluvio-Glacial Sand and Gravel (5 areas);
- Weathered Permo-Triassic Sandstone (5 areas).

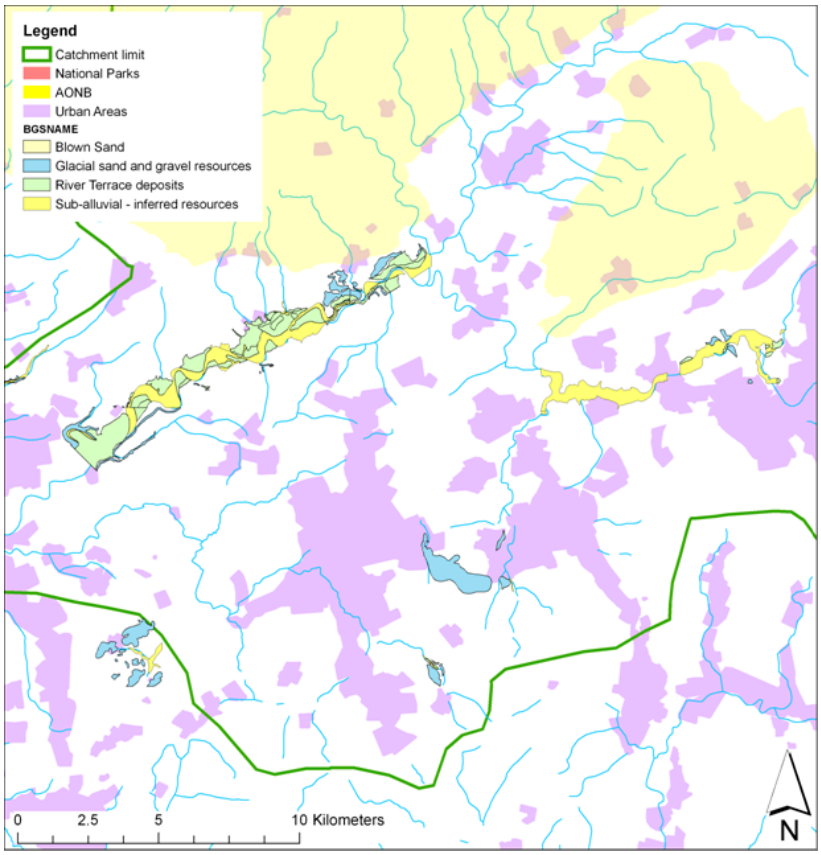

Figure 3: Exert from the Entec mapping that highlights identified sand and gravel aggregates within the Ribble catchment.

2.4.2 One of the principal limitations of this approach is that it focuses upon areas identified in the BGS linework. If the current mapping contains inaccuracies and limitations then these are perpetuated in subsequent studies. The more obvious of these limitations is first that the extensive drift plain that blankets Lancashire is identified as diamict in the BGS mapping, but clearly is likely to include glacial diamicts as well as fluvioglacial sands and gravels. Second, the identification of river terracing is patchy between the different BGS map sheets, and this point is developed in the subsequent section. In addition to this, the BGS utilised their borehole data to identify some new sites outside of the existing polygons identified as sand and gravel within the 1:50000 BGS mapping. Clearly there remains a paucity of high quality published information relating to Lancashire's sand and gravel geology, and there is consider scope for further study.

2.5 LIMITATIONS OF THE AVAILABLE GEOLOGICAL DATA

2.5.1 The two main sources of information about the Ribble river terraces are the BGS mapping and PhD research by Bernando Chiti (Chiti 2004). The BGS mapping (Figure 4) varies in precision through the catchments, varyingly identifying alluvium and river terrace gravels or a suite of river terraces and alluvium. The maximum number of river terraces indicated by the BGS mapping is three, but their location and extent through the catchment is difficult to gauge.

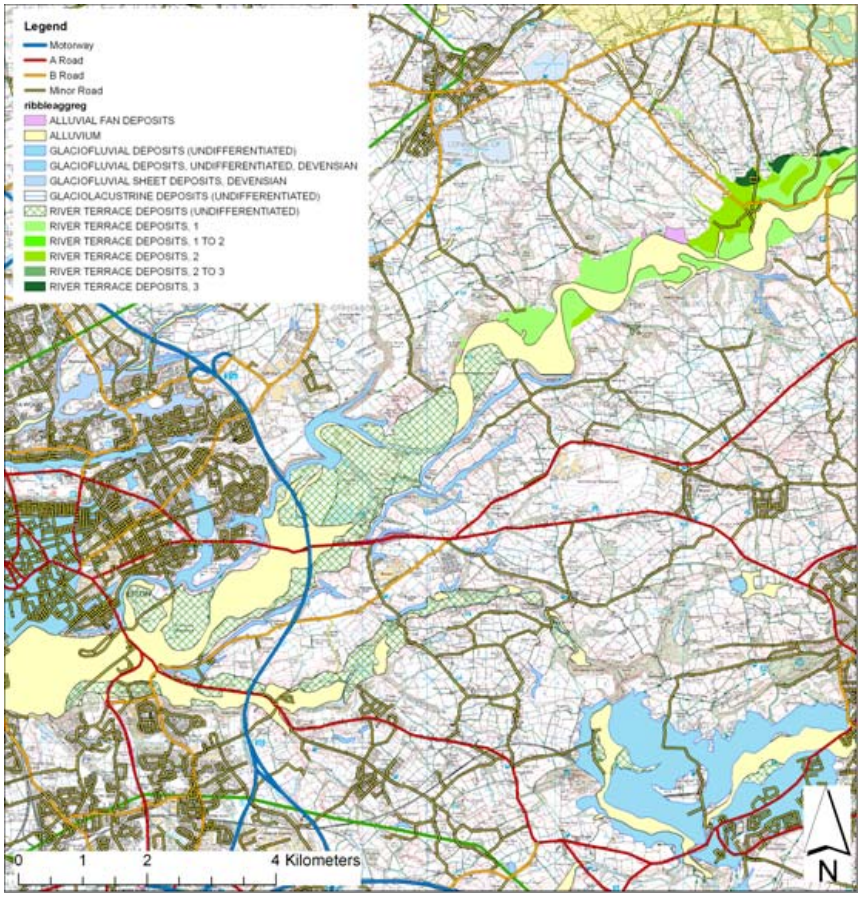

Figure 4 British Geological Survey mapping of the lower Ribble river terraces.

2.5.2 Chiti (2004) mapped in some detail a comparatively short reach between Preston and Ribchester, and identified four river terraces (Figure 5). The Ribchester and Brockholes terraces overlap to some extent with areas identified by the BGS as river terrace, and the Walton and Cuerdale terraces correspond with areas the BGS have mapped as alluvium.

This correspondence works at a general level; closer examination reveals considerable discrepancies, which means that the spatially more extensive mapping carried out by the BGS must be treated with considerable scepticism. Chiti (2004) supports his terrace mapping with detailed stratigraphic investigation, accurate height-range correlation between terraces, geochronological control and palaeoenvironmental interpretation.

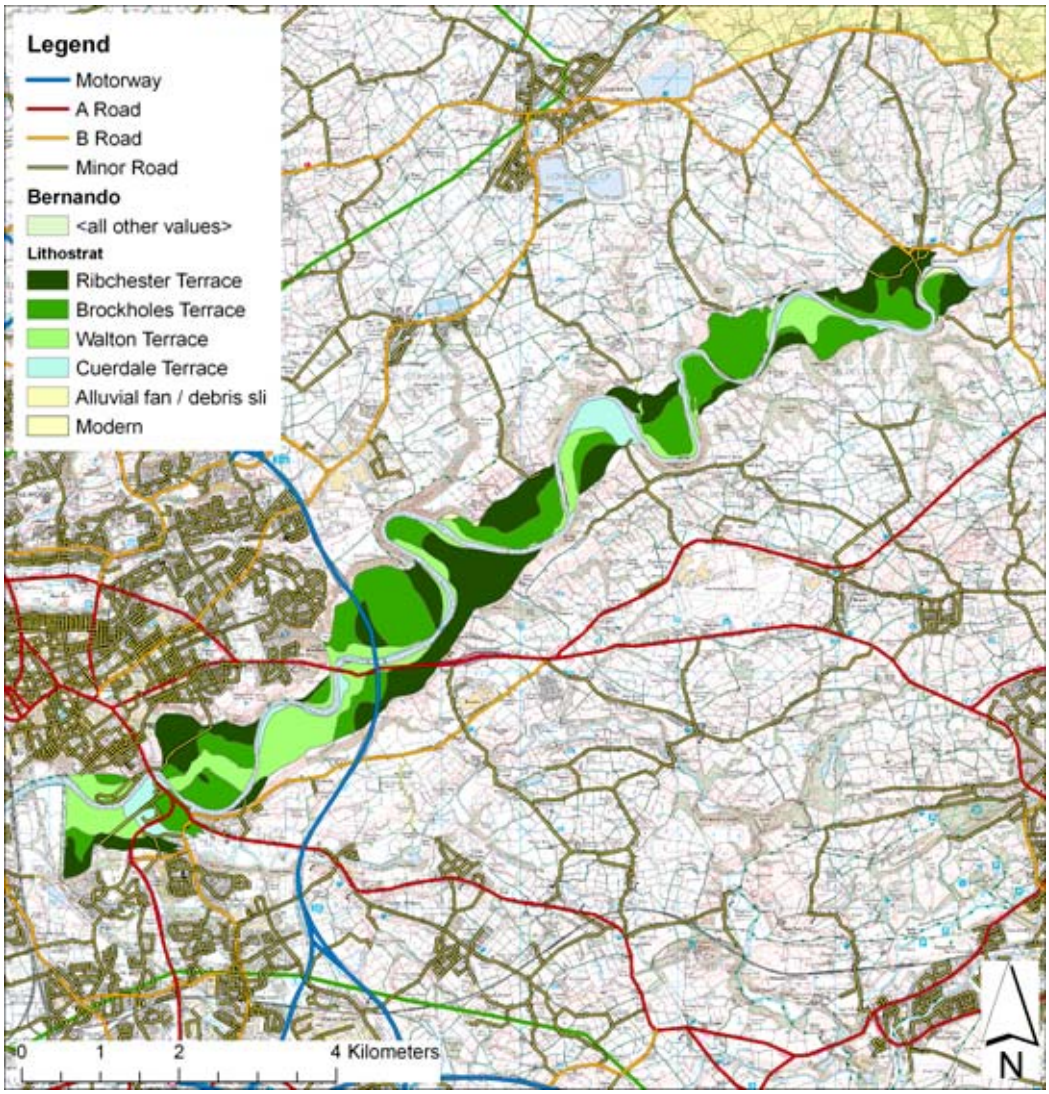

Figure 5 Mapping of the lower Ribble river terraces by Bernando Chiti (2004).

2.5.3 A broad chronological sequence of terrace development has been proposed by Chiti:

- Ribchester Terrace (Undated but Pleistocene age after 15 kyrs BP and before 9000 BP) Deposits comprise large quantities (4 m thickness) of sand and gravel, but with clay units.
- Brockholes Terrace (before 9000 cal. BP) Deposits comprise basal sandy gravels (3 m thickness) overlain by variable silty sandy gravel.
- Walton Terrace (After 4700 cal. BP and before 1900 BP) Deposits typically comprise 1-2 m gravel (possibly older), then an erosional cut and aggradation of fine grained silty-clays 2-3 m thick.
- Cuerdale Terrace (1400-1050 cal. BP) Aggradation of fine grained silty-clays.

2.5.4 From the stratigraphic data it appears that the basal sand and gravel of the Ribchester and Brockholes terraces are the best sources of aggregate. It is not possible to identify this

sequence of terraces from the BGS mapping and unfortunately Chiti's mapping only covers a limited reach within the Ribble.

2.6 DEVELOPING A RIVER TERRACE SEQUENCE FROM LIDAR DATA

2.6.1 Light Detection and Ranging (LIDAR) is an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground. The data are held in millimetre vertical units. Each file covers a 2km by 2km area, and is at 2 metre horizontal grid cell size. Three types of data are available: raw ground height, height normalised by removing vegetation and buildings and the residual between the two previous layers. To assess the geomorphology the ground surface after treatment to remove buildings and vegetation is used and the 2x2km grid data is amalgamated into larger tiles. ARCGIS was used to derive 0.5m altitude contours. The LIDAR Dem and contouring were used in tandem to map the river terracing of the Ribble and Calder (Figure 6). The LIDAR DEM was also interrogated to identify the height range of each terrace fragment. Plotting of these heights (Figure 7) as a height range diagram against thalweg confirms the broad sequence identified by Chiti, and demonstrates that LIDAR offers a methodology for rapid mapping of the river terrace sequence. Comparison of the LIDAR mapping with the BGS, suggests that:

- Areas identified as alluvium including river terraces equivalent to the Ribchester, Brockholes and Walton terraces.
- Areas identified as river terraces 1-3 may not be correctly assigned.
- Areas identified as river terrace undifferentiated can be differentiated.
- There are areas of river terrace not identified as such on the BGS mapping.

2.6.2 Comparison of the LIDAR mapping with Bernando Chiti's suggests that:

- The sequence of terraces is broadly correct.
- The mapping is reasonable accurate, but the LIDAR provide better locational information.
- Certain terrace fragments maybe incorrectly assigned within the Ribchester-Brockholes-Walton-Cuerdale sequence of rivers.
- The LIDAR height-range data appears broadly comparable with recorded height-range data (Chiti, 2004), but there are discrepancies.

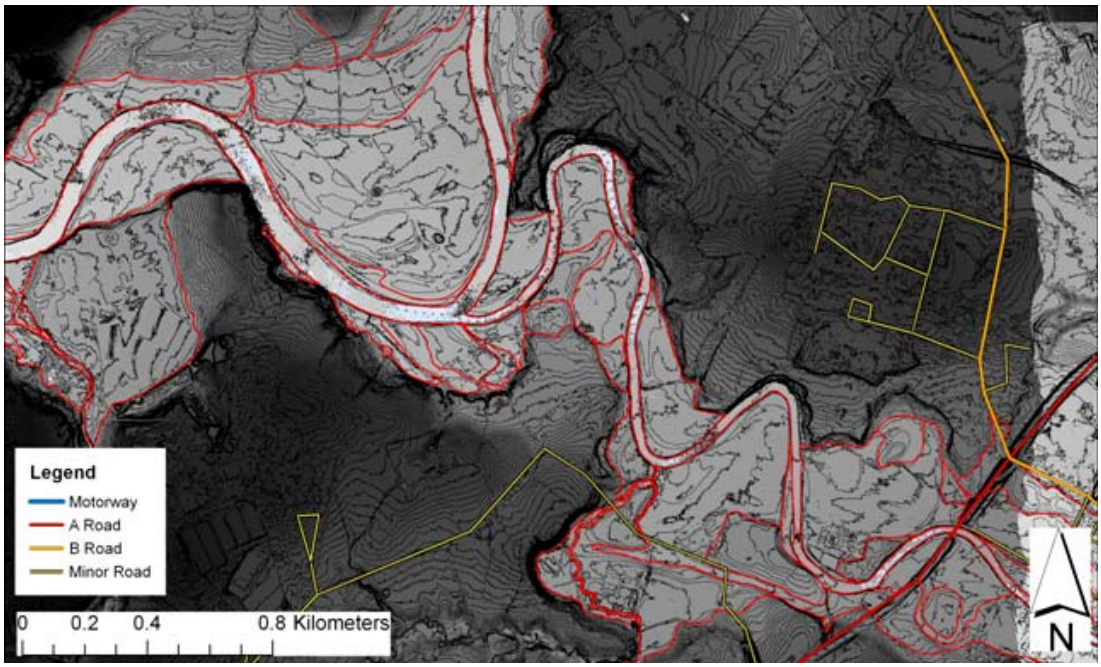

Figure 6 LIDAR based mapping of river terrace fragments at the Ribble – Calder tributary junction.

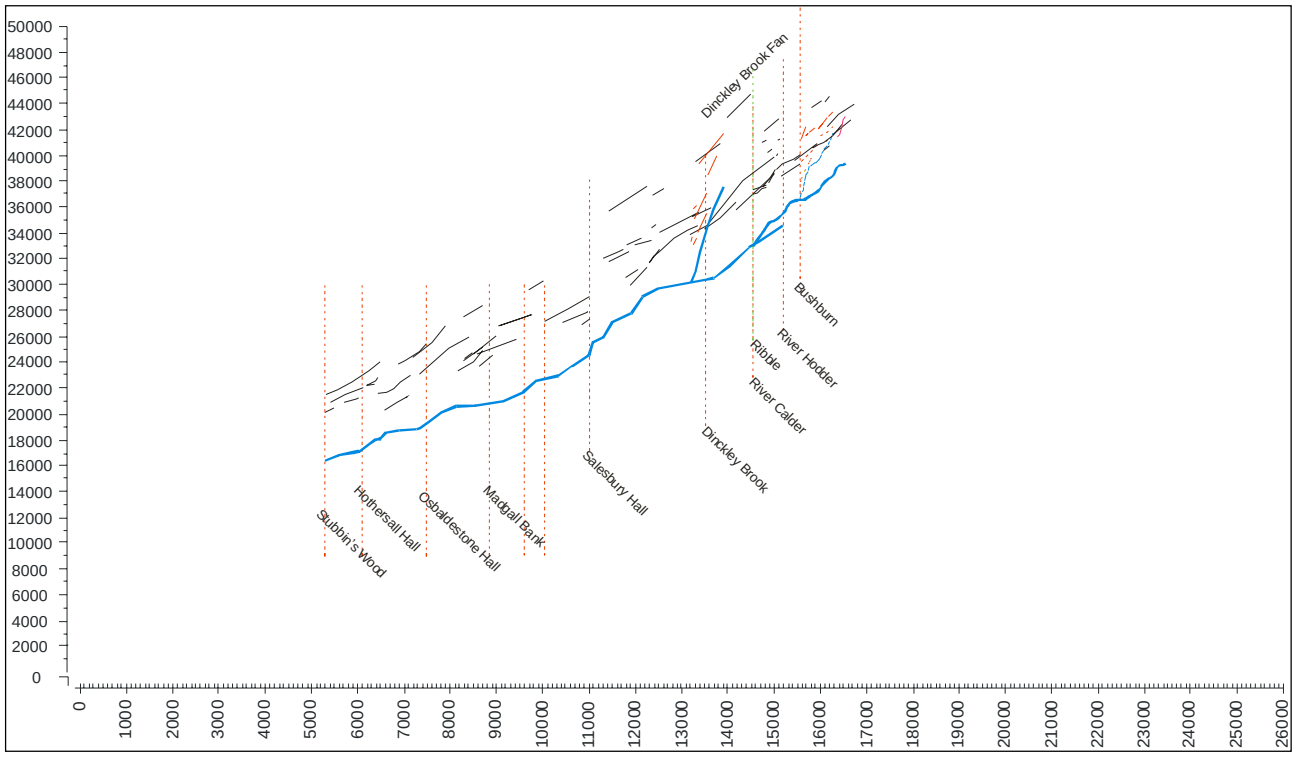

Figure 7 LIDAR based height range data for Ribchester to the Ribble – Calder tributary junction.

2.7 BOREHOLE EVIDENCE: LIMITATIONS OF THE AGGREGATE MAPPING

2.7.1 Boreholes records provide a ready means of confirming the geology depicted on BGS drift maps and the identification of potential aggregate resources. The BGS hold copies of all deposited borehole records at their national headquarters and summary data, including borehole number, location and depth are available on their website. This facility provides a useful 'first search' capability for identifying boreholes of use in the aggregate search

process and over 8,000 boreholes were originally identified in the area of the Ribble catchment. This number was reduced considerable by firstly filtering out all boreholes not located (on the geological maps) in areas underlain by potential aggregate groups (principally glacial sand and gravel and alluvium). A second filter was then applied that excluded all boreholes of less than 5 m depth (the minimum commercially useful thickness of potential aggregate resources) and those identified as confidential. Further filtering based on sampling selective boreholes in areas (such as highways and motorways) where close spacing of boreholes contained redundancy, has reduced this number to some 600. To date, some 250 of these boreholes have been catalogued from BGS records mainly in aggregate priority areas in the lower Ribble. In this case the aim of the borehole analysis is to construct, where borehole distribution and density permits, two or three dimensional models of aggregate distribution in order to assess potential resources.

2.7.2 The process of cataloguing borehole records has demonstrated that, like the comparison of LIDAR boundary data with BGS drift boundaries, BGS maps, 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 located in areas of non-aggregate mineral, such as till, show significant thicknesses of potential mineral hidden by thin surface tills. More modern maps, not available for the Ribble area, are based on the identification of sediment-landform assemblages, which provide more accurate depiction of likely sediment type. As a consequence of these problems a significant number of boreholes, originally rejected as occurring in areas of non-mineral, will have to be brought back into the assessment process.

2.8 THE WORK PROGRAMME

2.8.1 *Phase 1: progress*

8	Collation, incorporate existing geological data	LCC ENTEC report Mineral reserves BGS solid and drift Bernando Chiti's mapping
9	Identify, obtain, aggregate data, boreholes	Boreholes identified Details obtained from BGS archive
10	Analysis of geological datasets – prospect ranking, aggregate value and potential	Constrained by limitations of the mapping datasets
14	Palaeoenvironmental data capture – liase with Sue Stallibrass	
15	HER/archaeological data capture (all eras, nb including industrial era and historic buildings).	
16	Incorp HER, archaeology, palaeo-environmental and aggregate data into GIS	
17	Analysis of integrated geological and heritage datasets. Prepare and deliver of preliminary report and GIS	
18	Trial of GIS with LCC, EH, EnAg, feedback	

2.8.2 ***Phase 2: priorities***

20	Acquisition and incorp of LiDAR. Analysis of LiDAR and AP data sources to provide detailed geomorphology mapping and producing and terrace h/r diagram and assessment of aggregate prospects.	Mapping in progress Height/Range in progress
25	Fieldwork – geomorphological mapping, programme of truthing the existing data and information newly derived from analysis of the LiDAR data. Identify location of exposed sections, palaeochannels, hollows, depositional settings conducive to organic sedimentation.	Priority once LIDAR mapping is complete
26	Fieldwork – surveying by EDM to establish height relationships between river terraces.	Clear need to truth the LIDAR height range data
27	Consult BGS archive for boreholes relevant to understanding the geomorphological, palaeoecological and geoarchaeological potential of the deposits.	Borehole information largely collated, but there
28	Fieldwork to secure a chronosequence for the Ribble terraces Sampling any organic deposits exposed within sections for 14C dating to secure chronology of the Ribble terraces Sampling of fine grain sands for OSL dating to secure chronology of the Ribble terraces Sampling to examine evidence of waterlogging	Bernando Chiti's dating is a start rather than a finished story Preliminary sample is being tested for sensitivity

2.9 PROPOSED VARIATIONS TO THE PROJECT DESIGN

2.9.1 The analysis of the geological data highlights that potential and current areas of aggregate production are not considered in the current project design. To include these as additions to the current project a case for a variation would have to be made.

a) Solid aggregates form the basis for much of the current aggregate extraction and include lithologies that crop out through out the Ribble and in particular occur in the National Park and AONB. These areas are not component of the current project.

b) Analysis of the BGS boreholes indicate that the lowland drift plain that is mapped generically by the BGS as till includes potential reserve of high grade sand and gravel. This area would benefit from detailed mapping of the glacial geomorphology.

3. ARCHAEOLOGICAL, HISTORICAL AND PALAEOENVIRONMENAL DATA COLLECTION AND ASSESSMENT

3.1 GIS DESIGN (TASKS 5-7)

3.1.1 ***Task 5:*** the GIS was built using ArcGIS 9, which is the same system in use at Liverpool University, ensuring full compatibility of data. MIDAS standards for the description of spatial data (English Heritage 2004), and the Archaeological Data Service GIS Guide to Good Practice (Gilling *et al* 1998) were followed in the creation of descriptive data about the GIS layers produced during this stage of the project.

3.1.2 ***Tasks 6-7:*** The database for storing archaeological and palaeoenvironmental event and monument data was built in accordance with the latest MIDAS guidelines (RCHME 1998) using Microsoft Access 97 software. This version has been used as it is both backwards compatible with earlier versions, and can be read by most later versions. A trial version of the database was passed to Lancashire County Council and to Liverpool University to ensure full compatibility with their systems.

3.1.3 ***Further work on database:*** to facilitate the interpretation of the data and additional data capture from the Aerial Photographs and LIDAR datasets some alterations will be made to the database to allow easy interaction between that, the GIS and the image data. In particular this will allow the interpretation of oblique air photos and other images that cannot be georeferenced by allowing the user to click on a feature on the map and have the appropriate image open up for viewing.

3.1.4 A further enhancement will allow a two-way link between the GIS and the database, allowing the user to select records in the database, using a query for example, and zoom straight to them in the GIS, or conversely to click on a feature in the GIS and have the appropriate record appear in the database.

3.2 HISTORIC MAPPING (TASK 12)

3.2.1 Historic Mapping for the project is divided between holdings within the Lancashire County Council Environment Directorate (lower Ribble study area) and the North Yorkshire County Record Office (NYCRO (upper Ribble study area).

3.2.2 ***Lancashire:***

- The Ordnance Survey First Edition 1:10,560 (6" to 1 mile) mapping has been obtained digitally, georeferenced and incorporated together as a single layer image catalogue within the project GIS (Fig 8)
- The Ordnance Survey Second and Third Editions 1:10,560 (6" to 1 mile) mapping has been scanned from base maps provided by the Lancashire Record Office and was undertaken the Lancashire County Council Environment Directorate. The scans provided by LCC have been trimmed, georeferenced and incorporated together as a single layer image catalogue within the project GIS.

Figure 8: First Edition Mapping of Lancashire over Modern Vertical Aerial Photograph

3.2.3 *North Yorkshire:*

- Half of the OS first edition mapping 1:10560 (6" to 1 mile) for the upper Ribble study area has been incorporated and is georeferenced. The remainder has been ordered from the North Yorkshire County Record Office and will arrive on disc as scanned images during the week 15-19 August (this has been delayed as NYCRO is waiting for the repair of its CD writer). Upon arrival it will be georeferenced and incorporated with existing block as a single layer image catalogue within the project GIS.
- There was no 1930's period mapping held by NYCRO for the upper Ribble study area. A full suite of 1:2500 (25" to 1 mile) second edition scale maps were available to be scanned, but were considered to be too early to show significant landscape change since the First Edition, this compounded with the cost of scanning at 1:2500 map scale precluded obtaining this mapping. Following a conversation with David Gander (English Heritage OSLO) it is proposed to utilise the Ordnance Survey/Landmark Digital 'Epoch Mapping', under English Heritages' End User Licence. This would mean the provision of 3rd edition OS mapping for the duration of the project, after which all working copies would be destroyed and the original discs returned.
- Paper copies of tithe maps and apportionments for North Yorkshire will be collected on the 18th August from the NYCRO. The area, though relatively small, is complex as it covers eight parishes; Hellifield, Long Preston, Rathmell, Settle, Giggleswick, Wigglesworth, Langcliffe. and Halton West.

3.3 AERIAL PHOTOGRAPHS (TASK 13)

3.3.1 An almost complete collection of aerial photographs has been obtained for both Lancashire and North Yorkshire; the only outstanding photographs is a small block held by North Yorkshire County Council (for the upper Ribble area) and will be obtained when the North Yorks HER officer returns from leave.

3.3.2 ***Lancashire:***

- HER point data showing the locations of available aerial photography has been incorporated in the project GIS. Approximately 115 scans were made at the Lancashire Record Office, in light of studying the GIS records.
- An additional order was placed, and has been received, from the National Monuments Record, Swindon, based on identifying gaps in the coverage provided by the Lancashire holdings, which included historic RAF coverage.
- A full Vertical Colour Survey has been provided by Lancashire and has been incorporated Into the Project GIS.
- The above have already 'earmarked' several potential new sites (Fig 9)
- A flight plan has been drawn up for JQ to undertake supplementary oblique coverage of both study areas, and is awaiting an appropriate weather window.

Figure 9: Aerial Photograph showing earthworks within curtillage of Sawley Abbey

3.2.3 ***North Yorkshire:***

- HER point data showing the locations of available aerial photography has been incorporated in the project GIS.

- Oblique and vertical photographic coverage used to identify sites from the Dales Mapping Project has been scanned and incorporated and is in the process of being compared to point data holdings to ensure no duplication of scans.
- Several runs of vertical photographs have been identified from the point data sets and will need to be scanned; however Mr Nick Boldrini, HER Record Officer for North Yorkshire Council, is on leave until the 15th august and this cannot be addressed until after this date.

3.4 SMR/ARCHAEOLOGICAL DATA CAPTURE (TASK15)

3.4.1 HER/SMR data has been received from both authorities and has been incorporated into the project GIS; this was thoroughly scrutinised and all duplications were identified. All current monuments and events were recorded and have been issued with PRN or other HER/SMR inventory numbers and includes results of work that has been carried out but not yet accessioned. These results therefore provided a large selection of potentially new monuments and events. The current Holdings show an archaeologically rich and diverse historic landscape within the two study areas.

3.4.2 ***Lancashire:***

The following table summarises Lancashire County Council holdings

Inventory	**Count of records**	**Comments**
Monuments	788	This includes 155 sites identified from the Ribble 1890's Survey. This survey holds no data within the study area that is not already held in the monuments inventory
Listed Buildings	227	Five monuments are duplicated in the monuments table. Inventory includes 12 Grade I, 15 Grade II*, and 200 Grade II
Events	50	Excavations, Surveys, Watching Briefs etc
Portable Antiquities Scheme	6	Artefacts made by the general public and reported to the PAS Liaison Officer
Scheduled Ancient Monuments	20	Repeat entries for parts of the Ribchester Roman Complex
Registered Parks and Gardens	1	Stoneyhurst College grounds partially within study area
Conservation Areas	10	Areas that are within, cross or are immediately adjacent to the study area
Designated Ancient Woodland	77	Areas of woodland coverage since 1600 AD, and are either ancient or replanted

Table 1: Summary of Lancashire County Council holdings within the Ribble study area

3.4.3 In addition to the above, 15 sections of Roman Road are recorded as running through the study area, of which six are classed as 'Certain', four as 'Probable' and five as 'Possible'.

3.4.4 The main source of additional information to date is the Ribble Valley Catchment Survey undertaken by Lancaster University Archaeological Unit (LUAU), now OA North (LUAU 1997). This survey was carried out between January and March 1997 on behalf of the Environment Agency, and was designed to enhance manageability of the areas archaeological resource, in the event of river management works. From the results of this survey 158 sites are located within the study area, of which 81 sites had not, and have still not, been accessioned into the Lancashire SMR. The remaining 77 records were visits to known SMR sites. These constitute new events, and have been cross referenced to the corresponding SMR site numbers.

3.4.5 From a check of all currently recorded Events data, it was found that 14 archaeological projects have been undertaken by OA North within the study area, Which have not been accessioned. Again these constitute new Events. Though it must be noted that not all projects in the OA North archive had been internally accessioned with a grid reference and may not have been picked up by the GIS live link.

3.4.6 In total the basic examination has identified 172 potential new Monuments or Events within lower Ribble study area. This is before the aerial photographs are fully scrutinised, or Palaeoenvironmental data is added to these sites. All the above data has been entered into the project data base.

3.4.7 ***North Yorkshire:***

The following Table summarises the North Yorkshire Council holdings:

Inventory	**Count of records**	**Comments**
Monuments	34	
Listed Buildings	135	2 Grade I, 6 Grade II*, 127 Grade II
Events	13	Excavations, Surveys, Watching Briefs etc
Portable Antiquities Scheme	0	
Scheduled Ancient Monuments	1	
Registered Parks and Gardens	0	
Conservation Areas	4	Areas that are within, cross or are immediately adjacent to the study area
Designated Ancient Woodland	6 areas	Areas of woodland coverage since 1600 AD, and are either ancient or replanted

Table 2: Summary if North Yorkshire County Council holdings within Ribble study area

3.4.8 In addition to the above, the point data from the Dales Mapping Project (DMP) has been obtained, and is complimented by the site drawings which were supplied by Mr Rob White of NYDNPA; in total 114 sites were located by this survey within the study area. These were supplied partly as digital images, with the remainder being scanned georeferenced and incorporated into the project GIS. A record of all the earthworks and sites recorded as part of the DMP is therefore present and available to inform the heritage and archaeological landscape analysis. The survey, for example identified field systems and ridge and furrow

on the low lying plains of the Ribble, near Langcliffe, in an area with no current HER point data (Fig 10).

3.4.9 The events data for North Yorkshire has been provided in summary form and is to be further consulted for detail in some instances: in particular the detailed data from the Hellifield and Long Preston Bypass Archaeological Survey needs to be accessed, and as with the aerial photographs, this can only be done once the HER officer for NYCC returns from leave (after the 15th of August).

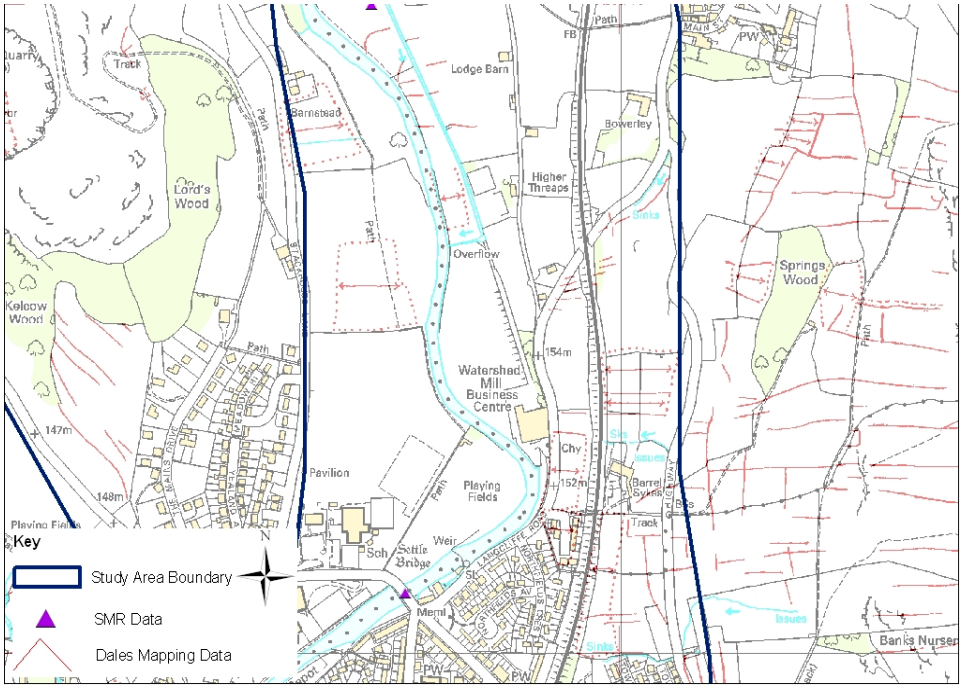

Figure 10: Langcliffe, Showing Dales Mapping Project site data in red

3.5 PALAEOENVIRONMENTAL DATASET (TASK 14)

3.5.1 In total eighteen events have been entered into the environmental database. Sources for the environmental database include books, the relevant journals, unpublished PhD theses, the internet, the North West Wetlands archive and discussions with university departments. The database does not include the environmental records of charred and waterlogged plant remains from archaeological events for example Ribchester and Walton-le Dale. The number of environmental events from within the study area is very low and perhaps highlights the need to extend the documentary search.

3.5.2 ***Lancashire:*** thirteen palaeoenvironmental events have been entered into the database from Lancashire. Only three of these events are within the study area itself with the remaining ten being events that are of regional significance either as records of vegetation or sea-level change. A decision was taken to include those events which record the changing sea-levels in the North West because they are directly relevant to the fluvial history of the River Ribble.

3.5.3 In the absence of any extensive number of palaeoecological events recording vegetation change in the study area, sites such as Red Moss, near Bolton in greater Manchester, Fenton Cottage, Over Wyre, Lancashire, Winmarleigh Moss, Over Wyre, Lancashire, and the site from Fairsnape Fell in the Forest of Bowland have been included because they are of regional importance. The most relevant site in the Lower Ribble is that of an organic rich fill

of a palaeo channel at Higher Brockholes, associated with archaeological remains (Chiti 2004).

3.5.4 ***Yorkshire:*** eight palaeoenvironmental events have been entered into the database from Yorkshire. Seven of these are from the Craven District and one from outside the district at Tadcaster (Bartley 1962). There have been a number of significant paleoecological investigations of valley and basin mires in the Craven district of Yorkshire, notably near Ingleborough (Oybak and Bartley 1997) and Malham (Pigott and Pigott 1964). Potentially the most significant site is at White Moss (SD 792 546) which is a lowland source just ourtside the northern study area (Bartley et al 1990).

4. BIBLIOGRAPHY

Allot and Lomax 1990 *Sand and Gravel Resources of Lancashire*, Preston

Bartley, DD, 1962 The stratigraphy and pollne analysis of lake deposits near Tadcaster, Yorkshire *New Phytol*, **61**, 277-87

Bartley, DD, Jones, IP, Smith, RT, 1990 Studies in the Flandrian vegetation history of the Craven district of Yorkshire: The Lowlands, *Journ Ecology*, **78**, 611-32

Brown, AG, 2004b *The Environment and Aggregate-Related Archaeology: A Position Paper*, Univ. Exeter, Unpubl Rep

Chiti, B, 2004 *Holocene fluvial and marine influences and settlement interactions in the Lower Ribble valley, Lancashire, UK* , University of Stirling PhD thesis

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

English Heritage, 1991 *Management of Archaeological Projects*, 2nd edn, London

English Heritage, 2000 MIDAS: *A Manual and Data Standard for Monument Inventories*, Swindon

English Heritage, 2004 *Map Depiction - an annex for MIDAS*, Swindon

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

English Heritage, 2005b *Aggregates Levy Sustainability Programme: Priorities*, (http://www.english-heritage.org.uk/default.asp?WCI=Node&WCE=8535)

Entec UK Ltd, 2004 *Lancashire Minerals and Waste Local Plan- Sand and Gravel Study*, Shrewsbury

Gillings, M, Halls, P, Lock, G, Miller, P, Phillips, G, Ryan, N, Wheatley, D and Wise, A, 1998, *Archaeological Data Service GIS Guide to Good Practice*, York

LUAU, 1997 *River Ribble Catchment Lancashire And North Yorkshire Archaeological Rapid identification Survey*, unpubl rep

Oybak, E, Bartley, DD, 1997 Late Glacial and post glacial moss records from a valley bog, Sniddle Moss, in the Ingleborough region, *Naturalist*, **122**, 53-6

Pigott, CD, and Pigott, ME, 1963 Late-Glacial and Post-glacial deposits at Malham, Yorkshire, *New Phytol*, **62**, 317-34

Royal Commission on the Historical Monuments of England (RCHM(E)), 1998 *The Monument Inventory Data Standard*, Swindon

