CARLISLE URBAN ARCHAEOLOGICAL DATABASE

Method Statement

Oxford Archaeology North

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SUMMARY

Carlisle City Council has initiated an urban archaeological strategy as a contribution to a national programme of conserving and managing the archaeological resources of 35 of England's historic towns and cities. As part of this, the Council commissioned Oxford Archaeology North (OA North) to undertake the preparation of an archaeological database intended to form the foundations for an assessment of the state of Carlisle's archaeological resource. OA North began this work in March 2006 and the final database was completed and supplied to Carlisle City Council in December 2007.

The aims of the project were to compile an archaeological database for Carlisle and this entailed the examination of a range of archaeological, documentary and cartographic sources. These were used in the compilation of a complete list of all recorded actions ('Events') undertaken in Carlisle. In total, 1234 Events were defined, and mapped. These were used as the raw data in the definition of areas of archaeological or historical interest ('Monuments'), of which 909 were defined. The project also produced a Deposit Model of the principal horizons of the natural subsoils and the upper level of the Roman deposits.

The database was compiled in Microsoft Access 97, with the spatial datasets being created in ArcGIS 9.2 and output in either shapefile format (for vector datasets) or TIN format (for the deposit models). The deposit modelling has been completed in ArcMap 3D analyst.

This document represents a brief report upon the methodology used during the compilation of the Carlisle Urban Archaeological Database. It is intended to provide guidance for the user upon its structure, and intended outputs.

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The archaeological data capture was undertaken by John Zant, Marc Storey and Rebecca Briscoe. Joanne Cook managed the database, GIS tasks and edited the database structure, while the georeferencing of historic maps was undertaken by Marc Storey. The compilation of the database and GIS elements, along with the data modelling, was undertaken by Rebecca Briscoe. The report was written by Rebecca Briscoe, Joanne Cook, and John Zant, and edited by Jamie Quartermaine and Rachel Newman.

1. INTRODUCTION

1.1 CITY OF CARLISLE

1.1.1 The archaeological and historical importance of the City of Carlisle (NY 399 559, Fig 1) is well known and documented and the city can be listed alongside York and Chester as one of the major political centres of Northern England during the Roman and medieval periods (OA North 2006). For some time there has been a recognition of the need for a comprehensive collation of the wide variety of sources for the archaeology and history of the city to aid the curatorial processes that protect the historic environment.

1.2 BACKGROUND AND NATIONAL CONTEXT

1.2.1 Department of the Environment (DoE) planning guidance (*PPG16*; DoE 1990) identifies the presence of archaeological deposits as a material consideration in the determination of a planning application, and it expects planning authorities to adopt a curatorial role in this process. *PPG15* (DoE 1994) similarly recognises the archaeological potential of standing buildings, and the historic environment more generally.

1.2.2 National policy on urban archaeological resources was set out in *Managing the urban archaeological resource* (English Heritage 1992). This proposed the development of a three-stage process for achieving this aim:

- Urban Archaeological Database (UAD): creation of a database of archaeological information to support informed planning advice;
- Urban Archaeological Assessment (UAA): a written assessment that synthesises current archaeological knowledge and understanding of a city in terms of local, regional and national importance;
- Urban Archaeological Strategy (UAS): a strategy for managing the archaeological resource and updating the database.

1.2.3 As a result of this, and after the completion of a pilot study by the former Carlisle Archaeological Unit (CAU) in 1996 (McCarthy 1998), Oxford Archaeology North was commissioned by Carlisle City Council to undertake stage one of the process - the Urban Archaeological Database (OA North 2006).

1.2.4 ***Brief Description of the UAD***: English Heritage (1993a) states that a UAD comprises the following elements:

- an urban area base map (in this case, supplied under licence to the project by Cumbria County Council);
- event records, in a database;
- an event overlay depicting events, suitable for use in a GIS;
- monument records, in a database;
- a monument overlay depicting monuments, suitable for use in a GIS.

Modern UADs tend also to contain a model of archaeological deposits. The precise definition of an Event is given in *Section 3.1*, and Monuments are described in *Section 4.1*. Furthermore, the database must necessarily contain related tables holding such information as bibliographic sources, position, and dating information for Events and Monuments. The full structure is shown in *Appendix 1*, with further details in *Sections 3* and *4*.

1.2.5 ***The Carlisle UAD***: this document reports on the methodology used to produce the Carlisle UAD. It does not represent a full user manual, as it was agreed from the outset that, to gain most use from this data, it should be designed to nest within established external datasets, such as the Cumbria Historic Environment Record (HER), rather than as a stand-alone product. As such, the usage of the datasets will depend on the specific software being operated by end-users.

1.2.6 Consequently, this method statement has two main functions: firstly it comprises a breakdown of the methodology of the UAD and gives details of the data supplied and its structure. Secondly, the report provides an assessment of the veracity of the data and discusses any problems encountered in its collection and analysis that may impact on its future use. It is hoped that in this way the value of the project and the data it contains will be clearly defined for future users, along with any limitations.

1.3 AIMS AND OBJECTIVES

1.3.1 The aims and objectives of the overall urban archaeological strategy for Carlisle are set out in the Project Design (OA North 2006), but the aims for the UAD itself can be summarised as follows:

- to establish not only the known archaeological resources within the city, but also to identify the potential survival for such deposits;
- to provide an improved ‘early-warning system’ for development control by highlighting the most archaeologically important parts of the city;
- to initiate the compilation of the UAA;
- by interfacing with the HER, to highlight the context of the city within its wider environs.

1.3.2 To achieve these aims, the following objectives were identified:

- the creation and verification of a definitive database and GIS of known archaeological material within the study area in the form of event and monument records;
- the rapid appraisal and assessment of the survival of known deposits to provide information in the form of a deposit model.

1.4 STUDY AREA

1.4.1 The expansion of Carlisle beyond its historic core is a relatively recent event. Cartographic evidence suggests that the extent of the medieval city corresponded in broad terms to the extent of the Roman settlement, and even as late as the nineteenth century, cartographic evidence shows that settlement beyond this historic core was limited (Ordnance Survey 1865). Maps such as Smith’s of 1746 show that a distinction can be drawn between the townships and settlements that were independent from the core of the city, such as Stanwix, Denton Holme and Etterby, and those suburbs that are historically part of the city such as Rickergate, Botchergate and Caldewgate.

1.4.2 A study area was therefore created that excluded the outlying townships, yet encompassed the historic core of the city and its suburbs. The shape of the study area was designed to nest within the proposed Extended Urban Survey (Fig 1), and to work in conjunction with the Cumbria HER.

1.5 DATE RANGE

1.5.1 The date range for the study extends from the prehistoric period through to *c*1750. The end date reflects a desire to correlate the cut-off with a significant change in the development of Carlisle and an appropriate city map, so that a definitive snapshot of the city can be provided for that date. The mid-eighteenth century was a time when the essentially medieval layout of the town still survived, but before the major expansion of the city in the mid-nineteenth century. It also has the considerable advantage in that it coincides with the production of Smith's map in 1746, which defines the extent and character of the city at that time. Later developments within the historic core, such as the development of the canal in 1821 (Ramshaw 1997), will be covered by the proposed EUS for Carlisle.

2. SUMMARY OF DIGITAL DATA PROVIDED

2.1 DIGITAL DATA TRANSFERRED

2.1.1 The database was created in Microsoft Access 97 format, and the spatial datasets in ArcGIS 9.2, output as standard shapefiles. The datasets were transferred to Carlisle City Council in this format but were converted into Mapinfo format, more suitable for importing into GGP, for Cumbria County Council. The information below refers to shapefile format (.shp) but the file names remain the same regardless of the data transfer format.

2.2 EVENT DATA (*SEE SECTION 3*)

2.2.1 ***Data Definition:*** Archaeological observations of all kinds, including, but not exclusively, archaeological interventions and non-intrusive surveys, any artefactual stray finds, listed building descriptions, pictorial records, and documentary sources which refer to a specific structure or locale.

2.2.2 ***Files Supplied:***

Event_point.shp	A point shapefile showing the centre-point of the location of all events in the UAD area.
Event_polygon.shp	A polygon shapefile showing the extent of events in the UAD area where such information was available.

2.3 MONUMENT DATA (*SEE SECTION 4*)

2.3.1 ***Data Definition:*** Records archaeological interpretations of event data, primarily structures and parts thereof, both extant and those no longer so, which have their foundation prior to the 1750 cut-off.

2.3.2 ***Files Supplied:***

Monument_point.shp	A point shapefile showing the centre-point location of all monuments in the UAD area.
Monument_polygon.shp	A polygon shapefile showing the known extent of monuments in the UAD area where such information was available.
Interpolated_Monument.shp	A polygon shapefile illustrating the predicted extent of certain well-documented monuments.

2.4 DEPOSIT MODEL (*SEE SECTION 5*)

2.4.1 ***Data Definition:*** Models of the current ground surface, the top of the natural subsoil, and the top of selected interpreted archaeological horizons for the purpose of generating deposit models.

2.4.2 ***Files Supplied***:

dm_fcellar.shp	A polygon shapefile that records properties with full cellars.
dm_pcellar.shp	A polygon shapefile that records properties with part cellars.
dm_poss_cellar.shp	A polygon shapefile that records buildings which were of a period and style contemporary with adjacent buildings with known cellars, or that had a previous function that indicates cellaring (eg former public house) but for reasons of access could not be verified as having cellars of their own.
Truncation.shp	A polygon shapefile that records areas of known truncation through previous archaeological excavation and cellaring.
Natural_points.shp	A shapefile containing the 3D point data from which the natural surface model was derived.
Roman_points.shp	A shapefile containing the 3D point data from which the Roman surface model was derived.
Mod_idw	A raster model of the modern ground surface.
Roman_surface	A TIN model of the top of Roman deposits below the city.
Natural_surface	A TIN model of the depth of natural subsoils below the city.
Natural_Error	A TIN model showing areas of error in the natural surface model.
Roman_Error	A TIN model showing areas of error in the Roman surface model.

2.5 DATABASE (*SEE* ***APPENDIX 1***)

2.5.1 ***Data Definition:*** The database compiled for the project incorporating all the information gathered on events, monuments and sources, as well as all the raw data for the deposit models.

2.5.2 ***Files Supplied***:

Carlisle_UAD.mdb	A Microsoft Access 97 database.

3. EVENTS

3.1 DEFINITION

3.1.1 An event is defined as an observation of any kind that provides archaeological or historical information of value to the UAD. This includes, but is not confined to, archaeological observations of all kinds, including, but not exclusively, archaeological interventions and non-intrusive surveys, artefactual stray finds, listed building descriptions, pictorial records, and documentary sources that refer to a specific structure or locale.

3.2 COLLATING THE EVENT DATA FOR CARLISLE

3.2.1 The sources detailed below, identified in the Project Design (OA North 2006) as Task 4, were consulted during the data-gathering stage of the project, and the task numbers listed below refer to the tasks as set out in the Project Design. Events created from these archives and sources represent not only archaeological interventions but also a wide range of non-archaeological events that have contributed to our understanding of Carlisle's development. These include antiquarian observations recorded in antiquarian and archaeological journals, documentary records of construction, destruction or alterations to the city's fabric, and pictorial sources, such as historic mapping, paintings and sketches. With respect to the cut-off date for the project, whilst post-1750 sources were consulted, later events were only incorporated into the database if they provided information that was relevant to the pre-1750 city.

3.2.2 In total, 1234 individual events were recorded (Fig 2), which is a lower figure than the original estimate provided in the Project Design (OA North 2006, table 8), as many of the events were found to have been referred to by multiple sources.

3.2.3 ***Sources:*** part of the UAD project remit was to provide a comprehensive database of sources on the historic environment of Carlisle. Consequently, as each of the sources was assessed during the data collation phase, it was recorded in detail in the bibliography table within the database (see *Appendix 1*), along with cross-references to all relevant event and monument records. This bibliography table enables the origins of the data collated for the UAD to be clearly referenced and provides the location of the primary data on which the events and monuments were based. Each source was recorded with all key reference details, including its type, title, author, location and the title of the series, if appropriate. Although the bibliographic table primarily consists of written sources, both published and unpublished books, articles and accounts, the table also records the location of pictorial material in archives such as the Cathedral Library and Carlisle City Library.

3.2.4 Several sources, such as H R T Summerson's *Medieval Carlisle: the city and the Borders from the late eleventh to the mid-sixteenth century* (1993), were invaluable in providing links to primary documentary sources relating to events. Where that was the case, the primary reference was then consulted where possible, and recorded within the database. Whilst this allowed a more thorough investigation into an event or monument, it also has the effect of downplaying the contribution that such important resources as Summerson played within the UAD.

3.2.5 ***Carlisle Archaeological Unit/Carlisle Archaeology Limited (CAU/CAL) archaeological archives (Task 4a):*** an accurate listing of all archaeological events carried out by CAU/CAL between 1977 and 2001 was created during Stage 1 of the Carlisle Archives Project (OA North 2003). Summary data, including the site name, event type, description and date fields for each of the records, were exported, along with locational information, from the database created for the Carlisle Archives Project (*ibid*). The events were reformatted to fit the UAD structure and assigned a Primary Record Number (PRN), to form the core data of the UAD Events Table. For ease of reference, the site name in this table concatenates the title of the intervention as given by CAU/CAL and the site code, eg Long Lane: LLA_A-B. The summary data were then enhanced by consultation with the primary CAU/CAL archive at Shaddon Mill, Carlisle, and also with the records of the National Monuments Record (NMR) (*Section 3.1.8*).

3.2.6 ***OA North Archive (Task 4b):*** the database of OA North interventions and projects was consulted and the interventions undertaken within the study area were identified. The reports for each intervention, and for the recent River Eden GIS Project (OA North 2004), were summarised and entered into the database with key details.

3.2.7 ***Other Archaeological Unit Archives (Task 4c):*** the majority of investigations conducted by other units were researched using the *Archaeological Investigations Project* at Bournemouth University (covering the period from 1990 to 2004) and the data collated from the reports held by the Cumbria HER. However, it became clear during the course of the project that there were some gaps in the data relating to very recent investigations that had not yet been entered into the HER. These reports were requested separately from the organisations involved and were added to the database in the same manner as the OA North reports.

3.2.8 ***Pre-1977 Interventions (Task 4d):*** events pre-dating the formation of CAU in 1977 and antiquarian interventions were collated from the *Transactions of the Cumberland and Westmorland Antiquarian and Archaeological Society*, as well as other national journals, including the *Archaeological Journal, Journal of Roman Studies*, and *Britannia*. In addition, the unpublished journals of Robert Hogg, Keeper of Archaeology at Tullie House Museum from September 1948 to May 1975 (Tullie House Museums Collection), provided vital additional information for a number of events undertaken in the mid-twentieth century. Details of these events were summarised and formatted into the database in an identical manner to later interventions; however, it was often necessary to source the National Grid Reference (NGR) of these events from modern or historical mapping.

3.2.9 ***Published CAU/CAL excavations (Task 4e):*** the published work of CAU/CAL was exported from the Carlisle Archives Project database. This information was augmented by published and unpublished client reports relating to these events.

3.2.10 ***National Monuments Record (Task 4f):*** digital data from the NMR in the form of event and monument shapefiles, consisting of polygons, points and lines, were collated and assessed. Several hitherto unknown events were identified and additional detail was appended from the NMR records to existing UAD events, including the NMR number(s) for cross-referencing. Identifying the specific events from their mapped positions was on occasions difficult, as they were often recorded with only limited accuracy.

3.2.11 ***Cumbria County Historic Environment Record (HER) (Task 4g):*** as with the NMR records, the HER dataset was transferred in the form of event and monument shapefiles. During the creation of the UAD events, it became apparent that the separation of data into monuments and events was not necessarily clear-cut. The difficulty with this distinction was apparent in the HER data, as some of the data required clarification and re-classification before they could be incorporated into the UAD. Prior to the incorporation of any new events or monuments from the HER, a thorough examination of the records was undertaken, comparing descriptions, documentary sources and mapped locations, to ensure that no duplicates entries were made. At this stage, events already recorded in the UAD were cross-referenced with their HER reference number. New events included the identification of several recent desk-based surveys and evaluation interventions in the study area, and these provided a list of client reports that were then accessed in full from the HER.

3.2.12 ***Cumbria County Council Listed Buildings Record (Task 4h):*** the act of listing buildings in the study area was recorded as an event in its own right (as was the creation of the Hadrian's Wall World Heritage Site). This reflects the fact that these events altered the status and protection of the monuments in question.

3.2.13 ***Carlisle City Library (Task 4i):*** the photographic archive of Carlisle City Library contains thousands of images of the city dating from the late nineteenth century onwards. When consulted during the design of the project, the local history librarian, Stephen White, estimated that there were approximately 300 images of relevance to the UAD, including around 50 of pre-1750 buildings which have since been demolished (OA North 2006). This was, however, a rough estimate and in order to quantify the number and types of photographs available in the City Library Archive, the library's online resource of 3500 images of the area (www.cumbriaimagebank.co.uk) was consulted. Additionally, various local publications of historic photographs from the archive were also viewed which proved useful, as often the photographs were recorded with more detailed descriptions in these publications than in the archive itself.

3.2.14 For the purposes of inclusion within the UAD, it was agreed (OA North 2006) that only photographs taken before 1900 should be considered. However, as 1900 was essentially an arbitrary date and because the archive system does not divide the photographs chronologically, all the photographs in the archive were examined during the course of the search. The archive is divided by street, with key buildings such as the Castle, Old Town Hall and Cathedral warranting separate folders. Care had to be taken to ensure that the photographs of certain monuments, such as the Crown and Mitre Inn or Highmore House, related to the monuments as they appeared during the period of the UAD, rather than to later buildings on the same site or post-1750 improvements/re-facings of the monuments. The photographs were added to the database as events and copies were made into a .pdf file to provide hyperlinked images for the GIS interface (only available in shapefile format).

3.2.15 ***Carlisle Cathedral Library (Task 4j):*** as with the City Library archive, only pre-1900 photographs were included in the UAD as events. The primary resources of the Cathedral archive had been transferred to the County Record Office some years previously, so the images held were predominantly photocopies. This meant that only a few were clear enough to warrant copying, but the archive, coupled with David Weston's intimate knowledge of the sources relating to the Cathedral and precinct buildings, provided a comprehensive list of early images that were held in other locations. It was, however, possible to copy engravings published in Lyson's *Magna Britannia* (Lyson 1815) and Billings' *Architectural Illustrations, History and Description of Carlisle Cathedral* (Billings 1840). Other useful illustrative information was also gathered, particularly in the form of John Robinson's interpretative plan of the Cathedral close (Weston 2000, 86) and the alterations to its buildings, and a scale plan showing the cloisters before they were removed.

3.2.16 ***Tullie House Museum and Art Gallery, Carlisle (Task 4k):*** Tullie House Museum and Art Gallery holds an important collection of eighteenth- and nineteenth-century paintings and drawings of Carlisle, which were of considerable value in establishing the character and form of specific areas of the city. The database of the collection of paintings by local artists was accessed with the aid of Melanie Gardiner, Keeper of Fine Art. As with the photographs, each painting or other illustration generated an event record that included a cross-reference to the Tullie House acquisition number, and a copy of the image was made into a .pdf file for incorporation into the GIS interface.

3.2.17 Tullie House Museum and Art Gallery also holds a large number of documents, including the Ordnance Survey cards and a database of acquisitions, that were pertinent to the Carlisle UAD. These sources were assessed with the assistance of Tim Padley, Keeper of Archaeology. The museum also contains a large collection of artefacts that have been recovered as a result of either chance discoveries or in the course of archaeological interventions. Chance finds that could be accurately located within the study area, and that pre-date 1750, were recorded as events. However, event records were not created for certain classes of stray finds, for example background scatters of Roman and medieval pottery, as these do not reveal anything of significance about the development of the city. Events that were already recorded in the UAD were cross-referenced with their acquisition number.

3.2.18 ***Other Institutions and National Sources (Task 4l/n):*** the catalogues of the British Museum and the Bodleian Library in Oxford were consulted to source any further early images of Carlisle. The earliest prospect of the city, dating from 1672, was discovered at the Royal College of Arms in London.

3.2.19 ***Cumbria County Record Office, Carlisle (Task 4m):*** the archives of the Record Office in Carlisle were consulted but no new material pertaining to the UAD was uncovered.

3.2.20 ***Summerson's Medieval History (Task 4o):*** this was used extensively to enhance the record for existing events and to provide information on primary documentary and cartographic sources but did not provide any new events.

3.2.21 ***Carlisle City Council Planning Department (Task 4p):*** the main reason for consulting the City Council was to provide information on boreholes as part of the deposit modelling process (*Section 5.2*). As a result of the floods of January 2005, however, which destroyed much of the City Council's archives, no data was available, and hence no new events were created.

3.2.22 ***Oral Sources (Task 4q):*** when the majority of the events had been compiled, letters were written to a number of possible contributors (OA North 2006, appendix 7) selected for their intimate knowledge of the historic environment of Carlisle and their previous work in the city. Given the size of the dataset, a list of 'starting points' for discussions was drawn up, which reflected perceived weaknesses in the data collated from other sources and sought to draw on the individual's specific expertise (*ibid*). These varied dependent on the background of the individual but included:

- further information regarding watching briefs and early 'salvage' excavations undertaken by CAU/CAL, as these events are particularly sparsely recorded in the archive. In particular, locating significant features within linear watching briefs such as pipe trenches, was a key point for enhancement of the dataset;
- details of any unpublished work the individual had undertaken which may be of relevance. For example, it had been indicated that Bruce Jones completed a survey of the medieval tenements for the Lanes area which was as yet unpublished;
- personal specialisms, 'pet' projects and casual observations. If any of the individuals consulted had a special interest in a particular time frame / project within the city centre, this level of knowledge was of great interest to the project, especially if it related to unpublished material.

3.2.23 Although several key local archaeologists were interviewed, no new events, monuments or sources were identified from the survey and, as a consequence, no further detail was added to the dataset from the oral consultation.

3.2.24 ***River Eden Project (Task 4r):*** this project mapped the changing course of the River Eden through Carlisle (OA North 2004) and provided information on a number of primary documentary references for events relating to the river and its palaeochannels. As with Summerson (Task 4o), in these cases the primary sources were recorded within the database rather than this secondary source.

3.2.25 ***Cartographic Sources (Tasks 6, 7 and 9):*** as many historic maps of the city as possible were consulted during the project (Table 1). Where possible, these were scanned and georeferenced within the GIS (eg Fig 3), and were also entered into the database as events in their own right.

Map Title	**Cartographer**	**Date**	**Photograph or copy**	**Georeferenced within GIS**
Ancient Plan of the City of Carlisle	Anon (publ 1815)	*c* 1560	n/a	Yes
Cumberland and the ancient citie Carlile (sic) Described with many memorable antiquities therein found observed	J Speed	1610	n/a	No
Plan of the City of Carlisle and the batteries erected by the Duke of Cumberland	G Smith	1746	high-res scan	Yes
Plan and section of the City and castle of Carlile (sic)	Board of Ordnance	1747	Photocopy	Yes
Survey of Cumberland (with plan of Carlisle inset)	J Hodgkinson and T Donald	1770-1	Photocopy	Yes
Plan of the City of Carlisle and places adjacent	W Hutchinson	1794	Professional digital photograph	Yes

Map Title	Cartographer	Date	Photograph or copy	Georeferenced within GIS
Carlisle town plan	G Cole and J Roper	1801	high-res scan	Yes
Plan of the City of Carlisle from actual survey	J Wood	1821	Photocopy, high-res scan	Yes
Ordnance Survey First Edition Revised 1:2500 data (Landmark)		1865	Digital	Yes
Ordnance Survey First Edition 1:500 Mapping		1865/ 1881	Digital	Yes

Table 1: Historic maps used within the UAD

3.3 LOCATING THE EVENTS

3.3.1 Wherever a site or trench location plan was available for the event, this was georeferenced against the modern Ordnance Survey landline data and was digitised into a shapefile (Fig 2). The highest level of information available was used, so that when the exact position of a trench was known, this was recorded rather than a more general area. This provided not just the position, but also the extent of the works, and in total, 187 events were mapped in this manner, including all the post-1977 interventions. A central point was calculated for each site from its polygon and this was transferred digitally to the database record. For the remaining 1047 events, the location was mapped as point data only, using information provided in the source documents and historical mapping. In this way it was possible to identify the location of all the events with some degree of confidence.

3.3.2 The events were recorded in the database using a single Ordnance Survey grid reference, with a precision of between 1m and 1000m, and a qualifier, detailing whether the site was positively identified, the centre of a group, a find spot, or simply referring to a locality (Fig 2). Positions were given as a centre-point of the event, deemed for the digitised location to be accurate to 1m, while the majority of pre-1977 events were located to an accuracy of 10m. Several events were recorded that referred to the city as a whole; for example, the Jacobite siege of November 1745 had a notable impact on the city (Oates 2003), yet gave rise to no recordable monuments within the study area. Such events were given the grid reference of the centre of the study area and a precision of 1000m. Some other events were not precisely locatable, for example McKie's observations during the cutting of sewers along several of the main roads during the 1850s (McKie 1880) or the many illustrations incorporated in the database. In these instances, the events were given a centre-point position on the street/monument they related to and a precision of 100m. For areas such as the Cathedral precinct, where there were several events that could not be assigned precisely, each event was given the same nominal point within the area and a precision of 100m.

3.4 ASSESSMENT OF THE EVENT DATA

3.4.1 As a guide to future users, it is important to provide an assessment of the level of confidence in the final dataset. As with any collation exercise, the quality of the data produced is heavily dependent on the quality of the source material. For the Carlisle UAD, there was considerable variation in the type and content of sources; however, close adherence to the format of the database structure (*Section 3.5*) has ensured that the event data has been standardised. As a minimum requirement, all events have descriptions, dates, and locations and are cross-referenced where appropriate to all other known archives to aid the sourcing of further information across both local and national datasets. In addition, the events have been categorised according to their type as defined by set lists laid out in the *Inscription Word Lists* (Fish 2005), to enable a simple recognition of the form of intervention. Given the expansive range of source material, it was necessary to add five further sub-categories to the 'non-archaeological intervention' type, to improve clarity. These were:

- cartographic event;
- documentary event;
- pre-1900 photograph;
- historic alteration;
- building listing.

3.4.2 While the object of the UAD is to provide summaries of the pertinent data with a comprehensive bibliography of sources for further reference, it was considered vital to include the most detailed data available for location, date and type of event. Care was taken to limit the use of abbreviations in the records to avoid confusion at a later date.

3.4.3 The CAU/CAL events had already been processed and assessed during the Carlisle Archives Project, but during the course of the UAD it was possible to add further information to the event summaries, to ensure that the most accurate data possible were recorded. Any variation in the precision of an event's location was recorded (*Section 3.3*), allowing a judgement of its accuracy and therefore value to be made by users of the UAD.

3.4.4 It became evident during the course of the project that some sites had been subject to several events over a period of years, often conducted by different contractors and recorded under different site names. To view the events relating to a particular monument in context, they have been grouped so that related interventions can be examined in the events form. As an example, Figure 4 shows a screenshot of the list of interventions at 7-9 Fisher Street, related to the initial desk-based assessment.

3.4.5 In summary, the Event data have been collated according to the standards set out in the Project Design (RCHM(E) and English Heritage 1993; OA North 2006), with a thorough interrogation of a variety of sources leading to the creation of 1234 events that are key to understanding the historic environment of the city. Through thorough cross-referencing of the reference numbers of national and local records, as well as the individual source documents, the data will be robust enough to form the starting point for further detailed interrogation. Additionally, by ensuring complete compatibility with national data standards, such as MIDAS (English Heritage 2003), and pertinent use of explanatory notes within the database, the data will be transparent and comprehensible to any user of the UAD.

3.5 EVENT DATA STRUCTURE

3.5.1 The tables and structure of the event data within the database are illustrated in Table 2, which also illustrates the field headings for each of the tables. A full database relationship diagram can be seen in *Appendix 1*.

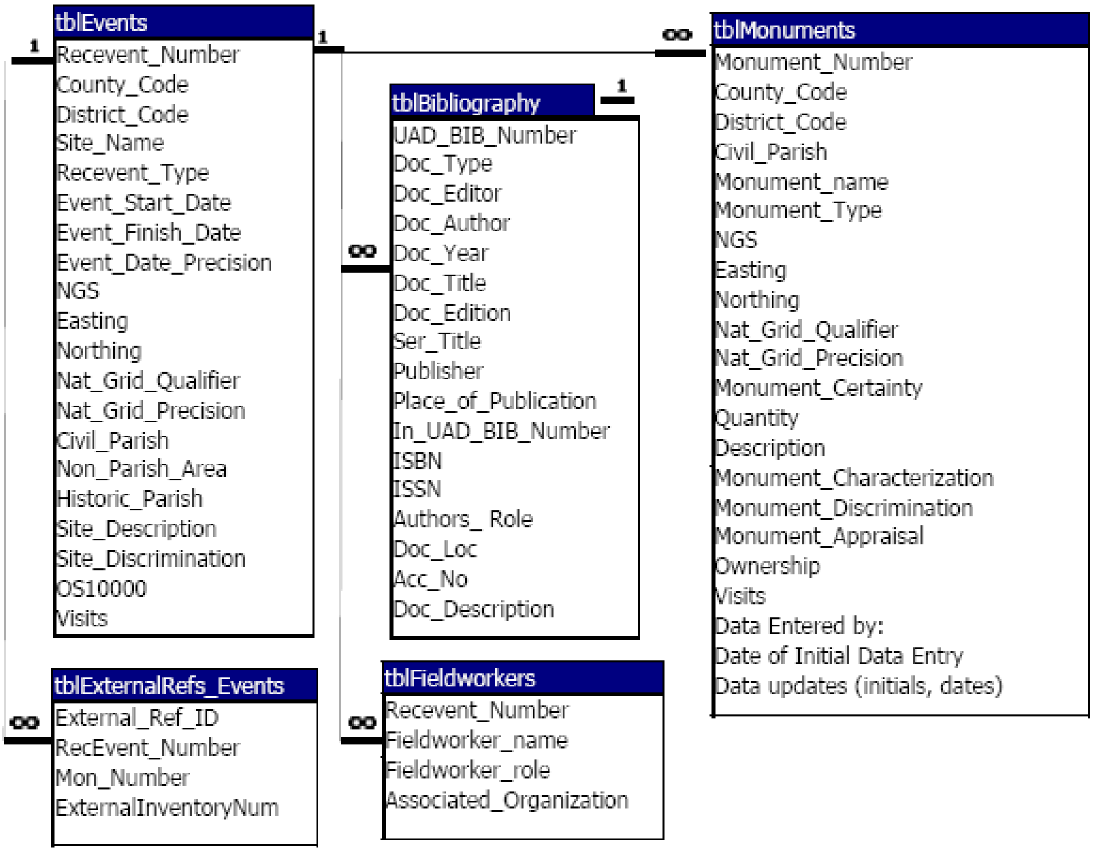

Table 2: A simplified relationship diagram showing how the Event Table links to other key tables in the database

3.5.2 The field headings are fully described in the database table design view for each table. Some of the fields, however, were not used in the UAD, but rather were included for use in the Assessment Phase (*Section 1.2.2*). For ease of reference the descriptions for fields used in the UAD are summarised in Table 3.

Field Name in Event Table	**Definition**
Recevent_Number	Primary Reference number for the event record
County_Code	County in which the event took place
District_Code	District in which the event took place
Site_Name	Name of the event, as given in the site report or other relevant documentation

Field Name in Event Table	**Definition**
Recevent_Type	Type of event, defined in the lookup table *tlkpEventTypes*
Event_Start_Date	Date event commenced
Event_Finish_Date	Date event ended
Event_Date_Precision	Precision of the date range given as defined in lookup table *tlkpMonDatePrecisions*
NGS	National Grid Reference 100km square
Easting	The full six-figure National Grid Reference easting
Northing	The full six-figure National Grid Reference northing
Nat_Grid_Qualifier	A code, defined in lookup table *tlkpNGRQualifier*, indicating whether the given NGR refers to a single site, a group of sites, or an inaccurate locality only.
Nat_Grid_Precision	A number, defined in lookup table *tlkpNatGridPrecision*, indicating the precision (in metres) of the given NGR
Site_Description	A free text description summarising the event
Compilation_Date	Date of compilation of the record
Data_Updates	The date of the last update to the data
Compiler	Compiler's Initials
SiteCode	Site code as referenced in the original grey literature / primary resource

Table 3: The Event table field definitions

4. MONUMENTS

4.1 DEFINITION

4.1.1 A monument is defined as an archaeological interpretation of the event data, primarily extant structures and those no longer in existence, and parts thereof, which have their foundation prior to the AD 1750 cut-off.

4.2 DERIVING THE MONUMENT DATA FOR CARLISLE

4.2.1 Following consultation with the primary archives (*Section 3.2*) and the creation of the Event table, it became possible to define monuments based on the event record, as defined in the Project Design (OA North 2006, task 11). An assessment of all the sources, including historical maps, was undertaken and a list of monuments, together with a detailed bibliography, was compiled.

4.2.2 In total, 909 individual monuments were created (Fig 5). These could be divided into five prehistoric monuments (Fig 6), 449 of the Roman period (Fig 7), 327 that were medieval (Fig 8), and 111 that were of post-medieval date (Fig 9); 17 monuments were of unknown date. This is a lower total figure than the estimated total set out in the Project Design (*op cit*, table 8), since the original estimate can now be seen to have contained duplication as a result of the multiple sources used.

4.2.3 The aim of the UAD is to provide an information point, which has synthesised and collated data for ease of future interpretation, rather than it being an exhaustive source for the city in itself. As such, monuments were recorded with a brief description of their form and the evidence upon which their derivation was based, cross-referenced to the original sources as well as to the events which led to their discovery. Original context numbers from events were referenced in the descriptions of the monuments and, where original descriptions were deemed to be erroneous, with the benefit of hindsight, they were modified; however, no emphasis was placed on re-analysing the primary data. The monument type was detailed using the *Inscription Word Lists* (Fish 2005) for consistency of identification and reference for future analysis.

4.2.4 Once the data relating to each monument had been entered, the records were cross-referenced in the database to their corresponding events and sources, providing a comprehensive listing of all the source elements that had contributed to the derivation of the monument. The monument records were also cross-referenced to the reference numbers of external databases, such as the NMR and the Cumbria HER.

4.2.5 The sources for each monument were recorded in the same way as were the event records (*Section 3.2*). However, where appropriate, page references were recorded for each monument in the 'Pages' field of table *tbl_mon_src* (the linking table that joins individual monument records to their bibliographical sources) so that the detail relating to a specific monument might be accessed more swiftly.

4.2.6 Some of the monuments represented parts of larger entities, such as the cathedral or the Roman fort, and as such, ‘parent monuments’ were created to link together the related (child) monuments within the database (Figs 10 and 11). Parent monuments were treated as monuments in their own right, and the database structure was modified slightly from the original to show how the parent and child monuments related to a given record. The parent monuments are listed in Table 4.

4.2.7 The existence of the parent monuments as entities within the historic environment of Carlisle is undoubted; however, defining their exact extent was not possible in many cases, as they, for the most part, have only been identified by localised sample excavation. Notable exceptions to this, such as the first Roman fort and the medieval Castle, have their extents shown in Figure 10, and are also mapped as Interpreted Monuments (*Section 4.4*, Fig 12).

4.2.8 In some cases, while the location of a parent monument was fairly well known, its exact extent was not. For example, the post-medieval city is shown on early maps but generally only in a stylised fashion. In these cases, it was decided to err on the side of caution and mark the monument as 'not properly located' rather than risk misinterpretation by attempting to map the exact extent.

Monument Number	**Parent Monument Name**	**Properly Located (y/n)**
6	The first Roman timber fort	y
61	The second Roman timber fort	y
101	The Roman stone fort	n
128	Possible fort annexe (first timber fort)	n
130	Possible fort annexe (first/second timber forts)	n
600	The Roman civil settlement (core area of settlement)	n
565	The Roman civil settlement, southern periphery (possibly beyond the core settlement)	n
566	The Roman civil settlement, northern periphery (possibly beyond the core settlement)	n
883	The Roman civil settlement, western periphery (beyond the core settlement)	n
297	Southern Roman cemetery	n
298	Possible eastern Roman cemetery	n
299	Possible western Roman cemetery	n
626	The early medieval settlement	n
603	The medieval city	y
601	The medieval city defences	y
318	The medieval castle	y
602	The medieval Cathedral (the Priory of St Mary's) and Cathedral Close	y
383	The Dominican friary (Blackfriars)	y
393	The Franciscan friary (Greyfriars)	n
567	Western (Caldewgate) suburb of the medieval city	n
568	Northern (Rickergate) suburb of the medieval city	n
569	Southern (Botchergate) suburb of the medieval city	n
604	The post-medieval city	n
570	Western (Caldewgate) suburb of the post-medieval city	n

Monument Number	Parent Monument Name	Properly Located (y/n)
571	Northern (Rickergate) suburb of the post-medieval city	n
572	Southern (Botchergate) suburb of the post-medieval city	n

Table 4: The Parent Monuments, listed in broad chronological order

4.3 LOCATING THE MONUMENTS

4.3.1 Monuments were located in the database in the same way as events, with an NGR, qualifier and precision recorded for each (*Section 3.2*). As with the event mapping, the extent of the monuments was crucial to the accuracy of the data. Wherever possible, monuments were digitised into polygons from published or archived site plans, resulting in the location being precise to within 1m. In total, 532 monuments were mapped in this way, with the NGR in the database representing a centre point of the monument polygon.

4.3.2 As with the event data, the quality of sources meant that precise extents could not always be mapped, and for the remaining 339 monuments the location was recorded as point data, again with qualifier and precision fields, using historical and current mapping.

4.4 INTERPRETING MONUMENT EXTENTS FROM KNOWN DATA

4.4.1 After plotting and analysing the location of all the known monuments, it was clear that there were circumstances in which their extent could be extrapolated beyond the known data, for example, linking together sections of Roman road and predicting its line between these known extents. The criteria used to select those monuments that could be enhanced in this way were strict, and for a monument to be considered, it must have satisfied the following:

- a significant body of archaeological evidence supporting its position and extent;
- a significant body of evidence from which its form and thus its size could be predicted;
- a significant possibility that unexcavated parts of the monument survived as buried deposits that could be at threat from development.

4.4.2 Great care was taken to ensure that the interpretative polygons for monuments were based on sound evidence; however, there were obvious biases to this dataset, and some monuments proved easier to interpret than others. For example, the nature of the evidence allowed the alignment of several Roman roads to be predicted with some confidence, since these monuments have a standardised form and have been traced through excavation at several points within the city. Another monument whose extent could be predicted with some accuracy was the Dominican Friary (Fig 11). On the other hand, the evidence gathered through the course of the UAD could not support, for instance, a prediction of the extent of early medieval settlement, partly because of the limited nature of the evidence and partly because the structures and other material contained within this monument would not have had a standardised form. A list of interpreted monuments for which extents greater than those excavated could be inferred is included in Table 5 (Fig 12).

Monument Number	Monument Name	Monument Type
2	Prehistoric trackway within the northern Lanes	Trackway
4	Prehistoric course of River Eden, palaeochannel at Rickergate	Palaeochannel
782	Suggested course of River Eden during the Roman period	Palaeochannel
6	The first Roman timber fort	Fort
8	West rampart, first Roman timber fort	Rampart
876	East rampart, first Roman timber fort	Rampart
877	North rampart, first Roman timber fort	Rampart
878	North gate, first Roman timber fort	Gate
11	Southern ditches, first Roman timber fort	Ditch
881	Western ditches, first Roman timber fort (possibly)	Ditch
882	Eastern ditches, first Roman timber fort (possibly)	Ditch
12	Main north to south road, first Roman timber fort	Road
13	Main east to west road, first Roman timber fort	Road
14	South *intervallum* road, first Roman timber fort	Road
15	West *intervallum* road, first Roman timber fort	Road
879	North *intervallum* road, first Roman timber fort (possibly)	Road
880	East *intervallum* road, first Roman timber fort (possibly)	Road
16	*Principia* (?), first Roman timber fort (primary phase of occupation)	Building
28	Barrack, south-west quadrant, first Roman timber fort (primary phase of occupation)	Barrack
29	Barrack, south-east quadrant, first Roman timber fort (primary phase of occupation)	Barrack
30	Barrack, south-east quadrant, first Roman timber fort (primary phase of occupation)	Barrack
26	Possible barrack, south-west quadrant, first Roman timber fort (primary phase of occupation)	Barrack
46	Barrack, south-west quadrant, first Roman timber fort (secondary phase of occupation)	Barrack
47	Barrack south-east quadrant, first Roman timber fort (secondary phase of occupation)	Barrack
45	Probable barrack, south-west quadrant, first Roman timber fort (secondary phase of occupation)	Barrack
53	Minor north to south road, south-west quadrant, first Roman timber fort (secondary phase of occupation)	Road
54	Minor north to south road, south-east quadrant, first Roman timber fort (secondary phase of occupation)	Road
169	Major north-west to south-east road, Roman civil settlement (Botchergate)	Road
170	Major north-west to south-east road, Roman civil settlement (Blackfriars Street/Cathedral)	Road
171	Major east to west road, Roman civil settlement (southern Lanes)	Road
173	Major north to south road, Roman civil settlement (English Damside)	Road
175	Major north-west to south-east road, Roman civil settlement (Tullie House Museum/Abbey Street)	Road
176	Major north-south road, Roman civil settlement (Scotch street/ Rickergate)	Road
179	Possible north to south road, Roman civil settlement (St Mary's Gate)	Street

Monument Number	Monument Name	Monument Type
191	Roman bridge over the River Eden	Bridge
601	The medieval city defences	Defences
318	The medieval stone castle	Castle
602	The medieval Cathedral (the Priory of St Mary's) and Cathedral Close	Cathedral
383	Dominican Friary (Blackfriars)	Friary
393	Franciscan Friary (Greyfriars)	Friary
398	Late sixteenth century timber bridge over the Priest Beck	Bridge
502	Seventeenth century stone bridge over the Priest Beck	Bridge
503	Seventeenth century stone bridge over the River Eden	Bridge

Table 5: Monuments with predicted extents, in broad chronological order

4.5 PHASING THE MONUMENTS

4.5.1 The timespan of the UAD was divided into five periods, as defined on *the Inscription Word List* (Fish 2005); these are the prehistoric, Roman, early medieval, medieval and post-medieval periods. Each monument was assigned to one of these, with precise dates being recorded where available. However, it became clear that the breadth of these periods rendered them of little use for more detailed analysis and did not in fact accurately reflect the development of Carlisle. For example, at Carlisle it is more appropriate to date the beginning of the Roman period to AD 72/3, when the first timber fort was founded (Caruana in prep), rather than AD 43, the date of the Roman invasion of southern England. Similarly, it is logical to view the medieval period as beginning with the historically attested arrival of William II at Carlisle in 1092 (Earle and Plummer 1892), rather than with the Battle of Hastings in 1066, which had little immediate impact in the region. A three-tier system was therefore devised, consisting of the generic period, a shorter and more definitive sub-period, such as 'early Roman (late first century-early third century)', and finally 'accurate' or 'scientific' dates for those monuments when this information was available.

Generic periods *(date range)*	**Sub-periods** *(date range)*
Prehistoric *(to AD 72/3)*	**NO SUBDIVISION**
Roman *(AD 72/3-c AD 410)*	Late first century-early third century *(AD 72/3- c AD 200)*
	Early third century-end of Roman occupation *(c AD 200-c AD 410)*
Early Medieval *(c AD 410-1092)*	**NO SUBDIVISION**
Late Medieval *(1092 - c 1540)*	Late eleventh century-late thirteenth century *(1092-1296)*
	Late thirteenth century-mid sixteenth century *(1296-c 1540)*
Post-Medieval *(c 1540-1750)*	Pre-1700 *(c 1540-1699)*
	Post-1700 *(1700-1750)*

Table 6: The period and sub-period divisions within the Carlisle UAD

4.5.2 The sub-divisions were based on broad structural, archaeological and, where possible, historical, evidence. For the Roman period, the likely elevation of the settlement at Carlisle to the status of a tribal capital (the *civitas Carvetiorum*) in the early years of the third century AD, as evidenced by epigraphy (Edwards and Shotter 2005), has been taken as a convenient point to mark the shift from early Roman to later Roman traditions. This is not, of course, to suggest that the town underwent an overnight transformation in or around AD 200; change is likely to have been a far more gradual process. Nevertheless, archaeological evidence from the city broadly supports the idea that the early years of the third century saw the beginnings of a change in the character of the Roman settlement. The widespread use of stone for buildings in both the fort and the town appears to commence during this period, and there is also some evidence to suggest an increase in civic pride, manifested in the construction of large stone buildings such as a possible bath-house on the site of the present Market Hall (McCarthy 2002, 84), an apparent decline in the amount of pottery and other refuse being deposited in the core area of settlement, and the establishment of a possible municipal rubbish dump on Botchergate, south of the settlement (*op cit*, 87). For the later medieval period a convenient chronological division is provided by the beginning of the Anglo-Scottish wars in 1296, which heralded the end of a period of comparatively peaceful development for the city during the twelfth and thirteenth centuries and the beginning of a prolonged period of instability and relative impoverishment (Summerson 1993). The beginning of the post-medieval period in Carlisle has been taken to date from the Dissolution of the Monasteries, *c* 1540, which resulted in significant changes to the city, both physically and socially. The sub-division of the post-medieval period *c* 1700 is broadly coincidental with the increasing use of stone in the construction of private houses, and the concomitant increase in the survival of such buildings in the modern city. For some parts of the city, such as the Lanes or within the Roman fort, where very detailed occupational sequences have been established by modern archaeological excavation, these subdivisions may appear over simplistic, but it was considered that further subdivision would be unworkable for the city as a whole.

4.5.3 The precise date assigned to a particular monument varied, dependent upon the quality of the dating evidence. A table of the types of dates used was constructed (*Appendix 1*) to clarify the quality of the dating and to detail whether the date referred to the construction, demolition, alteration, use or disuse of the monument. In addition, two catch-all terms were used: ‘extant’, for cartographic sources when no more specific date type was appropriate, and ‘description’, for documentary sources when the date recorded refers to the first depiction or description of the monument (with the implicit recognition that the monument must have been extant prior to this date). Wherever possible, a monument was recorded with period, sub-period and precise date (whether obtained from radiocarbon determinations, dendrochronological dating or extrapolated from finds), within a tiered system, to allow the highest level of information available to be recorded, whilst maintaining comparability across the city.

4.6 ASSESSMENT OF THE MONUMENT DATA

4.6.1 One of the biggest challenges when synthesising the Monument data was the variety and quality of sources (*Section 3.2*). The scope of the project meant that sources included historical mapping, antiquarian accounts, private journals, published articles and client reports from recent excavations to name but a few, which covered a time scale of over 500 years.

4.6.2 Given this, it was vital to record the Monument data in a standardised manner so that the records would be comparable, and to allow the identification of monuments that were recorded by more than one event. As with the event data, the monument data adhere strictly to MIDAS standards (English Heritage 2003) to ensure compatibility with other Historic Environment Record systems. Internal and external cross-referencing was a vital part of the data structure, which will allow the monuments to be compared with records held in other databases, such as the Cumbria HER and the NMR. The internal event and source references for each monument provide a reference network supporting the monument interpretation, with links to the primary data.

4.6.3 The varying quality and content of the source material also had implications for the monument mapping. While the extent and location of some monuments could be shown to within 1m, for others, the lack of illustration or poor quality reproduction from the site archive meant that the accuracy to which the monument could be mapped was compromised. For the most poorly located, a single NGR point was given, but for those monuments for which polygons could be drawn, the source of the original drawing and its scale were recorded as part of the shape file. This provides users with an understanding of the accuracy of the source data, alongside the record of the precision of the grid reference given in the database. Without this metadata, it would be possible to make inferences about the archaeology at resolutions greater than the source datasets, but with it such inferences are clearly not valid.

4.6.4 Additionally, the interpreted monuments mapped are not intended to provide a definitive or locationally accurate extent beyond the areas known through excavation. However, the recognition of the separate parts of the same monument, through different events, is one of the key strengths of the UAD as a collaborative tool and the natural extension of this is to highlight those areas where known monuments may survive. It is hoped that the interpreted monument polygons will act as a visual aid for users of the UAD.

4.7 MONUMENT DATA STRUCTURE

4.7.1 The structure of the monument data in relation to the key tables in the database is given in Table 7, which also illustrates the field headings for each of the tables. These headings are fully described in the database table design view for each table, but for ease of reference the descriptions for the monument table are given in Table 8.

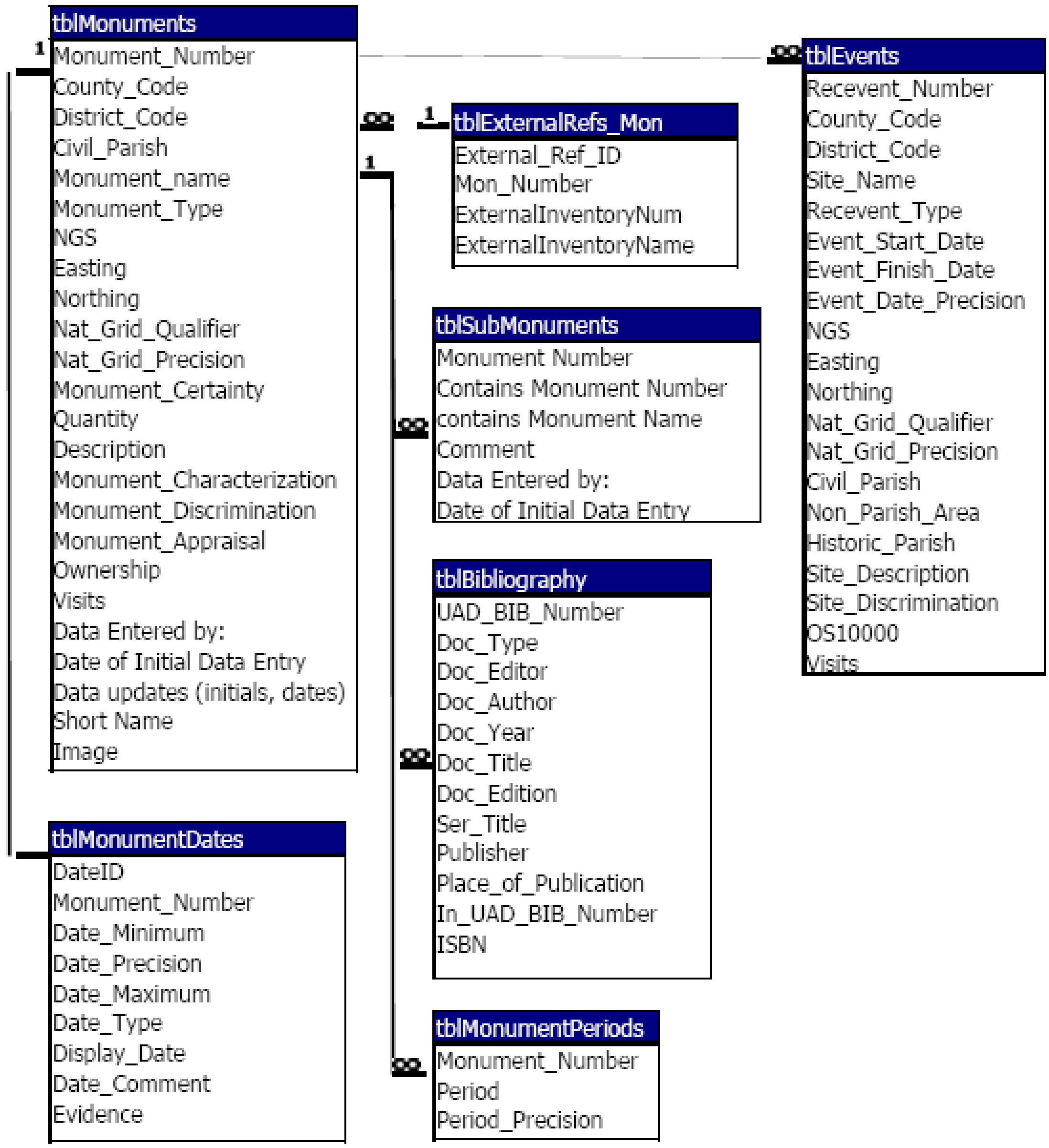

Table 7: A simplified relationship diagram showing how the Monument Table links to other key tables in the database

Field Name in Monument table	Definition
Monument_Number	The numeric string which uniquely identifies each monument
County_Code	The numeric string which uniquely identifies each monument
District_Code	The codes for each District currently used by the National Buildings Record, the National Archaeological Record (London) and English Heritage, derived originally from the National Census
Civil_Parish	The name of the civil parish is entered. If there is no civil parish then the District name is entered
Monument_Name	Name or names by which a monument is known
Monument_Type	The term or terms by which a monument has been classified. This will normally be the interpretation of the monument by function or form
NGS	NGR 100km square
Easting	The full six-figure easting of the NGR
Northing	The full six-figure northing of the NGR
Nat_Grid_Qualifier	A code, defined in lookup table *tlkpNGRQualifier*, indicating whether the given NGR refers to a single site, a group of sites, or an inaccurate locality only
Nat_Grid_Precision	A number, defined in lookup table tlkpNatGridPrecision, indicating the precision (in metres) of the given NGR
Monument_Certainty	Indicates the certainty of a monument type
Short Name	A short free-text description to aid HER searches
Images	File name of images relevant to this monument

Table 8: The Monument Table Field Definitions

5. DEPOSIT MODEL

5.1 INTRODUCTION

5.1.1 Predicting the survival and depth of archaeological deposits is a complex and inexact process, particularly in urban areas. However, some prediction of what might underlie the modern ground surface is essential when formulating appropriate mitigation strategies for development. As part of the UAD it was proposed that a deposit model should be created from excavation and borehole data across the city to refine the predictive process (OA North 2006, 53-4).

5.1.2 The deposit model is formed of three terrain models; the modern ground surface (Fig 13), the top of Roman deposits (Fig 14) and the top of the subsoil underlying the archaeological deposits (Fig 15). Further distinction of deposits was not thought possible, given the inconsistent nature of the archaeological and borehole evidence, and this indeed proved to be the case. Height data were collected from a number of sources and were processed using ArcGIS to create the terrain models, through which sections could then be drawn indicating the modelled height of each surface. The model was then interpolated to calculate the residual error of the data and assess its accuracy.

5.2 DATA COLLECTION

5.2.1 The data for the deposit model were collected from four main sources:

- published excavation reports;
- the CAU/CAL archive at Shaddon Mill, Carlisle;
- borehole records held by Carlisle City Council;
- a rapid walkover survey to establish the whereabouts of extant cellars.

5.2.2 Data from excavations in the city were examined and recorded in the database and linked to the event from which they derived. Spot heights were recorded with details of which horizon these related to (for example, the top of Roman strata), a six-figure NGR, together with a precision value identical to those used for the Event and Monument data, and an absolute height in metres, to give a three-dimensional co-ordinate. In total, 486 points were collected as part of this exercise, incorporating 369 spot-heights for the natural subsoil and 117 heights for the top of Roman levels. To enable qualitative judgements to be made about the accuracy of the height data, a confidence level was ascribed to each point as it was recorded, based on the quality of the source material.

5.2.3 The deposit heights were sourced in a number of ways, either through the written description of the event, from plans and sections in excavation archives, from published reports, or from borehole records found within the CAU/CAL archive. Due to the varied nature of the source material, many points had not been rectified to the OS datum, but were recorded as a height below the current ground surface. To exclude these points would have reduced significantly the amount of data available for analysis, particularly for the modelling of the top of Roman deposits. Therefore, recorded heights below surface were converted relative to the OS datum using the height of the current ground surface from LiDAR data obtained from the Environment Agency (see *Section 5.4* for more detail).

5.2.4 While borehole records cannot inform the models of the historical deposits they did provide useful data for the top of the natural geology. It had been hoped that borehole surveys for areas outside the historic core could provide a spread of data beyond the archaeological interventions and certainly Council records provided much information during the compilation of the Oxford UAD (Oxford Archaeology 2002), generating over 550 coordinates. Unfortunately, as a result of the severe flooding of the City Council's archives in January 2005, no borehole surveys were available for the study area from this source. Several surveys were located in the Shaddon Mill archive, however, and these were incorporated into the deposit model.

5.3 MAPPING TRUNCATION

5.3.1 The deposit model also incorporated mapping of areas of known truncation (Fig 13). Data for this were derived from two sources, the event polygons mapped as part of the UAD, which demonstrated truncation by the location of associated archaeological works, and a walkover survey to establish the extent of cellaring in the study area.

5.3.2 The rapid walkover survey of cellar lights in the study area was designed to highlight those areas where deposits may have been truncated or destroyed, particularly along the street frontage. The Project Design (OA North 2006) proposed that a simple visual survey of cellar lights would provide sufficient evidence for the existence of cellars, and in some areas, such as the late nineteenth-century housing to the east of Botchergate, this proved to be the case. However, it became clear that for many buildings, in particular the commercial properties in the historic centre of Carlisle, that a lack of visible cellar lights did not indicate an absence of cellaring. To this end, the strategy for the survey was altered to incorporate a brief questionnaire of staff at each accessible property. Properties that could not be included for reasons of security included banks and schools. Where a building was vacant or closed during the hours of the survey (eg night clubs and bars), then all accessible areas around the building were examined for possible indications of cellaring including hatches, bricked apertures and subterranean stairwells.

5.3.3 The cellared areas were digitised into four shapefiles; one depicting full height cellars (2m or more below ground level); one depicting part cellars (reduced height cellars such as coal cellars, or sunken floors up to 1m below ground level); a file depicting probable cellars; and finally a file indicating which properties were inaccessible at the time of survey; each was recorded with appropriate metadata regarding their creation. The significance of the division into these categories directly relates to both the truncation of the archaeological deposits incurred by cellaring and the problems of access while surveying.

5.3.4 For buildings with full height cellars, it is considered likely that few archaeological remains will have survived below the cellar floor, although in some parts of the historic city centre the very earliest archaeological deposits may remain intact beneath these floors. With part cellars in the area of the walled city, it is highly likely that archaeological deposits, in particular those of Roman date, will survive below the cellar floor. This cannot be assumed for the entire study area, as in the Botchergate area, for example, it is known that the ground level was reduced prior to late eighteenth- and nineteenth-century development. On sites like 53-63 Botchergate (OA

North 2002), all medieval and post-medieval deposits had been stripped away, leading to the modern surface being virtually identical to the top of the surviving Roman deposits.

5.3.5 The third and fourth categories of 'probable cellaring' and 'inaccessible buildings' are closely related. The file 'inaccessible buildings' gives details of properties for which it was not possible to verify the extent of cellaring at the time of the survey. The file 'probable cellaring' relates to buildings that were of a period and style contemporary to adjacent buildings with known cellars, or that had a previous function that indicates cellaring (eg former public houses), but for reasons of access could not be verified as having cellars of their own. As such, these files serve to flag unknown and likely areas of truncation for future reference and verification.

5.3.6 Given these access restraints, the digital representation of the survey must be recognised as schematic rather than wholly representative. Where cellars in domestic properties are known, the area shaded is representative of the street frontage, minus any rearward extensions to the footprint of the property. For commercial properties, the whole footprint has been digitised into a polygon where cellars were present; however, there may be areas within the shaded zones where truncation has not occurred and these extents should therefore not be treated as definitive. Because of this, all areas should still be subject to a thorough detailed assessment of cellar extents prior to any development on the site.

5.4 MODELLING THE DATA

5.4.1 The primary task of the surface modelling was to create a Digital Terrain Model (DTM) of the current ground surface. Ordnance Survey 5m resolution height data had been purchased for the project for this purpose, but this was found to be of little value, as the low resolution gave an accuracy of only ±6m in some areas when compared to known spot heights. This was a particular problem in areas where there were steep slopes or sudden height changes, such as around the castle promontory.

5.4.2 It became apparent that a limited amount of LiDAR data could be made available under licence to the project, and this was duly obtained. These models are routinely used by the Environment Agency for assessing flood risk and give heights that can be accurate to ±0.25m (Environment Agency 2007). LiDAR data collected in 2002 was obtained from the Environment Agency for the study area and formed the basis of the deposit models.

5.4.3 However, the four tiles needed to cover the study area had been flown at different times, had different resolutions, and had been subject to different processing techniques to remove the inaccuracies created by the presence of buildings. This led to a considerable discrepancy in both the height and the level of detail for different parts of the study area.

5.4.4 Various attempts were made to merge the Ordnance Survey data and the LiDAR data, and to 'downgrade' the resolution of the LiDAR data to form a consistent surface model, but in the area of the Cathedral there was still a noticeable discrepancy, or cliff, in the modern ground surface model, with a difference of approximately 9m in the area around the Cathedral.

5.4.5 ArcMap's 3D analyst extension was used to interpolate a three-dimensional raster of the modern ground surface, using the Inverse Distance Weighting technique. In tests

(Hageman and Bennett 2000, 116) this method was shown to be most accurate for regularly spaced grids of data points. A 'cliff' in the data is clearly shown in the Cathedral area (Fig 13) and therefore this model should be used for display purposes only.

5.4.6 To create surface models for the top of Roman deposits and natural subsoils, levels were extracted from the CAU/CAL site archives, where available, or from published reports (*Section 5.2*). Many of the levels for deposits were already converted to metres OD, therefore it was still possible to create reliable deposit models for the Roman and natural surfaces that were not affected by the discrepancies in the modern surface model. However, in some cases only relative heights had been recorded, and it was clear that the model would not be accurate in these areas, as the modern ground surface had been used to establish the absolute height of the levels. The source of the data used to derive the heights of the points, and whether it was absolute or relative, was recorded in the attribute data of the shapefiles, to provide a record of the technique used for each point.

5.4.7 Once all the height data had been standardised, it was possible to create surface models of the sub-surface deposits (Figs 14 and 15). A triangulated irregular network (TIN) was created, as this method is best suited for irregularly spaced data points (Hageman and Bennett 2000, 117). No attempt was made to predict the deposits outside of the extent of the original data points.

5.4.8 In order to verify the accuracy of the models, the heights from the interpolated surfaces were compared back to the heights from the original data points. From this, average error and standard deviation were calculated (Table 9). An error surface was then created for each model to illustrate visually the areas where they are most inaccurate (Figs 16 and 17).

5.4.9 However, the need for a qualitative assessment of the data alongside the quantitative analysis was highlighted in the creation of the model depicting the surface of the natural subsoils. The lack of points from within the castle precinct means that the interpolation algorithm in ArcGIS has incorrectly modelled the castle area as a gentle slope rather than a steep promontory (Fig 15). This was ameliorated to a certain degree by restricting the extent of the model of the natural subsoils to a much smaller area, avoiding the extraneous outlying points.

Surface	Max Error (m)	Average Error (m)	Standard Deviation
Top of Roman	0.73	0.05	±0.12
Top of natural subsoils	1.60	0.04	±0.14

Table 9: Errors calculated for the modelled surfaces

5.5 MODELLING THE THICKNESSES OF THE DEPOSITS

5.5.1 One of the primary aims of a deposit model from a planning perspective is to estimate the depth below the modern ground surface at which significant archaeological deposits are likely to be encountered. Unfortunately, the discrepancies in the modern ground surface make this impossible at this time, and until a reliable model of the modern ground surface, such as consistent LiDAR data, is made available.

5.5.2 It was further anticipated that the thickness of the Roman (and pre-Roman) deposits could be calculated by subtracting the model of the surface of the natural subsoils from that of the Roman deposits. However, the errors in the model of the surface of the natural subsoils (*Section 5.4.9*) meant that only a limited area of the model could be used. The result (Fig 18) was, again, not considered reliable when examined qualitatively, as it is unlikely that there are Roman and pre-Roman deposits of more than 5m in depth anywhere in Carlisle, let alone in the area of the Cathedral.

5.6 ASSESSMENT OF THE DATA MODELS

5.5.1 It is necessary to assess both the results of the data models and the methodology used to create them. The results are discouraging as they suggest that none of the models can be relied upon, when examined qualitatively against prior knowledge of the topography of, and archaeological deposits in, the study area. However, the statistical errors are low, indicating that the correct technique has been used, and as such the inconsistencies in the modern ground surface dataset must be held as the main cause of problems in the models.

5.5.2 Other issues included a preponderance of relative heights, rather than absolute, being recorded in the primary excavation archives. The irregular distribution of points, with outliers having an undue influence over the model, was also a problem. It is to be hoped that improvements in the modern ground surface dataset, such as consistent LiDAR coverage, might improve this issue and lead to a more reliable model. Furthermore, as modern archaeological work increasingly uses digital means of recording, future archaeological investigation in Carlisle should add to and improve this body of data.

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APPENDIX 1: DATABASE STRUCTURE

ILLUSTRATIONS

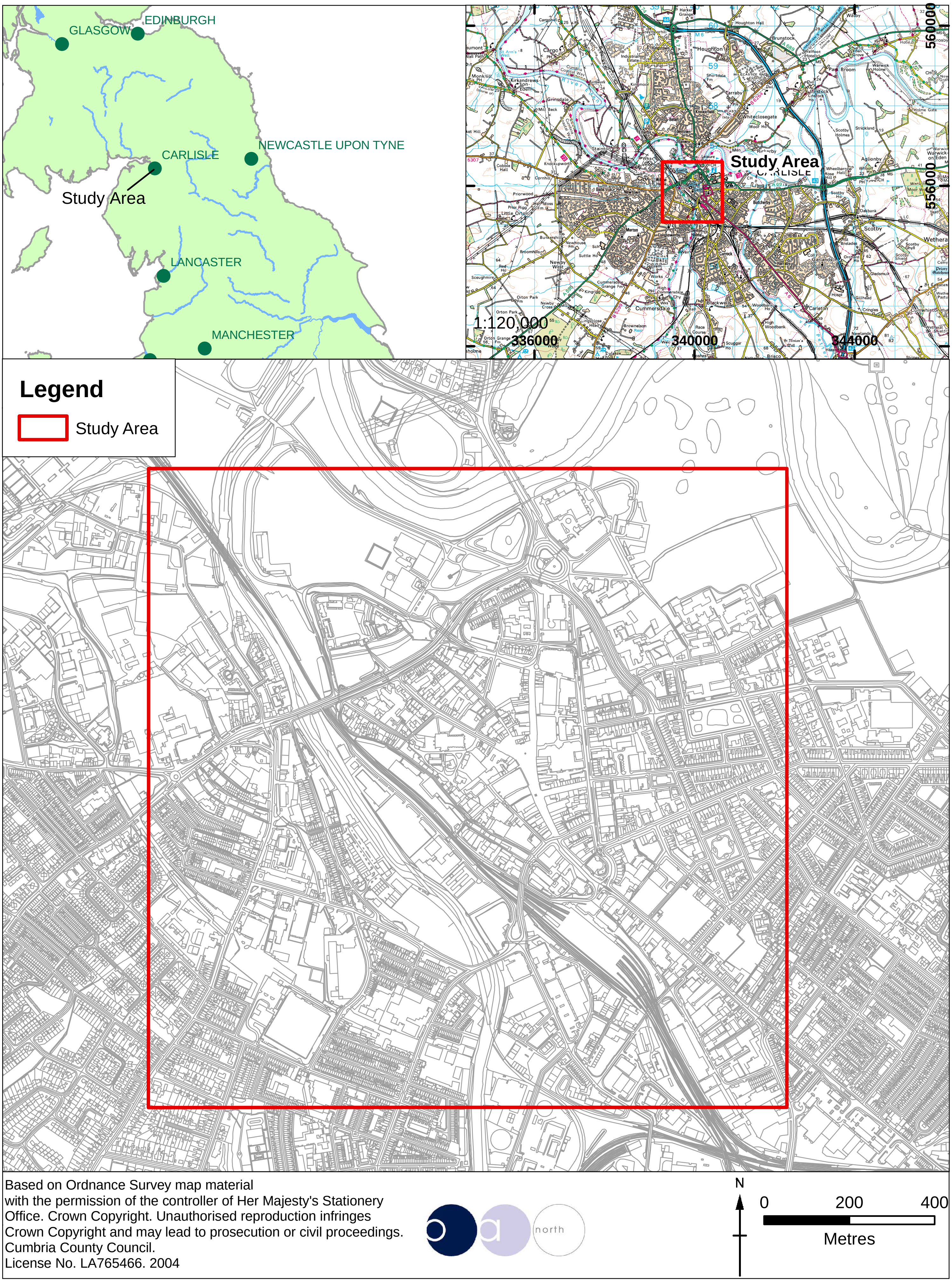

Figure 1: Location of Study Area

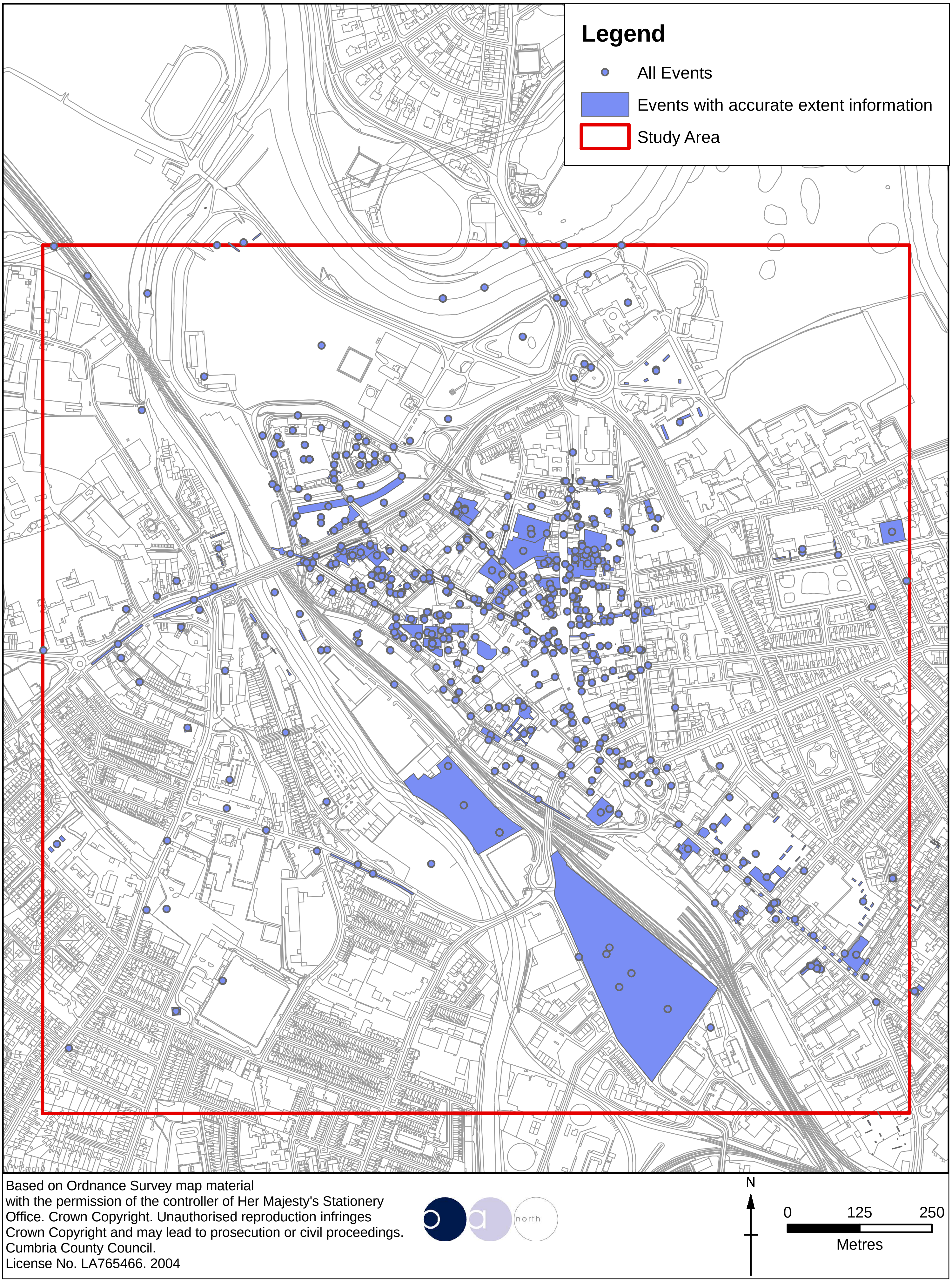

Figure 2: All events recorded within the Study Area

north

N

0 75 150
Metres

Figure 3: Excerpts from the 1560 *Ancient Plan of the City of Carlisle* superimposed on modern Ordnance Survey mapping

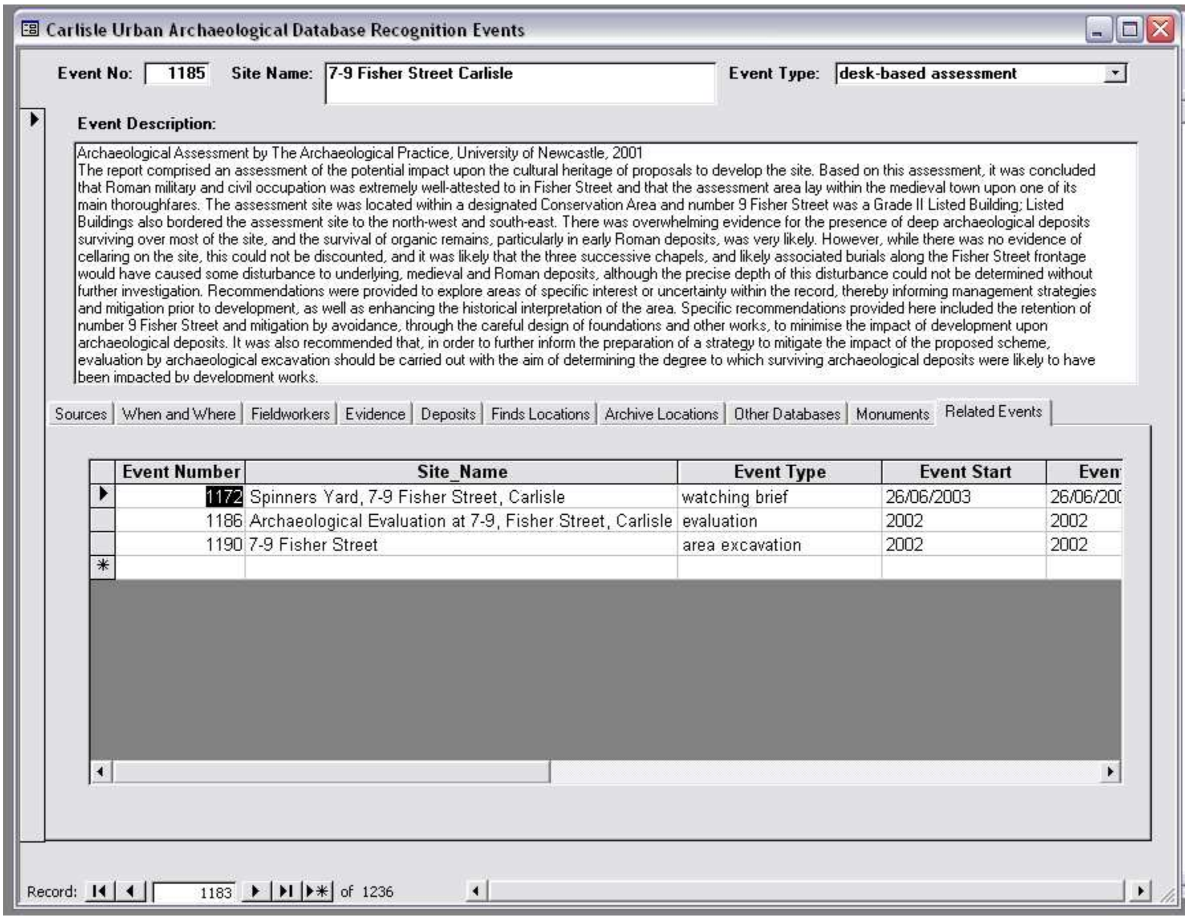

Figure 4: A screenshot of the Recognition Event for 7-9 Fisher Street, showing Related Events

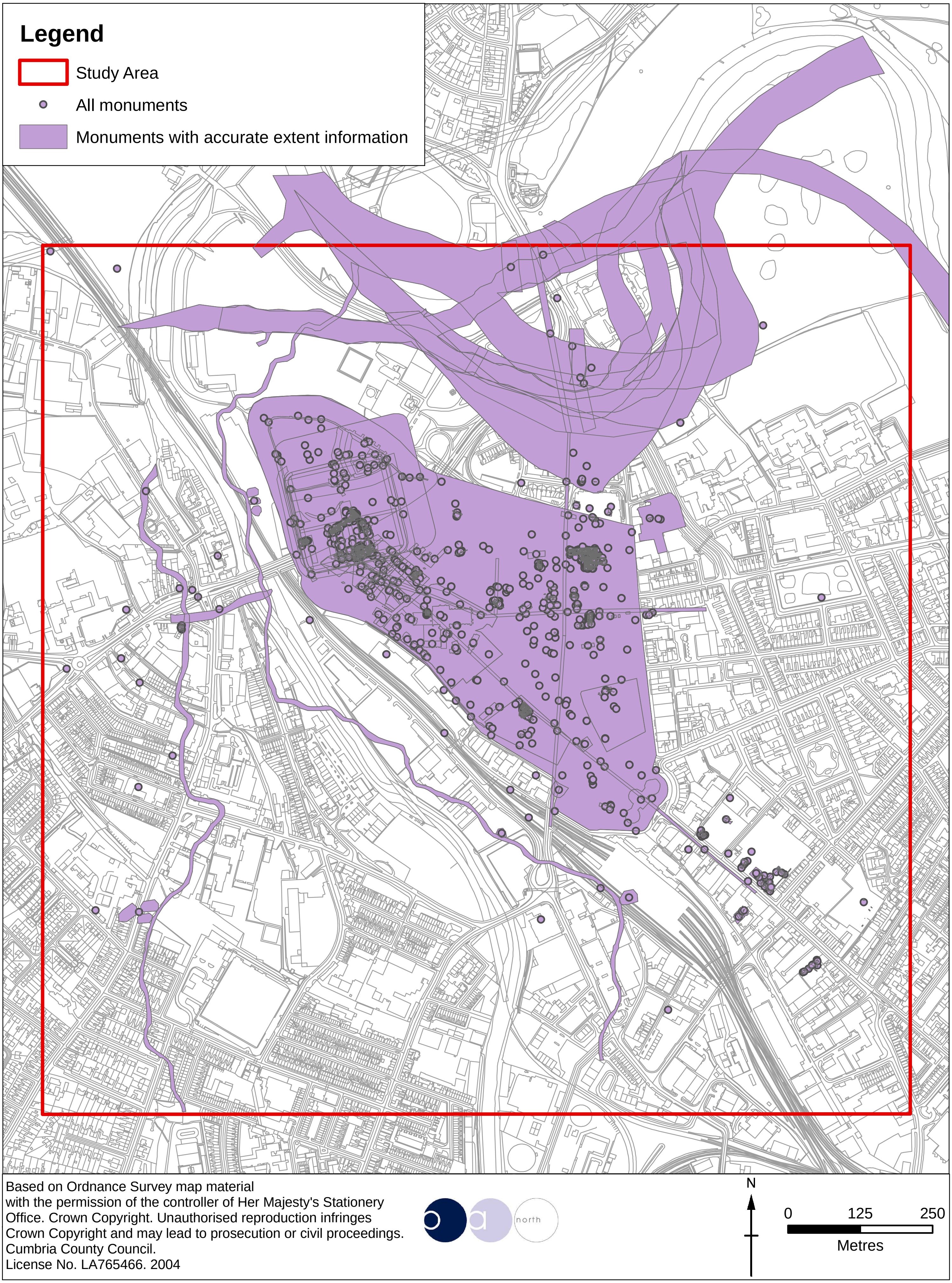

Figure 5: The monuments recorded within the Study Area

Figure 6: All prehistoric monuments recorded within the Study Area

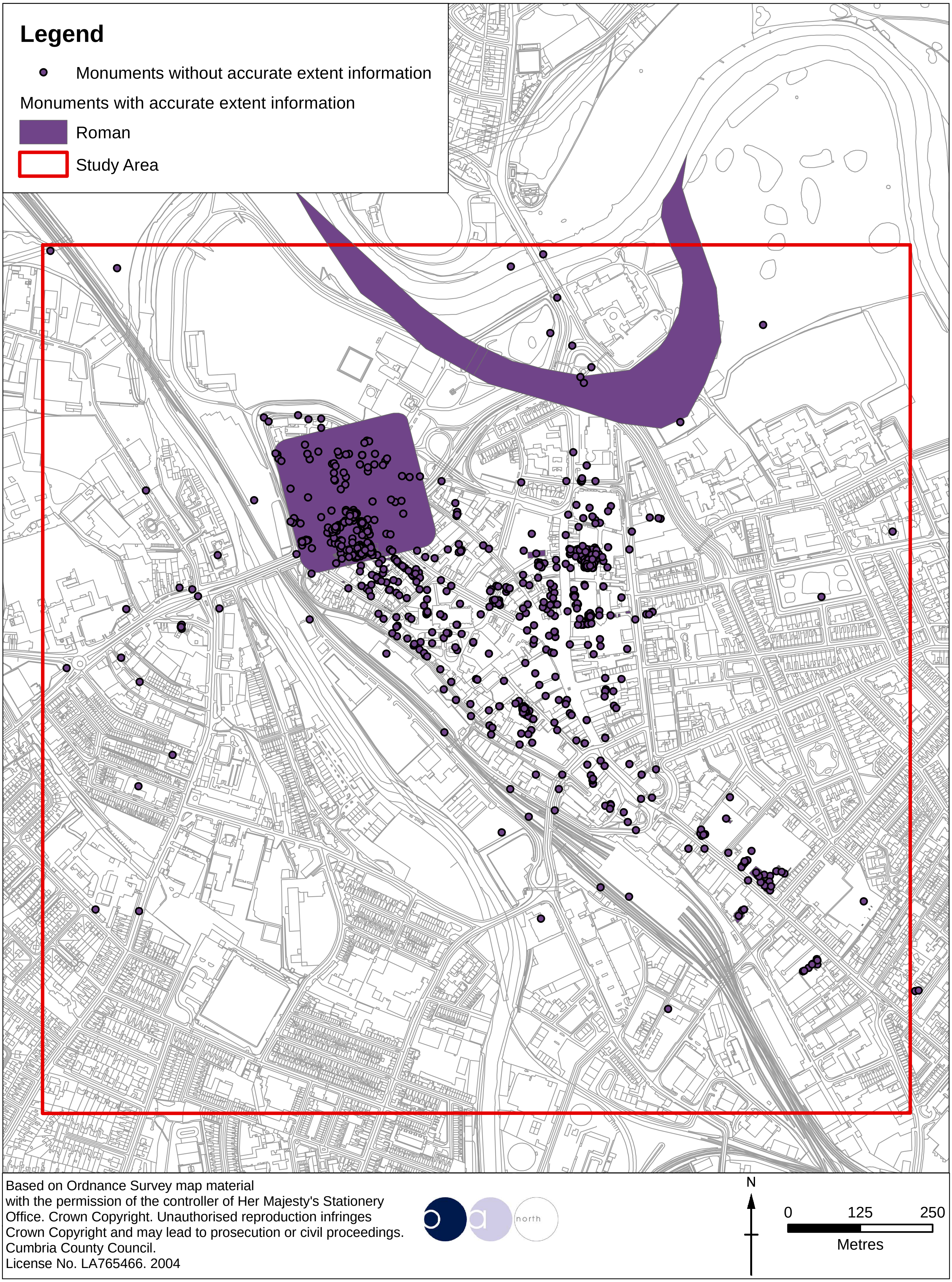

Figure 7: All Roman monuments recorded within the Study Area

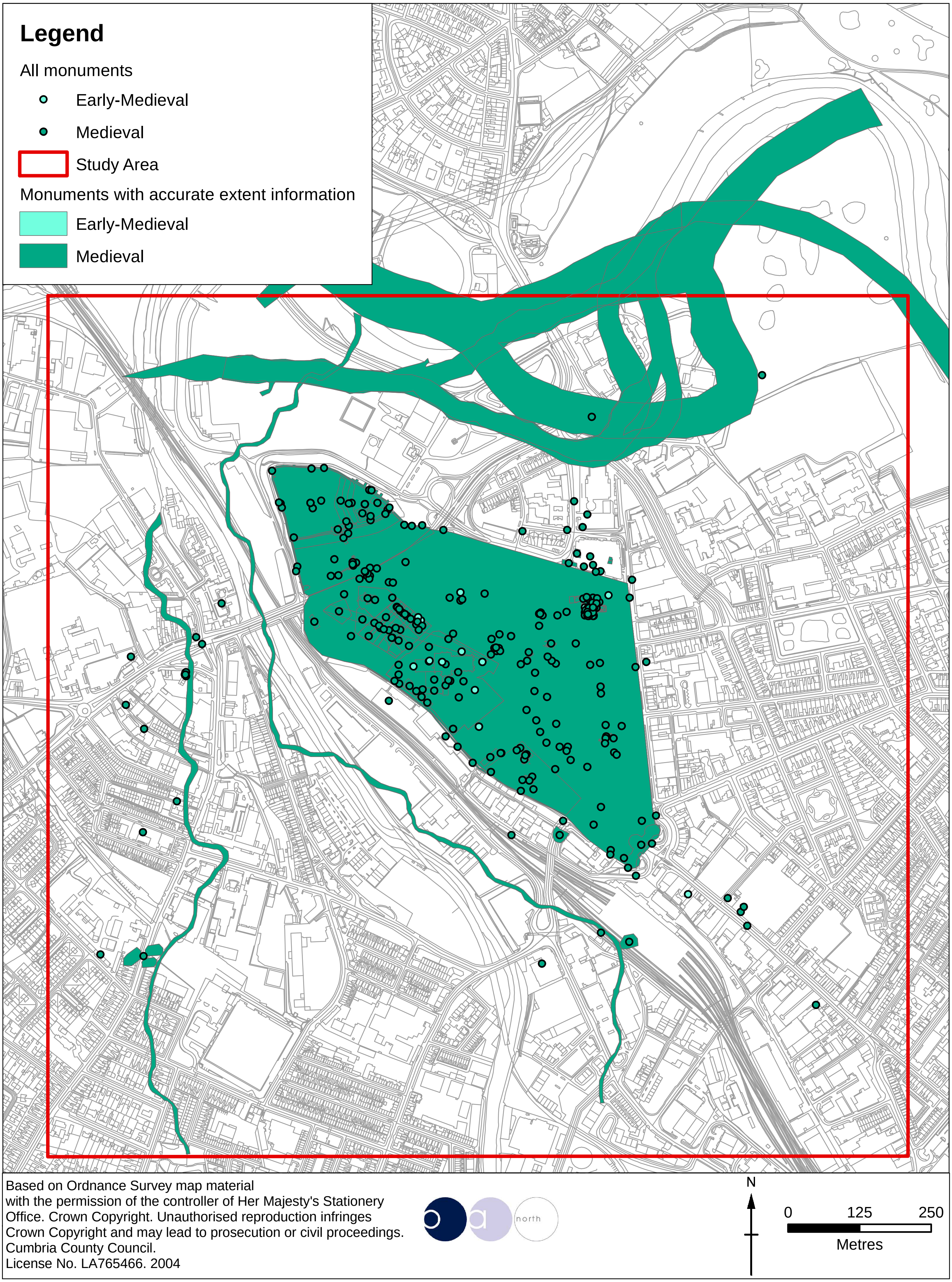

Figure 8: All medieval monuments recorded within the Study Area

Figure 9: All post-medieval monuments recorded within the Study Area

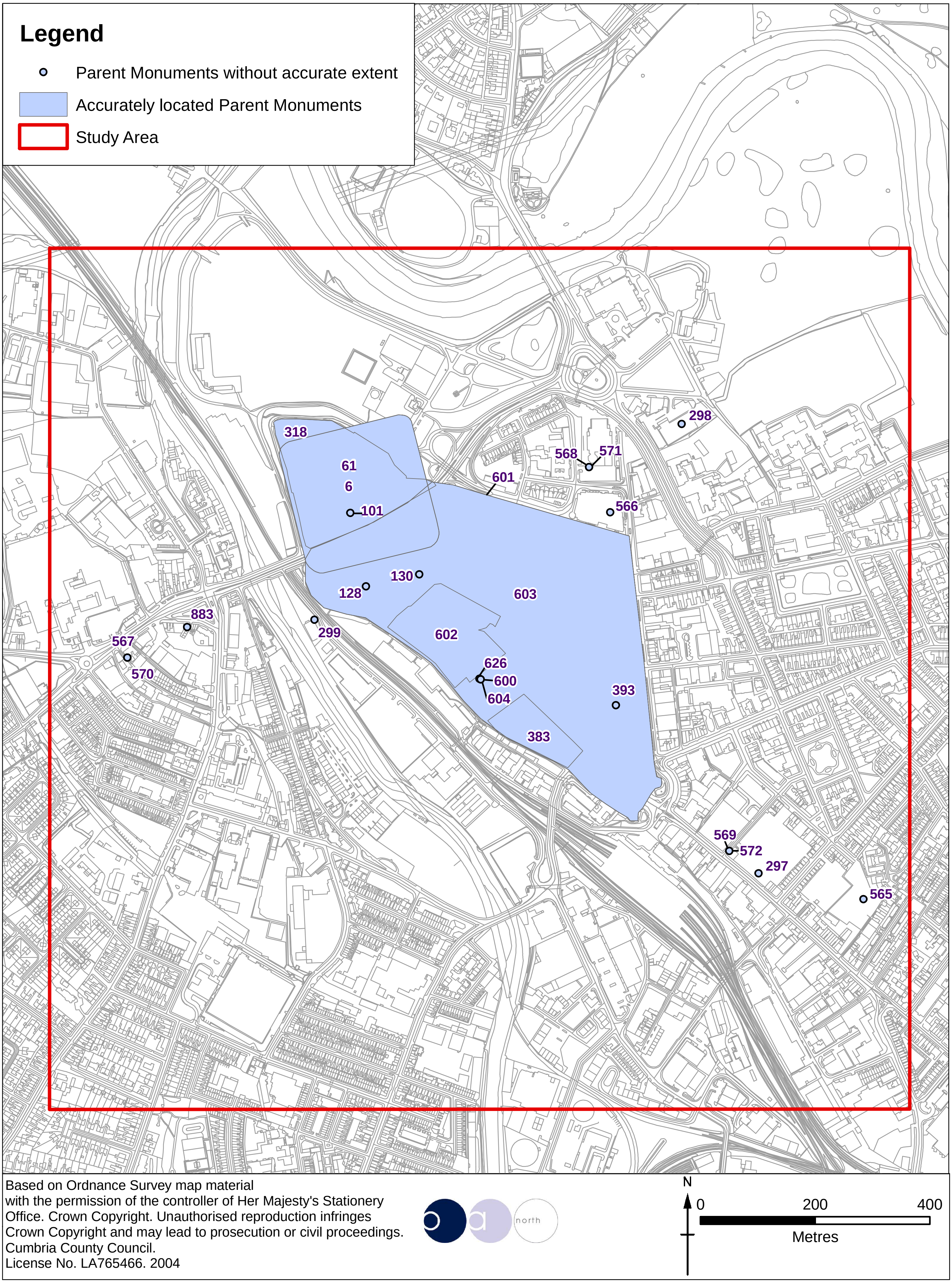

Figure 10: Parent monuments within the Study Area

Figure 11: The Blackfriars parent monument and individual child monuments superimposed on an excerpt from the 1560 *Ancient Plan of the City of Carlisle*

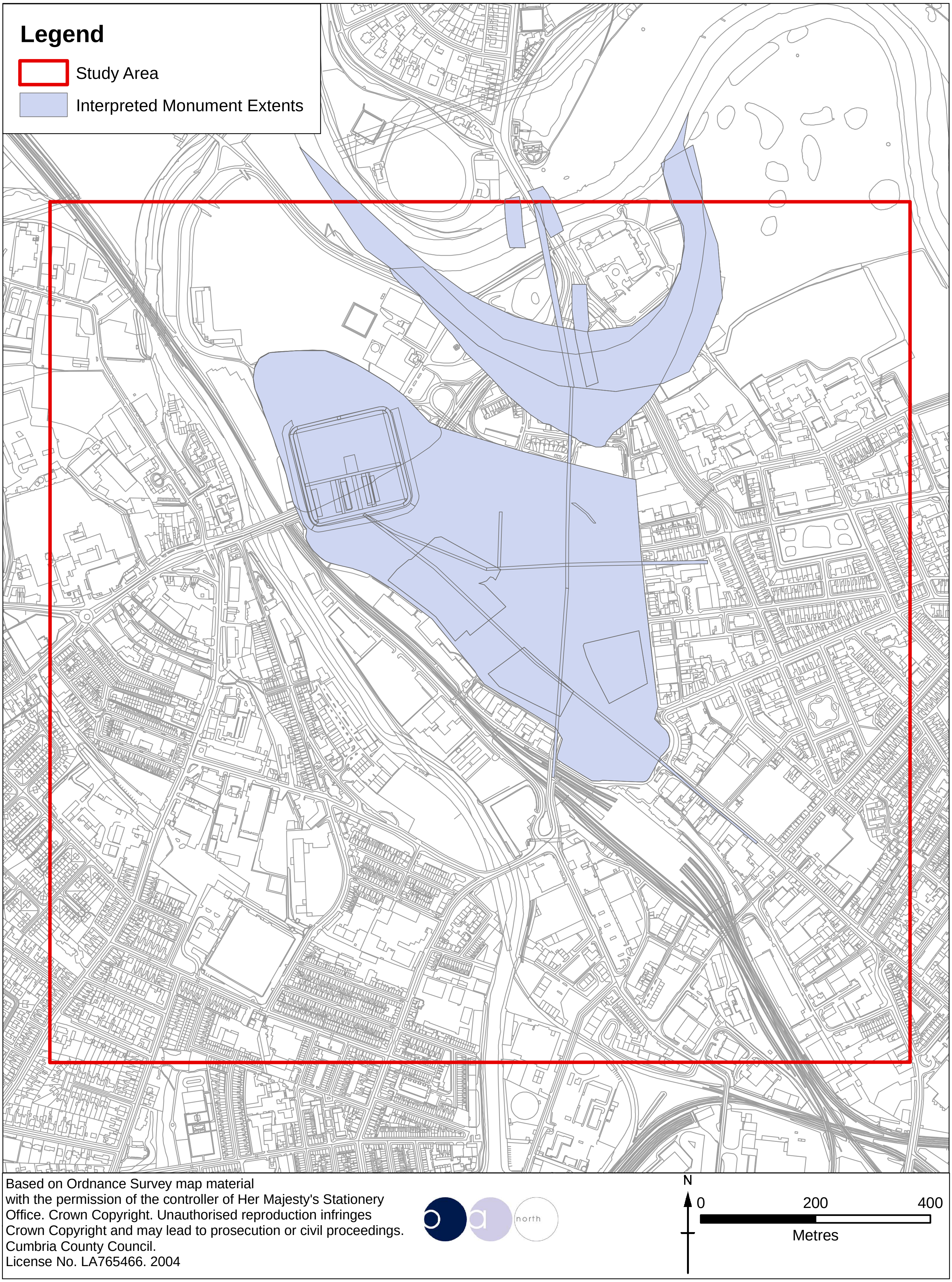

Figure 12: Extents of interpreted monuments within the Study Area

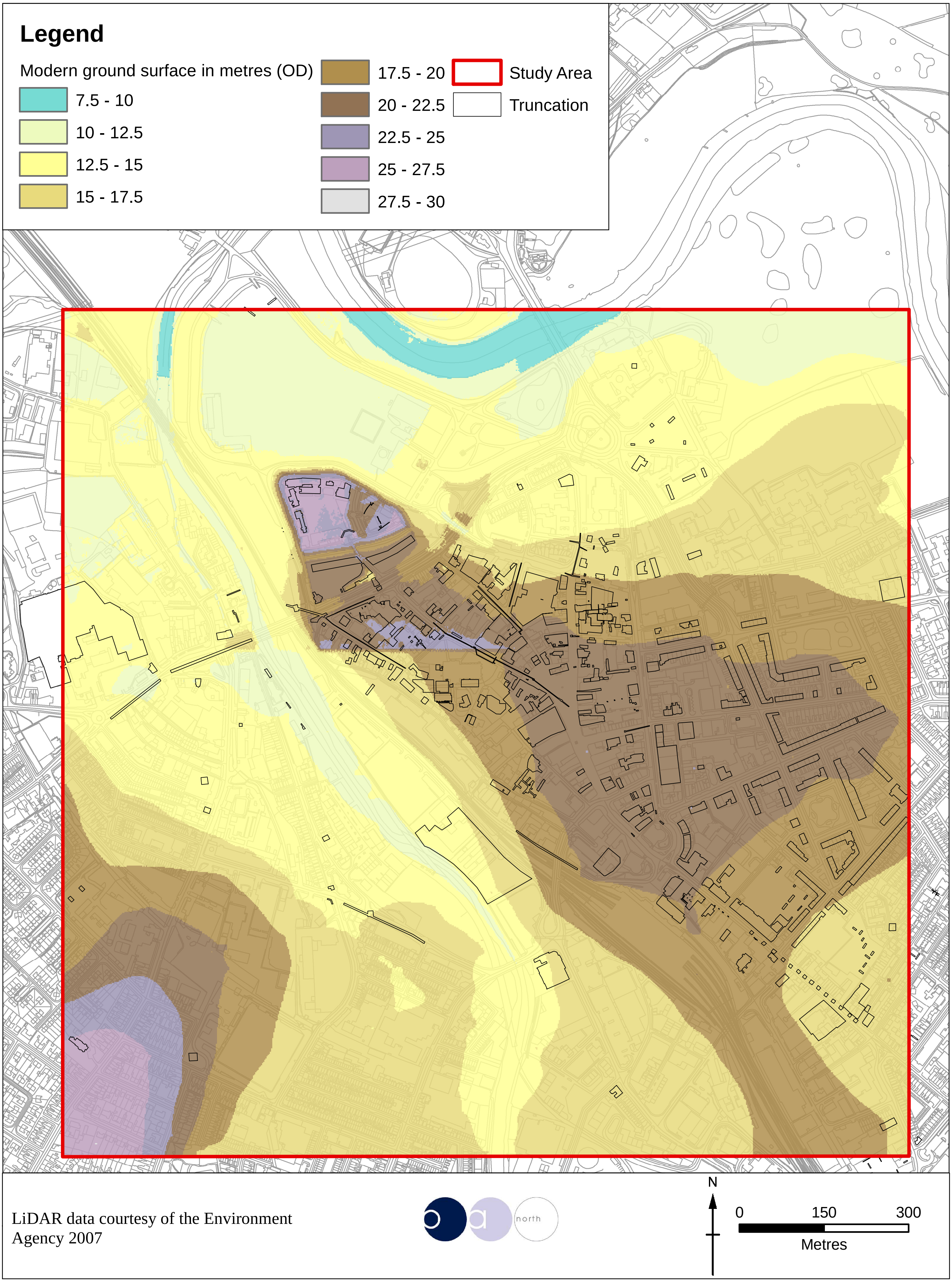

Figure 13 : Modern ground surface raster based on LiDAR data, showing areas of truncation. The "cliff" in the surface data can clearly be seen in the north-west of the Study Area

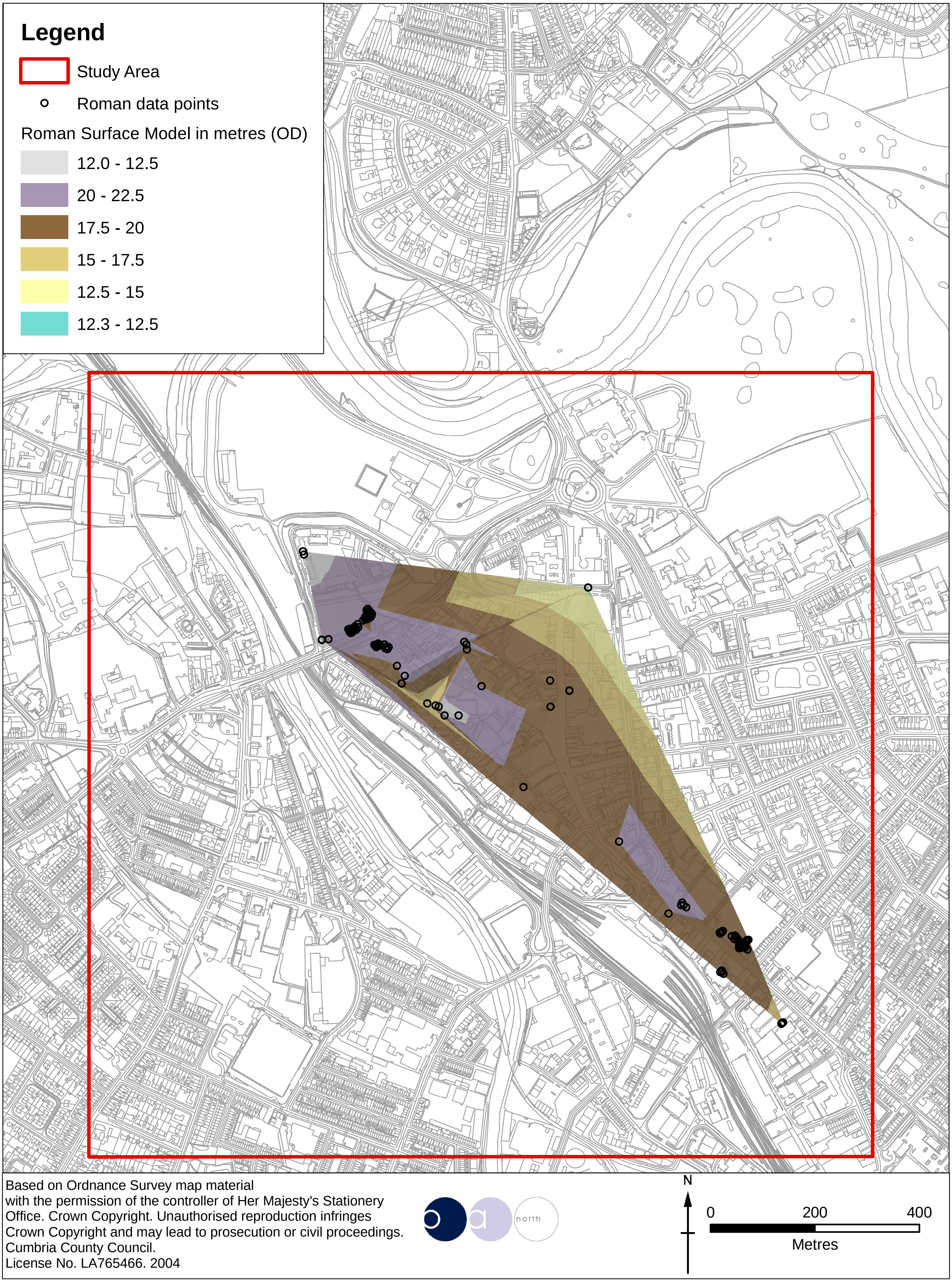

Figure 14: Surface model for the top of Roman deposits in the Study Area

Figure 15: Surface model for the top of natural subsoils in the Study Area.
The inaccuracies in the area of the castle can be clearly seen

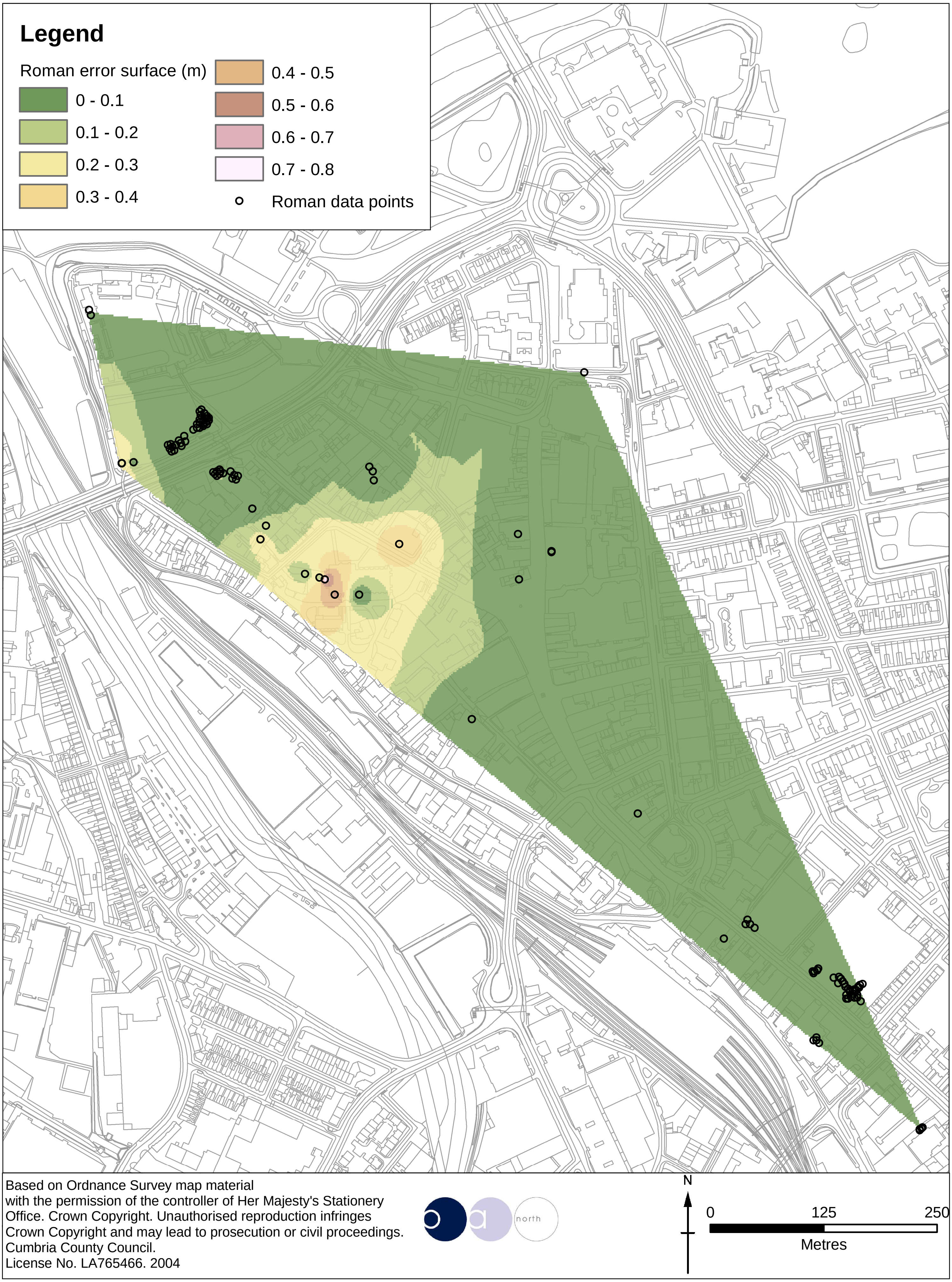

Figure 16: Error model for the top of Roman deposits in the Study Area

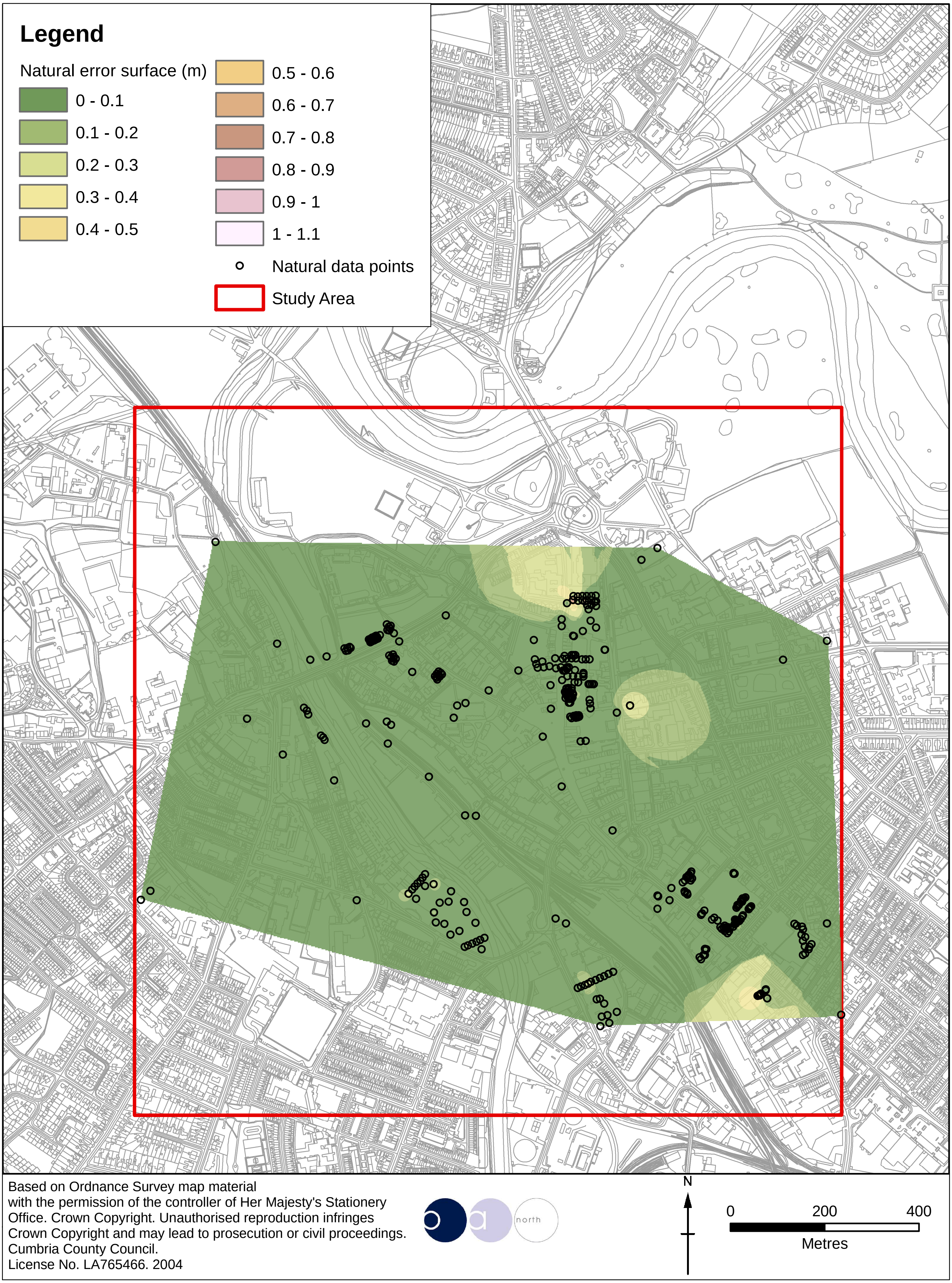

Figure 17: Error model for the top of natural deposits in the Study Area

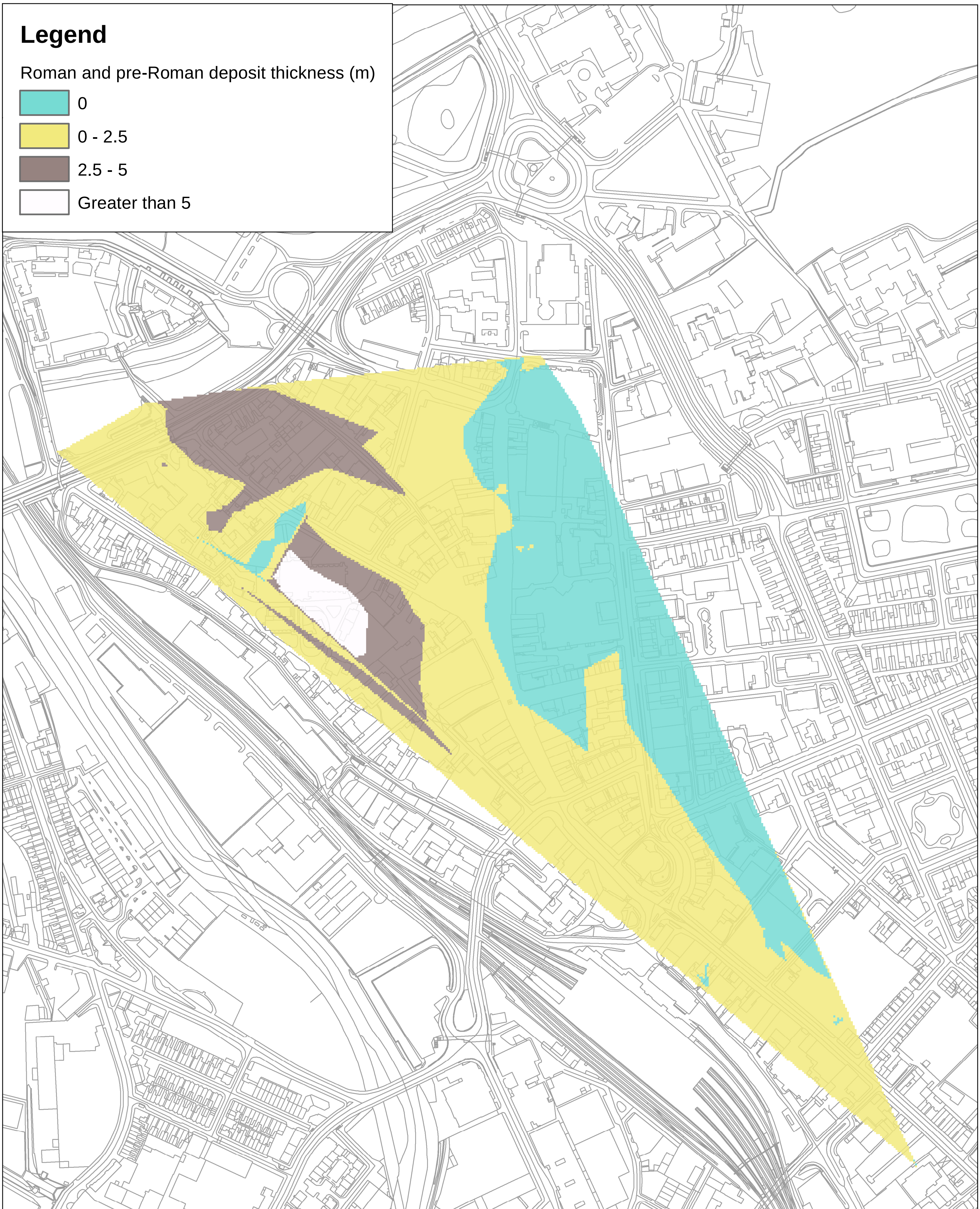

Figure 18: Thickness of Roman and pre-Roman deposits within the area of the Roman surface model. The inaccuracies in the area of the cathedral can be clearly seen