WINDERMERE REFLECTIONS
STAGE ONE

Archaeological and Historical Land Use Resource Assessment for the Windermere Catchment

Oxford Archaeology North

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SUMMARY

Oxford Archaeology North (OA North) was invited by the Lake District National Park Authority (LDNPA) and The National Trust to compile a heritage resource assessment within the catchment of Lake Windermere. The primary aim of this part of this assessment was to collate all readily available historical and archaeological information to provide the client with data that will facilitate and inform the development of Reflections on History, part of the wider Windermere Reflections. Windermere Reflections is itself only part of the Windermere Catchment Restoration Program which aims to improve water quality in the catchment, in addition to promoting and improving understanding of the natural and historic heritage resource within this area.

The work was primarily desk-based, and involved the production of GIS datasets, achieved by enhancing the existing Historic Landscape Characterisation and data from the Lake District National Park Historic Environment Record and National Trust Sites and Monuments Record for the catchment. This facilitated the production of a report comprising a non-technical summary of the assessment, its methodology, and a detailed assessment of the development and heritage of the study area with respect to the three key themes of woodland, water and minerals.

This assessment has served to reveal the remarkable extent and depth of human history within the catchment. Humans have manipulated the Lake District landscape since at least since the Mesolithic period when they commenced the deforestation of the extensive, post-glacial upland forest, and also, in the succeeding Neolithic period, undertook a large scale extraction for axes around Great Langdale. From the Bronze Age onwards, deforestation proceeded at an urgent pace as a result of an agricultural expansion onto the marginal fells around the periphery of the Lake District. Apart from a brief hiatus in the Iron Age, during a period of climatic decline, there has been a progressive deforestation of the woodlands. This reached a peak in the medieval period, when whole areas of woodland were clear felled to provide wood for industrial operations. Subsequently the woodland has been subject to management by coppicing enabling the survival of woodlands. The impact of man has continued into the present and belies the concept of the Lake District as a natural landscape.

Mineral/ Stone Extraction: the geology of the Lake District is diverse, providing a wide array of minerals and rocks available for extraction, which include copper, lead and iron ores, as well as slate and limestone. This geological wealth has been both recognised and exploited and the remains of industrial workings are scattered across the hillsides and valleys. Beyond the Neolithic axe working the earliest recognised mineral working from the catchment was from the medieval period, when local iron ore was smelted in the numerous bloomeries that are found across the area. More intensive working of minerals occurred from the sixteenth century when lead mining was initiated at Greenhead Gill lead mines, and copper was extracted in nearby Coniston. During the post-medieval period the industries were dramatically expanded, with intensive working of slate, large scale mining for both copper and lead and limestone quarries.

Woodland: the natural woodlands were cleared, initially, to enable the working of the Langdale axe factories and, subsequently, to allow for agriculture, but ultimately the biggest impact has been the demands of the burgeoning iron industry which required large amounts of charcoal to feed the bloomeries. The woodlands of the Windermere catchment endured exploitation during the medieval period better than most, with many

being subject to coppiced management allowing for their long term survival despite the heavy demands for charcoal. The study has demonstrated that the vast majority of the woodland within the catchment area is relatively old deciduous woodland, depicted on the OS first edition map of 1864.

Water: from an early age the distribution of settlements and agriculture has been determined by the availability of water sources for domestic supplies and also by the use of lakes and rivers for communication. The manipulation of the streams to provide power and water for industrial working reflects an inevitable progression of the controlling of water supplies. The ultimate expression of this process came with the creation of reservoirs to provide water for both domestic and industrial purposes reflected by the Thirlmere Aqueduct that takes water from the Thirlmere reservoir towards Manchester.

Options for engagement and participation: there is great scope to establish a community project to examine and document various aspects of the three themes of woodland, water and mineral and stone extraction within the catchment. This could entail leading groups of volunteers to undertake documentary research and then survey of selected archaeological or historic sites or landscapes. The study would look at elements of each theme. For the woodland this could potentially be recording of the remains of woodland industries, such as charcoal burning platforms, or areas of designed woodlands within parks and pleasure grounds. For stone and mineral this could include areas of former slate quarries and the remains of the copper industry. For the water theme there is the potential to look at water powered and water fed mills, such as fulling mills, which were an important part of the local textile industry.

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Oxford Archaeology North would like to thank the Lake District National Park Authority for commissioning the project and, in particular, to Eleanor Kingston for her considerable support. Thanks are also due to Jamie Lund at The National Trust for his valuable input. We would also like to thank all staff who responded to our enquiries at the various Cumbria Record Offices in Carlisle, Kendal, Whitehaven and Barrow, along with the Lancashire Record Office in Preston. Further thanks must go to the staff of the Armitt Library and Museum, in Ambleside.

The primary documentary research was undertaken by Jeremy Bradley and Vicky Bullock. The report was written by Jamie Quartermaine, Vicky Bullock, Jo Cook and Peter Schofield. Compilation of the GIS data was managed by Jo Cook, with the assistance of Jo Povall and Dana Campbell. The report was edited by Jamie Quartermaine, who also managed the project.

ABBREVIATIONS USED IN THE TEXT

ALGAO	Association of Local Government Archaeological Officers
ALSF	Aggregates Levy Sustainability Fund
DEFRA	Department for Environment, Food and Rural Affairs
EH	English Heritage
EIA	Environmental Impact Assessment
GIS	Geographical Information System
HER	Historic Environment Record
HLC	Historic Landscape Character
KML	Keyhole Markup Language
LDNPA	Lake District National Park Authority
MIDAS	Monument Inventory Data Standard
NE	Natural England
NMR	National Monuments Record
NT	National Trust
NWWS	North West Wetlands Survey
OA	Oxford Archaeology
OS	Ordnance Survey
SMR	Sites and Monuments Record
SPIRE	Shared Spatial Information Services
SQL	Structured Query Language
UAD	Urban Archaeological Database

1. INTRODUCTION

1.1 CIRCUMSTANCES OF THE PROJECT

1.1.1 Oxford Archaeology North (OA North) was invited by the Lake District National Park Authority (LDNPA) and The National Trust to compile a heritage resource assessment within the catchment of Lake Windermere (Fig 1). The aim of this assessment is to inform the development of Reflections on History, part of the wider Windermere Reflections project funded by the Heritage Lottery Fund. Windermere Reflections is in turn part of the Windermere Catchment Restoration Program which aims to improve water quality and aid the publics understanding of the heritage and the environment of the lake and its catchment.

1.1.2 This heritage resource assessment focuses on the three themes of woodlands, water and stone / minerals in the catchment. The three themes were chosen because of their significance in the catchment and their ability to provoke discussions about natural and historic/ cultural landscape. It is intended that the assessment, as well as defining the resource, will highlight areas of further study as part of the Windermere Reflections project, and, where there is the potential for engagement with the public. For the purposes of the present project, the mineral element of the project was taken to include both mineral sources, such as metal ores, and stone sources, such as slate and volcanic tuffs, which were also heavily exploited.

1.1.3 This assessment was based upon an enhancement of the existing Historic Landscape Characterisation (HLC) and selective thematic data from the Lake District National Park Historic Environment Record and National Trust Sites and Monuments Record for the catchment. The study examined the development of woodland, defining historic coppicing and plantings, as well as woodland industries, such as charcoal burning, bark peeling and potash burning. The development of water was examined through an investigation of how man has used and manipulated water sources, such as becks, rivers and tarns, and how he has used it for power and industry. The development of mineral and stone extraction was examined, ranging from one of the worlds earliest large-scale stone-working operations around the summits of Great Langdale and Scafell Pike to more recent large scale lead and copper mining operations.

1.2 AIMS AND OBJECTIVES

1.2.1 ***Aims:*** the primary aim of this assessment is the creation of an enhanced GIS dataset for use during the development and delivery of Reflections of History. The creation of this practical reference included:

- Creating an effective evidence base that utilises all readily available sources of information relating to the history and development of woodland, water and mineral/ stone extraction across the catchment and also includes a history of land use in the study area. This included a comprehensive inventory of known archaeological sites and areas of archaeological significance.

- Improving, amending and enhancing the Lake District National Park HLC data for the Windermere catchment through the analysis of photographic evidence and historical mapping;
- Producing GIS layers that incorporate and demonstrate these efforts and that are complimentary to both Historic Landscape Characterisation (HLC) and LDNPA Historic Environment Record / NT Sites and Monument Record data;
- enabling and facilitating the future understanding and appreciation of heritage within the catchment;

1.2.2 ***Objectives:*** the overall objectives of this assessment was to collate and analyse the resources pertaining to the historic land use of woodland, water and minerals / stone in the Windermere catchment area by bringing together and analysing existing datasets. The results are presented as a synthetic report, but primarily in graphic, GIS form, highlighting known archaeological sites and areas of archaeological significance.

2. METHODOLOGY

2.1 INTRODUCTION

2.1.1 ***Project Design:*** in response to a Lake District National Park Authority (LDNPA) project brief (*Appendix 1*), OA North compiled and submitted a project design to undertake the assessment (*Appendix 2*). Throughout the project, all work was undertaken in accordance with the LDNPA-approved project design. In essence, the project aimed to collate and examine various sources to gain an understanding of three specific themes of historic land-use, comprising woodland, water management and mineral extraction within the catchment. The project was undertaken in three stages:

- *Stage One:* project inception, data acquisition and GIS 'set up';
- *Stage Two:* data extraction, collation, analysis and creation;
- *Stage Three:* report production and output creation.

2.1.2 ***Summary of Outputs:*** the results of the project are presented in this report, and as a series of GIS layers.

2.1.3 *GIS outputs*: for each of the themes of historic land-use, the GIS output is split into two sections: 'assets' and 'evidence'. The 'assets' layer comprises the recordable geographic outlines of the themes, at the present time, and at various dates defined by the available historic mapping. The 'evidence' layer represents supporting data, and takes the form of (for example) HER entries relating to an historic watercourse, or accompanying feature, or archaeological evidence for charcoal production. In this way, the data in the 'evidence' layer feeds back into the 'assets' layer by providing fine-grained detail on the location of the 'asset' at a given time. Spatial data is produced in ESRI shapefile or Mapinfo tab format, as required, with appropriate metadata. The spatial datasets comprise:

- 'Assets' dataset - one dataset for each of the three themes (woodland, water and mineral resources);
- 'Evidence' dataset - this can be presented as one convenient dataset or three based on themes.

2.1.4 *Documentation:* in accordance with Section 6 of the LDNPA brief (*Appendix 1*), the documentation of this project comprises:

- A concise report that includes summaries of the archaeological and historical background of the catchment, past and present land use, and supporting illustrations. Importantly, these aspects of the report relate to and support the main assessment of the catchment's woodland, water and areas of mineral extraction;
- A printed gazetteer detailing all known archaeological sites and areas of significance or potential archaeological significance;
- A complete index to the project archive;

2.2 STAGE ONE: GIS 'SET UP' AND DATA ACQUISITION

2.2.1 ***GIS Set up and ongoing Support:*** a MIDAS-compliant (Forum on Information Standards in Heritage 2007) GIS system has been set up for the project. All data is in standard formats, to ensure full compatibility with the systems currently in use at the LDNPA and The National Trust. Feature and layer-level metadata is provided in line with the Archaeological Data Services Guide to Good Practice for GIS (*ibid*). Throughout the project there has been ongoing monitoring of data integrity, security and quality. The following datasets were captured, assessed and incorporated, as required, into the GIS dataset.

2.2.2 ***LDNPA Data Acquisition:*** the following datasets were provided by LDNPA:

- Ordnance Survey (OS) Modern 1:10,000 raster mapping;
- OS Modern Mastermap vector mapping;
- OS 1st Edition raster mapping (*c* 1864, 6 inch to the mile);
- OS 2nd Edition raster mapping (1899, 6 inch to the mile);
- OS 3rd Edition raster mapping (1911 (surveyed in 1888) 6 inches to the mile);
- HER data, including data from The National Trust Sites and Monuments Record;
- Statutory designations (Scheduled Ancient Monuments, Parks and Gardens, Listed Buildings);
- Lake District National Park Historic Landscape Characterisation (Newman and Hardie 2007).

2.2.3 All datasets were supplied geo-referenced and compatible with the project GIS. Although OS Third Edition map coverage was incomplete, the shortfall was made up by additional data acquired from The National Trust (see below).

2.2.4 ***National Trust Data Acquisition:*** datasets supplied by The National Trust fell into two main groups: those that contained geospatial data that could be added to the project GIS, and those that contained non-spatial information that could be used to inform the analysis but could not be added to the GIS. A rapid assessment of each dataset was undertaken initially to establish which group it belonged to.

2.2.5 *Spatial sources:*

- OS Third Edition mapping (1914 (surveyed in 1888) 25 inches to the mile);
- Claife Station Conservation Plan 2008 (Rutherford 2008);
- Fell Foot Conservation Management Plan 2008 (Rutherford 2008);
- Great Langdale Campsite Flood Risk (Gibson *et al* 2008);
- Great Langdale Historic Landscape Survey and Monitoring Reports (Lund and Southwell 2002);
- M Davies-Shiel Survey (Davies-Shiel 1990);
- Monk Coniston Designed Landscape Survey Report (Chris Burnett Associates 2003);
- St Catherine's, Windermere Historic Landscape Survey (OA North 2005b);

- Tarn Hows 2003 (Chris Burnett Associates 2001);
- Veteran Trees Survey (Preston and Milligan 2010);
- Windermere Catchment Fluvial Audit (Jacobs Engineering UK Ltd 2009a; 2009b);
- Ambleside Roman Fort report (Garlick 1975);
- Colwith Force Bloomery (Lax 1998a);
- Eller How Gardens (LUAU 1999);
- Greenburn Mine report (Oswald *et al* 2000);
- Elterwater Gunpowder Works (Jecock *et al* 2003);
- Wray Castle Designed Landscape Survey (Chris Burnett Associates 2005).

2.2.6 *Non-spatial sources:*

- Borrans Field Conservation Management Plan 2009 (National Trust 2008);
- Deer Parks in the Barony of Kendal (Cook 2009);
- Ambleside Roman Fort interpretation leaflets (Shotter nd);
- Thomas West's Guide to the Lakes (West 1778);
- Wray Castle Estate Maps from sale particulars (Anon 1898; 1920; 1928);
- Reedbed Verification method report (Bennett 2010).

2.2.7 ***OA North Data Acquisition:*** OA North holds reports on several surveys conducted within the catchment. These comprise:

- Stickle Tarn, Langdale Archaeological Survey (OA North 2005a);
- Martcrag Moor, Langdale survey (OA North 2009);
- Upland Peats Survey (OA North 2010);
- Lake District National Park Survey (*eg* Claris and Quartermaine 1989).

2.2.8 ***Kendal Record Office, Kendal, Cumbria (CRO(K)), Data Acquisition:*** cartographic and primary documents, as well as secondary sources pertaining to the study area, were consulted at the record office and, where appropriate or viable, were georeferenced and incorporated into the GIS, or for non-spatial sources, incorporated into the report.

2.2.9 *Spatial Sources:*

- WDB/35/184 A Map of Rydal Demesne in the County of Westmorland, 1770;
- WDB/35/133 Millbeck Estate Map, 1852;
- WDB/35/134 Plan of the Raw Head Estate, 1853;
- WDB/35/556 Box 5 Tower Bank Sawrey, 1898.

2.2.10 *Non-spatial sources*

- WDRC/8/233 Rydal and Loughrigg Tithe Map, 1838;
- WDRC/8/244 Undermillbeck Tithe Plan, 1838;

- WDRC/8/289 Ambleside Below Stock Tithe Plan, 1838;
- WDRC/8/285 Ambleside Above Stock Tithe Plan, 1838;
- WDRC/8/238 Langdale Tithe Map, 1839;
- WDRC/8/284 Troutbeck Tithe Map, 1841;
- WQR/I/6 Applethwaite Enclosure including Hugill and Troutbeck, 1842;
- WDRC/8/293 Grasmere Tithe Map, 1843;
- WDRC/8/77 Blea Tarn Tithe Map, 1846;
- WDX/1087 Plan of Attwood, Lonethwaite, Sike Side and Latterbarrow Estates, 1882;
- WDB/35/785 Plan of Harry Place and Pye Howe Estate Map, 1893;
- WD/NT/45 Maps of the Water Supply of Grasmere, 1903.

2.2.11 ***Whitehaven Record Office, Whitehaven, Cumbria (CRO(W)), Data Acquisition:*** a list of possibly pertinent cartographic and primary documents was obtained by prior enquiry, and high-resolution copies were requested of relevant material as required. Where appropriate or viable, extracts of primary sources were georeferenced and incorporated into the GIS, or the report.

2.2.12 *Spatial sources:*

- D/CU/ Estate Plan 10 The Great Lake of Windermere *c* 1802;
- D/Cu/3/145 Offers for timber, Heald Plantation, Belle Grange *c* 1911.

2.2.13 ***Lancashire Record Office, Preston, Lancashire (LRO), Data Acquisition:*** cartographic and primary documents, as well as secondary sources pertaining to the study area were consulted at the record office and appropriate copies obtained. Where appropriate or viable, extracts of primary sources were geo-referenced and incorporated into the GIS, or for non-spatial sources, incorporated into the report.

2.2.14 *Spatial sources:*

- DDN 2/15 A Plan of Joseph Hunter's Estate known by the name of High Wray situated in the parish of Hawkshead, Lancashire, 1794;
- AE/4/4 Claife Enclosure Award, 1799;
- DDN3 Box 2 2/6/1836 Map of Low Wray;
- DRC 1/15 Hawkshead Tithe award and Schedule, 1847;
- AE/4/8 Enclosure Award; Hawkshead Moor, Borwick Ground Fell, Holme Fell and Tom Heights, and Monk Coniston Moor, 1862;
- DDN3 Box 2 29/9/1898 Conveyance Plan of the Estate;
- DDN3 Box 2 14/7/1920 Plan of the Wray Castle Estate;
- DDN3 Box 2 19/1/1927 Wray Castle Estate Plan.

2.2.15 ***Armitt Library and Museum, Ambleside, Cumbria, data acquisition:*** the library was visited by prior appointment in order to consult historic maps and pertinent secondary and unpublished sources. Copies of relevant documents were obtained as necessary.

2.2.16 *Non-spatial sources:*

- Saxton, C, 1690 Map of Westmorland;
- Speed, J, 1927 Map of Westmorland;
- Morden, R, 1637 Map of Westmorland;
- Abercrombie, P, Kelly, S, 1932 Cumbrian Regional Report;
- North West Water Authority Annual Reports 1976-1978;
- AM Box 107 Stack 3c 338/2 Lakeland Mines and Quarries Trust reports;
- Whitehead, A, 1985 Cumbria Inventory of Ancient Woodland.

2.2.17 ***Additional Data Sources:*** in addition, data on current Forestry planting was obtained from the Forestry Commission.

2.2.18 ***Scanning and Georeferencing of historic maps and other data:*** the OS 3rd Edition mapping (1911-3) supplied by The National Trust was not in a georeferenced format. Each map sheet was geo-referenced against the modern 1:10,000 OS mapping and its residual error recorded. At least six control points were used for the geo-referencing. When only a small part of the map sheet fell within the project catchment, only that part was geo-referenced.

2.2.19 Other spatial sources were scanned and geo-referenced where possible. Again, the modern 1:10000 OS mapping was used as the base, and the number of control points, and the residual error, were recorded. In some cases, figures appeared useable but contained no information that could be identified in enough detail on the modern OS mapping, and could not, therefore, be geo-referenced.

2.3 STAGE TWO: DATA EXTRACTION, COLLATION, ANALYSIS AND CREATION

2.3.1 ***Extraction of data from the HLC:*** the present and historic land cover of the catchment was mapped as part of the Cumbria and Lake District Historic Landscape Characterisation Project (HLC; Newman and Hardie 2007). This was clipped to the Study Area, and the features relating to the three themes of wood, water and stone / minerals were extracted. There were a number of methodological differences between the current project and the HLC. The HLC has been mapped at a much lower scale as it is county-wide, and is not intended to show smaller discrete features, but rather the general land cover. Consequently, many smaller features were not mapped. Furthermore, the published methodology for the HLC did not provide an explanation for all of the fields in the HLC GIS attribute table, so some interpretation has been required to extract the features relevant to the present project's themes. The following HLC GIS fields were thought to contain information relevant to the project themes:

- Topograph: records presence or absence, and physical type, of woodland or water;
- Topograph0: records presence or absence, and physical type, of woodland or water on OS 1st Edition mapping;
- Morphology: records shape of enclosure, but also the presence of extractive industry;

- Morphol0: records shape of enclosure, but also the presence of extractive industry on the OS 1st Edition mapping;
- Code: the Mastermap code for this land cover type;
- Code_0: the Mastermap code for the land cover type shown on the OS 1st Edition mapping;
- Interpretation: records the category of land cover, such as Ancient Woodland, Ornamental Parkland, and so on;
- Interpration_1-4: records historic changes in category of land cover;
- Date: describes the map series that the land cover has been seen on. Pre-1770 indicates that the feature pre-dates the Enclosure Act. 1770-1864 relates to features marked on the OS 1st Edition mapping. 1864-1950 relates to features shown on OS Third Edition mapping. Post-1950 relates to modern features;
- Change: a yes/no field indicating whether there has been any change of land cover;
- Change0: a yes/no field indicating whether there has been any change of land cover since the OS 1st Edition mapping.

2.3.2 Using a combination of these fields, features relating to each of the three themes of the present project were extracted, as they either related to the modern or to the historic land cover. As, potentially, a particular land parcel could belong to more than one theme (historic woodland then quarried-out, for example), separate queries were written for each theme, and an Assets Dataset created accordingly. The attribute data in the HLC (and therefore in the Assets layer) was adjusted for clarity and to meet the needs of this project. The final fields included are as follows:

- Name: the common name that this land parcel is known by (where appropriate);
- Theme: the overall theme for this land parcel, in other words, wood, water, or stone / minerals;
- Theme_Type: the broad category of feature, defined according to the word list in *Appendix 1*;
- Theme_Subt: the broad sub-category of feature, defined according to the word list in *Appendix 1*;
- Definition: the specific feature type (derived from the HLC or from the National Monument Record Thesaurus);
- Source1-4: in order, the earliest cartographic source that a feature appears on, through to the latest;
- Source_oth: the non-cartographic source that a feature appears on or in.

2.3.3 ***Extraction of data from HER:*** as The National Trust SMR data had been recently amalgamated with the LDNPA HER there was no need to do separate extractions as defined in the project design (*Appendix 2*), once confirmation had been received that the dataset was up to date. Each entry in the LDNPA HER was examined for relevance to each of the three project themes, using the Royal Commission on the Historical Monuments of England (RCHME) Thesaurus of Monument Types

(RCHME and EH 1995) and tagged with the relevant theme prior to extraction into new datasets to form the basis of the Evidence layers.

2.3.4 ***Digitisation of additional features:*** the Assets and Evidence layers were overlain on the historic OS mapping, beginning with the 1st Edition. Features shown on the mapping, but not already present in the Assets and Evidence layers, were digitised. All features present on the 1st Edition mapping were tagged with that as their first source. This process was repeated for the Second and Third Edition maps, with new features being tagged with the appropriate map series as their first source, and existing features being tagged to show which additional series they appeared on. This map regression was completed with the modern 1:10,000 series. Features that appeared on several map series but changed shape dramatically, such as patches of woodland, were digitised again as separate features and tagged accordingly.

2.3.5 Further data pertaining to the Evidence and Assets layers were extracted from the results of the documentary search described above (*Section 2.2*). If features could be digitised with sufficient accuracy as polygons, and were directly related to one of the three themes, they were added to the Assets layer. In addition there were also features incorporated that could only be located as points, either because only a single location was available or because the source information was not accurate enough for digitisation. In both cases, they were tagged with the relevant theme and source, and the other attribute fields were completed where possible.

2.3.6 Historic maps pre-dating the OS 1st Edition map (*c* 1864), and that could not be geo-referenced, were examined by eye. Features that could be clearly identified with confidence as being pre-OS 1st Edition were tagged as such, but were not digitised. Historic maps with a publication date overlapping with the OS series were also examined to provide a comparison, but not digitised as it was felt that they could not provide much additional information within the constraints of the present project.

2.3.7 Finally, the Assets layer was exported as Keyhole Markup Language (KML) and viewed in Google Earth. A check was undertaken to ensure that changing from the British National Grid co-ordinate system, as used within the GIS, and the global Spherical Mercator-based projection used in Google Earth, did not result in a reduction in accuracy. Additional features shown on Google Earth but not present in the Assets layer were then digitised as KML. As Google Earth shows an altitude rather than a scale, an altitude of less than 500 metres was used for this digitisation. The additional features were then opened in the GIS and re-projected to use the British National Grid co-ordinate system, then merged, saved as shapefiles, and finally merged with the existing Assets layers.

2.3.8 ***Using the Evidence layer to add additional detail in the Assets layer:*** for each theme, a query was written to extract the data for each theme_type (see *Appendix 3* for the breakdown of these). A spatial query was then written to count the number of Evidence point features of a given theme_type that fell in each Asset's polygon. This made it possible to, for example, see the number of woodland-industry sites within each polygon of the Woodland Assets layer, or the number of water-powered industry sites within each polygon of the Water Assets layer.

2.4 STAGE THREE: REPORT PRODUCTION AND OUTPUT CREATION

2.4.1 ***Gazetteer of known and potential sites:*** the results of Stage Two, specifically the information relating to known archaeological sites or areas of significance, were collated and presented in a consistent and easily accessible format, one that complimented the GIS outputs and was consistent with HER records.

2.4.2 ***Assessment of the historical and archaeological development of the three themes and how these relate to the overall development of the area:*** following on from the data collation and analysis of Stage Two, the catchment area was assessed in detail with respect to the historical development of woodlands (including the identification of distinctive and ancient character, the development of historic woodland exploitation and woodland industries); water (with emphasis on how watercourses and water bodies have been impacted by man); and minerals (highlighting the development of mineral extraction and resource exploitation). Knowing that this assessment will help to identify future 'Reflections on History' projects, the assessment will inform future developments in the landscape, and improve an understanding of the heritage resource and historic character of the catchment.

2.4.3 ***Archive Preparation and OASIS:*** in accordance with the brief (*Appendix 1*), the project archive will be compiled to meet with current guidelines. This will include all GIS data and accompanying metadata, along with all administrative documentation relating to the project, the report and an index. As part of this process, OA North will incorporate a summary of the project onto the OASIS site.

3. TOPOGRAPHICAL AND HISTORICAL BACKGROUND

3.1 INTRODUCTION

3.1.1 This section sets out a brief archaeological and historical background of the Windermere catchment, with emphasis on the three themes of woodland, mineral and water. It is not intended to be a comprehensive review of the archaeology and history of the area.

3.2 LOCATION, TOPOGRAPHY AND GEOLOGY

3.2.1 ***Location and topography:*** the Windermere catchment covers an approximate area of 23,000 hectares (Fig 1) in the Lake District National Park; it is relatively large and contains several other significant still waters. To the north of Windermere lie Grasmere and Rydal Water, with Loughrigg Tarn and Elterwater to the north-west, and Blelham Tarn and Esthwaite Water located to the west; several other smaller tarns occur within the catchment. The main inflows to Windermere are the rivers Brathay and Rothay, at the head of the Lake, Trout Beck, draining the north-east side of the catchment, and Cunsey Beck, which drains Esthwaite Water. The outflow from Windermere is the River Leven, which discharges into Morecambe Bay via an estuary shared with the River Crake, the outflow from Coniston Water (Pickering 2001, 19).

3.2.2 The diverse character of the topography of the Windermere area, from the high mountains and the lakes to the lower hills and the woodland, contributes to the natural beauty of the area. It is also a cultural landscape, influenced by man's use of the land and lakes. The contrasts between the wide open spaces of the lake, the intricate patterns of woodland, pasture, designed landscapes, settlements, and the distant views of the fells, have created a landscape that is unique in England (LDNPA 2010).

3.2.3 There is a distinct difference in character between the eastern and western shore of the lake and between the north and south basin. The northern section of the Windermere catchment is characterised by upland terrain and rough grassland and is part of the Cumbrian massif. Here it includes Park Fell, Red Screes, Scandale Fell, Rydal Fell, Grasmere common, Dale Fell, Langdale Fell, Furness Fells, Lingmoor Fell and Loughrigg Fell. Typical elevations of the fell peaks are 600-700m (Jacobs 2009a, 12). Bowfell, the Langdale Pikes, and Fairfield are well-known landmarks forming part of the view from the north basin. In the southern basin, the hills are more gently sloping and often wooded. The eastern shore reflects Victorian prosperity and design, with fine houses set within designed landscapes. The western shore is influenced by farming and forestry, and has a less-developed, more natural, appearance (*ibid*).

3.2.4 In the northern part of the catchment are four, large, flat-bottomed U-shaped valleys, and three steep-sided V-shaped valleys. The U-shaped valleys are Little Langdale, Great Langdale, Grasmere, and Troutbeck. It is these four, previously glaciated, valleys that most clearly delineate the northern part of Windermere catchment. Little Langdale and Great Langdale converge at Elterwater to form one valley, whilst Rydal Beck, Scandale Beck, and Stock Ghyll lie at the base of steep

V-shaped valleys, and have a greater potential for direct sediment supply for Windermere from the hill slopes (*ibid*).

3.2.5 ***Geology:*** the Lake District consists of a mass of ancient rocks, in three major bands running east-north-east to west-south-west, surrounded by a rim of appreciably newer rocks (Pickering 2001, 9). The northern end of the Windermere catchment falls within the Borrowdale Volcanic Series, formed in the late Ordovician, some 450 to 410 million years ago (*ibid*); these provide much of the mineral wealth in the area, and also include some layers of slate (*op cit*, 10).

3.2.6 At the south-eastern limit of the Borrowdale Volcanic Series of rocks is a narrow band of Coniston Limestone formed in the late Ordovician Period at a time when the area was inundated by warm, shallow seas. Outcrops of these rocks occur on either side of the North Basin of Windermere, often associated with small, limekilns (Pickering 2001).

3.2.7 The southern part of the catchment area is composed of sedimentary rocks laid down in the Silurian Period (approximately 400 million years ago). Covered by a warm, shallow ocean, sediments of sand and mud accumulated to a depth of over 5km and eventually formed the rocks now called the Windermere supergroup of shales, slates, grits and flags. The countryside in this area is much less rugged than that to the north, with few hills over one thousand feet (300m) in height (*ibid*).

3.2.8 The erosion of glaciers moving slowly southwards created long, straight, U-shaped valleys with craggy knoll-like outcrops. Lakes, notably Windermere and Coniston, now occupy ice-scoured valleys. Glacial drift deposits held back the waters of Windermere which now drain out through an overflow channel to the west rather than directly south (Countryside Commission 1998, 66).

3.2.9 The drift geology around the lake is largely a product of glacial activity, being mostly till (boulder clay) deposited in the post-glacial period, over 10,000 years ago. The overlying soils consist of typical brown earths of Denbigh 1-Type (OA North 2005a, 14). On the higher areas of the catchment to the north, the soils are mostly poorly drained, brown podsols, characterised by a brown mineral upper layer and a pale, acidic lower part from which nutrients, minerals, and so on, have been leached away by water. There are also some thinner, immature, ranker soils with impeded drainage and a top peaty layer. On the higher ground, the soils are characteristically gleyed, with impeded drainage and a peaty top layer; some deeper accumulations of peat occur locally (OA North 2010).

3.3 LAND USE

3.3.1 Today, Windermere's landscape character, particularly on the eastern side, is strongly influenced by Victorian development in and around Bowness and Waterhead. The shoreline has a variety of large houses set in spacious grounds, often with distinctive boathouses. It is a designed landscape, and the fashion of the time for planting exotic trees, now fully mature, helps define its character. Outside the settlements it is a strongly patterned landscape, with sharp contrasts between the remaining semi-natural woodlands and improved and semi-improved meadows and pastures. Stone walls, close-cropped fells, and hedgerows, are all important components of the Windermere landscape (*op cit*).

3.3.2 The majority of the vegetational cover in the Windermere catchment is grassland, with a roughly even split between rough pasture and improved grassland. Much of

the rough grassland is associated with sheep grazing, while improved grassland supports both sheep and cattle (Jacobs 2009b, 11). Around 20% of land cover is woodland, of which broadleaf and mixed woodland, much of it former coppiced wood, is more common, while other areas have been more recently replanted. Coniferous plantations are also present within the catchment (*ibid*).

3.3.3 The northern section of the catchment can be divided into two types of land use, upland, rough grassland areas and flatter, improved grassland valley bottoms. The majority of the land is steep, and rocky outcrops are commonplace. The land use is a mixture of scrub, bracken, heath and rough grassland, with a small number of broadleaf trees in some areas. The valley bottoms have much gentler gradients than the valley sides, and provide better land for farming, and improved grassland, for grazing. Along the flat valley bottoms, are clusters of trees, in direct contrast to the sparser tree cover in the upland areas. Ambleside is the second largest urban settlement, and is located in the northern part of the catchment; other settlements include Grasmere and Elterwater (*op cit*).

3.3.4 The south-western part of the catchment is characterised by a mixture of land use types, predominantly mixed woodland and, to a lesser extent, improved grassland. There are several areas of open water and a few small settlements, including Hawkshead. Approximately 70% of land cover is woodland, which includes semi-natural woods and coniferous plantations. The wooded areas are made up of a mixture of broadleaf and coniferous trees, and there are some rocky outcrops amongst the wooded areas (*ibid*).

3.3.5 Compared to the western section of the catchment, there is a significantly smaller area of woodland on the south-eastern side of the lake. A distinctive characteristic of this area is the presence of the urban area of Windermere and Bowness, which is the largest urban settlement in the catchment (*ibid*).

3.4 ENVIRONMENTAL EVIDENCE

3.4.1 Environmental analysis of the Windermere valley has shown that the higher land, over 1000 feet above sea level, had been progressively deforested since Neolithic times (Pearsall and Pennington 1973, 226-30). This suggests that the area was certainly being exploited for resources and is also likely to have been settled to some extent. The Windermere valley would have been very important in terms of access to and from the Langdale area, and is likely to have been visited by groups travelling north to the axe factories there.

3.4.2 The first signs of significant human interference with the natural vegetation cover occurred at around 4000-4500 cal BC in north, west and south Cumbria, where pollen evidence indicates small reductions in the cover of tree species, particularly elm, along with the presence of weeds associated with human activity, such as plantains (Pennington 1970). However, this activity (which may represent small-scale clearances) was soon to be totally eclipsed by the first large-scale deforestation in the region, which began *c* 4000 cal BC in the west Cumbrian coastal areas. During the first part of the fourth millennium BC, large-scale clearances of forest took place there, associated with cereal cultivation, which has been identified from Barfield Tarn sediments (*ibid*). Because of this intensive activity, the west Cumbrian coastal strip was possibly one of the earliest areas to become permanently deforested in the country. Around the same time, initial small-scale clearings were being undertaken at the upper edges of the fellside

forest cover around the head of Langdale, which was almost certainly associated with the initial workings of the Langdale axe factory sites (Hedges *et al* 1994, 360). Deforestation activity there intensified in *c* 3000 cal BC and continued for several centuries. Studies of the sediments from Blea and Angle Tarns have also indicated increased soil erosion contemporary with this activity, and wood charcoal has been identified stratified in muds at Langdale Combe associated with the clearance levels. All the evidence points to the current open and leached nature of the landscape above *c* 500m in this area as having been initiated during the Neolithic period (Walker 1965).

3.4.3 In the Central Lake District woodland the Bronze Age is thought to have been subjected to a number of small scale temporary clearances of the oak and alder woodland followed by regeneration (Chiverrell 2006). Temporary episodes of forest clearance have been recorded in pollen diagrams from Coniston Water (Pennington 1997, 49), Blelham, Loughrigg and Red (Helvellyn) Tarns (*ibid*, Pennington 1981, Haworth *et al* 2003). This is contrast to the lowlands (Chiverrell 2006; Wimble *et al* 2000) and sites at intermediate altitudes such as Burnmoor Tarn and Devoke Water where major and more permanent clearance episodes took place (*ibid*, Pennington 1997,49). Pollen data from the Central Lake District suggest almost total deafforestation during the Iron Age and Romano-British Period at Devoke Water and Blea Tarn (Chiverrell 2006) and was followed by a period of regeneration.

3.4.4 Some native settlement is likely to have existed in the local area prior to the establishment of the Roman fort at Ambleside. The pollen record from Blelham Bog shows an increase in deforestation around 300BC, during the late Iron Age, as do many areas of Cumbria and northern Britain, suggesting that the local region was being actively settled (Wells 1991).

3.4.5 Environmental evidence suggests that the gradual deforestation of the higher slopes in the Windermere basin appears to have slowed after the end of the fourth century AD, although not before the majority of woodland above 1000 feet had been felled (Kipling 1974, 65). Pollen analysis from sites in the High Furness has shown a decline in the amount of oak pollen, combined with an increase in pollen from grasses and heather around this time (Taylor 1983, 89).

3.4.6 The Early Medieval Period *c*1450-1050BP saw a further major episode of woodland clearance in the Central Lake District. This has been recorded and dated in pollen diagrams at Coniston Water from 1270 to1110BP, to after 1370 BP at Devoke Water and to after 950BP at Blelham Tarn (Pennington 1981, 1991, Chiverrell 2007).

3.4.7 The woodland history around Coniston Water records that the woods were extensively managed by coppicing (Pennington 1997, 50). Between 1600 and 1800 the amount of oak present in the Coniston area was probably at its lowest but after that there was extensive planting of trees such as pine. The pollen diagram from Coniston Water suggests that hazel pollen, which had previously been abundant, declined after 1900 when the woodland was no longer coppiced for charcoal production and trees were allowed to grow shading out the light demanding hazel (*ibid*).

3.5 HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

3.5.1 The following section presents a summary of the historical and archaeological background of the general area. This is presented by historical period, and has been compiled in order to place the study area into a wider archaeological context.

Period	Date Range
Palaeolithic	30,000 – 10,000 BC
Mesolithic	10,000 – 4000 BC
Neolithic	4000 – 2,200 BC
Bronze Age	2,200 – 700 BC
Iron Age	700 BC – AD 43
Romano-British	AD 43 – AD 410
Early Medieval	AD 410 –1066
Late Medieval	1066 –1540
Post-medieval	1540 – *c*1750
Industrial Period	*c*1750 – 1901
Modern	Post-1901

Table 1: Summary of British archaeological periods and date ranges

3.5.2 ***Late Palaeolithic and Mesolithic periods:*** around 11,000 BC there was a rapid amelioration in climate; the ice-sheets which had covered the Lake District started to withdraw, and typical tundra vegetation developed (Hodgkinson *et al* 2000, 32). The landscape was covered with hardy plant species, such as lichen, mosses, and grasses, and small shrubs, such as juniper and dwarf willow. Pine and birch became gradually more dominant and, after 9000-8000 cal BC, hazel, oak and elm also began to encroach (Pennington 1997). Dense woodland developed to an altitude of approximately 700 metres in the Lake District and, by *c* 6000BP, most native trees are thought to have been present in Cumbria (*op cit*, 45) with extensive areas of alder in valley and uplands hollows where the drainage was impeded. Throughout most of Cumbria oak was the dominant tree in the drier parts of the valleys extending up into the uplands, with elm to be found growing at intermediate altitudes (*ibid*).

3.5.3 The first part of the Mesolithic period probably enjoyed a more continental climate, being warmer and drier than today. A shift to wetter conditions followed, which would have encouraged a rise in water tables. This may be reflected in the vegetational record for, as the post-glacial period progressed, the nature of the woodland cover changed subtly. Although oak and elm still dominated the drier soils on hillsides, alder began to occupy large areas of the less well-drained valley floors.

3.5.4 The effects of human activity on the vegetation become noticeable in the palaeoecological record of the time, particularly in the fringe areas of the region. There is good evidence from lowland Lonsdale, on the southern limestone fringe of the Lake District, which shows that small-scale anthropogenic clearance of woodland cover was taking place towards the latter part of the period (Taylor *et al* 1987; Middleton *et al* 1995, 188-9). Charcoal is also common in the Mesolithic

stratigraphy of the lowland raised mires surrounding the uplands, although it is not known for sure whether this burning was directly associated with human activity (Huckerby and Wells 1993).

3.5.5 Some of the earliest suggestions of clearance come from the uplands, where recent evidence for burning (charred Empetrum seeds radiocarbon dated to 5968-5732 cal BC (6965±BP; KIA23485) has been recorded close to the Langdale axe factories (OA North 2004). There is also some evidence for disturbance in the valleys from a pollen assessment of stratified deposits on the Calvert Trust Land, Bassenthwaite (NY 2360 2720), close to Borrowdale, where mineral inwash was recorded, suggesting some anthropogenic activity in the late Mesolithic/Early Neolithic (Hodgkinson *et al* 2000, 296-7). Similarly, at White Moss, near Grasmere, a further pollen assessment demonstrated some possible Mesolithic clearance activity (*op cit*, 316-7).

3.5.6 The archaeological evidence for contemporary settlement is patchy, partly reflecting the areas within which fieldwork has been concentrated. Scatters of Mesolithic flint assemblages are concentrated along the coastal plain and have been found from Walney Island (Barnes and Hobbs 1950), via Eskmeals (Bonsall *et al* 1986; Cherry and Cherry 1986) and as far north as St Bees (Cherry and Cherry 1973). However, a few scatters of late Mesolithic artefacts have also been identified from the limestone uplands of east Cumbria (Cherry and Cherry 1987: Wickers Gill, Howes Plantation, Tarn Moor 1/5, Rayseat 1/2).

3.5.7 The Eskmeals sites were ranged along the edge of the old coastline and, on excavation, occupation was found to be both fairly small and structurally simple. The Monks Moors 1 flake scatter covered 35m x 15m, within which there was an elongated oval arrangement of hearths and stake holes that was only 7m x 24m (Bonsall 1981). The chronology of the sites falls within the later Mesolithic period; radiocarbon dates from Monk Moors 1 suggest occupation of 5979-5382 cal BC (6750 ± 155 BP; BM-1216) and those from Williamson's Moss suggest that the earliest occupation was 4459-4336 cal BC (5555 ± 40 BP; UB-2545; Bonsall *et al* 1986, 26).

3.5.8 There is also a certain amount of evidence that the caves around Morecambe Bay witnessed continued occupation during the Mesolithic period, such as the Whitbarrow Bone Cave (SD 450 860) which revealed faunal remains; there is some uncertainty, however, as to the date of this material (*op cit*, 35).

3.5.9 ***Neolithic:*** in the Neolithic period, settlement was mainly concentrated around the edges of the Lake District, particularly on the West Coastal plain and in the Eden Valley. The latter holds some of the most noted prehistoric funerary and ritual monuments, including the stone circles of Long Meg and her Daughters, and the henge monuments of King Arthur's Round Table and Mayburgh (Higham 1986). However, the central Lake District has numerous significant sites, including the remains of the major axe factory sites of Great Langdale and Scafell Pike, whose products were ultimately distributed throughout the country (Claris and Quartermaine 1989). Radiocarbon dates from these sites indicate a date range from about 3800 cal BC to 3300 cal BC (Bradley and Edmonds 1993). The products of the Langdale axe workings are also found across the Windermere area, indicating some local activity during this period.

3.5.10 Approximately commensurate with the adoption of farming, from *c* 4000 BC, the Neolithic period saw an increase in more permanent settlement, and the

beginnings of the widespread construction of monumental architecture. Woodland clearance took place, evidenced by a fall in tree pollen, replaced by grass and, in some cases, cereal pollen (Quartermaine and Leech forthcoming). Evidence for deforestation, to create clearances for stock grazing and crops, has been discovered in lowland Cumbria, where Neolithic settlements, such as Ehenside Tarn, appear to have been. The only evidence for woodland clearance in the Lake District fells during this period is in Great Langdale (Higham 1986, 35). Soil disturbance, signs of fire and clearance of trees, notably Elm, at Langdale Combe have been radiocarbon dated to the Neolithic (Walker 1965, 500). Pollen analysis at five other sites within a 2km radius of the Langdale Pikes has provided further evidence for widespread deforestation, as indicated by an Elm decline, from *c* 3200 BC. Evidence from Stake Beck, Langdale Combe and Dungeon Ghyll suggest that these upland areas were cleared for grazing by the firing of lighter vegetation above the tree-line (Bradley and Edmonds 1993, 204). Research on the valley floor at Mickleden, below these sites, has shown disturbance to have been apparently more limited (*ibid*).

3.5.11 Around the summits of the central massif (Scafell and Langdale Pikes) are the remains of very large-scale axe production, which was at its most intensive around the end of the Neolithic period. The forest clearance in the vicinity of the sites, however, is not necessarily an indication of agricultural activity. There is no evidence of any settlements apart from very small, temporary camp sites on the main communication routes (Claris and Quartermaine 1989, 12) and the clearance is more likely to be a result of the industrial processes.

3.5.12 At approximately 2700 BC, however, there was sufficient clearance of woodland at Blea Tarn, Little Langdale, to allow areas of grassland to develop, which 'included the characteristic plant of human settlement the ribwort plantain' (Pennington 1973, 43). This clearance was temporary, lasting to approximately 2300 BC when the forest regenerated. However, at Angle tarn and Thunacar Knott, cleared at the same time, changes were more permanent, with blanket bog probably forming soon after the forest's destruction (*ibid*).

3.5.13 ***Bronze Age:*** the beginning of the Bronze Age in Britain developed gradually from the preceding Neolithic during the mid-third millennium BC. Lithic technology changed and a wider range of flint tools were used, including knives and scrapers. Perforated stone objects, such as axe-hammers, and bronze implements, also began to be used, pottery styles changed, single burials increase in occurrence in the archaeological record and monumental building changed (Hodgson and Brennand 2006, 29).

3.5.14 In the Bronze Age the greatest concentration of extant remains was again around the peripheral parts of the Lake District, typically on the marginal lands facing the West Coastal plain or on those above the Eden Valley (Quartermaine and Leech forthcoming; Cherry and Cherry 1987). These remains took the form of cairnfields, which were the result of the clearing of former forested lands to enable agriculture. Very few comparable remains have been found within the Windermere area, which may potentially reflect a lack of contemporary activity. The best of evidence of Bronze Age activity is represented by the funerary round cairns that adorn the summits of many of the surrounding hills (Mendus 2001).

3.5.15 ***Iron Age/Romano-British:*** the very end of the Bronze Age saw a return to a more densely forested landscape across much of the Cumbrian uplands as the clearances

were recolonised by secondary woodland (Hodgkinson *et al* 2000; Quartermaine and Leech forthcoming). The nature of the evidence also demonstrates a marked change from that which preceded it, with a decline in the relative abundance of archaeological material which typified the Middle Bronze Age, such as axes and other weapons, as well as ceramic material, and evidence for the settlement of formerly marginal land. The period is instead characterised by the introduction of defended sites and hillforts, such as that of Castlesteads at Natland, near Kendal, or Castle Crag in Haweswater (LUAU 1998). Overall, the period is not well represented within the archaeological record of the Windermere catchment and there is a paucity of sites definitely attributed to the Iron Age; however, a small enclosed settlement, adjacent to High House Farm and to the north of Ings, may date to this period (NY 437 010; Crookenden and Crookenden 1993).

3.5.16 In the years following the invasion of AD 43, the Roman army advanced as far as a line between Chester and York, but the frontier of the empire was not extended beyond this until the reign of Vespasian (AD 69-79). In AD 71 the Romans, led by Petillius Cerialis, crushed the *Brigantes* and by AD 79, a main road was established north from Chester, with forts at Low Borrow Bridge and Brougham. In *c* AD 90, a fort was built at Watercrook, Kendal, in the loop of the river Kent (Potter 1979). A road was driven north-westwards to the head of Lake Windermere, then on through the hills to Ravenglass; forts were established at Ambleside (Leech 1993; Shotter 2004) and Hardknott, with the former occupied in the Trajanic period and the latter between AD 120 and AD 138 (Bidwell *et al* 1999).

3.5.17 Evidence from elsewhere in the region (Quartermaine and Leech forthcoming) indicates that the rural settlement was dispersed and of a native, non-Romanised character. Pollen evidence suggests a continuing deforestation of the valley slopes in the wider region, but the earliest evidence for clearance in the valley is from the later first millennium AD (Birks 1993).

3.5.18 ***Early Medieval:*** as is the case throughout Cumbria, evidence for early medieval activity is extremely limited. Following the withdrawal of Roman governance in the early fifth century, it seems that the region fragmented into a number of small kingdoms. The seventh century saw the expansion of the kingdom of Northumbria, which had incorporated the area of modern day Cumbria by the middle of the century (Kirkby 1962). Anglian crosses have been found at Kendal and Heversham, but few settlements have been located to date, presumably because those on the fertile lowlands would have been destroyed by later ploughing (though considerable place-name evidence exists; Rollinson 1996). Great Langdale contains none of the common Anglo-Saxon place-name endings such as *–tun* or *–ham* which are distributed evenly in the surrounding lowlands (Lund and Southwell 2000). It is generally believed that the Angles had little desire to push into the valleys because they either operated an arable-orientated farming system, which would have been more productive in the lowlands, and/or there was already enough land in the lowlands for settlers (Whyte, cited in Rollinson 1989, 56).

3.5.19 The native Cumbrians were probably not displaced, and lived alongside their new lords. In AD 685 Ecgfrith of Northumbria made grants of land to St Cuthbert, offering territory in Cartmel and Carlisle '*et omnes Britannos cum eo'*, 'including all the British inhabitants' (Crowe 1984), suggesting a substantial native population. There is interesting evidence from a hillfort at Shoulthwaite, in the

Thirlmere valley, where there were two radiocarbon dates obtained from the base of a rampart ditch, that were of early medieval date (cal AD 538-676, (AA-33591, Gu-8251, 1435±50 BP) and AD 560-690, (AA-33592, Gu-8250, 1400±50 BP) (LUAU 1999b). The implication is that either the hillfort was constructed at that date, or more likely was reoccupied at that date, and at this time there was evidently a presence within the central Lake District and would suggest that this was a period of tension.

3.5.20 During and after this time, land use within the assessment and wider area seems to have been largely pastoral; Bryant's Gill, Kentmere, dating to the eighth century and consisting of a rectangular, stone-footed structure, is perhaps typical of contemporaneous farmsteads encountered in the uplands of the region (Dickinson 1985). However, a timber hall-type structure of possible early medieval date has recently been excavated at Shap, Cumbria by OA North (Heawood and Howard Davis 2002).

3.5.21 The eviction of Norse settlers from Ireland in AD 902 seems to have created the impetus for Scandinavian activity in Cumbria (Higham 1986). Whilst the extent of actual settlement has not been established, their effect was considerable: many place-names in Cumbria being derived from the Old Norse, with many dialect words to the present day coming from the same source. In the uplands, many place names contain derivatives of Old Norse. Examples include *Langdale* –the long valley, *Kirk How*- the meeting place on the hill, and *thrang* – narrow road (Smith 1967, 203-4). There are many place names derived from a combination of Old Norse and Old English, such as *Oxendale* – valley of the ox, *Walthwaite* contains the common Norse place name ending for clearing, 'thwaite' but the derivation of 'wall' is most likely Anglian.

3.5.22 The disappearance of the tree cover around this time is also recorded throughout High Furness by the Scandinavian suffix '*thwaite*', which suggests a clearing in the woods. Local examples of the *-thwaite* suffix include Esthwaite meaning 'clearing in the ash trees', Loanthwaite, and Cowperthwaite. However, not all examples are representative of Norse activity, as the use of the *-thwaite* suffix continued until at least the thirteenth century (Winchester 1987, 41).

3.5.23 Other local place names that derive from Norse include Wray meaning 'nook', Claife meaning 'cliff', and Latterbarrow meaning 'hill where the animals lie' (Ekwall 1922, 218). Other place names appear to combine Norse toponyms with personal names, such as Harrowslack meaning 'the slopes belonging to Harrald'. Other examples include Tock How, which combines the hill or 'how' belonging to 'Toki' or 'Tocca' and Hawkshead or 'Hawkesete' combining the Norse for farm with the name Houkr (Ekwall 1922, 218).

3.5.24 In 1993 LUAU (now Oxford Archaeology North) undertook a survey of a moot mound or *law ting* at Thingmount, Fell Foot Farm, Little Langdale (Quartermaine and Krupa 1994). The mound was terraced and the form closely comparable with the Tynwald moot mound on the Isle of Man (Robinson *et al* 1990). It is located within an area of gently sloped ground, adjacent to a stream, which is also comparable to the Tynwald example and may have been used for open-air assembly for matters of local government. At these *things*, local affairs were discussed, justice administered, and laws promulgated, a system which extended over a considerable part of northern Europe (Cowper 1891, 2). Communications would have been an essential requirement for such a meeting place, and the

location of the site is well suited for communications within the Lake District. It is located adjacent to the line of the Roman road that passed over Wrynose and is in the centre of the Lake District with approaches from other parts of the Cumbrian Fells via the Blea Tarn pass and the Little Langdale Valley (Quartermaine and Krupa 1994).

3.5.25 ***Medieval to post-medieval:*** during the medieval period the north and east section of the Windermere catchment formed part of the Barony of Kendal, the west shore and land as far as Coniston was held by the Abbey of Furness, and the small section in the south-east was in the parish of Cartmel (Kipling 1974, 67). The documents of the medieval and post-medieval period provide convincing evidence of the widespread occurrence, and importance in the economy, of woodlands (*ibid*).

3.5.26 In 1127 Stephen of Bologne and later King of England, granted a group of Savigniac monks, then dwelling at Tulketh, near Preston, 'the forest of Furness and Waughneia (Walney) and everything in Furness except the land of Michael le Flemming' (Wood 1998, 27). The remote Bekansgill valley near Dalton was chosen, and here the Abbey of St Mary of Furness was founded, the most important foundation of the Savigniac Order in the British Isles. In 1147 the Savignacs amalgamated with the powerful Cistercian order (*ibid*). Within forty years the original charter had given rise to a dispute between the monks of Furness and William de Lancaster, first Baron of Kendal. Both parties laid claim to the Furness Fells, the ownership of which had not been clearly defined. The matter was finally resolved in 1163 by a committee of 'thirty sworn men' representing the Abbey and the baron who 'beat out' the bounds of the disputed territory and divided it.

3.5.27 Prior to 1127 a handful of farms founded by Norse settlers are likely to have existed in pockets of cleared woodland between Windermere to the east and Hawkshead village to the west. The late twelfth and thirteenth centuries appear to have seen a dramatic rise in the number of farms on the Abbey's lands, as well as the amount of enclosed land (Lund 2000, 14). The exploitation of the woodlands by the Abbey was documented in 1246, when William de Lancaster, fourth Baron of Kendal, made a grant to the Abbey of Furness of two 'suitable boats, namely one on Windermere…..to carry their wood and timber and whatever else they need' and an almost identical grant was also made between 1247 and 1297 (Brownbill 1919, cited in Kipling 1972, 159).

3.5.28 The Cistercian economy was based in developing previously uncultivated lands in a profitable way and to develop sheep farming and from it a trade in wool. The Abbey received royal licence in 1338 to create new enclosures or 'parks' throughout Furness Fell generally (Atkinson 1886-8, 173). Many of the remote upland farms established at this time can be identified by their 'park' name, with numerous examples situated between Lake Windermere and Grizedale (for example Low Park Dale, High Park Dale, Low Park, Park Farm and High Park).

3.5.29 There is also evidence of medieval activity in the Mickleden Valley (Quartermaine and Leech forthcoming), where rectilinear and boat-shaped structures, with associated field systems, are seemingly superimposed onto a prehistoric cairnfield. Such reuse would inevitably involve a certain amount of adaptation of the earlier features, as well as the construction of new boundary markers and domestic structures. Pollen analysis from beneath a stone bank had ambiguous results, but

suggested a broad date range for this activity, falling between the start of the Roman period and the seventeenth century (*ibid*). Significantly this activity was seemingly beyond the extent of the medieval ring garth in Great Langdale, which separated the tenanted land from the manorial waste, and was probably established by the thirteenth century (Lund and Southwell 2002, 13). The establishment of the ring garth, here and in other valleys of the catchment, represents the establishment of communal farming in the valley bottom, and was the basis for the subsequent enclosure and agricultural exploitation of the valleys. To maximise the communal land it is likely that the becks would have been managed to limit flooding of the enclosed land, although the physical remains of any early stream management are unlikely to survive.

3.5.30 In 1537, the time of the dissolution of the monastery, two lists of property and rents were compiled, one by the Abbott, the other by the King's Commissioners. The abbott's list, quoted in Brownbill (1919 cited in Kipling 1974, 71) includes the following: 'farmers of three 'smythes' in Furneys Fells employed for making iron, for licence to enter, cut down and use wood and water sufficient to maintain and keep the said 'smythes'. The tenants of Furness Fells who 'keeps a fire' were to pay yearly rent and similar charges for a licence to workmen to cut down 'various trees within the woods there as well for the 'bastying, coolying and blekyng' as for the making of 'carte-sadles, cartwheles, carde-bourdes, cupps, hoopes for cowpers' and other necessaries payable at Easter as appears in the court-rolls (*op cit*).

3.5.31 From court rolls of the sixteenth century it is clear that the woods were being heavily exploited. The demands of the bloom-smithies led to a complaint about the destruction of the woods by the tenants of Hawkshead to the Duchy of Lancaster. As a result, the bloom-smithies were abolished in 1546 by a decree of Queen Elizabeth (Kipling 1974, 72). The woods were, for a yearly rent, given over to the tenants who then had a vested interest in conserving them. In 1567 the Surveyor of the Woods of the Duchy of Lancaster made a report which included a list of woods of Furness. In the whole of High Furness there were 1, 280 timber trees and 8,260 saplings. Those listed comprised: *Conyson*, Waterhead and Ternclose; Elterwater Park and Skelthwaite; Brathowe and Hawkshead Field; *Wraa* and Colthouse, *Sawraye* and *Elehouse*; *Grathwait*; *Consaye Close*; *Haverthwait*, *Fynsknot Stot Park* and Brendwood (Kipling 1974, 74). Eighty years later in 1649 a Parliamentary Survey recorded the there were '*growing upon the lands of Customnary Tnants in high furness between three and four thousand Timber Trees (most of them but of small growth) which we estimate worth be sold [£713. 10s]'* (Kipling 1974, 73)

3.5.32 The Abbey appears to have maintained three corn mills: Hawkshead, Satterthwaite and Cunsey, as well as a fulling mill at Sawrey (Cowper 1899, 90). Natural resources, of which iron ore and woodlands were the most important, were also exploited by the Abbey (Wood 1998). A number of iron forges owned by the Abbey in the Furness Fells are documented, although it is unclear where these early smelting sites were located, although charcoal fuel is likely to have been produced throughout High Furness.

3.5.33 Fisheries and the rights of tenants to fish certain waters were also important, with penalties and disputes being recorded. The Abbey controlled fishing in much of Windermere, Esthwaite Water and Coniston Water. The rental of 1538 records the

letting of the freshwater fishery called '*Blalhm Tene* (Blelham Tarn) in Wray to one John Bowthe for 2s. p.a.' (Brownbill 1919, 617).

3.5.34 Lists of property were completed on the death of each holder of the Barony of Kendal, and these contain many references to woodlands. In 1283 William de Lyndesay held at his death '…a forest called Trutebeck…there is another forest there…there is also a park there…the pannage of the said forest is worth 20s yearly...' similar entries occur in lists made in 1334 and 1437 (Kipling 1974, 68). In 1340 a grant was made to William de Coucy and his heirs of free warren (hunting rights) in Windermere, Grasmere, Troutebeck, Langdale, Ambleside and Applethwaite and 'licence to impark his wood of *Troutebek* and to hold it so imparked withoute impediment from the King or ministers' (*ibid*). In 1347 John de Coupeland was granted, as part of his reward for taking prisoner David de Bruys at the battle of Durham, a portion of the manor of Kendal saving unto the King the several park and wood upon *Le Bradewood*, a wood in the island of *Wynandermere*…' (*op cit*, 69). In 1440 Henrey Waren was granted the office of keeper of the park of Troutebeck, with the herbage, pannage, 'wyndfall' and 'browesyng', and in 1442 Walter Strykland the park of Calgarth 'with the herbage and pannage thereof and the fishery in the water of *Wynandremere*'. In 1560 fines were imposed for cutting down trees at Windermere. The existence of 'parks' in Troutebeck resulted in more clearance of woodlands than in other districts and, excluding common land (which was not wooded), it is unlikely that more than a quarter of remaining land was wooded at the end of the medieval period (*op cit*, 70).

3.5.35 Mining did not have a significant impact on the region until the activities of the Company of the Mines Royal during the reign of Queen Elizabeth. In 1564 Thomas Thurland and Daniel Hechstetter were granted the right to mine gold, silver, copper and quicksilver in Cumberland, Westmorland and Lancashire, and in 1568, the company was incorporated by Royal Charter as 'the Governor and Society for Mines Royal' (Adams 1988, 19; Donald 1994). Documentary sources indicate that German miners and engineers had begun work at Grasmere in 1564, and by the end of the decade the Company of the Mines Royal had begun extracting lead ore from the Greenhead Gill mines, and this continued until 1573 when the mine was closed.

3.5.36 Copper was being worked from the Caldbeck Fells from 1568 (Donald 1994), and there was considerable investment in the Keswick area with the establishment of smelt mills and a whole network of packhorse trails was set up to transport the ores and the charcoal to smelt them (Fleming 2000). Copper was being mined at Coniston from about 1590, and this remained active until at least 1620 (Adams 1988, 146). The surviving remains at Coniston are mainly from the intensive nineteenth century activities, but traces of the seventeenth century work can still be seen in the lower and upper parts of Red Dell, in the form of hand driven 'coffin' shaped levels. The mining activity in the region associated with Mines Royal lasted well into the seventeenth century, but is said to have ended with the destruction of the works by Parliamentary troops at the time of the Civil War (Donald 1994).

3.5.37 ***Post-medieval and Industrial:*** the agricultural revolution which swept through the country in the eighteenth century made only limited inroads into Westmorland, as much of the land was too poor to produce a reasonable crop; in 1794 it was reported that no peas, beans, clover, or rye were grown in Westmorland (Rollinson

1996). Farm implements were primitive and made entirely of wood, and mechanisation was virtually unknown – even wheeled vehicles were a rarity, with preference given to pack-horses (*ibid*). By the nineteenth century all this had changed, with the introduction of lightweight ploughs, and mechanised processes. The greatest impact, however, was caused by the enclosure of much of the common land; land was thus given over to single ownership and only small areas of woodland still remained. Between 1763 and 1800 over 10,000 acres of former common land in Westmorland had been enclosed and improved whilst, after the General Enclosure Act of 1801, the process increased in scale. Most of the enclosure awards for the area are part of this later process, dating from 1813 onwards. Many of the field boundaries visible today conform to those on the First Edition OS map of *c* 1864 and were probably enclosed during this period of reform.

3.5.38 Allied to this enclosure were increasingly sophisticated fertilising techniques. Lime kilns took advantage of the local limestone beds, in order to provide fertiliser for the newly enclosed fields. Lime-burning had been practised from the Middle Ages for mortar and whitewash, but its increasing use in the seventeenth and eighteenth centuries to improve the acidic soils of the Lake District led directly to the appearance of numerous small field kilns. These kilns were usually located adjacent to paths by which limestone could be brought in and quicklime taken out. Their relative isolation and small scale suggest that they were used primarily for the local production of lime as a fertiliser (Johnson 2002).

3.5.39 *Woodland:* during the seventeenth century the making of charcoal became increasingly important with the growth of the iron industry, and in the eighteenth century coppice woods used for charcoal burning were a valuable source of income to landowners (Kipling 1974, 75). In 1663, a census of trees growing on crown lands was undertaken. For some parts of the Barony of Kendal a list has been preserved which gives the details of the numbers and value of individual trees, which ranged from four pence to at least two shillings. Kipling states that timber trees formed only a small proportion of woodlands, as the value of non-timber trees is almost seven times higher (*op cit*, 76).

3.5.40 Other woodland industries included the manufacture of bobbins for the Lancashire cotton industry. The first bobbin mills of Lakeland arose around the end of the eighteenth century in response to the demands of the cotton industry. Bobbin production multiplied as they formed an integral part of the new spinning machinery introduced by Hargreaves, Arkwright and Crompton: the bobbins were loaded with spun yarn, and sent to the weaver. As the cotton industry became subject to geographical specialisation in the mid-nineteenth century, so hampers of full bobbins were sent from the spinning towns of south Lancashire to the weaving towns in the east of that county (Marshall and Davies-Shiel 1977).

3.5.41 The ubiquitous presence of green bracken, which when burned provided a ready supply of crude potash, was also a major factor in the development of the local cloth industry. Occasionally twigs of birch were also burnt and potash kilns became a fixture of the local area; local sixteenth-century documents refer to the 'elyeing of ashes' (Rollinson 1996; Marshall and Davies-Shiel 1977). The actual practice was highly restricted due to the scarcity of bracken in some areas; seventeenth-century sources mention 'bracken dalts' and 'bracken rooms' used by particular farms for the purpose. Many records exist of the right of customary

tenants to cut bracken after Michaelmas. The resultant ashes, were an important source of income when sold to fullers and cloth merchants.

3.5.42 Woodland was also used for potash production; alders were cut down and used in the same way. It is perhaps unsurprising, therefore, that the workers making potash also began producing charcoal in great quantities during the medieval period for smelting iron, often from scavenged wood (Winchester 1987). A potash kiln at Baneriggs, Grasmere, has been found, which at some time in its history had been converted into a charcoal-burner's hut, with an adjacent charcoal-burning platform (HER 30648). Some 200 of these kilns have been found in Cumbria, and some appear to be closely associated with fulling mills. Charcoal burning was particularly prevalent within the estate and manorial lands, with much of the estate woodland incorporating former coppiced wood, and considerable number of charcoal platforms, particularly in Low and High Hag woods (Sections 5.2 and 5.3). These names are themselves significant, as the name Hag means a coppice marker.

3.5.43 In the nineteenth century the eighteenth-century plantings produced valuable material, as shown by account book entries showing income gained from the sale of wood (Kipling 1974, 85). To the south-west of Lake Windermere the woodlands were mainly devoted to coppice, and in some parts this continued into the twentieth century. In the Graythwaite estates the policy differed, as no plantations of soft woods were made until 1850, and even then were of small extent. Before the eighteenth century the main species were oak, ash, alder, hazel, holly and thorn. During the eighteenth to nineteenth centuries many different species were planted, including birch, poplar, sycamore, Scots fir, larch and conifers (Kipling 1974, 87). The demand for charcoal was fed by the Elterwater gunpowder works and Backbarrow blast furnace up until the 1920s when the blast furnace was converted to a coke operation (OA North 2005c). Despite this demand the woodlands had been carefully managed and woodland had steadily increased through the nineteenth century. In the First World War, however, the woods were felled extensively as expediency overrode the needs of conservation.

3.5.44 *Stone and Minerals:* during the late seventeenth and early eighteenth centuries iron ore is reputed to have been mined in the fells around Langdale (Lund and Southwell 2002). This contributed towards the iron industry which became an important part of the economies of Furness and to a lesser extent the Windermere area. The principal site from the catchment was the Cunsey Forge, on the west shores of the lake; this had a long association with iron working as a bloomforge from 1618 to 1715, a refining forge from *c* 1715 to 1762), and limited activity up until the beginning of the nineteenth century.

3.5.45 Renewed working of the Coniston copper veins occurred from the 1760's when the Macclesfield Copper Company, under the direction of one of its partners Charles Roe, raised limited amounts of ore in the last half of the eighteenth century (Marshall and Davies-Shiel 1977, 142; Holland 1987, 61), but by 1795 they had abandoned Coniston (*op cit*, 63-75). The main period of activity at Coniston followed the acquisition of the mines by John Taylor in 1818, but competition from countries such as Chile, after 1882, hastened the destruction of the English copper mining industry (Marshall and Davis-Shiel 1977, 148). Other copper mines of the area include those at Tilberthwaite and Greenburn (HER 3153); the earliest date of mining of the latter is unknown, but documentary

sources indicate that a reasonably intense and prolonged period of mining had been in existence by 1690.

3.5.46 Lead working was an important part of the regions post-medieval economy, most notably at Greenside just to the north of the catchment. The extraction of ore was being undertaken from the 1820's, and from 1834 smelting operations were undertaken at the site. It became one of the major employers of the area and continued up until the 1960s (Marshall and Davies Shiel 1977).

3.5.47 Another major Lakeland industry was slate working for roofing, which exploited the green Borrowdale Volcanic slates. Honister was working from 1753 (*ibid*) and others of the region, notably from the Elterwater area, were also in operation by the later eighteenth century. It was in the nineteenth century that the industry flourished and by its end, slate quarrying was one of the most important industries in the Lake District.

3.5.48 *Water:* the abundance of fast flowing streams provides an abundant supply of power, that can be used to drive grinding mill stones in a corn mill or hammers in a fulling mill, which date back to the fourtenth century (Marhsall and Davies Shiel 1977, 59). The lathes of bobbin mills were water driven and their productive peak was in the mid nineteenth century when at least 49 sites were operating within the Lake District; the notable example from the catchment was the Stott Park Bobbin Mill, which even now has survived as a working museum. One notable water powered industry from the catchment was the Elterwater gunpowder works which was established in 1824, and continued to prosper, before finally closing in 1930.

3.5.49 *Communications and the changing Perception of the Lake District:* the 'discovery' of the Lake District by writers and artists in search of the picturesque in the late eighteenth century is well known. Such writers as Thomas West and Thomas Gray made tours of the Lake District, describing their journeys in tourist guides, which encouraged a small number of wealthy visitors to follow in their footsteps. Accommodation, shops, mountain guides and other facilities began to be provided to service this new 'industry'. The area became even more popular after the opening of the Kendal and Windermere railway in 1847 (Lund and Southwell 2002, 21). Contemporary with this was the buying up of land and building of villas by gentlemen landowners, notable examples are St Catherine's, Windermere, Wray Castle, and Brockhole which was rebuilt in the new style.

3.5.50 The opening of the Windermere to Kendal railway line improved the fortunes of those working the localised slate quarries, as the slate could now be carried to Windermere by horse and cart to enable rail transport out of the area (Rollinson 1996). At Windermere, a different type of housing was brought into being by the railway, for the members of the upper middle- to upper-class built their villas and created 'Arcadia' overlooking the lake. By the end of the century, the former hamlet had assumed the proportions of a town and the introduction of the Windermere Express made it possible for tired businessmen to travel in little over two hours to their rural retreats after a hard day in the Manchester Cotton Exchange. But in addition to being an early example of a commuter settlement, Windermere also developed as a tourist centre, for the railway made it possible for many middle-class visitors to enjoy Lakeland holidays. Soon hotels, boarding houses and 'lodging houses' were catering for all tastes. Bowness, the older settlement on the lake shore, also participated in this new-found prosperity, and in 1883 local directories indicated that there were 45 boarding house keepers in

Windermere and 43 in Bowness (Rollinson 1996; Marshall and Davies-Shiel 1977).

3.5.51 As tourism developed and the industrial developments brought reservoirs, railways and large-scale mining and quarrying to the region, organisations such as the Thirlmere Defence Association and the Lake District Protection Society were formed at the end of the nineteenth century. The conservation of the Lake District landscape as something to appreciate and enjoy was influenced by John Ruskin in the later nineteenth century. His efforts and passions for the natural and historic environment played an important part in the conservation movement, leading to the formation of the National Trust and culminating in the designation of the Lake District as a National Park in 1951. Tourism has now overtaken farming as the region's main economy and the conservation movement has had to contend with the fact that some of the significant threats to the landscape, are a symptom of its considerable popularity as a tourist location, leading to over-development and erosion and the eclipsing of the historic agricultural economy.

4. STONE AND MINERAL EXTRACTION ARCHAEOLOGICAL EVIDENCE

4.1 GEOLOGICAL BACKGROUND

4.1.1 ***Introduction:*** the Lake District consists of a mass of ancient rocks, in three major bands running east-north-east to west-south-west, surrounded by a rim of appreciably newer rocks. The oldest are the Skiddaw Slates (Skiddaw Group) in the north of the area (Pickering 2001). These sedimentary rocks consist of a series of darkish-coloured slates with occasional coarser grits, laid down some five hundred to four hundred and fifty million years ago (in the early Ordovician Period, when the region was covered by a shallow sea).

4.1.2 To the south is a broad band of hard rocks with a very different origin - the Borrowdale Volcanic Series (BVS). This band was formed in the late Ordovician, some 450-410 million years ago, during a period of intense volcanic activity. Eventually the volcanic activity subsided, leaving behind a mixture of solidified lava, and ash that became the rocks we see today. A band of fine-grained tuff of the BVS group was used in the Neolithic period to make axes, and it also includes layers of slate, such as the green slates of Honister and Elterwater, that make superior roofing slates and building material by comparison with the Skiddaw Slates (Pickering 2001, 10). It is from within these rocks that are found the bands of minerals that were extensively exploited in the post-medieval period.

4.1.3 At the southern edge of the Borrowdale Volcanic Series is a very narrow band of Coniston Limestone, older than much of the Carboniferous limestone surrounding much of the Lake District, and formed in the late Ordovician Period. Outcrops can be seen on either side of the North Basin of Windermere and are often associated with small limekilns (*ibid*).

4.1.4 The southern part of the Lake District, is composed of sedimentary rocks laid down in the Silurian Period (approximately 400 million years ago) at a time when the landmass was located to the south of the equator. Covered by a warm, shallow sea, sediments of sand and mud accumulated to a depth of over five kilometres and eventually formed the rocks now called the Windermere supergroup of shales, grits and flags (*ibid*).

4.1.5 The region was successively covered by Devonian rocks and then by limestone from the Carboniferous Period (340 to 280 million years ago). During the Permo-Triassic Period (280 to 195 million years ago) the land was uplifted and became increasingly arid. Early Palaeozoic rocks are believed to underlie the whole region and the existing surface geology is complicated by diverse and ore-rich mineral deposits, which have had a marked influence on mining activity in the area (*op cit*, 11).

4.1.6 The southern part of the catchment lies on Silurian shales of the Windermere Supergroup. Whereas the northern part lies on rocks of the Borrowdale Volcanic Series. These two contrasting parts of the catchment are separated by a thin band of Coniston Limestone. The lower slopes of the catchment are covered by glacial deposits of various thickness, with alluvial deposits on the valley floors of the rivers Rothay and Brathay. In general, the soils are poor but have been 'improved' by modern agricultural activity (Pickering 2001, 19).

4.2 EARLY MINERAL AND STONE WORKING

4.2.1 ***Mesolithic period:*** a single site of Mesolithic date was identified during the survey that related to the minerals theme. The Ambleside flint find (HER 4435), comprised a Mesolithic core-trimming flake that was found during a rescue excavation ahead of cable laying in Borrans Road.

4.2.2 ***Neolithic period:*** the Borrowdale Volcanic rocks of the central Lake District include a fine-grained tuff that will fracture conchoidally and could also be ground down and polished. It outcrops in a band around the higher summits, including Scafell Pike, Glaramara, Fairfield and Langdale. It was during the Neolithic that the potential of the rock was recognised for the manufacture of tree felling axes. There are considerable numbers of axe working areas across the slopes of the craggy summits of Pike of Stickle and Harrison Stickle; there are at present a total of *c* 240 individual working sites within 19 known working areas in the Langdale area (Claris and Quartermaine 1989). Suitable stone was won either from naturally detached scree, or in a limited number of instances from quarries, where the rock was detached by fire setting, a process of heating and then quenching with water to form workable cracks in the rock. The artefacts produced were rough-out axes, which had the basic form of an axe but with rough irregular surfaces. The secondary stage of polishing to finish the axes took place away from the axe factory sites, and of the limited number of known polishing sites, none are documented from the Windermere catchment area. The final products, petrographically classified as Group VI axes, were distributed all across the country. They are the largest group of stone axes in the Neolithic and demonstrates that stone working was being undertaken on an impressive scale within the Windermere catchment from an early date.

4.2.3 From the HER the sites dating to the Neolithic period (Fig 10) are all associated the manufacture of stone tools, including findspots for adze, chisels (HER 16936), maces / hammers (HER 19119) and flakes (HER 19479). There is a limited number of dispersed axes, including a Neolithic axe found in Dunney Beck (HER 1859), a rough-out axe of unspecified type found 1958 at High Close, just above the tarn (HER 1861), and two axe finds at Grasmere (HER 1862 and 1865), comprising a polished stone axe found in 1896 and a small stone axe found in a garden *c* 1925. At Huyton Hill, Ambleside, a polished stone axe was found in the school grounds (HER 1880). At Slackfoot, Troutbeck a five and a half inch long polished axe was found (HER 1903) and at Ibbotsholme two stone axes were found *c* 1899 (HER 1905). At Hawkshead, a broken polished stone found at Waterson Ground in 1896, during the digging of a drain (HER 2037) and a perforated stone implement was also found at Hawkshead in 1885 (HER 3569). At Calgarth, a polished stone axe was found *c* 1913. The distribution of the Neolithic axes is concentrated around the central and northern sections of the present study area. In the far north-east corner of the present study area, an adze was found in 1896 between High Bull Crag and John Bell's Banner (HER 17166).

4.2.4 ***Bronze Age period:*** nine sites of Bronze Age date have been identified within the study area (Fig 10), all of which were findspots that were outputs of mineral working in antiquity. They included adze finds (HER 1882 and 1900), axe finds (HER 1901, 1859 and 2049), hammer finds (HER 2044), and finds of scrapers and arrow heads (HER 3008, 3009 and 3010). These discoveries were concentrated in the Langdale area in the north-west portion of the study area.

4.2.5 ***Romano-British period:*** the Windermere valley was strategically important to the Romans as it provided a line of communications into the heart of the Lake District. In addition to the fort at *Galava*, Ambleside, at the head of Lake Windermere, finds of Romano-British date, that were derived from quarrying, included a Dungeon Ghyll quern find (HER 3005) and two inscribed stones identified at Ambleside (HER 1887) and at Brownsrig (HER 4059). There were no known mining or processing sites of Romano-British date within the study area.

4.2.6 ***Early Medieval to Late Medieval periods:*** a single site of early medieval date was identified during the survey. At Satterthwaite a stone resembling a Saxon millstone, with a small channel and a semi-circular recess, similar to a basin, was found at Field Head Moss near Graithwaite High (HER 2059). It is likely that some quarrying was being undertaken for slate during this period as a number of high status buildings, such as Hawkshead Gatehouse, had slate roofs from the outset; however, it is not known what quarry source was used.

4.2.7 *Iron Production:* in the medieval period mineral extraction and processing was primarily represented by bloomeries, which are charcoal-fuelled iron smelting furnaces which produced wrought iron (in contrast to blast furnaces whose first product, cast iron, had to be refined into wrought iron). During the smelting of iron oxide, the ore is reduced leaving metallic iron, which forms a spongy mass or 'bloom' within the furnace. In addition, slag is produced from a combination of the gangue elements and some of the iron oxide, which liquifies at over 1200ºc separating from the bloom and which can then be tapped off from the bottom of the furnace. Once a smelt is complete the bloom is removed and must be hammered to squeeze out the residues of slag within it. This primary refining probably took place immediately to take advantage of the latent heat (Bowden 2000, 40). There are broadly two types of site, a simple bloomery marked solely by a mound of slag, and much larger 'bloomforges' equipped with water management systems and dedicated storage buildings (*ibid*). Bloomeries are mentioned in documents from the twelfth century onwards, and, in the absence of further evidence, a medieval date has often been assumed. However, recently work on bloomeries within the Lake District National Park, by the LDNPA and National Trust, have been dated by radiocarbon analysis and have produced a range of dates between cal AD 1170 and cal AD 1650 (Beta Analytic Inc 2002; 2003). Local place-names, such as Cinder hill, Cinderstone Beck and Black Beck are often indications of the presence of a bloomery (*ibid*). The furnaces of the simple bloomeries were probably cylindrical clay shafts, about 1-2m in height, and the furnace would have had a blowing hole to take the blast from the bellows and a small archway on one side to allow the slag to be tapped into a hollow outside (*ibid*).

4.2.8 In total, 12 medieval bloomeries were identified some with surviving evidence in the form of earthworks. The sites are very widely spread, on either side of Lake Windermere from the southern tip of the South Basin and as far north as Grasmere Common. A farm building was once the office for a forge at Cunsey (HER 2687), and was in use before 1584; it was known then as 'Les Smithies'.

4.2.9 A good surviving example of a medieval bloomery is at Colwith Force, and lies 5km to west-south-west of Ambleside, close to the eastern end of Little Langdale on the southern bank of the River Brathay; only 100m upstream is Colwith Force waterfall. The site comprises a bloomery mound associated with the remains of two, rectangular, stone buildings, beside the River Brathay. The bloomery is

probable of medieval date and is overlain by a later charcoal burning platform; a second charcoal burning platform lies on the periphery of the site. In 1997 the RCHME undertook a survey of the site as part of a project on the iron industry and related woodland industries of Furness and south-west Cumbria (Lax 1998a).

4.2.10 Although the bloomery was situated close to a river. It was concluded, following the survey, that the water power was required for other purposes and that the bloomery did not rely on water power (Lax 1998a, 10). The results also suggested that the stone buildings did not house the furnace (*ibid*). Excavation of comparable sites elsewhere, and the general lack of upstanding stone structures enclosing bloomery sites in Furness, implies that bloomeries were commonly enclosed by wooden structures. A network of tracks and paths was identified at the site including a principal access route via Colwith Bridge. Charcoal for the bloomery could have been obtained locally from Atkinson's Coppice, although the bloomery is overlain by a charcoal burning platform, implying that after the bloomery went out of use the site was adopted for charcoal burning (Lax 1998a, 11). The diversity of the woodland economy is also illustrated by the presence of a potash kiln, showing that the brashings from the trees were a useful resource, as well as the coppiced wood, bark and timber (*ibid*).

4.2.11 Despite the predominance of iron processing sites, relatively little is known about the extraction sites for the iron ore, and what is known comes from documentary evidence form the thirteenth, fourteenth and fifteenth centuries, and this was evidently on a small, local scale and would have left little archaeological expression.

4.2.12 *Copper Extraction:* the intensive, systematic and heavily capitalised exploitation of the district's reserves, however, began in the late medieval / early post-medieval period. In 1564 Thomas Thurland and Daniel Hechstetter were granted the right to mine gold, silver, copper and quicksilver in Cumberland, Westmorland and Lancashire. In 1565 a mining company was formed and in 1568, the company was incorporated by Royal Charter as 'the Governor and Society for Mines Royal' (Adams 1988, 19; Donald 1994). Bloomeries or bloom-smithies had been prohibited in 1564 because of the alleged denudation of the woodlands, and perhaps the needs of the Mines Royal had been anticipated (Marshall and Davies-Shiel 1977, 32). The mining activity associated with Mines Royal lasted well into the seventeenth century, but is said to have ended with the destruction of the works by Parliamentary troops (*c* 1650) (Donald 1994).

4.2.13 A potential Elizabethan trial mine is known from the Grasmere area (HER 38816) and other sites of the period included the copper mine at Greenburn Beck (HER 3153), one of several copper mines in the Coniston area. The earliest date when mining began at Greenburn is unknown, however, documentary sources indicate that a reasonably intense and prolonged period of mining had been in existence by 1690 (Fig 12). A single lead mine is also represented by Greenhead Gill (HER 1891), which is a small well-documented sixteenth century Mines Royal mine, with possible later activity (Donald 1994). Documentary sources indicate that German miners and engineers began work at Grasmere in 1564, however, this may relate to a smithy nearby rather than at the mines themselves where work may not have started until later in the decade. Lead ore was mined here until 1573 when the mine closed down (HER 1891; Adams 1988). The remains include stone buildings and walls, and associated with these were a leat, washing floor, mine shaft, an adit, two bridge abutments, and a number of square depressions in the ground which

are probably box buddles, used to separate the ore from the veinstone. On the west side of the gill are some small open cast workings and two shafts, one of which, St Benedict's, is mentioned in company account books for 1569. An inventory drawn up by the Company of Mines Royal in 1586 indicates the main building was a stamphouse and waterwheel, with twelve stamps, and a loft to sleep the workmen.

4.3 POST-MEDIEVAL MINERAL AND STONE WORKING

4.3.1 ***Introduction:*** the number of quarrying, mineral extraction and processing sites increased dramatically within the study area during the post-medieval period (Fig 10), with the greatest number associated with quarrying, most of which are distributed in central and north-central locations. Most mining activity is clustered in the central, northern section of the study area, around the northern fells of Grasmere. Post-medieval processing activity was represented by a total of 35 sites, including forge sites, lime kiln sites, a gunpowder works at Elterwater (HER 3124), an arsenal at Pull Wyke Powder Works (HER 17183), sledways and industrial buildings. The sites are widespread but are concentrated to the west and north-west of Lake Windermere. Some of the sites survive as earthworks, but many have been destroyed and only a limited number survive as extant buildings.

4.3.2 ***Quarrying***: it is likely that slate has been worked and used in Cumbria since the prehistoric period. There is evidence of its use by the Romans - at their fort at Hardknott for example (Bidwell *et al* 1999) – and also at important buildings in the medieval period, for example, Calder Abbey. Outcrops of slate on the surface were the initial source, but these developed into open quarries, although later the so called 'metal' was mined underground via a level driven through to the vein. Workable slate is obtained from two main geological deposits; the cleaved tuffs of the Borrowdale Volcanic Group of the Ordovician series which give the silver-grey slates of Coniston Old Man; the green slates of Broughton Moor, Hodge Close and Kirkstone (Williams 1991). The green slates of Coniston, Tilberthwaite, Elterwater, Borrowdale and Honister, belong to the Borrowdale Volcanic Series.

4.3.3 The massive expansion of the industry through the eighteenth and nineteenth centuries was in response to the demand for slate roofing as a result of the growth of industrial towns in Northern England. It depended, however, on two factors that influenced supply - an effective transport system away from the quarries and mines, and advances in technology within them. Initially, goods were transported by cart or sledge down to water. The slate was originally won by hand, and then gunpowder was introduced from 1800 and compressed air drills from 1910. Diamond-tipped saws replaced the cutting of blocks by hammer and chisel from the 1930's. Railways provided a great stimulus to quarrying and, in particular, the opening of the Coniston branch of the Furness railway (1859). In a large number of quarries, extensive excavations have taken place in the twentieth century, such as at Loughrigg, Elterwater, Moss Rigg and Tilberthwaite. In some quarries, notably those worked by the Elterwater Green Slate Co Ltd, powerful and well-equipped steam and hydraulic machinery was used to raise slate from the deep portions of the quarries, as well as tramways for its transportation. The principal slate quarries being worked within the study area during the later twentieth century included: Moss Rigg; Parrock; Lords; Colt Howe; and Kirkstone.

4.3.4 In total, 498 quarry sites were identified during the survey. Of these, 20 are shown on the 1st Edition map (*c* 1864). Flag Stone Quarry is the only site specifically

named and recorded as a stone quarry, and appears on the 3rd Edition (1911-3) and modern mapping. Five other sites are recorded as evidence of stone quarrying, but do not appear on historic mapping, two of which are Roman inscribed stones (HER 1887 and 4059). Of the 498 quarry sites identified during the survey, 76 sites were associated with slate quarrying. Of these, nine sites are shown on the 1st Edition map (*c* 1864). The sites include Sty Rigg, Mirk Hole and Sandbuts, all of which are situated in an area of intensive quarrying activity to the east of Great Intake, south of Little Langdale. The quarries at Tilberthwaite were both open and mined, with huge visible caverns; the rock was removed using blasting powder. Between 1864 and 1899 (2nd Edition) a further four slate quarries were operational; Mirk Hole Slate Quarry had expanded and Broad Moss Slate Quarry was operational. An additional two sites to the east of Tarn How were also operating at Old Slate Quarry and Highwood Slate Quarry.

4.3.5 ***Limekilns:*** small kilns, with associated quarries are scattered across the central northern section of the present study area. In total, 15 lime-kilns were identified. Many smaller limekilns were for local agricultural use, such as in Low Furness (Marshall and Davis-Shiel 1977, 158). The work was often a by-industry carried out by farmers and builders and involved a method of making lime that was achieved by burning alternative layers of broken limestone and charcoal or peat. During the firing process the calcium carbonate of the limestone was converted to calcium oxide or quicklime, cleared from the hearth after about 24 hours (*op cit*, 159). Mixed with water this produces slaked lime, calcium hydroxide, which was used as lime putty for building. The limekilns were of the simple draw type, in which the fuel and limestone were placed in the kiln in alternate layers; as the fire moves up the kiln burnt lime is drawn out at the bottom. Examples of this type of kiln can be found throughout the county, most dating from the late eighteenth to mid nineteenth century. Examples within the study area include Riddings Limekiln (HER 17244), lying to the west of Silverhowe, overlooking the shores of Grasmere, Low Grove limekiln, Lakes (HER 17274) and a lime kiln at Atkinson's Coppice, Colwith Bridge (HER 30697).

4.3.6 ***Iron Mining and processing:*** there is indirect evidence for the early working of iron ore in many parts of this region, and small-scale mining undoubtedly took place in the medieval period. The records of this industry are inextricably linked with the charcoal industry, as charcoal was crucial to iron production, and the abundance of wood in Furness was a significant factor in the initial growth of the region's iron industry (Miller 2005, 180).

4.3.7 *Iron Mining:* the nineteenth-century iron mining industry was conducted on a larger scale. One of the main distinguishing features between early and later mines was the use of gunpowder for driving shafts and levels, prior to this date the mines were hand-worked limiting their extent (Marshall and Davis-Shiel 1977, 135). The iron mines in the volcanic rocks of the Lake District were at one time of importance, although inferior to those in the Skiddaw Slates (Postlethwaite 1965, 127). Robinson (1709), cited in Postlethwaite (1965, 127), stated that 'Langdale and Coniston mountains do abound most with iron veins, which supplies with ore and keeps constantly going a furnace in Langdale, where great plenty of good and malleable iron is made'. The ore which supplied this furnace is supposed to have been raised at Red Tarn, at the head of Browney Gill to the south-west of Langdale and in Tongue Gill, at the foot of Fairfield, north-east of Langdale.

4.3.8 *Bloomforge and Smelt Mills*: in total, 13 features defined as bloomforges or forge mills were identified during the survey, and included a blacksmiths workshop and a carriage. The bloomforge operates on a similar basis as the bloomery, and again produced wrought iron, but had a more sophisticated water power system for the bellows, and mechanical hammers, and usually had stone built hearths with iron plates. They were more productive operations and the furnaces were often associated with storage buildings. The sites are all of post-medieval or uncertain date and are distributed around the central to southern sections of the study area, on either side of Lake Windermere. The sites included Satterthwaite Bloomery Forge, Cunsey Forge and Blackwell Forge. These were for the most part located in areas of woodland and adjacent to a water supply, both being necessary for the manufacturing process. In total, 2 features defined as smelt-mills were identified during the survey, both of which are defined as being of medieval date.

4.3.9 *Cunsey Forge:* Cunsey Forge was erected on a plot of land adjacent to Cunsey Beck, which provided the power to drive the forge bellows and hammers and comprised a bloomery/bloomsmithy, a bloomforge (1618-1715), a refining forge (*c* 1715-62) and buildings associated with later developments (post *c* 1762). The forge continued as an iron-working site for over 130 years, during which time it was refurbished and modified on several occasions. Much of the forge had been dismantled by the beginning of the nineteenth century (Fell 1908, 209). The mixed woodlands to the west and south-west of the forge, known as Great Ore Gate and Little Ore Gate respectively, comprise coniferous plantations, although both contain dense groups of hardwood species, some of which were coppiced in antiquity. Similarly, on the north side of Cunsey Beck, lies a tract of woodland known as 'Machell Coppice' (Miller 2005, 175).

4.3.10 The origins of Cunsey bloomforge may be traced to March 1618, when William Wright acquired a lease of land at Cunsey on which to erect an ironworks (Phillips 1977, 37). It is probable that much of the iron ore smelted at Cunsey was obtained from the mines in Low Furness, although other sources were sought such as the 'pits in Grasmere, or any other pits within their lease nearer to Windermere water' (LRO DDSa 38/2, cited in Miller 2005, 179). An early eighteenth century document, dated to 27 January 1701, refers to William Brathwayte of Bryars in Sawrey Extra agreeing to supply Miles Sandys '50 wayloads of charcoal yearly at Consey forge' (LRO Ddsa 2/18, cited in Miller 2005, 180). It is likely this was only one of a number of sources, probably within a 5km or so radius of the forge (Miller 2005, 180). Analysis of charcoal samples recovered from Cunsey forge identified a mixture of diffuse porous roundwood species, such as alder or hazel, and ring porous species, including ash and oak (OA North 2004a). A refining forge appears to have supplanted a bloomsmithy or bloomforge of seventeenth century origins. The remains at Cunsey Forge as a whole are substantial and extensive and provide one of the best examples of a bloomforge/refining forge in the region, but significantly there are few physical remains of the bloomforge itself (Miller 2005, 195). At the site of the forge is a silted-up pond created by building a 2m high dam across the valley bottom; the stream has broken through this towards its northern end, but close to its southern end is the headrace to the forge. The forge itself has been lost, but its wheelpit can be identified close to the track further up the valley (Bowden 2000, 68). Large slag and waste heaps fill the valley bottom below the dam, while beside the track are a series of ruined stone buildings associated with the forge. The principal remains are of a two-storey terrace of three single-fronted cottages, two rooms deep, radically altered on

conversion to a barn. Eighteenth century re-modelling of the site, including a transition from wooden to stone construction, reflects significant changes in the iron industry as a whole during this period, and an expansion of the Cumbrian industry to serve the increased demands for iron throughout the country (*op cit*, 196).

4.3.11 The forge was in the hands of William Rawlinson or John Machell prior to the formation of the Backbarrow Company in 1711, when it became one of the Company's concerns. In 1715, the Backbarrow Company's lease expired, and was taken over by the Cunsey Company who immediately reconstructed the forge and worked it as a refinery in conjunction with their furnace (Fell 1908, 192). Cunsey Furnaces (HER 2687 and 2058) and Backbarrow, the first two blast furnaces in Furness, were built in 1711-12. Pig iron produced in the blast furnace was converted to wrought iron in the charcoal-fired finery forge.

4.3.12 It is probable that the most important trading and transport route was via Windermere. Iron ore will also have been transported to the smelting sites by packhorse, and some finished iron goods by the same means. In the years before 1750, a team of six packhorses made the journey from Hawkshead to Kendal twice a week, while another team made regular trips from Hawkshead to Whitehaven (Taylor 1983, 127). Upon the expiry of the Cunsey Company's lease in 1750, it was thought that their collateral passed to the Backbarrow Company, and that neither Cunsey blast furnace nor forge worked after this date (Fell 1908, 193). However, an inventory of goods, compiled in 1757, lists the equipment present in the forge, and suggests that the site may have remained in operation (LRO DDsa 2/27, cited in Miller 2005, 181). In 1818, the Backbarrow Company was bought out by Harrison, Ainslie and Company who, in 1824, inherited the Cunsey site as part of the Backbarrow Company concerns (Fell 1908, 209). The absence of Cunsey forge from Greenwood's 'Map of the County Palatine of Lancaster' (1818) suggests that little remained of the site at this date (Miller 2005, 181). The remaining structures were subsequently used for agricultural purposes until they were demolished in the 1980s. In 2003, OA North undertook an archaeological investigation of Cunsey Forge, and demonstrated that the site was one of the best examples of a bloomforge/refining forge in the region (Miller 2005, 195).

4.3.13 *Blast Furnaces:* the transition from the production of wrought iron by the bloomforge process to that of cast iron in the blast furnace had spread across Britain by the end of the seventeenth century. A few bloomforges continued operation in Cumbria into the early eighteenth century, but the principal development was the introduction of the blast furnace. These were initially charcoal fired and the industry was established because of the availability of high-quality hematite ore, water power and of extensive woods, which were being coppiced for the production of charcoal (Bowden 2000, 47). These vastly increased the output of iron, and were associated with investment from outside the region and the emergence of large iron companies (Miller 2005, 177). There are no blast furnaces within the catchment; however, the large and extremely important blast furnace at Backbarrow, was just beyond the southern edge of the catchment area. Although outside, it would have drawn its charcoal from the woods within the catchment.

4.3.14 ***Copper Mining:*** the mining of copper in the Lake District was essentially initiated with the arrival of mining experts from Germany in 1563. By 1568 the Company of Mines Royal had been formed, and the mines of the Caldbeck Fells received a

first mention in their accounts for this year (Donald 1994). The Company of Mines Royal worked the Coniston mines about 1599 (Donald 1999), although the present traces of activity are those left mainly by the intensive nineteenth century activities.

4.3.15 Copper mines within the catchment include Drycove Bottom, Tilberthwaite and Greenburn. Tilberthwaite mine has left remains of buildings and earthworks, including wheelpits, crushing houses and terraced settling pits (Marshall and Davies-Shiel 1977, 148-9). A level or adit near Blake Rigg Gill, Tilberthwaite (HER No 35920), was apparently hand-worked to a depth of about 45m, probably by two or three local men on a small-scale when the price of copper justified the effort (*op cit*, 136). Another such example is a bowl-shaped depression at Dry Cove bottom, to the south of the catchment.

4.3.16 *Greenburn Copper Mine:* up to about 1870 many mining companies were formed with varying degrees of success, but thereafter rapid decline set in as a result of foreign competition. Then in the twentieth century there were renewed, and sporadic bursts of mining activity, some on quite a large scale (Adams 1988, 20); one such example is the Greenburn Copper Mine which has episodes of activity over an extended period including the twentieth century. The mine occupies a remote location 3km west-south-west of Little Langdale (Oswald et al 2001, 1), and is regarded as an outlier of the Coniston Copper Mines. In 2000 English Heritage undertook a detailed archaeological survey and investigation of the Greenburn Copper Mine (*ibid*).

4.3.17 Greenburn is a relatively well preserved, extensive and impressive mining landscape containing the remains of a wide range of upstanding and buried mining components dating from the seventeenth to the twentieth centuries. These include levels, shafts, trials, water management systems for powering machinery, remains of transportation systems for moving ore, remains of buildings associated with processing ore, spoil heaps, dressing waste and remains of a range of associated buildings. An incline linking Birk Fell Mine with Greenburn Copper Works was laid with wooden rails and is dated to 1850 (Oswald *et al* 2001). The nearby Tilberthwaite mine was re-opened in 1850 by the Barretts (who also operated the phenomenally rich Hodbarrow haematite mine of Coniston) who constructed a deep adit level for the purpose of intersecting all six veins. A number of associated shafts are also known. Other associated features included an engine shaft, engine house, numerous buildings, tips and paths.

4.3.18 ***Lead mining:*** the copper mining enterprises of Coniston were undoubtedly impressive, but the lead mining enterprise at Greenside, in the Glenridding Valley just north of Patterdale, was perhaps the most important mine of the region during the nineteenth-century. The mine was eventually closed in 1962 after roughly two centuries of operations. Whilst Greenside mine is outside the catchment area, a single lead mine was identified within the present study area, at Greenhead Gill, Grasmere. This mine began as a Company of Mines Royal operation in 1564 and closed *c* 1573.

4.3.19 *Greenhead Gill Lead Mine:* this was a small well-documented sixteenth-century Mines Royal mine, albeit with some possible later activity (HER 1891), and is located in the narrow valley of Greenhead Gill. Documentary sources indicate that German miners and engineers began work at Grasmere in 1564, however, this may relate to a smithy nearby rather than at the mines themselves where work may not

have started until later in the decade (Donald 1999). Galena and gangue were mined here until 1573 when the mine closed down. An inventory of all property at Grasmere drawn up by the Company of Mines Royal in 1586 indicates that the main building was a stamphouse measuring 36 ft x 31 ft with a waterwheel, 12 stamps, and a loft for the workmen to sleep in. There was also a small room behind the loft, which was possibly sleeping quarters or an office. Another small building with a slated roof is also mentioned at the complex. Other features described include 11 square box buddles that were sunk into the ground, with three supports for the launder to the waterwheel, and a 'rowle wagon servinge for within the Mynes' which suggests use of an underground wagonway by the German miners. The drilled level at the southern end of the complex indicates that some work has been carried out here since the sixteenth-century and the second building at the northern end of the complex may belong to an unrecorded mining venture possibly undertaken in the early years of nineteenth-century (Donald 1994).

4.4 MINERAL RESOURCE ASSESSMENT

4.4.1 A map regression of mineral extraction in the Windermere catchment shows widespread quarrying activity since the mid-nineteenth century, although much of this activity was relatively small-scale (Figs 10-12). The OS 1st Edition mapping (*c* 1864) shows a large number of small-scale quarry sites distributed across the central to northern part of the catchment, and relatively few around the southern part of the area. This reflects the areas of good quality Borrowdale Volcanic slates, and, in particular, there is a cluster of sites in the High Wray and Pull Beck areas and to the south of Little Langdale. There are also clusters around Bowness and Windermere, where materials were required for buildings. There are far fewer mining sites, most of which are situated in the Tilberthwaite and Little Langdale areas, and were associated with Greenburn Beck Copper Mines, with another cluster of sites around Elterwater and a number of individual sites on the fells to the north of Grasmere, some of which are associated with a copper mine at Dunmail Raise. A further five sites are known around the northern part of the catchment. Those on the west are associated with Pull Beck Copper Mines and those on the east with Troutbeck Iron Works. A single mining site is known from the tip of the south part of the catchment, comprising a late nineteenth-century coal depot. This depot was identified on the OS Second Edition map and is situated adjacent to Lakeside Station, where the Furness railway branch line terminates. The completion of the Furness railway was completed in 1857, also bringing the relatively unknown southern Lake District to the attention of tourists and proposals for branch lines almost immediately followed (Millward and Robinson 1970, 242).

4.4.2 Mineral processing sites, such as bloomeries, have a fairly even and widespread distribution, although there are very few in the north-east corner of the Windermere catchment area. There is a marked concentration of bloomeries and smithies around the southern tip of the catchment, such as Smithy How Wood, Colesteads Wood and Gunners How Bloomery, where there was more available coppiced woodland for the charcoal industry. Waste sites, such as spoil platforms, have a central to northern distribution but there are few clusters and most are individual sites often associated with old quarry workings.

4.4.3 Between the OS 1st Edition and 2nd Edition mapping (1864-1899) only eight mineral extraction sites were lost, including two slate quarries, two gravel pits and four small localised quarries. An additional 26 features are shown on the 2nd Edition map (1899) which do not appear on the 1st Edition, 18 of which are quarries and two gravel pits. The sites are distributed across the central portion of the study area, around Windermere in the east, perhaps coinciding with the expansion of Windermere and Bowness, and around Blelham Tarn. Four features were lost between the 2nd and 3rd Edition maps (1899-1913), comprising short-lived quarry sites in Windermere.

4.4.4 In contrast, additional features shown on the 3rd Edition map (1911-3), include quarries, some of which are large sites, such as Banks Quarry, Little Langdale and High Fellside Quarries, Tilberthwaite and Brathay Quarries, all in the north-west and western parts of the study area. A number of larger sites were also operating in the east and north-east parts of the study area, such as Applethwaite Quarry and Park Quarry. Sixteen are sand and gravel extraction pits and included the works at Rayrigg, Windermere; these were generally located within areas of previous quarrying activity.

4.4.5 Mining sites shown on the 3rd Edition map (1911-3) include Howebanks Wood, Little Langdale. A number of features shown on the OS 3rd Edition, are not shown on any other map reflecting that they were very short-lived sites. Of these two were the mining sites at Howebanks Wood.

4.4.6 In total, 47 features associated with mineral extraction are shown on modern mapping, and of these, 21 are quarry sites distributed in broadly similar areas to previous extractive sites. Mining sites account for 20 features, and were overwhelmingly associated with the Greenburn Copper Mine and a single feature associated with processing activity is shown.

5. WOODLAND ARCHAEOLOGICAL EVIDENCE

5.1 INTRODUCTION

5.1.1 The woodlands of the region have both frustrated mans attempts to develop agriculture and have also been a significant asset, providing a resource and fuel for subsequent developments. The earliest major industry in Britain was around Great Langdale in the Neolithic period, and was for the production of tree felling axes that were ultimately needed to make clearings within the expanse of natural woodland to establish areas for agriculture. Even then, the woodlands were also a valuable resource, providing wood for domestic fires and providing grazing for their domesticated animals. Ultimately, it was the latter that had the greatest impact on the woodland resource, as the animals ate the emerging tree shoots and so the woods lost their ability to recover and declined. For much of the later prehistoric, Roman and early medieval periods the woodlands waned and rose in accordance with the extent of local settlement, but as the populations increased and the demands on the woodland resource increased so this ultimately led to the loss of natural woodland.

5.1.2 In the high medieval period woods were so valuable that they were ultimately a protected resource; woodland came under the control of the lord of the manor and in the forests and the chases, the lord also had control over trees on tenants land (Winchester 1987, 102). While the tenants could remove deadwood or take sufficient to make repairs on their houses, the right to commercially extract timber was exclusively that of the lord. One means to protect the woods was emparkment, which were intended to preserve the woodland habitat for deer, and there was a proliferation of these established in the thirteenth and early fourteenth centuries (*op cit*, 105); notable examples include Troutbeck Park and Calgarth (Kipling 1974, 69). Despite these controls, the right of tenants to graze their swine in the woods, coupled with the insatiable demand for wood to provide charcoal for bloomeries, had an irrevocable impact upon the extent of the catchments woodland. In the sixteenth century whole areas of woodland were clear-felled to provide charcoal for the expanding iron industry, typified by the activities of the Company of Mines Royal in the Derwent and Caldbeck Fells after 1564 (*op cit*, 120). In 1594 Walter Grame of Netherby leased the woods at Thick Side in Langstrath, immediately to the north of the Windermere catchment, to the Mines Royal with 'Liberty to take fell and cut down yearly all and every such woods and trees growing in the places aforesaid...' (CRO D/Law/1/155). The effect of this is plain to see today in the largely treeless expanse of valley head land. It is perhaps, therefore, not surprising that there were moves to establish walled coppices that kept stock out and the woods were subject to management techniques to preserve the resource. By 1537 there were perhaps a dozen coppiced woodlands belonging to Furness Abbey in Low Furness (*op cit*, 105). The subsequent increasing demand for iron and lead smelting into the industrial period meant that most of the existing natural woods became managed woods or new coppiced plantations were established to provide the valuable timber resource. In this period, the woods in the region could bring in up to double the profit of farming, and, consequently, they were expanded into the surrounding pasture in the eighteenth and nineteenth centuries (Marshall and Davies Shiel 1977, 166; Bowden 2000, 22).

5.1.3 The value of the woodland is demonstrated by the documented land valuations, and is typified by one of 1707, in which a valuation was made of 'the timber growing upon the Lady Otway's ground…' in the Brathay and Pullwyke area, on the north-west shores of the lake. The main item was 1,415 oak trees valued at £184. 7s. 0d. In 1748 the coppice wood of Scale How in Troutebeck was offered for sale 'excepting 38 old standard oaks and 28 young standards all marked with red lead', in all 66 oaks. Some of these 'marked trees' still stood in 1790 (*op cit*, 77). The woods in Applethwaite (Windermere) were also producing charcoal and bark in the eighteenth century. An account for 1771 for three woods in the Rayrigg estate shows a profit for felling, peeling, making the charcoal and transport to the lake shore (Rayrigg papers cited in Kipling 1974, 83). On the west side of the lake in the Pullwoods and Brathay estates, large-scale plantings were carried out at the end of the eighteenth century. In 1784 21,370 trees were planted (Brathay papers cited in Kipling 1974, 84) including an area around the west side of the lake, north of the ferry. A contemporary map of the Curwen estates, which stretched northwards from the ferry for about three miles and included the lake shore, shows the dates of plantations made by John Christian Curwen from 1798 to 1802 (*ibid*).

5.1.4 ***Claife Woodlands:*** the Claife woodlands have been extensively studied as part of a landscape survey by the National Trust (Lund 2000) and their changing landuse since the medieval period in part reflect patterns elsewhere in the catchment; as such they warrant more detailed assessment. The following landscape assessment is taken from the National Trust Hawkshead and Claife Estate landscape survey report (Lund 2000).

5.1.5 The earliest surviving documentary reference to the Furness woodlands dates from 1127 when Stephen of Blois granted 'forest' in the High Furness for the establishment Furness Abbey (Taylor 1983, 104), and a reference in the Coucher Book of Furness Abbey from 1271 records the making of charcoal in the Furness woods (Fell 1908, 162), which is likely to have been intended for iron production. The growth of the iron industry stimulated woodland management, and by the sixteenth century at least a dozen woodlands were managed by the Abbey to supply their iron bloomeries (Winchester 1987, 104). The number of trees throughout High Furness had evidently declined during the period of monastic control as, at the time of dissolution, a list of holdings prepared by the King's commissioners reported that there was no timber of any value throughout High Furness, as the woodland had been maintained for coppice to supply the smythes of the Abbey. Subsequently the King's Commissioners agreed to continue the letting of the local woods of 'birch, elder and hazel as well as a great deal of underwood' to John Sawrey and William Sandes at a yearly rent to the king (Kipling 1974, 71).

5.1.6 Local attempts to protect the woodlands appeared in 1538, with measures to outlaw trespass within woodlands (Kipling 1974, 72) but this had little positive effect, necessitating the abolition, by decree of Queen Elizabeth, of the bloomeries in 1546 (*ibid*) which was being held responsible blame for the rapid deforestation. By 1567 a survey of the woodlands around Hawkshead, undertaken on behalf of the Duchy of Lancaster, recorded only 1,280 timber trees and 8,260 saplings in the whole of High Furness (Kipling 1974, 74).

5.1.7 Some recovery of the High Furness woodlands appears to have taken place during the first half of the seventeenth century, but this appears to have been short lived as the new bloomsmithies and bloom forges required a far greater supply of

charcoal fuel that that required by the bloomeries. The later-seventeenth century appears to have seen a massive deforestation of the woodlands in High Furness. A description by Thomas Machell in 1692 of the Furness Fells is that they were 'large rocky mountains, formerly well clad with woods but now divested in a great measure of them' (Lambert 1989, 2).

5.1.8 *Claife Woods:* one of the earliest schemes of tree planting was undertaken by the Rev William Braithwaite who in 1797 planted upwards of 40,000 trees in the steeply sloping Station Scar Wood above Ferry Nab (Thompson 1970, 259), and it is likely that many of these were non-native exotic trees, as well as considerable numbers of oaks. At about this time John Curwen started to acquire land along the western edge of Windermere for his Belle Isle estate, and some of the first planting are likely to have taken place on Belle Isle during the early 1780's (Woof 1984, 14).

5.1.9 The greatest scheme of trees planting took place after the addition of the Heald Wood to the estate in 1795 and the 'Great Lake of Windermere' map annotates the area of the Heald Wood with the lines '1798 by the desire of my respected friend Dr. Watson Bishop of Llandaff I planted here 30,000 Larches' (CRO/D/Cu Estate Plans 10). By the 1830's the Curwen woodlands were well established along the Windermere shoreline, and the estate sale books record considerable profits from sales of larch and oak timber, bark peeling as well as from sales of coppice; profits from the estate appear to have been at their greatest between 1830 and 1860 (CRO/D/Cu/Box 148).

5.1.10 Between 1914 and 1918 the majority of conifer trees on the higher slopes were felled and not replanted. In some areas natural regeneration of larch was successful and about 50 acres was restocked in this way, but it was this area of regenerated woodland that was extensively felled for pitwood during the Second World War. The lakeside woodlands were catalogued in 1947 at which time sessile oak was predominant (CRO/D unlisted Working Plan of the Belle Isle Woodlands, 5). Among the broad leaf species ash and sycamore appear common, with wild cherry, Spanish chestnut, hazel, yew and black Italian poplar also found in some areas. Other species present include Sitka spruce, Norway spruce, Douglas fir and silver fir.

5.1.11 The two compartments Belt Ash Coppice and Pate Crag Coppice were not acquired for the Curwen estate until 1946. The woodlands in these compartments differ from those elsewhere on the estate, in that these have a predominance of sycamore coppice on the lower slopes as well as areas of relict alder and hazel coppice on the higher slopes; it is possible that these areas were maintained for coppice some time after the surrounding woodlands had been singled up for timber. The Curwen estate and woodlands passed to the National Trust in 1962 at the death of EA Curwen.

5.1.12 *Troutbeck:* the family papers of the Browne family, who owned Troutbeck Park, record fourteen coppice woods, mostly in the lower part of the valley. At intervals of fourteen years the coppice wood was sold for charcoal making and among the Browne papers are many records of such sales, for example a document of 1726 recording the sale of woods in New Close. In 1790 four coppice woods were sold, and in 1806 there is mention of the sale from one of these woods of 'Hoops sticks and Radling' (Kipling 1974). Scale How wood was sold for coppicing in 1714, 1734, 1748, 1763, *c* 1776 and 1790. In 1783 a new element had appeared in the

management of woodland, with a bill for tree seedlings from Messrs Archibald Dickson and Son of Hassendeanburn, Hawick, with further orders in 1788, 1790, 1792 and 1796 (Kipling 1974, 81). Late eighteenth-century accounts of tours of the Windermere area, such as that of Nathaniel Spencer in 1771, suggest that some planting had already been undertaken around the south-east side of the lake, although much of the western shore (probably from the islands northwards) was at that time not planted (Kipling 1974, 82).

5.2 WOODLAND RESOURCE ASSESSMENT

5.2.1 A map regression of the woodland of the Windermere catchment is revealing and shows that the majority of the woodland is in the southern part of the catchment area, and on both sides of the lake (Fig 6). In the north the woodland typically occupies the lower areas around the northern end of the lake, and along the River Brathay, near Elterwater and Skelwith; relatively few woodlands occupy the higher and steeper ground. Significantly, much of the woodland is mixed conifer and deciduous, and substantial areas of woodland are entirely deciduous. There are some conifer plantations, forming the western higher slopes of the large Heald plantation. As such, there is a very distinct contrast between the woodlands within the Windermere catchment and that of the adjacent Coniston catchment, which is dominated by the very extensive Grizedale forest plantations. The deciduous and mixed character suggests woodland that has developed over time from former coppiced woodland, and there are significant numbers of coppice place names within the study area (*c* 20 coppice names). The ancient character of the woodland is reflected in the map regression which shows that the great majority of the woodland within the catchment (Table 1) were in place on the OS 1st Edition map (*c* 1864; Fig 2). At that date 15.4% of the total catchment area (237.7sqkm) was under woodland as opposed to 17.1% today, indicating that woodland patterns have been fairly conservative. Most of these plots and compartments have irregular field boundaries, suggesting that they were not post-parliamentary enclosure plantations and there is the possibility that many of them have a far greater antiquity than the earliest usable mapping.

Area of woodland across extent of catchment	**Area (sqkm)**
OS 1st Edition map (*c* 1864)	36.87
OS 2nd Edition map (c 1899)	39.24
OS 3rd Edition map (*c* 1911-3)	43.12
Modern mapping (including areas of scattered trees)	47.63
Modern mapping (excluding areas of scattered trees)	40.82

Table 1: areas of woodland

5.2.2 The 2nd Edition mapping (1899) represents only a slight increase in woodland (6.4 % increase) and is mainly concentrated around Latterbarrow and Skelwith (Fig 3). In the case of the former, this is an expansion to the west of existing woodland and is formed of a series of woodland compartments that reflect earlier fields, and are most often named after 'intake' fields, which were themselves previously unenclosed fell.

5.2.3 The expansion of woodland between the 2nd and 3rd Edition (*c* 1899-1911-3) maps was again relatively limited, reflecting only a 9.8% increase, and was mostly on the eastern side of the lake, near Storrs and expanding out from the earlier Blake Holme Plantation (Fig 4). There was, however, a marked increase though between the 3rd Edition and the modern mapping, reflecting a mixture of expansions of existing plantations or, in a lot of instances, small isolated woodland plots, which reflect the planting of individual fields. The largest area of plantation is Esthwaite Intake (south-west of Esthwaite Water), which is predominantly conifer and fills an area between two blocks of woodland that date back to at least the OS 1st Edition mapping (*c* 1864). The greatest extent of recent woodland plantation is on the western side of the lake and, in particular, is up against the western boundary of the catchment. These are the easternmost elements of the extensive Grizedale Forest plantings, which are for the most part within the Coniston catchment.

5.2.4 While there have been significant areas that have been planted during the twentieth century (Fig 5), there have also been substantial areas that have ceased to be intensive woodland. Such areas are not devoid of trees, but instead retain a loose scattering of trees that are the residual elements of the former woodland. It is difficult to generalise upon the processes that have resulted in the loss of woodland, but many of these areas that were once woodland are now upland, managed pasture with occasional, or small clumps, of mature trees, and no small trees or scrub. One model for the decline of these areas is that a move to increased grazing, which inhibits woodland recovery, coupled with the selective cutting of older and diseased trees, has resulted in the gradual decline of woodland areas leaving only scatters of mature trees. The main areas that have seen this loss of full woodland are Rydal and High Park, and Low Sweden Coppice near Ambleside, Schoolknott Plantation, near Windermere, Birkett Houses Allotment, near Ghyll Head Reservoir, and Arnside Plantation, near Skelwith. Looking at the statistics of woodland coverage on each map (Table 1), the indications are that the overall increase of woodland since the OS 1st edition has been offset by the loss of woodland to upland pasture, and, if it was not for the encroachment of Grizedale Plantations into the Windermere catchment, then the amount of woodland would have been relatively uniform.

5.2.5 ***Charcoal Burning:*** there is a long history of charcoal burning within the catchment area. Charcoal was originally produced by burning uncoppiced fragments of wood within pits, hence the term pitsteads, and excavations of charcoal pits from Bark House Bank, Rusland, have produced thirteenth- to fourteenth-century dates (LDNPA 2008). Most of the charcoal burning platforms, however, are of post-medieval date, and reflect the heavy demands of the iron industry and, in particular, the iron forge at Cunsey, within the study area, and the Backbarrow blast furnace, just to the south of the study area. The early demand for charcoal is reflected in an agreement between the Penningtons of Muncaster and William Wright, dated 10th April 1623, referring to the sale of all oak and timber trees at Hacket Ground in Little Langdale (Fell 1908, 191). It is presumed that this was aimed at securing an ample supply of charcoal for the Cunsey Forge (Bowden 2000, 68).

5.2.6 Within the catchment are large numbers of charcoal burning platforms, and in select areas, particularly the Claife woodlands on the west side of the lake, they are particularly dense (Lax 1998b; Lund 2000). To an extent, this distribution

reflects that some areas have been subject to more intensive archaeological investigations, but nevertheless there are some, potentially significant conclusions that can be drawn. There were 504 charcoal burning platforms within the catchment, of which the vast majority were within the woodland areas that were first represented on the OS 1st Edition mapping (*c* 1864), and very few platforms were within the woodlands that appeared from the OS 2nd Edition onwards. The implication is that there was no expansion of charcoal production from the area during the second half of the nineteenth century; however, one of the main consumers of charcoal in the region was the Backbarrow iron works, and this continued to have a heavy demand for charcoal up until 1921, when the blast furnace was converted from charcoal to coke (OA North 2005c).

5.2.7 Perhaps the most significant aspect of the charcoal platform distribution is where there are significant numbers that are remote from any woodland, either now or from any of the OS maps. The largest group of these is at Troutbeck Park, on either side of Trout Beck and there are 66 platforms in this area outside documented woodland. The area has not been wooded since the OS 1st Edition map (*c* 1864), although there is now a loose scatter of trees across the area. The implication is that this was an area of former woodland that lost the majority of its trees prior to the OS 1st Edition map, and indeed may have been clear felled to provide charcoal. The documentary evidence (*Sections 3.4.42* and *3.5.34*) demonstrates that Troutbeck Park was a jealously protected area of woodland, which was emparked in 1340, but was subject to exploitation by the lord of the manor, and may have been more intensively worked than other areas. It is perhaps, therefore, not surprising that the area has a large number of charcoal burning platforms, but no woodland. In all likelihood the platforms in this area are earlier than the other platforms in the catchment that were supplying Backbarrow.

5.2.8 The other smaller group is in the Great Langdale valley, where there are six platforms on the northern side of the valley between Millbeck and Harry Place. In the 1820s there were seven small areas of woodland documented (Hodgson 1823-5) which approximately correspond with the sites of the platforms, but by the time of the OS 1st Edition (*c* 1864) the trees had been felled (Lund and Southwell 2002, 32). Now there is a scattering of trees, both mature and immature, and there is an implication of some limited regeneration. A sale of 'woods, coppice, timber in eleven enclosure at Harry Place' occurred in 1864 (CRO WD/AG 58/10) indicates that the woodland was a mix of larch, spruce, lime, oak and cherry. The wood species used by the blast furnaces is demonstrated by analysis of charcoal species from excavations at Cunsey Forge, which revealed a mixture of alder, hazel, ash and oak (Miller 2005, 180).

5.2.9 A small collection of at least ten charcoal burning platforms have been identified in the woodland of St Catherine's Estate in Windermere. The sites were found in close association with sub-divided coppice compartments where the boundaries of each coppice hag had been formalised using sinuous walls (OA North 2005b, 60).

5.2.10 ***Potash kilns:*** potash, or potassium hydroxide, produced by burning green bracken and birch twigs in a kiln and extracting the ashes, was used in the woollen industry to clean wool prior to bleaching. Its production experienced a boom that coincided with one in the woollen industry, centred on Kendal, in the sixteenth and seventeenth centuries (Munby 1985). These potash kilns are typically associated with woodland, and there is a substantial number of them scattered across the catchment from the HER data (88 potash kilns). Their distribution should,

however, be treated with a certain degree of caution as many have been identified on the HER using place name evidence alone and without site survey, and on re-examination they sometimes can not be found. This highlights the need for a programme of ground truthing to redefine the distribution. Despite this, there is a propensity for potash kilns to coincide with areas of woodland depicted on the OS 1st Edition mapping (*c* 1864) and, significantly, the locations of potash kilns do not often coincide with the groups of charcoal burning platforms.

5.2.11 ***Tanning Industry:*** an important industry for the area is the tanning of animal hides, which requires tannin, derived from oak bark, for the production of a liquor that tanned the animal skins into leather (Bowden 2000, 24-5). Tanning is an ancient and necessary practice for the production of leather clothes, but it was from the medieval period that it developed into a documented industry; Kendal had a long standing tradition of marketing the products of the tanning industry. This was an environmentally unsavoury process, producing strong unpleasant aromas and the tanning houses and pits were typically kept removed from settlements. In the eighteenth century there was a significant rise in the number of small tanneries as economic development precipitated an increased demand for leather (Howard Davis 1987, 238), and by 1850 there were 57 tanneries operating in South Lakeland (Marshall and Davies Shiel 1977). The best known tannery in the catchment is that at Rusland which was probably built in the eighteenth century, and certainly extant by 1762 (Howard Davis 1987), but there were also tanning mills on Stock Ghyll and Fisher Beck, near Ambleside.

5.2.12 Large quantities of oak bark was required by each tannery (Fig 7), which in part was obtained from the commercially coppiced woodland of south Lakeland, although this could not meet the demand of local tanneries and bark was imported from elsewhere in the country. Local supplies would be obtained from 25-30 year old growth, the bark peeled off during the spring when rising sap made the process easier, and it was then stored in bark barns to dry. The surviving remains of this woodland industry are bark peelers huts that are found scattered across the areas of woodland, yet despite the intensive nature of this industry, relatively few bark peelers huts (six in total) have been found within the area. To an extent, this dearth will reflect a lack of archaeological investigation rather than actual absence. Two are documented in Baysbrown Wood, Great Langdale (HER 30683, 30693), in a woodland compartment that has potash kilns but no charcoal burning platforms, and there is a further example at Brow Coppice, Skelwith Bridge (HER 30713). Interestingly, there is a bark barn (HER 38645) identified at Belle Grange, Claife, but there are no bark peelers huts; however, there were four huts identified as charcoal burners huts (HER 36794, 36805, 36822, 37335) by the Hawkshead and Claife Historic Landscape Survey. A survey by English Heritage categorises the same structures as bark peelers huts (Lax 1998a) and so some further work is necessary to determine their form and function.

5.2.13 ***Gunpowder Mills***: one of the most important industries of the region at the turn of the twentieth century was the manufacture of black blasting powder, produced at the gunpowder mills of Westmorland and Furness. This industry is described under the woodland section as its principal raw material that was derived from the region was charcoal. The Elterwater works (HER 3124) was one of seven powder manufactories, which operated in the historic counties of Westmorland and Furness at various times between *c* 1764 and 1936, all of which produced gunpowder chiefly for the civilian, rather than military markets. The industry

became established in Cumbria mainly in response to the increasing need for blasting powder from mines and quarries through the eighteenth century. Water power was readily available for the numerous grinding and other processes and saltpetre and sulphur were imported through ports like Milnthorpe and Greenodd. The third component, charcoal, was already a product of the widely cultivated coppice growth (Marshall and Davis-Shield 1977, 75), coming primarily from silver-birch, juniper and alder trees. The rural and wooded locations were also commensurate with the desirability to remove the works from populous areas and to minimise the effects of any explosions (Jecock *et al* 2003, 9).

5.2.14 Elterwater Gunpowder Mill was established in 1824 by David Huddlestone, a retired banker, in conjunction with a number of partners, on the site of earlier water-powered corn and fulling mills, and was the third gunpowder works to be established in Cumbria, after Old Sedgewick and its outstation at Basingill (*c* 1764/1790), and Lowood (1799). Initially, the factory comprised only a single incorporating mill, but rapidly expanded with additional mills, corning house, glazing house and other buildings added before 1840 and for most of its life was known as Elterwater Gunpowder Company. The factory continued to prosper, before finally closing in 1930. The main site covered an area of approximately 9.1ha, with a number of 'danger' buildings located on a small divorced sub-site ('Cylinder Hill'), on the valley side to the north (*op cit*,10). In the early years transport was by water, between Greenodd and Pull Wyke staithe on the shores of Windermere and by horse and cart between there and the factory. After 1846, the carts ran between the works and the railhead in Windermere town. As Elterwater developed, and more regard was paid to the safety of the workforce, trees and natural rock outcrops were incorporated into the layout as a barrier to dampen and help contain blasts. At closure, the danger buildings were, as required by law, burnt down and the site was converted into a holiday centre (*op cit*, 11). In 2001, English Heritage undertook a detailed archaeological survey and investigation of the site of the former Elterwater Gunpowder Works (*ibid*).

5.2.15 ***Parks and Gardens:*** within the area are a number of designed landscapes, which include ornamental parks, deer parks and gardens. Deer parks historically were left wooded to provide shelter for the deer, and were often afforded protection from assarting and squatter encroachment, but they became a protected woodland resource that was exploited by the lord of the manor and some, such as Troutbeck Park, was intensively worked for its wood. These medieval parks were enclosed lands that were, by the fourteenth to fifteenth centuries, largely private demesne pastures, often utilised as a source for estovers or turbary (Winchester 1987). Another medieval park that has been subject to woodland exploitation is Grasmere Park, and had residual woodland from the OS 1st Edition map associated with it.

5.2.16 In total, eight parks were identified during the survey. Examples include the park and estate land associated with St Catherine's, Windermere, Wray Castle, Calgarth Hall, Brockhole, Rydal Hall, and Graythwaite Hall. These typically have a greater diversity of tree species, reflecting the importation of often non-native tree types and the deliberate planting for visual effect. For example at Eller How, above Ambleside, is a small garden which was bought in 1863 by one Henry Boyle, who was a collector of diverse species, mainly of ferns, but the rest of his garden comprised an enormous diversity of tree types, often acquired from Kew Gardens (LUAU 1999). Some of the parks and gardens within the catchment have been

subject to detailed surveys, and include St Catherines (OA North 2005, Wray Castle (Lund 2000) and Eller How (LUAU 1999).

6. WATER ARCHAEOLOGICAL EVIDENCE

6.1 EARLY WATER MODIFICATION

6.1.1 Water is an essential commodity for sustaining life and patterns of settlement and for other activities have been in part determined by proximity to water sources since the earliest human presence within the catchment area. While a supply of water is an essential requirement for all domestic settlements, water has many other diverse uses and the availability of good water supplies has played a major factor in the extent to which man has modified the landscape (Fig 8).

6.1.2 The modification of water supplies to suit the needs of man is an ancient practice demonstrated at the waterlogged site at Stainton, Carlisle, from the Neolithic period when a water channel was modified with stakes to provide a fish trap (Paul Clark pers comm). In the Windermere catchment, however, the earliest evidence of a water-related feature is a burnt mound at Scandale Beck (HER 32542). Burnt mounds are characterised by piles of burnt stone and, where they survive, troughs. While it is evident that heated stones were used to heat up water it is not known for certain as to the purpose; however, there has been much speculation which has varied from the possibility of saunas to cooking (Barfield and Hodder 1987; Waddell 1998). The Scandale Beck burnt mound stands prominent on an area of flat, mostly boggy, ground, near Scandale Bottom (NGR 338040 508400) in the uplands of the north-west of the study area.

6.2 DOMESTIC SUPPLIES

6.2.1 Settlements are invariably located near water supplies and are provided with wells, troughs and pipes to provide convenient supplies to dwellings and stock. Wells are distributed along and around watercourses, predominantly those running into Lake Windermere with a cluster around Esthwaite Water. There were few identified in the Furness Fells and most were concentrated on the periphery of towns, such as Hawkshead, Grasmere and Windermere, or, more commonly, in fields surrounding the farms. In total, 17 wells were identified on the OS 1st Edition mapping, with a further 15 on the OS 2nd Edition maps. In addition, six wells were identified from the OS 3rd Edition maps (1911-3). Of these, one Holy Well was identified (HER No 1863; St Oswald's) and a single Romano-British well (HER No 2047) at Belle Isle Lodge Villa. During the building of a house on Belle Isle in 1774, workmen found a tessellated pavement in an area north of the house, and in the basement of the house is a well, which was purported to be Roman; however, this has not been confirmed as a Roman site (HER No 33571).

6.2.2 Troughs are another feature of domestic use of water supply. In total, only 26 features were specifically identified as troughs, six of which were identified from the OS 1st Edition maps and an additional two from the OS 3rd Edition maps (1911-3). The majority were to the east of Windermere and Troutbeck, and were probably associated with local farms. A single sheep wash site was identified on the OS 3rd Edition map associated with Low Skelghyll Farm, Holbeck.

6.2.4 Waste waters are produced from two primary sources: those from direct human activity (domestic sewage) and those from industry. Prior to the middle of the twentieth century, much of the domestic/combined sewage in the Windermere

catchment was treated locally, essentially by means of numerous, often small, septic tanks. Increasing population growth and tourism resulted in the decision in the 1960s, to centralise waste-water treatment at key facilities within the Windermere catchment. Accordingly, sewage treatment works were built and/or extended at Grasmere, Elterwater, Ambleside, Hawkshead and Tower Wood, to accommodate the waste waters from the main residential areas (Pickering 2001, 83). In total, eight sewage works were identified in the survey, all of which are of twentieth century date and on the periphery of centres of population. A single treatment works was also identified alongside the A591 at Town Head.

6.2.5 ***Drainage:*** agriculture needs the right amount of water in the ground and both uplands and lowland soils need draining to improvide productivity. Drainage features represent the most abundant water-related feature in the catchment, and have not been mapped because the scale of the task exceeds the available resources.

6.2.6 ***Water Courses:*** given that the narrow valley bottoms in the catchment are edged by extremely steep, and craggy, valley sides, these restricted areas have been subject to intensive exploitation, which extends back to the prehistoric periods as evidenced by Mickleden and other valley floors outside the catchment (Quartermaine and Leech forthcoming). In the medieval periods they provided the location for the ring garths, an area of restricted enclosed land that marked the cultivatable land from the waste, notably that at Great Langdale within the catchment (Lund and Southwell 2002). Within these lands, that have provided the main agricultural economy for many generations of peoples, runs the principal streams and the adjoining side becks, which have provided water for people and animal, but also have the potential of destroying crops in time of flood. The importance of maintaining the banks of the becks to restrict flooding would inevitably have been an important part of the improvement of the land; however, the ongoing water erosion would have undone any efforts and have removed the archaeological evidence for this activity. The well maintained beck sides in Langdale, for example, reflect recent maintenance and there are no extant indicators of early stream works within the present line of the beck.

6.2.7 There are, however, indicators of the lines of former streams that have been modified by a combination of human and natural agencies. At the eastern edge of Ennerdale Water, there are numerous former river and stream channels (Woundell Beck) extending immediately around the extent of the historic fields that contain substantial cairnfields, and which evidently were of ancient origin (OA North 2003, Fig 7). The implication is that either the fields were defined by the shape of the water courses, which is unlikely given that the fields have fairly regular shapes, or more likely that the water courses were modified to avoid the fields. Despite the fact that many of these becks now have a fairly natural appearance, this would seem to be a situation where man, as ever, has been controlling his environment and modifying the courses of the water courses.

6.2.8 At Mickleden in Great Langdale there is a similar situation where there are a number of historic courses of Mickleden Beck that are distinct from the present line, but it is not evident as to whether the changing lines are a result of natural or human agency. The present line of the beck is fairly straight through the area of the former cairnfield (to the north-west of the enclosed lands) and across the floor of the valley, yet there is an earlier, sinuous course of the beck to the north-east of the presnt line which is respected by the cairns of the cairnfield. While this

sinuous line was evidently the line of the beck in antiquity, it is not clear if the change from one to the other occurred as a result of mans involvement. Given that the present line is fairly straight it raises the possibility that this was an artificial adoption to provide more agricultural land on the valley floor.

6.2.9 Further towards the south-east, and partly within the enclosed lands, is a further historic line of the beck that takes an erratic, somewhat sinuous, course out from the position of the present Mickleden Beck weir (which is relatively recent), even though it clearly predates the weir. This line is respected by the south-eastern part of the cairnfield and is partly within the enclosed field, so it evidently predates the enclosure and is of some antiquity. While the change of course could have been caused by either artificial or natural means, there does exist the possibility that this reflects attempts to maximise the valuable valley bottom land at some distant point in the past.

6.2.10 Elsewhere in the catchment there are a total of 81 modified watercourses identified. A large proportion of these are distributed between Lake Windermere and Esthwaite Water. Of these, only two comprising Louper Weir and Stythwaite Steps, were identified from the OS 1st Edition maps. A further eight sites were identified on the OS 2nd Edition maps, including stepping stones, culverts and fords. These appear to have clustered around areas of industrial, extractive industries, such as Tilberthwaite and Grasmere, with a limited numer in the far northern perimeter of the study area. Eleven sites were identified on the OS 3rd Edition map (1911-3), most of which are present on the OS modern mapping. These include fords, weirs and stepping stones with a widespread distribution across the study area. A number are associated with industrial areas, such as the ford at Little Langdale quarries, providing access to a nearby road.

6.2.11 The course of Wynlass Beck was altered over time and offshoots of the beck were blocked, as evident from OS mapping, although the features were difficult to idntifiy during a survey (OA North 2005). Several sections of the beck were canalised and in the south a dam/weir structure crossed the beck and formed a boggy pool are behind it. A section north of the beck had also been heavily modified. Water-worn stone gullies were identified and drainage features had been used to clear the area, which would suggest that in the past a varity of natural and canalised water flows have had some considerable impact on the formation of the landscape. A large, former, localised mire, consisting of a bowl-shaped hollow may have been drained in order to form a formal landscape feature within the wood.

6.2.12 As a result of the Claife survey (Lund 2000) four weirs or small dams were recorded on local becks. The weirs all appear of similar design, enclosing an area of around 2 square meters and creating a fall of water between 0.5 and 2 meters in height. The example near located on Hill Top Farm land was identified as a gravel trap (NTSMR 25229) and may suggest a possible use for similar sites (Cliff Atkinson pers comm).

6.2.13 The largest programme of drainage work appears to have been undertaken in the nineteenth century with the re-cutting of a section of Blelham Beck between Low Wray Farm and Bee Holme. The 1836 plan of Low Wray Farm depicts a single watercourse that meanders through the pattern of woodland and fields to the north of the farm buildings (CRO/BD/TB/SP3/45). To the north an open drain is shown flowing from Lady Park Moss, marked as 'Old Park Cut' on the 1st edition OS

map surveyed in 1847-8, connecting a short distance below the outflow of Blelham Beck into Windermere.

6.2.14 By the time the area was surveyed by the OS in 1847-8 the course had been altered and a second channel had been cut a short distance to the west of the first. The new cut began at the junction between Blelham Beck and Hog House Beck, then flowed in a roughly straight course to the outflow at Bee Holme. The Old Park Cut is shown as still active as a drain at this time. By 1898 the original beck cut appears to have become silted up or deliberately blocked, and only the later straight channel appears to be discharging water into the lake (CRO/BD/TB/SP3/45). Only a short section of the Old Park Cut, a stretch of roughly 30-40m that is linked to the re-cut channel is now depicted as active.

6.2.15 It is possible that work to improve drainage was also carried out along the course of Hog House Beck (NTSMR 24740). The course of the beck appears to have changed little, an almost identical course to that shown on the Wray Castle Estate maps is depicted in 1737 (Strickland, T, Heelis Office). However survey revealed that the sides of the beck appear to have been re-cut and lined with stone flags, perhaps in an effort to improve the flow of water. Such a task is unlikely to have been undertaken other than as part of nineteenth century estate improvement.

6.3 WATER CAPTURE

6.3.1 Reservoirs and culverts take advantage of the large rainfall in the Lake District to provide industrial and domestic supplies. The most notable example is Thirlmere and the large aqueduct that extends through the catchment. In total, 23 reservoirs were identified including eight relatively small reservoirs were identified within the study area, including Welcome Nook and Holme Ground at Skelwith, High Wood at Hawkshead, a sluice and pond to the north-east of Low Wray Farm, Dale End Farm at Little Langdale, Moss Intake at Claife, and Dubbs and Borrans reservoirs, near Troutbeck. Three pump houses of twentieth century date were identified at Parkhill Wood, Troutbeck and Robinson Place, Great Langdale. The Windermere catchment contains several other significant still waters. To the north of Windermere lie Grasmere and Rydal Water, with Loughrigg Tarn and Elterwater to the north-west. Blelham Tarn and Esthwaite Water are located to the west and several other smaller tarns occur within the study area. These areas of water have been utilised and manipulated by human activity for various purposes.

6.3.2 Stickle Tarn Dam (HER No 60018) is a large dam on the southern side of Stickle Tarn, intended to provide a water supply for Elterwater gunpowder works. The dam is in good condition and has been maintained recently. The eastern part of the structure consists of a large weir to control the level of the tarn. In the centre of the dam is a sluice mechanism within a large chamber inside the dam and there is an elaborate dry-stone-revetted outfall leading to a narrow channel that converges with Stickle Ghyll.

6.4 FOOD SUPPLY

6.4.1 Water bodies have provided an invaluable food supply and a lot of the early settlements were situated near them to complement the diet. Fish traps, which are usually of wood construction and survive in waterlogged conditions, are indicators of man's attempts to tap this resource. In the medieval period they were called fish

garths and were weirs constructed across a river or esturary with a basket in the middle to catch the fish (Winchester 1987, 108). At this time the right to fish the lakes was typically a lordly prerogative and was extremely profitable, so much so that there were concerns about over-fishing. Furness Abbey controlled fishing in much of Windermere, Esthwaite Water and Coniston Water. The rental of 1538 records the letting of the freshwater fishery called '*Blalhm Tene* (Blelham Tarn) in Wray to one John Bowthe for 2s. p.a.' (Brownbill 1919, 617).

6.4.2 Ponds were also constructed in the medieval period to provide a more controlled food source, and were called *vivaries* from the latin meaning fish pond (*ibid*). The more common medieval features were man-made enclosures, often within rivers, and also mill ponds that provided an environment for controlled fish growth, as well as power for a mill (*ibid*). Fishing was also undertaken with nets from small boats but these rarely show up in the archaeological evidence.

6.4.2 Thirteen fish ponds were identified within the study area; of these two were identified on the OS 2nd Edition maps and eight from the OS 3rd Edition maps. Six of these sites form a cluster and include Hodson's Tarn, Lily Pond, Robinson's Tarn, Wraymire's Tarn, with an additional two unamed ponds adjacent to Fishpond Wood, Claife and possibly of importance to the Claife Estate. A fishpond was identified in Fish Garth Wood, Ambleside (HER 36071) and one to the north of Blelham Tarn, on land which formed part of the Wray Castle Estate (HER 37123), which is quite large being some 40 x 30m in size. The exact size of the feature is difficult to ascertain due to the heavy clogging and growth of weed in and around the pond. The pond has a well reveted slate wall on its downhill side and also three runoff channels have been built to let the water run out. The whole structure is well built and uses the natural gullies to lead the water to the sluice. Only two mill ponds were identified in the survey, both twentieth century in date. Low Stott Park, Finsthwaite mill pond is situated adjacent to both a settlement area and focus of industrial activity, with a former bloomery at Smithy Wood Haw and Stott Park Mill. In Hawkshead, the mill pond is associated with a mill race and a water-powered saw mill.

6.5 COMMUNICATIONS

6.5.1 From an early age it was recognised that the easiest means of communicating bulk goods was by water, and settlements have developed in proximity to natural water bodies to enable such communications (Fig 9). The location of the Roman fort at Ambleside is at the head of Lake Windermere, which would have provided a link through to the sea via the River Leven. The physical indicators of communication features in the catchment are typically jetties; because the lake is not subject to large fluctuations of water level or rough water and there is no requirement for protective port features. The communication features also include boat houses, landing stages and quays. It is likely that boats have been used on Windermere since humans first settled in the area. The early industrial traffic on the lake led to a right of navigation, and the monks of Furness Abbey used boats on the lake for transporting iron ore and wool during the twelfth and thirteenth centuries, a tradition that continued into the nineteenth century with steam transport for shipping coal, charcoal, stone and slate (Pickering 2001, 77-79). Since the decline of this trade the lake has been used primarily for pleasure activities.

6.5.2 Physical indicators of the use of rivers, streams and becks as communication and transport routes include bridges, fords and stepping stones. In total, 97 bridges are distributed throughout the study area along all the major and smaller watercourses, although there are less towards the south of the study area. The most northerly, Raise Bridge (HER 12942) lies over Dunmail Raise and was a rubble arch of segmental form, probably of seventeenth century date, but subsequently widened, and now overlain by a dual carriageway; the site is shown on the OS 1st Edition map. Troutbeck Bridge (HER 17153) crosses Trout Beck near its exit into Windermere and is documented from 1454. A common form of bridge is the 'clapper bridge' and in total, 22 clapper bridges were identified during the survey, the majority of which are distributed in the Hawkshead, Blelham Tarn and High Wray areas and were constructed from a series of stone or slate slabs. Sixteen of the bridges are noted on the OS 1st Edition maps, some in areas of extractive industries, such as Little Langdale and Grasmere, and a high proportion are in the south-west of the study area, including two bridges, Eel House Bridge and Cunsey Bridge on Cunsey Beck, associated with the Cunsey Forge. A large proportion of the bridges are of post-medieval date and are located on communication routes through the centres of population, such as Grasmere. Simple concrete bridges have been erected in some locations and may have replaced earlier clapper bridges. A number of stone-built bridges exist, the majority of which appear to have been built during the nineteenth and twentieth centuries, such as a stone bridge in Claife Woods (HER 37482). Others are located in areas of industrial activity, such as Poundfell Howe Bridge on the River Brathay at Greenburn. Types of bridge also include foot bridges, of which eight were identified. These are distributed predominantly around the centres of population, along the shores of the north basin of Lake Windermere, and are mainly of post-medieval or modern date.

6.5.3 In total, 153 Boat Houses were identified within the study area, reflecting the high level of activity on the lakes. The sites are distributed, as expected, on the shores of the large areas of still water. Only seven of these are depicted on the OS 1st Edition maps. Three jetties identified on the western shore of Lake Windermere and 23 quay features were identified, mostly of late nineteenth to twentieth century date, most are on the east and west shores of Lake Windermere, with a single site at the southern tip of Lake Windermere. There was a warehouse, wet dock (HER No 2684) and stone jetty (HER 37173) at High Cunsey. A total of 223 features matched the definition of landing stage; the majority occur down the eastern shore of Lake Windermere, with some examples on Esthwaite Water, Elterwater, Grasmere and Rydal Water.

6.6 WATER POWER

6.6.1 The abundance of fast flowing streams provides an abundant supply of power, which in the Lake District is fairly reliable because of its high rainfall. Leats take the water from a wear in a stream and the weight of the water on a wheel provides rotational power, and can be used to drive grinding mill stones in a corn mill or latterly for driving machinery in mills.

6.6.2 In total, 162 water-powered features were identified during the survey distributed along all the major water courses. Of these, 27 are water mills. Three medieval features were identified including the site of Seven Intakes mill, near Vicars, which lies on level ground on the right bank of the River Brathay close to Fell

Foot Farm (HER 1373). The site comprises fragmentary remains of a stone building with a possible second building to the north and apparently had two main enclosures. Although there is little supporting documentary evidence, it is possible the site may be linked with Hackett Forge. Tongue Gill Watermill is also of medieval date (HER 1848). There is documentary evidence of a corn mill in existence in Grasmere in 1324 that was still standing in 1493. At Hill Top Farm, Sawrey is a small dam located on Wilfin Beck which appears to hold back a small amount of the stream creating a small bowl. This dam appears to be some sort of trap, perhaps a mineral trap which would have collected material brought down by the beck.

6.6.3 A further two sites were identified as corn mills of post-medieval date comprising the corn mill at Ambleside (HER 30729) and a corn mill at Rydal Hall (HER 33568). Rydal Corn Mill, also known as the High Park Mill, is located 100m south-east of Rydal Hall where the bridge crosses the Rydal Beck. The mill does not pre-date 1471 when documentation refers to other mills in the area, and first appears in the records for 1575 when John Grigg noted as a miller (Carnie 2002). The mill was not in existence at the end of the eighteenth century. Three paper mills were identified during the survey, comprising Paper Mill Coppice (HER 1866), Troutbeck Paper Mill (HER 4056) and a paper mill at Scandale, Ambleside (HER 30723).

6.6.4 ***Bobbin Mills:*** the first bobbin mills of the region arose in response to the demands of the cotton industry at the end of the eighteenth century. The productive peak of the industry was 1847-70 when at least 49 sites were operating within the Lake District as a whole. Within the study area were Cunsey Bobbin Mill (HER 2683), and Stott Park Bobbin Mill (HER 3612), which was probably the last remaining bobbin mill of the Lakeland type, built in 1835 specifically for bobbin making. The original mill was water powered, fed from a millpond south of the wheel pit. In its heyday the mill would have employed 60-65 workers, making mostly thread reels for the cotton industry; it ceased production as late as the 1960s. Stott Park Bobbin Mill was built in 1835 by John Harrison and originally consisted of a single lathe shop. The mill was powered by a water wheel and it is thought the first turbine was installed at the mill before 1858; about 1880 a steam engine was installed. In 1983 the mill was reopened as an industrial monument. Stott Park Bobbin Mill is the best surviving example of the bobbin manufacturing industry in the country. It is operated as a working museum and contains original machinery, engines, turbines and a boiler. The mill's water management system survives well and the monument also contains fragmentary traces of the Stott Park Smithy. The water runs from High Dam, passing through a weir, to the water-powered mill and adjacent mill pond.

6.6.5 In total, 11 bobbin mills were identified in the survey. Cunsey Bobbin Mill (HER 2683), latterly a joinery works, was on or near the site of the furnace. Associated with it is a well-constructed headrace (HER 18495) by Eel House Bridge to the west, and farther west are a former mill pond and bridge. Other bobbin mills included Horrax's Mill, Ambleside (HER 3134) and Gill Head Bobbin Mill, Cartmel Fell (HER 18444).

6.7 CLOTH MANUFACTURE

6.7.1 The manufacture of cloth requires considerable amounts of water for the processing of fibres. Flax needs to be immersed in water to break down and wash away the outer parts of the stems, and retting ponds, with gates to control the flow of water, were constructed for this purpose. Three possible retting beds were identified during the survey one behind the Lowwood Hotel, near Ambleside (HER 32585), and two at Low Wray, beside Blelham Beck (HER 37096 and 37141).

6.7.2 Fulling mills were used to clean wool to eliminate oils, dirt, and other impurities, and to make it thicker by matting the fibres together to give it strength and increase waterproofing. The wool was washed and was pounded with a water-powered hammer to produce the felted fabric. The most common water-powered mills within the study area are the fulling mills. In total, 52 fulling mills were identified, predominantly along the watercourses running into the north basin of Lake Windermere. Of these, 8 are of probable medieval date with the highest proportion clustering around Grasmere. The sites include a fulling mill at Bainrigg (HER No 1852) on the River Rothay, and a sluice on Sourmilk Gill, to the north-west of Grasmere, which was traditionally said to have been used as a walk-mill; a further possible walk-mill was at Greenhead Gill (HER No 1855). The names Tenter's Brow and Tenter Tarn - the latter now-called Lily Tarn - are specific place-name evidence relating to the local manufacture and processing of cloth in the area. Neither name is given by the Ordnance Survey mapping of the area from the mid-nineteenth-century onwards. At Stock Bridge (HER No 1856) the name 'Tenters' was attached to a close (now allotments) to the left of the road where it emerges from Town End. The mill would probably have stood by the stream flowing under Stock Bridge and the word 'stock' may have been associated with the fulling industry.

6.7.3 An 'ancient fulling and caring mill' is recorded in the area of Fox Ghyll, Ambleside (HER No 33570). The site was last worked in 1824, having been worked from the seventeenth century. It is unknown what, if anything, of the industrial use of the site survives, although a possible millrace appears on the Ordnance Survey maps of the area. A single flax mill was identified at Stock Beck, Ambleside (HER 33556), and is one of the many mills of the town. The northern half of the building is recorded as a flax mill and the southern half of the building was previously a woollen mill. The mill building is the lowest in the town and has a specific mill leat leading to it. A further mill, Horrax's Mill, on Stock Beck, in Ambleside (HER 3134) was a four-storey building with a large wheelpit inside the southern end wall abutting the beck; the original dam remains *in situ*. The mill was flourishing in 1839.

6.7.4 A single cotton mill within the study area was identified at Stock Ghyll Park, Ambleside (HER No 30728). The mill complex known as the 'Waterfall' operated from 1822 to 1964. The mill was originally built as a cotton mill, but also included flax-working, and later had a production of wooden items, such as bobbins, hats and umbrellas.

6.8 INDUSTRIAL WASHING AND REFINING

6.8.1 Most of the extraction industries used abundant supplies of water for washing and processing ores. Lead processing entailed the washing of ore through sieves and

was driven by water power. At Greenhead Gill lead mine there is a twentieth century reservoir and dam. At Coniston, Levers Water was expanded with the construction of a dam to provide water for power and copper ore refining. At Greenburn Copper Mine, watercourses were altered flowing out of Greenburn Reservoir into Greenburn Beck and a system of leats was used to power the machinery. The gunpowder industry became established in Cumbria mainly in response to the increasing need for blasting powder from mines and quarries through the eighteenth century. Water power was readily available for the numerous grinding and other processes and was modified in the form of leats and weirs. At Colwith Force Bloomery, although the site is adjacent to the river Brathay, there was no evidence of any water power features and the proximity to a water supply was probably required for other purposes, such as, quenching and domestic purposes.

6.9 ORNAMENTAL

6.9.1 Common features within gardens or parklands are water features that were designed to add to the majesty of the landscape, and entailed the rerouting of water courses, the creation of lakes, ponds, waterfalls, and fountains. Seven features classified as designed or ornametal were identified during the survey. These are predominently on the eastern side of Lake Windermere and include a stone-built grotto house in local vernacular style, erected by Sir Daniel Fleming 1668-9 in the grounds of Rydal Hall (HER No 5612). According to Blake Tyson it may be one of the earliest surviving outdoor grottoes in Britain. It consists of one little room, originally wainscotted, with a window opposite the door which looks out upon a waterfall. In 1980 the building was beginning to fall derelict, but has since been repaired and is both Grade II* listed and included on the register of parks and gardens, no. 1662. The features also include a twentieth century fountain at Holehird, Troutbeck, and waterfalls and ornmental bridges in the formal gardens at Wynlass Beck. The two main waterfalls (HER 39813) are located on two courses of Wynlass Beck running through the wilderness garden. They have possibly been modified and cleared to form impressive waterfalls to be overlooked from bridges crossing the beck and from the pathway approaching from the west

6.10 HUMAN IMPACTS ON THE LAKE

6.10.1 ***Sand and Gravel Extraction:*** glacial activity in the Windermere catchment has left significant sand and gravel deposits on the bed of the lake, partly in the form of lateral moraines but largely as submerged river deltas. The resource was exploited until the 1970s using sand-barges as a platform for scooping sand and gravel from the lake bed, using a pole and derrick assembly and later a direct pumping technique (Pickering 2001, 74).

6.10.2 ***Commercial fisheries:*** it is probable that the fish populations of Windermere have always been exploited by man, but the earliest reference to a fishery on the lake dates from the medieval period, when Furness Abbey owned much of the land. One boat was authorised to fish using twenty nets but the nature of these nets and the method of fishing is not known. Seine (or draught) netting was the usual method employed and by the sixteenth century the lake had been divided into distinct sections, or 'cubbles', for the purposes of fishery legislation and control (Pickering 2001, 27). In addition to the nets, baited hooks on ling-lines were used

and possibly an early form of gill-netting but this was banned in the late eighteenth century (*ibid*). By the middle of the nineteenth century there was evidence of overfishing of some fish populations. Charr were particularly valuable and transported as far as London, in the form of potted charr. By the eighteenth and nineteenth century pots were made specifically for this purpose. The last commercial fishery on Windermere was closed in 1921 (*op cit*, 75). During the Second World War, Windermere 'perchines' (canned perch) were produced as a substitute for sardines.

6.10.3 ***Agricultural run-off:*** agriculture has directly affected the waterbodies in the Windermere catchment, largely as a result of material runoff. With the increased use of inorganic nitrogenous fertilisers in the catchment, some inevitably finds its way into the watercourses (Pickering 2001, 70). Another possible direct impact of agriculture is loss of soil as a result of ploughing or overgrazing. On the higher fells there is also evidence of soil and slope instability; heavy grazing has undoubtedly contributed to the problem.

6.10.4 ***Abstraction of water:*** some of the Cumbrian lakes comprise a vital water resource for areas remote from the Lake District. Much of this infrastructure was developed in the late nineteenth and early twentieth centuries, consisting of a series of rivers and lakes supplying water to the Carlisle region, West Cumbrian coast, Furness area and industrial Lancashire (particularly the Manchester region). Windermere forms part of this infrastructure with water being pumped into the Watchgate Water Treatment Works from the north basin. The Thirlmere aqueduct is also partly within the study area.

7. CONCLUSIONS

7.1 INTRODUCTION

7.1.1 The Windermere catchment is a region of contrast, from the still waters of the long, radial Lake Windermere to the craggy pinnacles of the mountains in its backdrop. The topography is one that is largely carved and created by ice; as glaciers cut and gouged their way down from the summit of a central volcanic dome, so they left behind massive, steep-sided valleys (Pennington 1978, 207-8). Its rugged beauty has made it a focus for poet and visitor alike. Since the eighteenth century (West 1778) travel guides and the lyrical writings of romantic poets, such as Coleridge, Wordsworth, and Tennyson have attracted the visitor (Wordsworth and Coleridge 1798; Tennyson 1830). To the visitor, the Lake District is presented as a remote, rugged and 'natural' landscape, a land unspoilt by humans and characterised by the romantic writings of William Wordsworth (Wordsworth and Coleridge 1798) and the works of Beatrix Potter (1903) and Alfred Wainwright (1955). The reality, needless to say, is very different. Humans have manipulated the landscape since at least since the Mesolithic period when they started the deforestation of the extensive, post-glacial upland forest, notably in the centre of the Lake District near Great Langdale (Pennington 1964; OA North 2004). At the same time they undertook large scale extraction for axes around Great Langdale (Claris and Quartermaine 1989). From the Bronze Age onwards, the deforestation was started in earnest as a result of an agricultural expansion onto the marginal fells around the periphery of the Lake District. The land has been farmed ever since, at varying levels of intensity, reflecting, in part, the ebb and flow of settlement onto the marginal fells resultant from climatic amelioration/deterioration and population pressures. The treeless, exposed, grass-covered fells of today are more a testament to the hand of humans than they are of nature, and the woods that do remain are much modified and adapted to man's needs.

7.2 THE THEMES

7.2.1 ***Mineral/ Stone:*** the extraction of mineral/ stone has played a very significant part of the Lake District's history, extending back to the earliest Neolithic axe working, and reflects that the geology of the Lake District is very varied, such that there has been a wide array of minerals and rocks available for extraction, which include copper, lead and iron ores, as well as slate and limestone. This geological wealth has been both recognised and exploited and the remains of the industrial workings are scattered across the hillsides and valleys. Beyond the Neolithic axe working the earliest recognised mineral working from the catchment was from the medieval period, when local iron ore was smelted in the numerous bloomeries that are found across the area. More intensive working of minerals occurred from the sixteenth century when lead mining was initiated at Greenhead lead mines, and copper was extracted in the nearby Coniston area. During the post-medieval period the industries were dramatically expanded, with intensive working of slate and limestone quarries. Not only were the minerals extracted, but linked to these there were the associated and intensive processing works, entailing the refining and smelting of copper and lead ores, and the manufacture of iron at Cunsey

Forge and Backbarrow (just outside the catchment). Significantly, there were also a number of gunpowder works, notably that at Elterwater, which were located in areas of extensive woodland and where there were low populations in the event of an explosion. These all reflect that even in the remote, beautiful and rugged hills of the Lake District, the industrial revolution left its mark.

7.2.2 ***Woodland:*** the natural woodlands were cleared, initially to enable the working of the Langdale axe factories (Claris and Quartermaine 1989) and, subsequently, to allow for agriculture, but, ultimately the biggest impact was the demands of the burgeoning iron industry, which was requiring large amounts of charcoal to feed the bloomeries and blast furnaces. The High Furness woodlands were owned by Furness Abbey who worked them to feed their bloomeries, the growth of the iron industry stimulated woodland management, such that by the sixteenth century at least a dozen woodlands were managed by the Abbey to supply their iron bloomeries (Winchester 1987, 104). The impact of charcoal burning was varied across the Lake District, but in select areas clear felling had taken place by the late sixteenth century, notably in Borrowdale and on the Caldbeck Fells as a result of the Company of Mines Royal, and there were considerable concerns about the ability of these areas to regenerate woodland. The woodlands of the Windermere catchment may have survived the medieval period better than most, with many being subject to coppiced management allowing for their long term survival, despite the heavy demands for charcoal.

7.2.3 One of the interesting results of the study is that the vast majority of the woodland within the catchment is relatively old deciduous woodland, which was depicted on the OS 1st Edition map. Of the 40.8sqkm of presently extant woodland within the catchment, 36.8sqkm of this was depicted on the earlier mid-nineteenth century mapping. This reflects that there has been only a small increase of the woodland, often by expansion out from existing plantations, or from small isolated plantings of individual fields. At the same time, however, there have been substantial areas (6.8sqkm) of woodland that have reverted to pasture land. These areas are now mainly grassland, with occasional mature trees, that reflect the limited survival of former woodland, but significantly there is no younger growth that will have been impeded by intensive grazing. These formerly wooded areas are significant, as they would fit in with national plans for forestry that include a desire to substantially increase the number of trees for timber production and carbon sequestration. Regionally, the North West has one of the lowest levels of forest cover in the country. The Forestry Commission has initiated management schemes, such as 'Complete Cover Forest Management', that aim for much more natural regeneration, a reduction of clear felling, and increased biodiversity. This does, however, need to be balanced against schemes for climate change mitigation and timber production. The re-establishment of woods on former woodland areas would minimise the impact on those areas that have not yet been disturbed by woodland crops.

7.2.4 ***Water:*** the importance of water to the region is embodied in its Lake District name, and is an important factor in the formation and development of the landscape, given the exceptionally high rainfall of the region. From an early age the distribution of settlements and agriculture was determined not only by the availability of water sources, but also by those areas with an over abundance of water; early fields are often dispersed around areas of poorly drained ground (Quartermaine and Leech forthcoming). The ability to use the lakes and rivers for

communication further emphasised the coincidence of settlement areas with water sources. The manipulation of the streams to provide power and water for industrial working reflects an inevitable progression of the controlling of water supplies. The ultimate expression of this process is with the creation of reservoirs to provide water for both domestic and industrial purposes, reflected in the catchment by the Thirlmere Aqueduct that takes water from the Thirlmere reservoir towards Manchester.

7.3 INDUSTRIALISATION OF THE CATCHMENT

7.3.1 The significance of the three themes is reflected in the fact that the industrial extraction of resources and their processing within the area drew upon combinations of all the three elements. Minerals and stone were extracted for roofing materials and their metal ores, but their processing drew upon the other elements. Water was used for ore processing, washing, and providing power, for example, driving lead processing buddles. At Cunsey Forge, iron ore was combined with charcoal obtained from the surrounding woodlands and the bellows were driven by water. The gunpowder factory at Elterwater used local charcoal, and imported potassium nitrate and sulphur, but the power was provided by water and the water reservoir for it was a modified tarn (Stickle Tarn) in the heart of the Langdale Fells. Charcoal from the woods was used to burn local limestone and create lime for agricultural and domestic purposes. There is a symbiosis highlighted between the three themes that indicates that they were all exploited in various degrees to provide for the needs of man, and the extent and enormous number of the modified themed features, demonstrates the extent to which the landscape has been managed and modified across millennia. It also demonstrates that any idea or suggestion that the Lake District is essentially an unspoilt or natural landscape is unfounded.

7.4 RECOMMENDATIONS FOR FURTHER WORK

7.4.1 The project has highlighted the considerable archaeological potential of the catchment, and the potential for undertaking further research into various aspects of the three themes. Outlined below are potential areas where this research can be continued at a professional level, and where there are opportunities for continued investigation that would be suitable for public engagement and participation.

7.4.2 *GIS Enhancement*

- Detailed examination and digitising in GIS of documentary records for the historically significant Curwen Estate that included the Claife woodlands along the Windermere lakeshore. Here there is a wealth of information about the estate that is not available digitally, but which would tell us about the historic development of the estate and allow the making of appropriate management decisions that acknowledge the archaeological wealth of the area. It is critical, however, that access to the full Curwen archive held at Whitehaven Record Office is agreed in advance.
- Detailed examination and digitising in GIS of the survey data relating to the Elterwater Gunpowder works, Greenburn Lead Mine and other complex multi-phase industrial sites. The reports for these are available

with extremely detailed mapping and phasing but this is not currently available within GIS and cannot therefore be easily used in conjunction with other data sources. While high quality data for these sites exists the lack of GIS data means that using and sharing this data is difficult.

7.4.3 *Community Project*

- There is great scope to establish a community project to examine aspects of the three themes of woodland, water and geology (mining and quarrying) within the catchment (Fig 13). There is considerable potential for engagement and outreach work with a strong emphasis upon research and fieldwork. This could entail leading groups of volunteers to undertake documentary research and then survey of selected archaeological or historic sites or landscapes. Ideally the survey techniques to be taught would be those that can be undertaken by the volunteer groups independently of the professional guidance to allow keen volunteers to continue their research beyond the scope of the project. Such an approach would also have the benefit of avoiding the need to purchase sophisticated electronic survey equipment.
- ***Woodland Surveys:*** the surveys of woodlands would entail the mapping of charcoal burning platforms / trackways and bark peelers huts, and would attempt to understand these features in relation to the available historic and cartographic records. Field survey would use a combination of hand-held GPS equipment and tape offset techniques to locate and record structures and other features. The aim would be to inform project participants about regional woodland history and provide them with an opportunity to take an active part in discovery and recording. This program of research and survey could be supplemented by seminars involving other specialists, such as foresters, ecologists and palaeoenvironmentalists, in order to present a broad and balanced picture of the significance and sometimes competing aspirations for local woodlands. The information collected during the project could then be recycled in locally advertised guided walks, presentations and on the web sites of the partner organisations, possibly via a series of downloadable walk leaflets or MP3 audio tours.
- There is also potential within the catchment to undertake a field study of designed landscapes and their development, and would look in particular at a select number of parklands. One of the key elements of this would be the identification of specimen and non-native trees which form part of arboreta and tree collections. This would entail a greater degree of documentary research and is appropriate for groups who are enthusiastic to undertake desk-based, as opposed to field-based, work. The suggested areas of woodland suggested for survey work are as follows:
    - ***Great Tower Plantation and associated environs:*** this is an area of known charcoal burning, which has been preserved by the Scout Association but minimal surveying has been carried out in this area;
    - ***Blake Holme Plantation:*** this is an area that can be traced back to OS 1st Edition mapping. Limited charcoal burning platforms have been identified in the area south of this plantation, but there is considerable potential for them;

- ***Cunsey Beck:*** this woodland area is associated with the forge and mill, but little investigation has been undertaken of the areas woodlands. There is potential for investigation to research charcoal burning and to establish links between these and the forge;
- ***School Knott Plantation:*** this is an area of extensive rapid tree growth which dropped out of use between OS 3rd Edition (1911-3) and modern OS mapping. This area has not been subject to surveys, though on preliminary aerial photography a number of potential areas for charcoal burning were noted;
- ***Baysbrown Wood, Great Langdale:*** an area of historic woodland closely associated with mining and quarrying and raises the possibility of linking woodland industries to mining.
- ***Tongue Intake, Little Langdale:*** this is an area showing limited charcoal burning which existed to the north of the identified area, therefore a widening of the survey area has been suggested to include areas of coniferous trees and former woodland.
- ***Rydal Park:*** the woodland history of Rydal and High Parks is extensive, but in recent years the woodland has been on decline. The area warrants further investigation into history of its woodland management and designed landscapes.

- ***Geology (mining and quarrying):*** a similar approach could be applied to research into the archaeology of the slate industry within the catchment, which has not received the benefit of recent detailed investigation. The key elements of the slate workings could be surveyed, subject to health and safety considerations, by volunteer groups and could match the development of the workings from field and cartographic evidence. The survey techniques would entail the use of theodolites or plane tables to reflect their greater extent. The history of each slate quarry would be subject to documentary work which, together with the field survey evidence, could provide an effective understanding of the development and operation of each quarry. The following are slate quarries that may be appropriate for survey:
  - ***Banks / Lingmoor Quarries, Elterwater*****:** extensive areas of slate quarrying;
  - ***Spoutcrag Quarry, Great Langdale:*** an extensive area of slate quarrying within an area of woodland;
  - ***Great Langdale Quarry*****:** this is very large area of slate quarrying on the edge of Elterwater;
  - ***Brathay Quarry, Skelwith*****:** a large quarry complex on the edge of Skelwith Fold.
- ***Mineral Extraction Sites:*** there are also numerous mineral extraction and processing sites that would provide a stimulating focus for survey and investigation. While several mineral mining complexes have been recorded in detail in the past, other sites have not had any serious research. The following area would be appropriate for survey:

- ***Greenhead Gill*:** an extremely important lead mining site, being an early Elizabethan working and which has surviving early remains.

- ***Water:*** there are numerous large and complex water-powdered mill sites in the catchment, and even a cursory investigation of such sites is likely to be beyond the scope of any possible volunteer based project. It is, therefore, proposed to focus on smaller and simpler milling sites; in particular, it would be possible to build a project around one single class of mills, such as fulling mills, of which there are a significant number of entries relating to this industry in the HER/ SMR. The fulling mills that are suggested for further survey are as follows:

  - ***Steps End Mill:*** a small fulling mill named as 'Steps-End' located at the point where the Rothay left Rydal Water;
  - ***Eaton Crag Mill:*** the site is located on Eaton Crag, which is recorded in the HER database as a ruined/ destroyed monument;
  - ***Sour Milk Gill Mill:*** an extant fulling mill with extant buildings with remains of a wheel pit and both head and tail race.

- Another valid approach would be to look at a small number of different types of water mill site. This could include a representative from each of the site types well represented in the catchment, such as corn mills or bloomsmithies.

7.4.4 *Project Completion*

- ***Reporting:*** on completion of the individual studies the information would be incorporated into an academic report which documents the development of the wider landscape over time. The study would highlight man's relationship to water supplies, the woodland resource and the abundant minerals and geology of the area. The reporting would be undertaken by professional archaeologists but with the assistance of the volunteers if there existed a desire and interest to do so amongst the project participants. There also exists the potential for dissemination of the information in a more accessible, popular format. This could take the form of a booklet which would be easily accessible to the visiting and resident public. Alternatively, the project could look at other ways of creating a lasting legacy. It may be possible to set up information for panels at some of the sites investigated. Information could be made available through a web site that would make available existing datasets (including the HER and SMR) and the project GIS for the catchment. This could be supplemented by access to downloadable reports, project archives, as well as more imaginative outputs, such as downloadable walk leaflets and MP3 audio tours.

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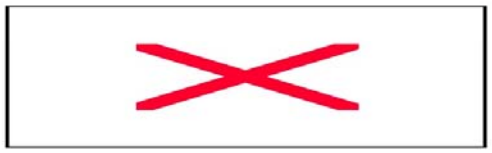
APPENDIX 1: PROJECT BRIEF



BRIEF FOR A RESOURCE ASSESSMENT

For 'Windermere Reflections'

June 2010

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Brief for a Resource Assessment

Location: Windermere Catchment
Proposed: A resource assessment to provide information that will feed into the 'Windermere Reflections', Reflections on History, project

Summary

Windermere Reflections is a partnership project funded by the Heritage Lottery Fund. We are at Stage One of the process of the bid, where the partnership is collating information and expertise to develop a number of projects under the banner of 'Windermere Reflections'.

The primary aim of 'Windermere Reflections' is to improve the water quality of the catchment, whilst improving our knowledge and aiding our understanding of the heritage in the catchment.

'Reflections on History' is one of 22 projects that have been identified to achieve the partnerships aim. This piece of work is to be used to inform the development of this project and has been awarded developmental money (c £8,000) in the Stage One process.

'Reflections on History' will celebrate the history of natural resource use in the catchment, under three themes, water, minerals and woodland. This assessment will gather the known information on these themes to provide the partnership with information to inform the development of the project.

Detailed proposals and tenders are invited from appropriately resourced, qualified and experienced archaeological contractors to undertake the archaeological project outlined by this Brief and to produce a report on that work. The work should be under the direct management of either an Associate or Member of the Institute of Field Archaeologists, or equivalent. No work may commence until approval of a specification has been issued by the Lake District National Park Authority.

1. Location.

1.1 The Windermere catchment covers an approximate area of 23,000 hectares (see map enclosed) in the Lake District National Park.

2. Archaeological Background

2.1 The catchment is an extremely rich archaeological resource, including 29 scheduled monuments, 3237 sites in the Lake District Historic Environment Record and 3030 sites in the National Trust Sites and Monuments Record.

2.2 Sites range from the Neolithic Central Fells Axe Productions Sites, the Roman Fort at Waterhead, medieval shielings in Troutbeck, woodland industries and a significant industrial past, including the extensive quarrying in the Tilberthwaite area.

Further details of these sites can be obtained from the Lake District National Park Authority, Murley Moss, Oxenholme Road, Kendal, LA9 7RL. Tel. 01539 792712/Fax. 01539 740822/Email Eleanor.Kingston@lake-district.gov.uk and the National Trust Sites and Monuments Record, The National Trust NW Region, The Hollens, Grasmere, Ambleside, LA22 9QZ. Tel: 015394 63825/Email jamie.lund@nationaltrust.org.uk

3. Brief for a Resource Assessment

3.1 The brief is to undertake a detailed historic landscape characterisation of the catchment, using both the Lake District and National Trust HERs in this process, to provide a detailed map and evidence base of the historic land use in the catchment under the three themes of water, minerals and woodland.

3.2 This characterisation is intended to be far more detailed than the Lake District HLC, focusing on the catchment area and providing a detailed study of the area. This should include the detailed examination of early mapping (OS and earlier, estate maps etc) and other appropriate sources in the Record Offices.

3.3 The historically background for the three themes of water, minerals and woodland should be assessed and areas of significance should be identified and described. Sites or areas of interest should be identified and appropriately mapped to aid understanding and interpretation.

3.4 This assessment, which includes information drawn from local HERs and HLC, will then facilitate the identification of various project themes which could be taken forward as projects. As such a list of potential projects that might be included in the next stage of the project should be compiled. Likely examples of further work include:

- identifying areas of distinctive woodland character and assessing its historical significance in the catchment (including deer parks and picturesque or garden planting);
- identifying areas of possible future woodland planting and where this is deemed appropriate;
- identifying significant historical water courses and their potential for future survey;
- identifying significant mining remains and where future archaeological survey is required.

3.5 A report assessing the archaeological resource will be compiled as well as GIS (Geographical Information System) layers, illustrating where the key themes can be found and their significance. Examples of layers to be included are: natural and modified water courses; areas of industrial activity and interest; areas of distinctive woodland character; tiles of early maps including Ordnance Survey maps and estate mapping (where available, existing and refined HLC for the catchment). All scans/copies of maps should be of optimum quality.

3.6 For the purposes of the assessment, the study area is defined as the Windermere catchment as defined in the attached map.

3.7 An archaeological resource assessment is not intended to reduce the requirement for further research or investigation or preservation. It may be seen as a guide to aid the development of projects within the Windermere Reflections project and for further

archaeological work within the Reflections on History project.

4. Resource Assessment Techniques

4.1 A desk based resource assessment must be made of all known and available sources of information relating to the study area, including (where appropriate):

- data in the Lake District Historic Environment Record;
- data in the National Trust Sites and Monument Record;
- data in the Lake District Historic Landscape Characterisation project;
- relevant data in the local Record Offices;
- maps (printed and manuscript);
- place and field name evidence;
- aerial photographs in both local and national collections;
- other photographic and illustrative evidence;
- published and unpublished documentary sources;
- local museum catalogues and artefact evidence;
- oral evidence;
- geological/soil surveys.

4.2 Organisations to be consulted should also include local museums, the Cumbria Record Office and Cumbria County Council Historic Environment Service (the latter holds collections of Aerial Photographs).

4.3 A draft copy of the assessment report should be sent to the National Park Authority and the National Trust. Comments from both organisations must be included in the final report.

4.4 The final assessment report must be completed by 15 October 2010.

4.4 Completion and deposition of the project archive.

5. Resource Assessment Proposal

A **detailed** proposal, including the following, should be prepared by potential contractors in accordance with the recommendations of the *Management of Archaeological Projects 2nd Ed.* (1991) and submitted to the National Park Archaeologist for approval:

5.1 A projected timetable for all resource assessment work, including staff numbers and specialist sub-contractors.

5.2 The names of the project director, supervisors, specialists and any sub-contractors to be employed on the project (including details of qualifications and experience of the key project personnel).

5.3 A separate itemised estimate of costs (core/project staff, specialist fees, travel/subsistence, archive preparation and copying, report preparation, overheads, contingency, specified other costs).

5.4 Any significant variations to the proposal must be agreed by the National Park Archaeology and Heritage Adviser in advance.

6. Reporting Requirements

6.1 The resource assessment should result in a report including:

- a concise non-technical summary of the results;
- a description of the methodology employed;
- a location plan at an appropriate scale;
- a summary of past and present land use;
- a summary of the historical and archaeological background;
- a plan and gazetteer of areas or sites known or potential archaeological significance within the study area;
- an assessment of the three themes of water, minerals and woodland;
- the production of GIS layers;
- a full bibliography of sources consulted and a list of any further sources identified but not consulted;
- an index to the project archive;
- a copy of the brief and agreed project design and an indication of any variations.

6.2 The report should be confined to a factual account of the archaeological information.

6.3 4 copies of the report should be deposited with the National Park Authority for distribution to its partners, on the understanding that it will be made available as a public document after an appropriate period. A digital copy should also be provided.

6.4 Any geographical information (e.g. GIS layers) compiled during the assessment should be deposited with the National Park Authority and the National Trust. It must be compatible with both of their mapping systems and be provided on the understanding that it will be used by the partner organisations and be made publicly available.

6.4 The Lake District Historic Environment Record (LDHER) and National Trust Sites and Monuments Record (NT SMR) supports the Online Access to Index of Archaeological Investigations (OASIS) project. The overall aim of the OASIS project is to provide an online index to the mass of archaeological grey literature that has been produced as a result of the advent of large-scale developer funded fieldwork. The archaeological contractor must therefore complete the online OASIS form at http://ads.ahds.ac.uk/project/oasis/. Contractors are advised to contact the LDHER prior to completing the form. Once a report has become a public document by submission to or incorporation into the HER, the LDHER may place the information on a web-site. Please ensure that you and your client agree to this procedure in writing as part of the process of submitting the report to the archaeological officer at the LDHER.

7. Monitoring

7.1 The National Park Archaeology and Heritage Adviser will be responsible for monitoring the assessment. A minimum of one week's notice of the commencement of work must be given by the archaeological contractor to the Lake District National Park Authority.

8. Further Requirements

8.1 The Code of Conduct of the Institute of Field Archaeologists must be followed.

8.2 It is the archaeological contractor's responsibility to establish safe working practices in terms of current health and safety legislation, to ensure site access and to obtain notification of hazards (eg. services, contaminated ground).

8.3 The involvement of the Windermere Reflections partnership should be acknowledged in any report or publication generated by this project.

APPENDIX 2: PROJECT DESIGN

1.1 AIMS

1.1.1 As stated in the brief, the main aim of this project is to provide a resource assessment that collates all available information on the history of natural resource use in the Windermere catchment, an assessment focused on the themes of water, minerals and woodland. This Stage One task, 'Reflections on History', is one of several projects that will inform the development of, and advance the aims of, the 'Windermere Reflections' partnership project. The 'Windermere Reflections' project's primary goal is to 'improve the water quality of the catchment, whilst improving our knowledge and aiding our understanding of the heritage in the catchment' (LDNPA 2010).

1.1.2 With these facts in mind, the proposed program of work in this project design aims to anticipate and feed into future 'Windermere Reflections' projects, helping to ensure that the advancement of the project occurs in a practical, efficient and timely manner.

1.1.3 The aims of this assessment are to create a practical reference for the 'Windermere Reflections' project, one that will guide and assist the future, Stage Two work; the creation of this practical reference includes:

1.1.4 creating an assessment and contributing an effective evidence base of all available sources of information relating to the history of land use in the study area; including a comprehensive inventory of known archaeological sites, areas of archaeological significance and potential archaeological significance, and data on past and present land use that relate to woodland, water and minerals;

1.1.5 improving, amending and enhancing the Lake District National Park HLC data for the Windermere catchment through the analysis of photographic evidence and historical mapping;

1.1.6 producing GIS layers that incorporate and demonstrate these efforts, layers that are complimentary to both HLC and HER data; improving and contributing to the future promotion of heritage within the catchment***;***

2. Objectives

1.1.1 This assessment of the resources pertaining to the historic land use of woodland, water and minerals in the Windermere catchment area by bringing together and analysing existing datasets.

1.1.2 The results will be presented both as a report, but primarily in graphic, GIS, form, highlighting known archaeological sites and areas of archaeological significance, and past and present land use in the catchment as they relate to woodland, water and minerals.

3. METHOD STATEMENT

3.1 Introduction

3.1.1 The project will build a detailed map and evidence base of historic land-use within the catchment, focussing on the themes of woodland, water and minerals. The output will comprise GIS layers and a full report, detailed below.

3.1.2 For each of the themes, the GIS output will be split into two sections: 'assets' and 'evidence'. The 'assets' layer will comprise the recordable geographic outlines of the themes, at the present time, and at various dates defined by the available historic mapping. The 'evidence' layer will represent supporting data, and may take the form of (for example) Historic Environment Record entries relating to a historic watercourse, or accompanying feature, or archaeological evidence for charcoal

production. In this way, the data in the 'evidence' layer will feed back into the 'assets' layer by providing fine-grained detail on the location of the 'asset' at a given time.

3.2 Summary of Stages

- *Stage One*: Project inception, data acquisition and GIS 'set up';
- *Stage Two*: Data extraction, collation, analysis and creation;
- *Stage Three*: Report production and output creation.

3.3 Summary of Outputs

- *GIS outputs*: spatial data will be produced in ESRI shapefile or Mapinfo tab format, as required, with appropriate metadata. The spatial datasets will comprise:
    - 'Assets' datasets: one dataset for each of the three themes (woodland, water and mineral resources)
    - 'Evidence' dataset: (this can be presented as one convenient dataset or three based on theme)
- *Documentation:* as per Section 6 of the brief, the documentation of this project will comprise:
    - A concise report that includes summaries of the archaeological and historical background of the catchment, past and present land use, and supporting illustrations. Importantly, these aspects of the report relate to and support the main assessment of the catchment's woodland, water and areas of mineral extraction
    - A printed gazetteer detailing all known archaeological sites and areas of significance or potential archaeological significance
    - A complete index to the project archive

3.4 Stage One: Project Inception, Data Acquisition and GIS 'Set Up'

3.4.1 ***Task 1 - GIS Setup and Ongoing Support***: a MIDAS-compliant (Forum on Information Standards in Heritage 2007) GIS system will be set up for the project. All data will be in standard formats, to ensure full compatibility with the systems currently in use at the Lake District National Park Authority. Feature and Layer-level metadata will be provided in line with the Archaeological Data Services Guide to Good Practice for GIS (*ibid*). Throughout the project there will be ongoing monitoring of data integrity, security and quality. This task will be undertaken by OA North's Senior IT Support and Development Officer, who has considerable experience of managing GIS and database systems for large and small-scale projects.

3.4.2 ***Task 2 - Management and Editing***: the project will be managed by one of OA North's experienced Senior Project Managers, who will provide ongoing managerial support throughout the project and full quality assurance for the final products.

3.4.3 ***Task 3 - Record Office, Local Studies Libraries, and Museums Data Acquisition***: project staff will visit the Record Office in Kendal, that covers the study area, and will gather primary and secondary data sources as available. This will include historic maps, place name records, secondary and unpublished sources relating to the three themes. A list of available sources will be obtained in advance by prior enquiry, but it is anticipated that this will include historic mapping such as tithe and estate mapping and secondary sources such as gazetteers of field and place names. Where possible, high-resolution scans or digital photos will be taken of the sources. It is anticipated that early maps (prior to the 1770 Jeffery's map) will not be of sufficient detail or spatial accuracy to be geo-referenced within the GIS but will be photographed or scanned as appropriate and used to inform the project qualitatively.

3.4.4 Other Sources will be consulted as appropriate and will include local studies libraries and museums; this will include the Armitt Library and Museum in Ambleside. Other pertinent secondary and unpublished sources will be accessed, including museum catalogues and artefact evidence. The OA North library will provide an invaluable source for geological and soils information as well as the standard secondary works for the Windermere catchment area. NMR will be consulted for aerial photographic sources.

3.4.5 ***Task 4 - Lake District National Park Authority Data Acquisition***: project staff will visit the offices of the Lake District National Park Authority to assess and obtain data. This is likely to include digital (scanned) copies of the Ordnance Survey 1st and 2nd Edition mapping, HER data, HLC data, and geological mapping. Available aerial photographic information from Cumbria County Council and LDNPA HERs will be examined and accessed.

3.4.6 ***Task 5 - National Trust Data Acquisition***: project staff will access copy of the SMR for the study area from The National Trust.

3.4.7 ***Task 6 - Scanning and Georeferencing of Historic Maps***: if any additional maps are available of sufficient detail and spatial accuracy, then they will be scanned and georeferenced within the desktop GIS. The level of accuracy of the georeferencing will be recorded to form part of the metadata for any features derived from this mapping.

3.5 Stage Two: Data Extraction, Collation, Analysis and Creation

3.5.1 ***Task 7 - Extraction of Data from the HLC***: the dataset for the Lake District HLC (Newman and Hardie 2007) will form the basis of the asset layers for the project, to be enhanced and added to throughout the remainder of the project. Information on present and past land cover is included within a number of fields within the HLC attribute table (*ibid*, Appendix 1: Data Structure, Methodology). Present land cover, and land cover as recorded on the Ordnance Survey 1st Edition maps, are recorded explicitly, along with their morphology, date, and an indicator of whether the land cover has changed. Further information on change throughout time is included in a series of Interpretation Fields.

3.5.2 Extracting all the land parcels that relate to a particular theme, either now or in the past will, therefore, require a complex series of queries within the desktop GIS. Structured Query Language (SQL) will be used to query the multiple attribute fields and combine the results into separate datasets for each theme.

3.5.3 New attribute fields will be added to each dataset to clearly show the source, the theme, the date range for which the feature exists, and other detailed information. Using these attributes it will be possible to classify the datasets in a number of different ways within each theme - such as by date, or even highlighting those areas that have changed between different date ranges.

3.5.4 ***Task 8 - Extraction of Relevant Data from HER and SMR****:* data from the LDNPA HER and the National Trust SMR will be merged into a single dataset to form the basis of the Evidence Layer. The merging process will involve a check for compatibility and duplication, and may require the addition of new attribute fields. Further fields will be added to record the source of the evidence (this will be useful when data from other primary and secondary sources are added), the degree of confidence in the spatial location, and any additional fields required for MIDAS compatibility.

3.5.5 The Evidence layer will be then examined thoroughly to discount entries not related to the three Asset layers. As the HER and SMR contain data on all historic events and monuments, there are likely to be many records that are not relevant. However, this cannot be a purely mechanical process. In part this search will utilise spatial location searching within the desktop GIS, filtering records that fall within the boundaries of the various Assets layers. A further text-based search of monument type based on the Thesaurus of Monument Types (RCHME and EH 1995) will highlight those that are not contained within the boundaries of the assets (perhaps because they are related to features that are too fine-grained to appear in the HLC). Finally a more qualitative assessment will also be undertaken to ensure that no relevant records are missed.

3.5.6 ***Task 9 - Digitisation of Additional Features****:* some of the activity relating to the three project themes will historically have been very small-scale, and as such the remains will have been too small to include within a county-level HLC. Furthermore, in some cases they are unlikely to form the dominant present-day character type within the landscape. It is therefore necessary to digitise features from modern, Ordnance Survey 1st and 2nd edition mapping, and any other maps that have been assessed as being of high enough spatial accuracy. Features from other data sources that cannot be identified with a high enough spatial accuracy to draw an outline will be added as point features within the Evidence layer.

3.5.7 Google Earth will be used to provide modern (2004) aerial photographic imagery. It is possible to display GIS data within Google Earth, by converting to Keyhole Markup Language (KML). Additional features can also be digitised within Google Earth and then converted back to standard

GIS formats to be used within the desktop GIS. It is anticipated that the level of accuracy of the Aerial Imagery within Google Earth will be adequate for this project

3.5.8 ***Task 10 - Use Evidence Data to Add Additional Features or Provide Extra Detail to Assets Layer***: data collated in the Evidence layer will be used to enhance the features in the Assets layers. This will involve a comprehensive analysis of the two datasets in the desktop GIS. Additional features, or changes to boundaries in the Assets layers, may be required at this stage as further detail becomes clear from the Evidence layer.

3.5.9 Using spatial joining within the GIS, basic statistics on the number of sites (broken down by theme and type) from the Evidence layer will be added to the Assets layer. In this way, it will be possible to select, for example, a feature from the Woodlands theme layer and immediately see how many wood, water, or minerals-related individual sites are within it.

3.5.10 ***Task 11 - Creating Zones of Significance***: a final level of analysis on the Assets layers will be to create 'zones of significance'. This will place a buffer around groups of related features such as mining complexes or axe factory groups to highlight the likely archaeological potential of the surrounding area. This will be a qualitative process, utilising our archaeological knowledge of the study area alongside the visual evidence shown in the GIS.

3.6 Stage Three: Report Production and Output Creation

3.6.1 ***Task 12 – Creating a Gazetteer of Known and Potential Sites***: the results of Stage Two, specifically the information relating to known archaeological sites or areas of significance, will be collated and presented in a consistent and easily accessible format, one that compliments the GIS outputs and is consistent with HER records.

3.6.2 ***Task 13 – Assess the Historical and Archaeological Development of the Three Themes and how these relate to the Overall Development of the Area***: following on from the data collation and analysis of Stage Two, the catchment area will be assessed in detail with respect to the historical development of woodlands (including the identification of distinctive and ancient character, the development of historic woodland exploitation and woodland industries); water (with emphasis on how water courses and water bodies have been impacted by man); and minerals (highlighting the development of mineral extraction and resource exploitation).

3.6.3 Knowing that this assessment will feed into the future 'Windermere Reflections' projects, the assessment will inform future developments in the landscape, and improve an understanding of heritage and historic character in the catchment.

3.6.4 ***Task 14 – Compile Report***: a full report will be compiled, comprising the following principal sections:

- A technical methodology summary, in addition to a concise but comprehensive non-technical summary of the results of the assessment;
- A summary of the historical and archaeological background and development of the Windermere catchment, as it relates to the three themes of woodland, water and minerals;
- A summary of past and present landuse (complimenting the GIS outputs), as it relates to the three themes;
- An assessment of the themes of water, mineral and woodland;
- Appropriate illustrations including location plans, GIS mapping showing gazetteer areas, sites and areas of potential archaeological significance, aerial photographs and ground photographs as appropriate;
- A full bibliography (including additional material that may be of value to future work);
- A full gazetteer of all known archaeological sites in the catchment, and areas of archaeological significance;
- An index of the project archive;
- A copy of the brief, project design and defining any variations from the project design.

3.6.5 ***Task 15 - Archive Preparation and OASIS:*** as per the brief (Section 6), the project archive will be compiled in accordance with current guidelines. This will include all GIS data and accompanying metadata, along with all administrative documentation relating to the project, the report and an index. As part of this process OA North will incorporate a summary of the project onto the OASIS site.

PROPOSED PROJECT TEAM

Personnel

The proposed project staffing is summarised in the table below:

Personnel	*Initial*	*Project Role*
Jamie Quartermaine	**JQ**	Project Manager and Landscape Archaeologist
Jo Cook	**JC**	GIS Specialist
Dana Campbell	**DC**	GIS Specialist
Peter Schofield	**PS**	Landscape Archaeologist
Anna Kathrin Hodgkinson	**AKH**	GIS Specialist
Joanne Povall	**JP**	GIS Specialist
Rachel Newman	**RN**	Senior Manager

1.1.1 The project will be led by **Jamie Quartermaine** (BA Hons Surv Dip MIFA). Jamie has considerable involvement in the running of major landscape GIS projects in northern England, which included the Upland Peats project, and the ALSF-funded HLC enhancement projects for the Ribble Valley and Kirkham (Fylde). Jamie's academic speciality is the way in which landscapes develop, and this will be directly pertinent for the present project. He has 25 years of experience of upland landscape recording, and includes the detailed recording of the Langdale Axe Farms

1.1.2 The core team will consist of a Project Officer/GIS Specialist (**Jo Cook**) and three GIS Specialists/Researchers (**Dana Campbell**, **Anna Kathrin Hodgkinson** and **Joanne Povall**). Jo Cook has significant experience in overseeing large-scale GIS projects; in particular, she had a key role in the creation of the Upland Peats and the Kirkham / Ribble landscape characterisation projects, and she developed the successful methodology for modelling the archaeological resource within the uplands of South West Cumbria. She has extensive experience in the use and management of GIS software, and, as part of OA's IT team, can provide on-the-spot IT support for the project. Jo will oversee the project set-up, methodological development and provide quality assurance.

1.1.3 **Dana Campbell**, **Anna Kathrin Hodgkinson** and **Joanne Povall** have substantial experience of working on large-scale GIS projects and are fully conversant with the principles of data capture and use in such projects. They have experience of using GIS-based information systems and construction and use of standards-compliant databases. **Jo Cook**, **Dana Campbell** and **Joanne Povall** also represent the team responsible for the recently completed North West Regional Historic Landscape Characterisation project. The archaeological landscape analysis will be undertaken by **Peter Schofield**. Peter has considerable experience of site recognition and field survey work in the uplands, including prehistoric landscapes, and has familiarity with undertaking landscape analysis.

1.1.4 OA North has a dedicated IT infrastructure and systems development team, as well as a successful graphics office, which can be utilised as necessary to provide support for the project. Further details are available in *Appendix Two*, and detailed CVs are provided in *Appendix Three* of this document.

RESOURCES AND COSTINGS

Proposed Time allocation

1.1.1 A detailed task-by-task breakdown of the anticipated personnel allocation, is provided in the table below.

5.2 WORK TIMETABLE

5.2.1 The phases of work will comprise the following elements. The days quoted are the duration for each individual stage and can be achieved within the year long programme.

i) Stage One

14 days

ii) Stage Two

19 days

iii) Stage Three

18 days

5.3 Staff Fees and Expenses

5.3.1 Accompanying the task-by-task breakdown of the anticipated personnel allocation (beginning on next page), are the day-rates for each staff member, additional anticipated costs, the costs per task and the total overall cost.

5.4 Proposed Task List

	Resourcing and Timing		
	Task	Staff	Allocated days
	Stage One: Project Inception, Data Acquisition and GIS 'Set Up'		
	GIS setup and ongoing support	JC	4
	Management and editing	JQ	2
		RN	1
	Record Office, Local Studies Libraries, and Museums Data Acquisition	VB	4
	Lake District National Park Authority Data Acquisition	VB	1
	National Trust Data Acquisition	VB	0.5
	Scanning and Georeferencing of Historic Maps	JP	2
	Stage Two: Data Extraction, Collation, Analysis and Creation		
	Extraction of Data from the HLC	AH	1
	Extraction of Relevant Data from HER and SMR	AH	1
		JP	2
	Digitisation of Additional Features	AH	5
		JP	5
	Use Evidence Data to Add Additional Features or Provide Extra Detail to Assets Layer	AH	1

	Resourcing and Timing		
		JP	2
	Creating Zones of Significance	DC/PS	2
	Stage Three: Report Production and Output Creation		
	Creating a Gazetteer of Known and Potential Sites	AH	1
		JP	1
	Assess the Historical and Archaeological Development of the Three Themes and how these relate to the Overall Development of the Area	JC/DC/ PS	3
		VB	3
	Compile Report	JQ	2
		JC/DC/ PS	6.5
	Archive Preparation and OASIS	JC/DC/ PS	0.5
	Totals		**51**

APPENDIX 3: WINDERMERE TYPE LIST

Theme	Theme Type	Theme Subtype
Wood	Woodland Industries	Bark Peeling
		Charcoal Burning
		Potash
		Saw Mill
		Timber Extraction
		Woodland Crafts
		Bobbin Mill
		Unknown
	Coppice Woods	-
	Semi Natural	Broadleaf
		Coniferous
		Mixed
		Scattered Trees
		Unknown
	Parkland	-
	Timber Production Plantation	-
	Former Woodland	Scattered Trees
	Place name	-
	Scattered Trees	-
	Designed or Ornamental	-
Water	Water Courses	Reservoir
		Lakes
		Tarn
		Main Rivers
		Becks
		Former Watercourses
		Modified Watercourses
		Drainage Ditch
		Defence
		Fish Ponds
		Watercourses
		Pool
		Former Wetland
		Collect
		Unknown
	Water Powered Sites	Water Mills
		Treatment Plant
		Water Wheel
		Filter Bed
		Paper Mill
		Dock
		Corn Mill
		Fulling Mill
		Mill Race
		Leat
		Retting Beds
		Hydraulic Ram
		Sewage Works
		Pump House
		Mill Pond

		Unknown
	Other Water	Designed or Ornamental Farming Equipment Leisure Storage Finds Cleaning Well Monitoring Equipment
	Place Names	-
Mineral	Mining	Copper Iron Lead Unknown
	Processing	Works Smelt Mills Blast Furnace Lime Kiln Gunpowder Works Lithics Coal Construction Kiln Unknown Forge Mill
	Quarrying	Gravel Sand and Gravel Sand Slate Finds Limestone Stone Unknown
	Waste	-

ILLUSTRATIONS

FIGURES

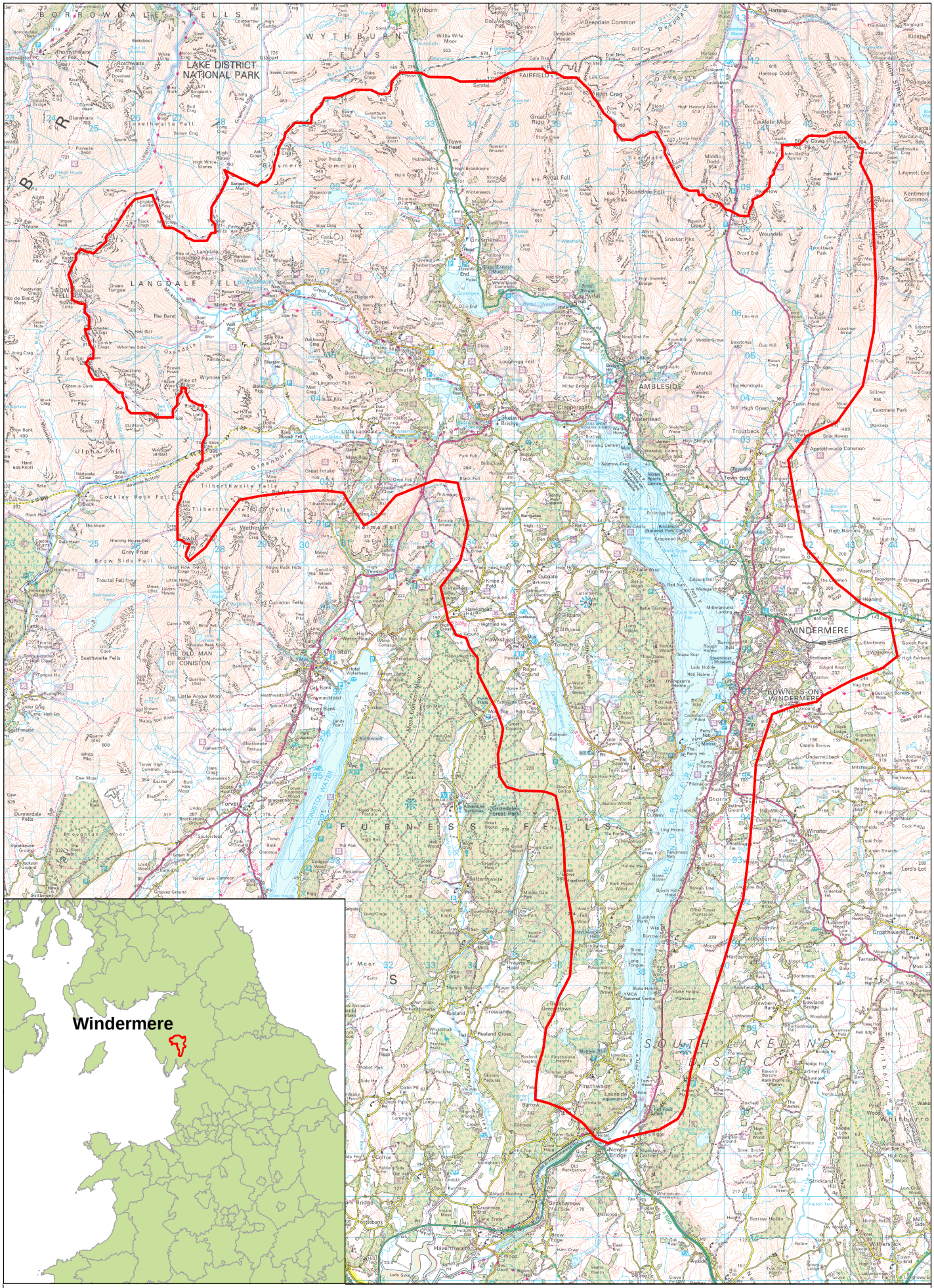

Figure 1: Location of Windermere Reflections catchment area

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N

0 1 2 3 4 5 Kilometres

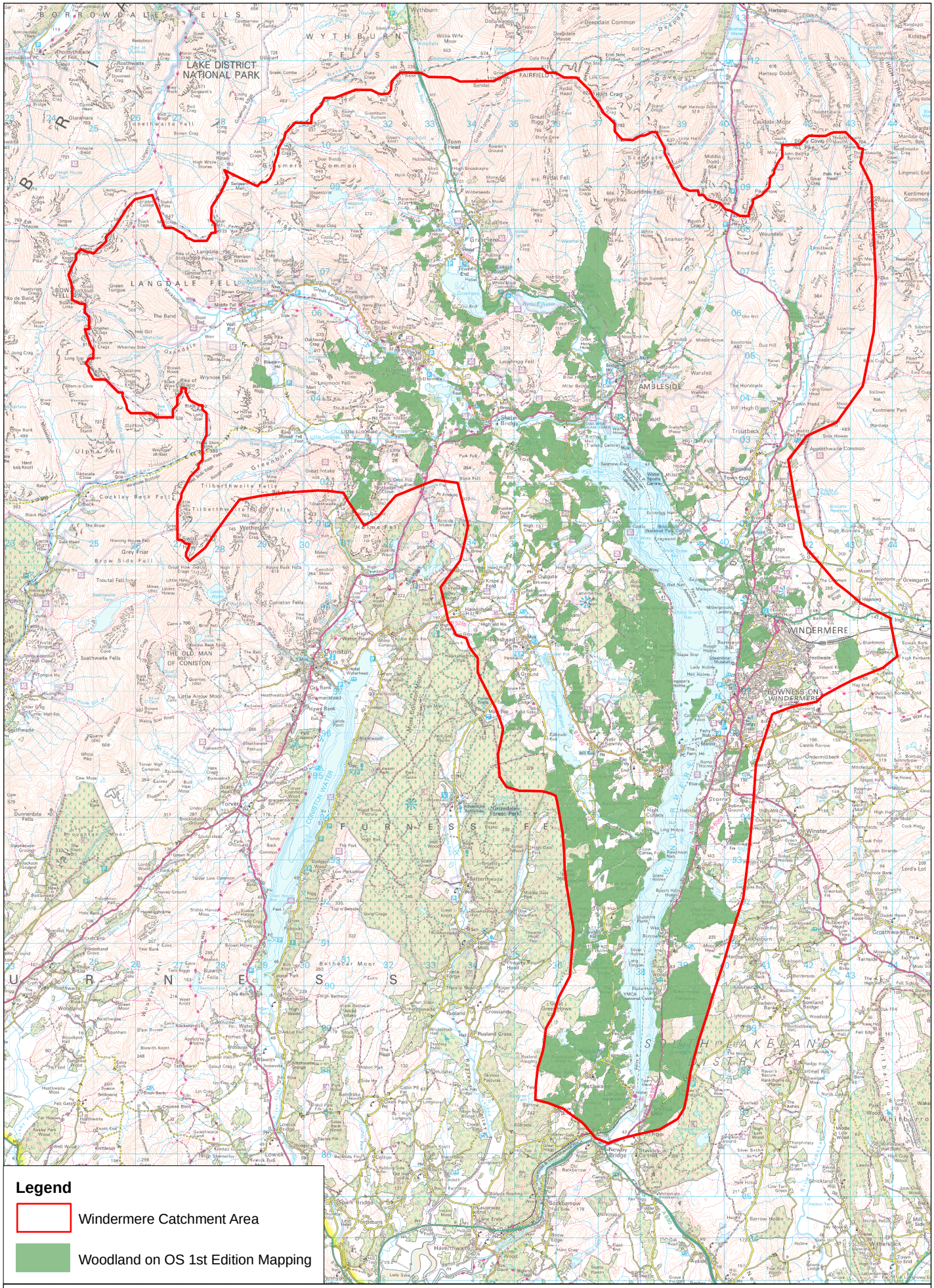

Figure 2: Distribution and extent of woodland according to OS 1st Edition mapping

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N

0 1 2 3 4 5 Kilometres

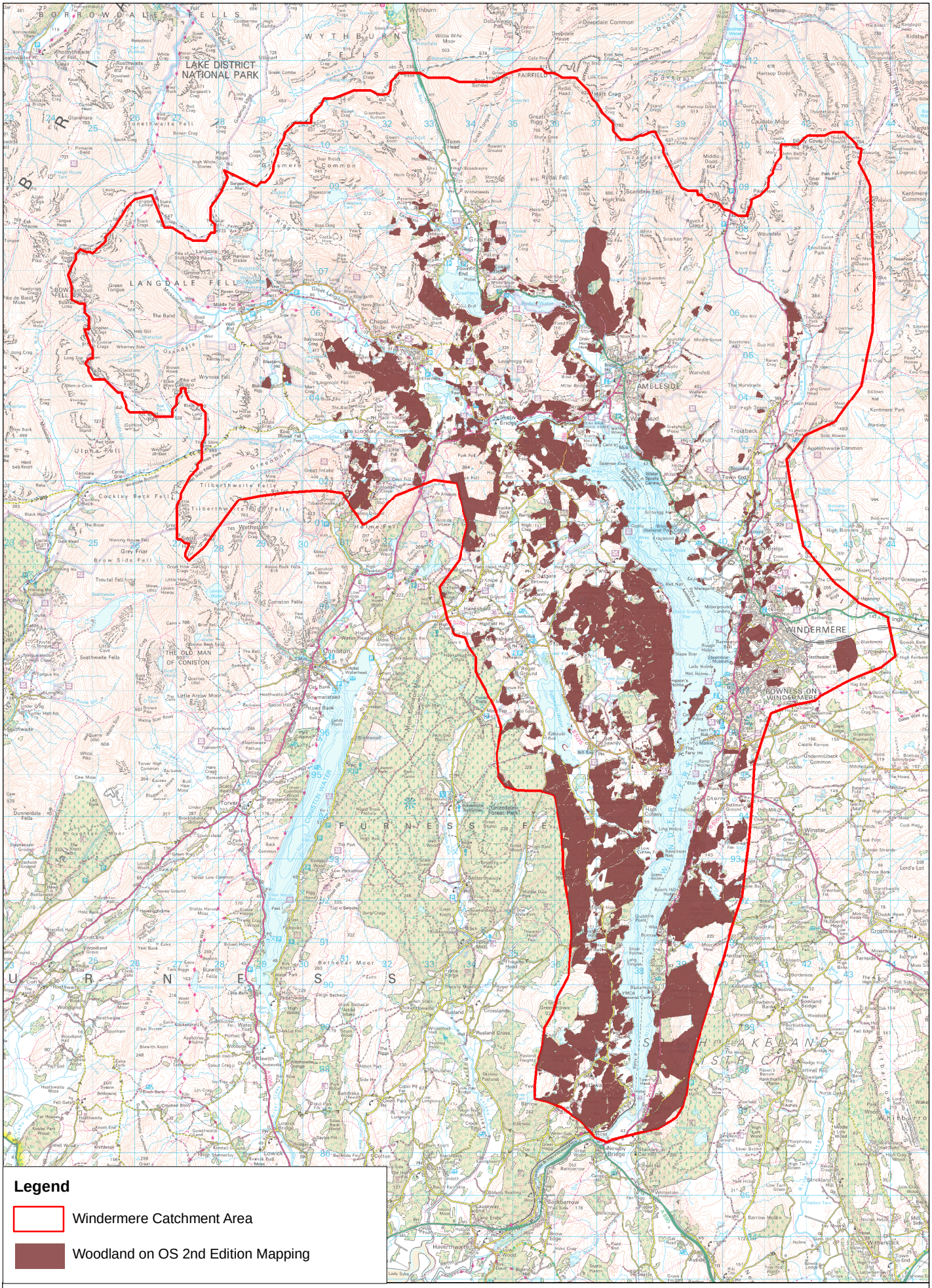

Figure 3: Distribution and additional extent of woodland according to OS 2nd Edition mapping

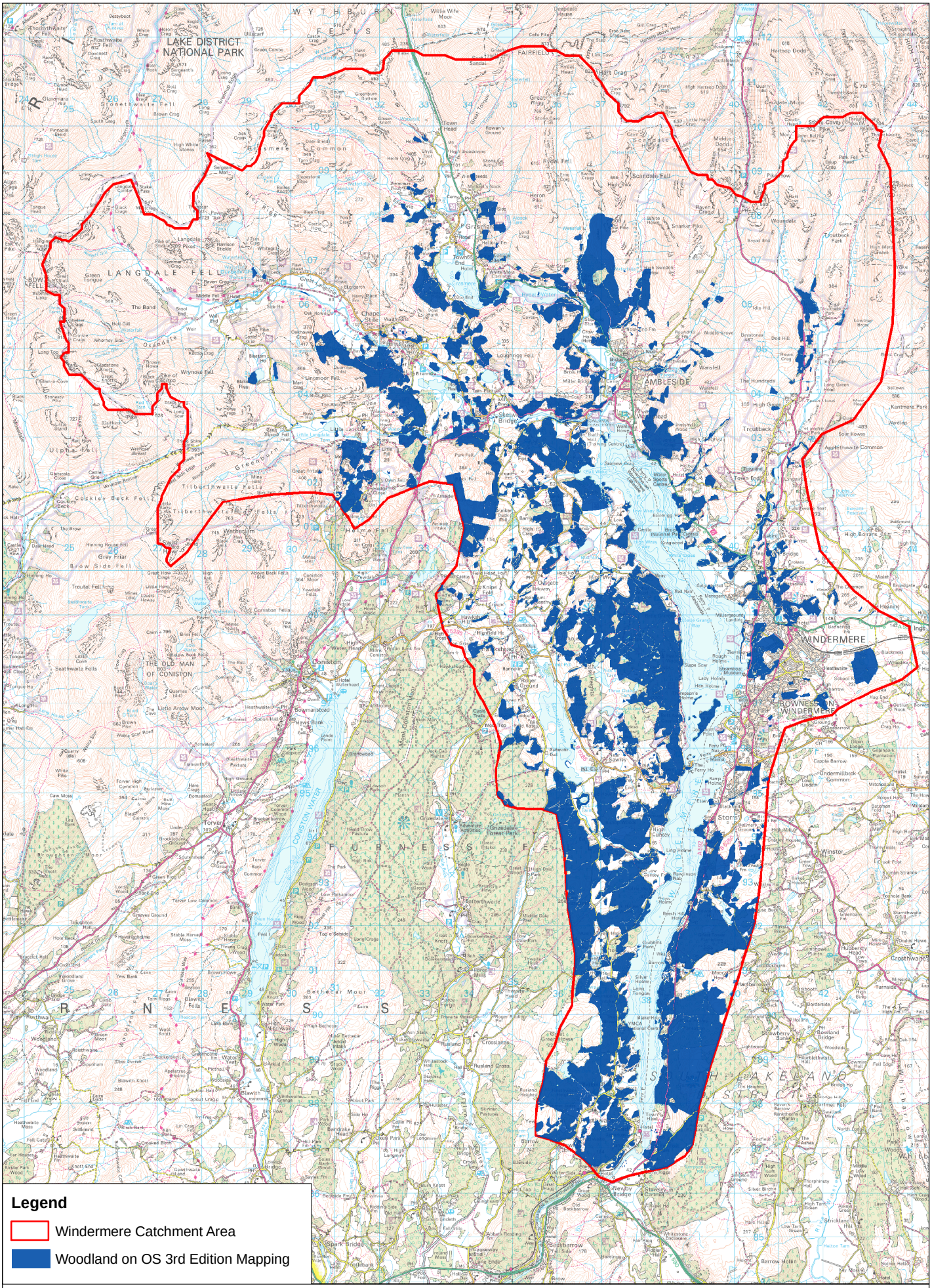

Figure 4: Distribution and extent of woodland according to OS 3rd Edition mapping

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N

0 1 2 3 4 5 Kilometres

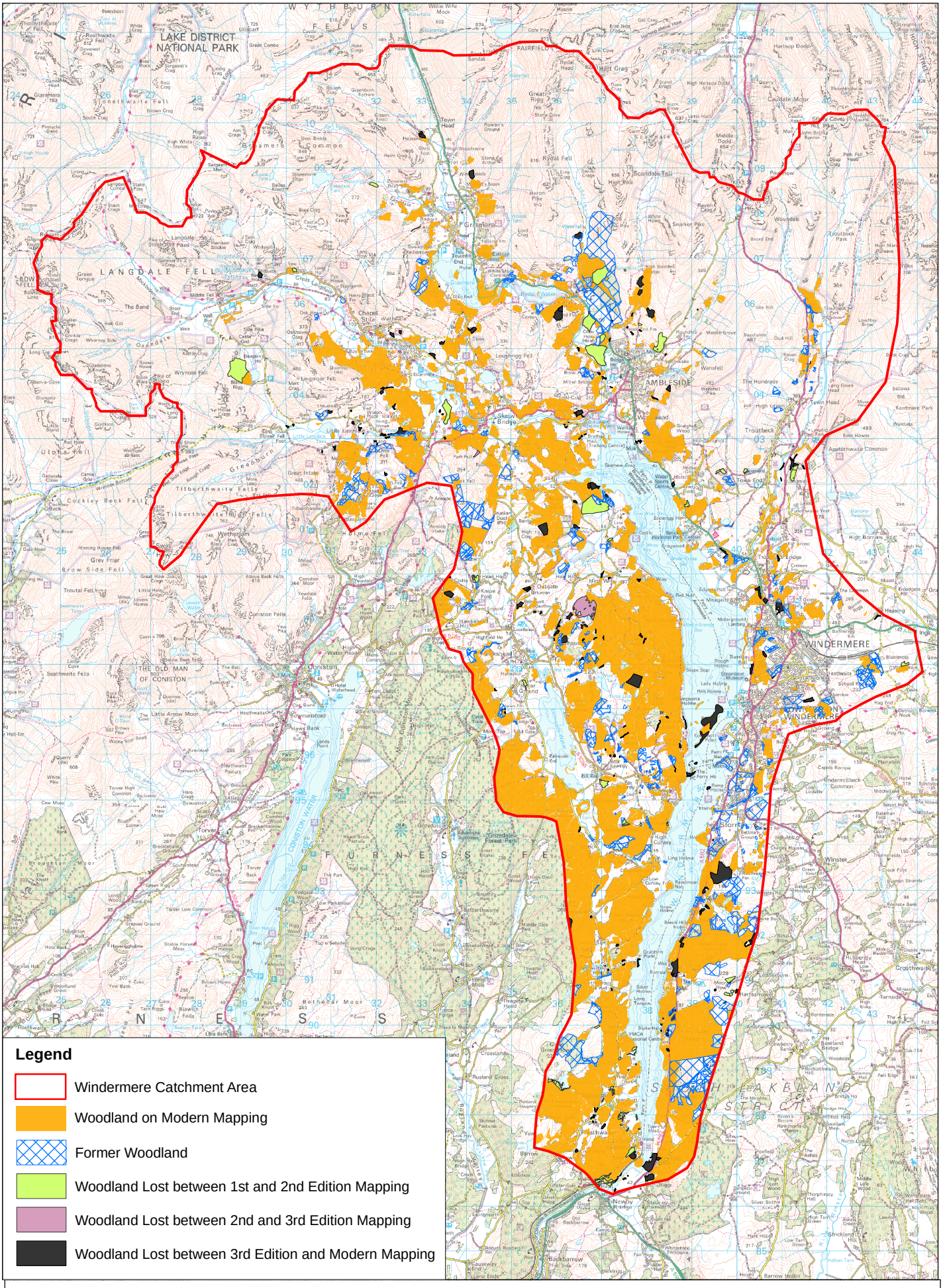

Figure 5: Distribution and extent of woodland according to modern mapping, highlighting areas of former woodland, and areas of woodland lost between the OS 1st, 2nd and 3rd Edition, and Modern mapping

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N

0 1 2 3 4 5 Kilometres

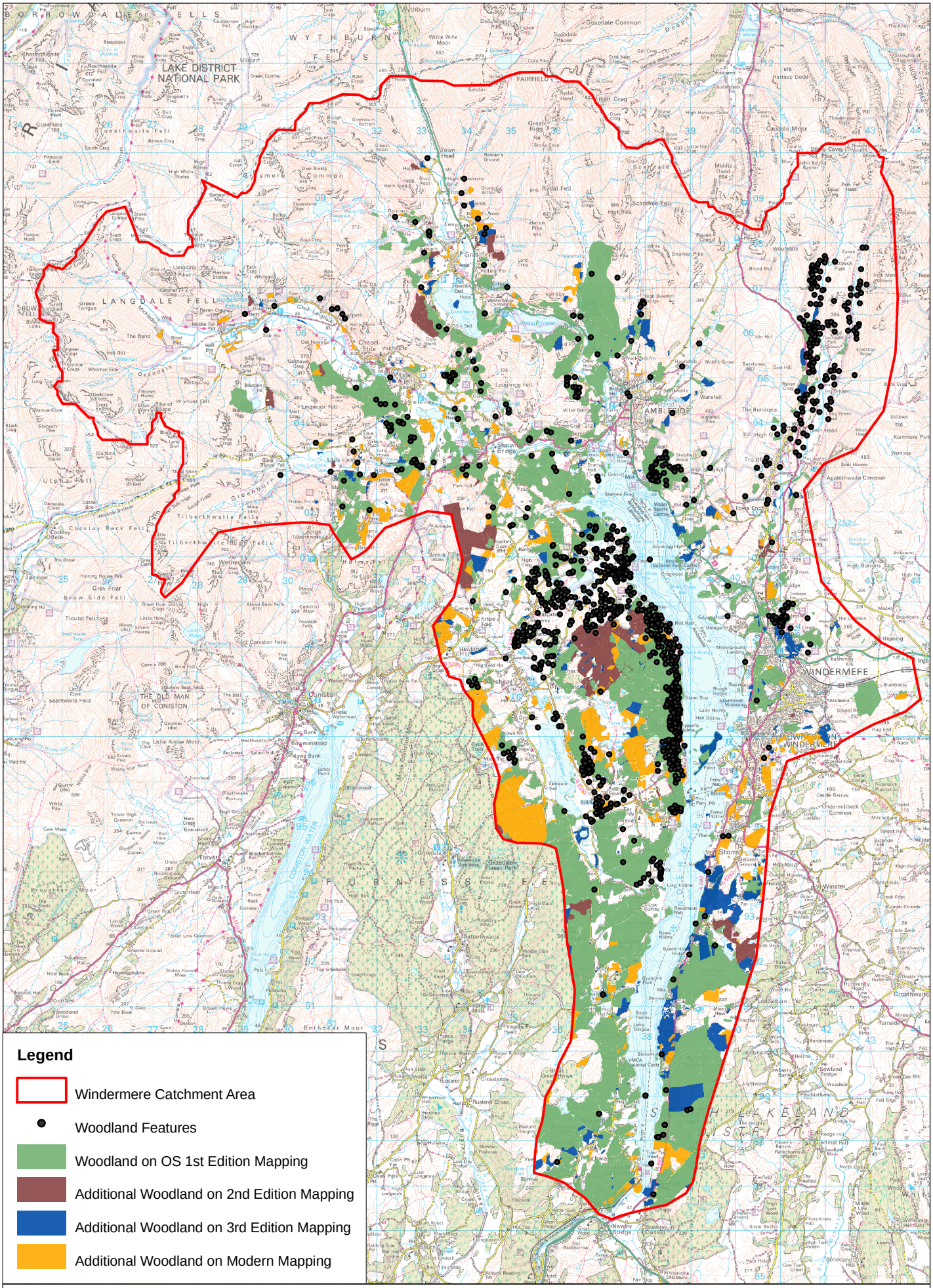

Figure 6: All identified features relating to woodland, against the extent of woodland on various historical and Modern mapping

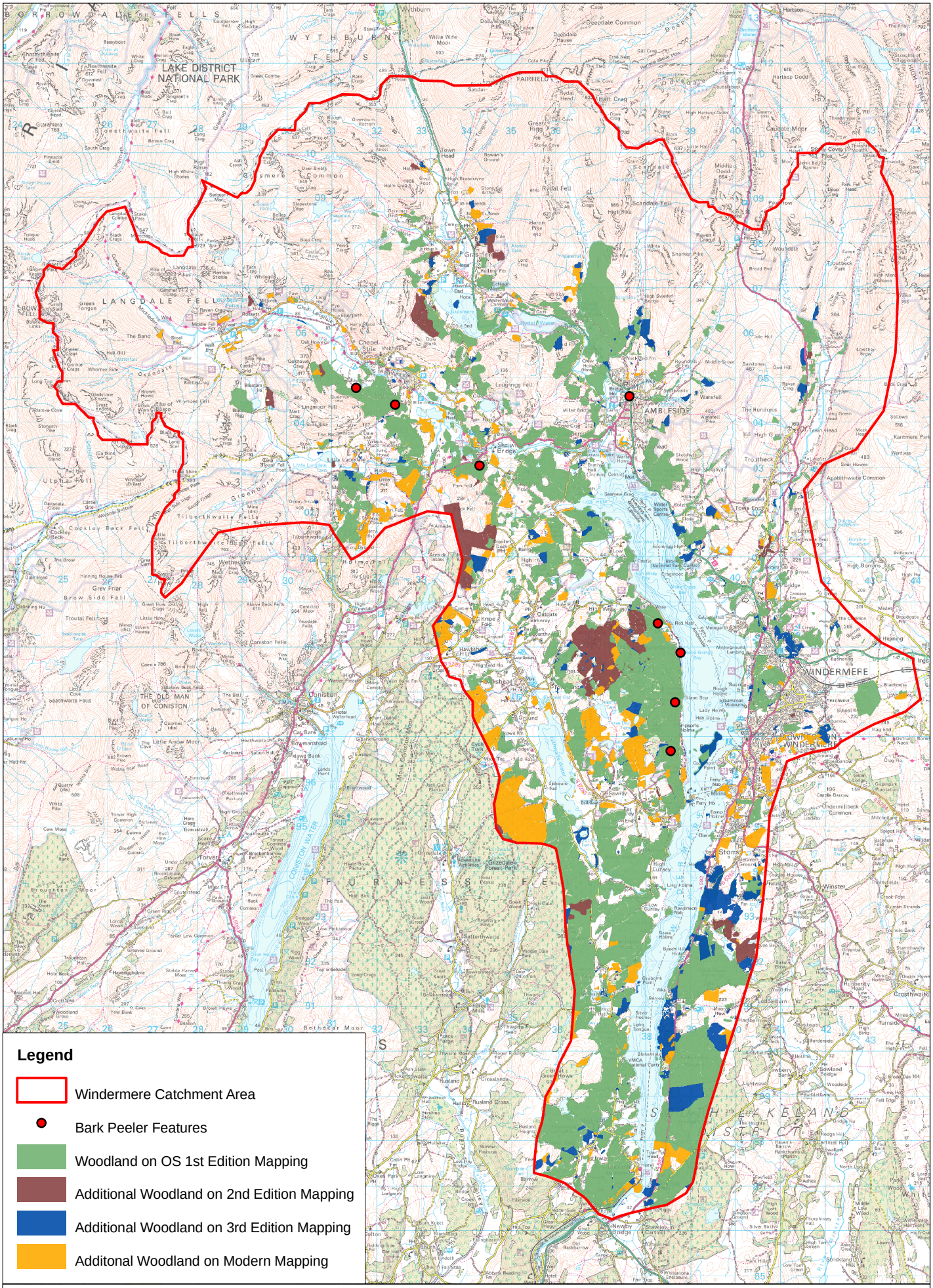

Figure 7: Bark peeler features, against the extent of woodland on various historical and Modern mapping

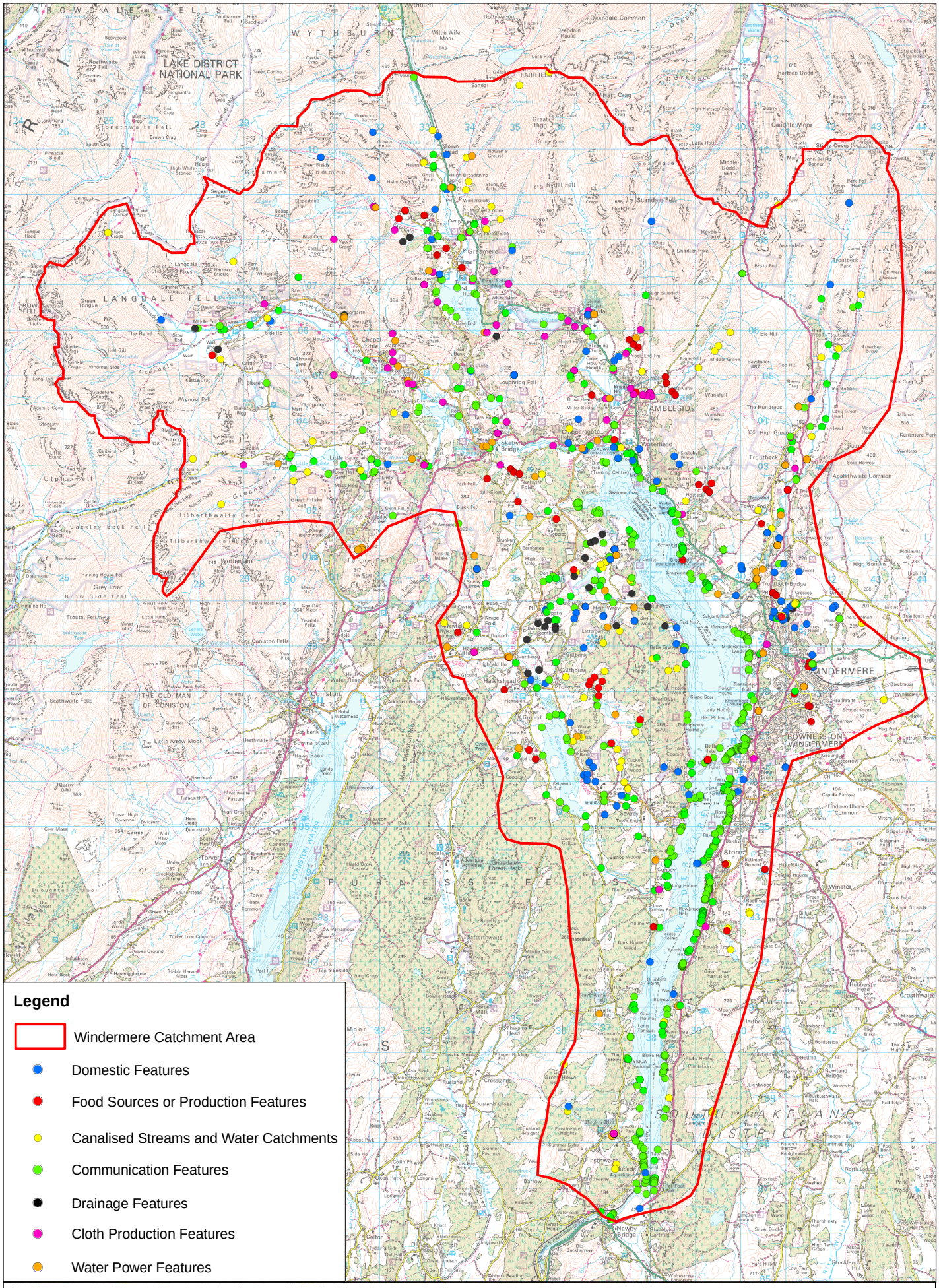

Figure 8: All identified features relating to water, according to broad groupings derived from subtype

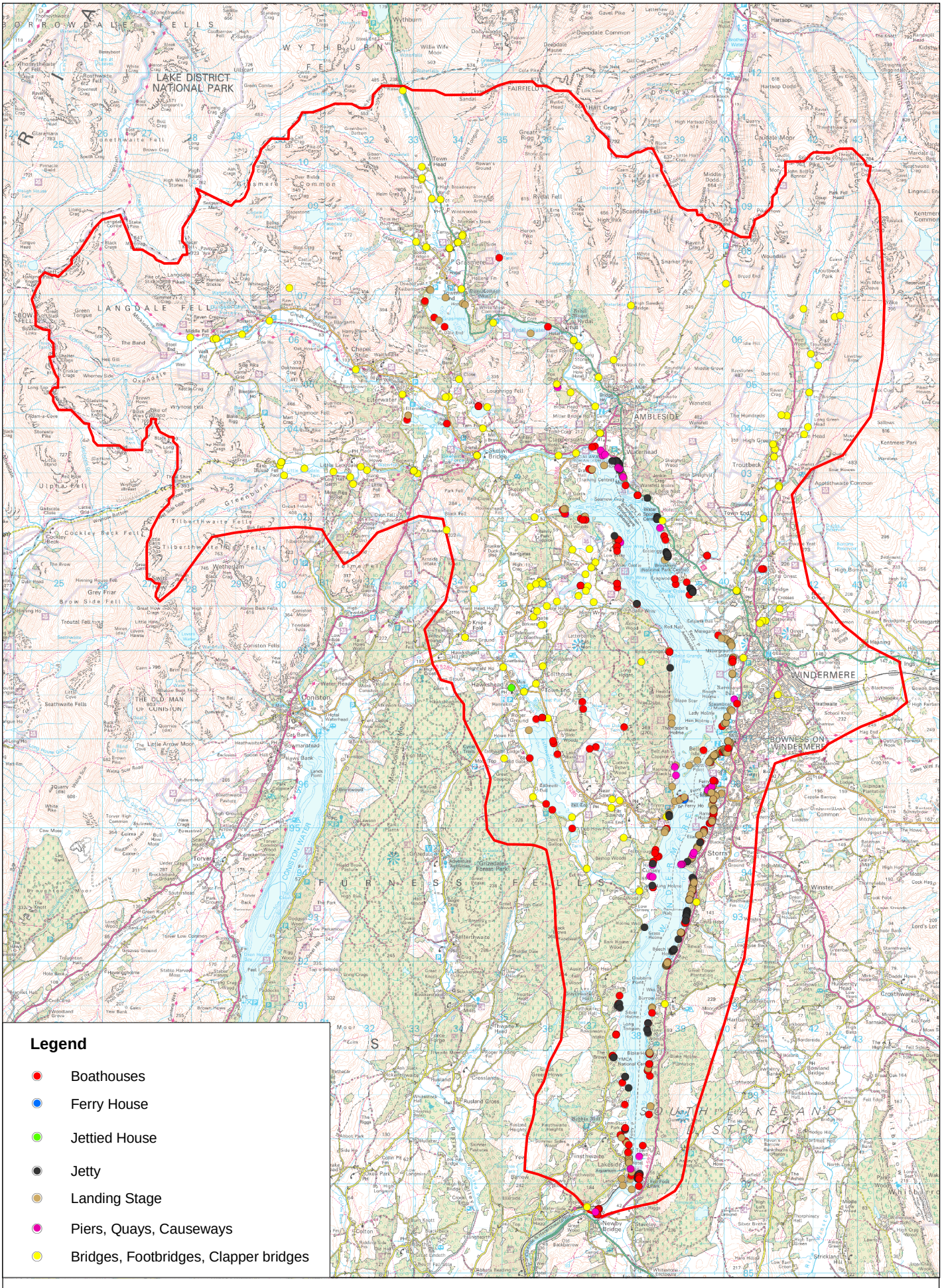

Figure 9: Identified "Communication Features" (see Figure 8) relating to water. These categories are derived from the description attribute field relating to the subtypes Lakes and Rivers

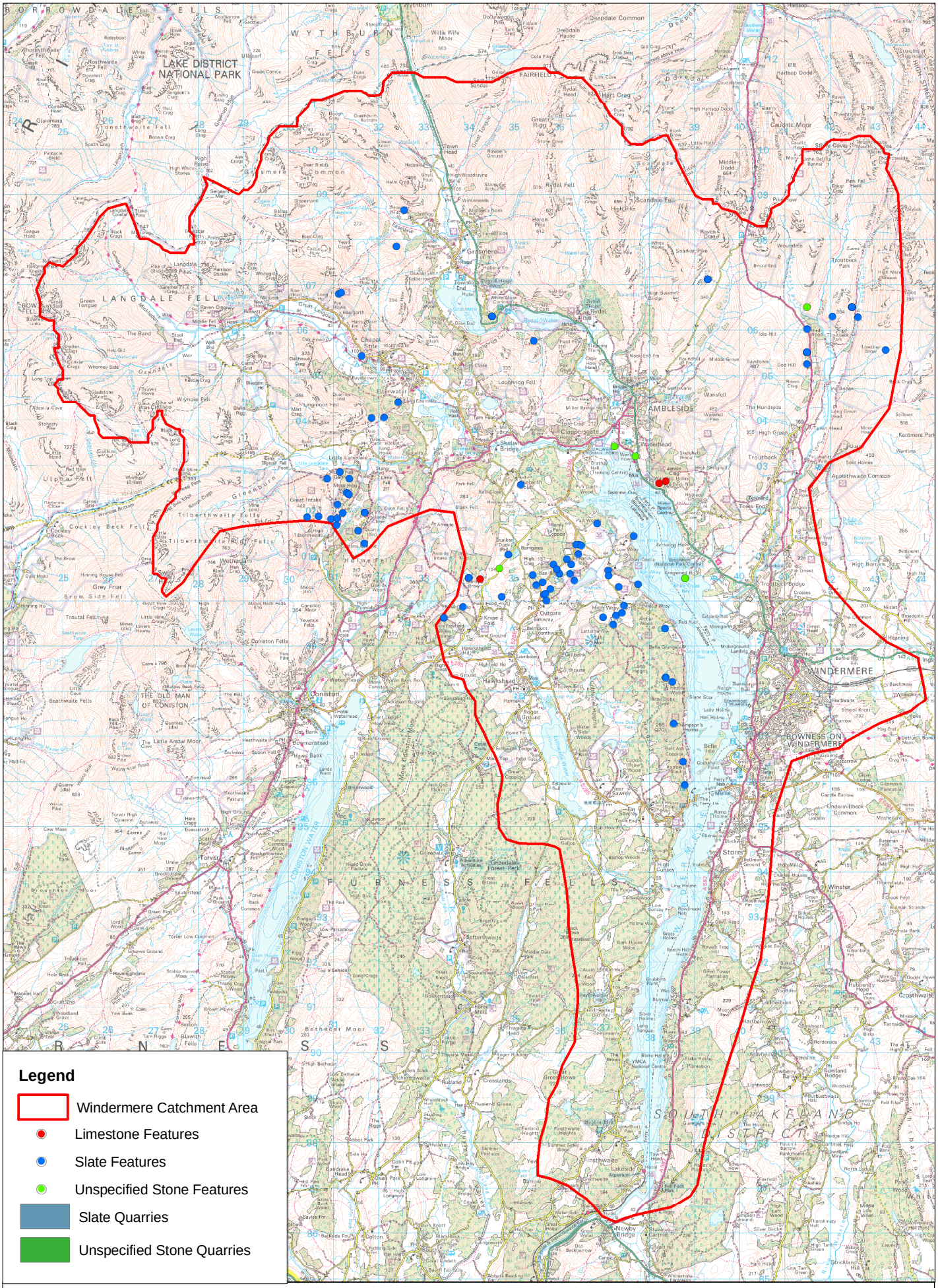

Figure 10: All identified features relating to stone quarrying industries

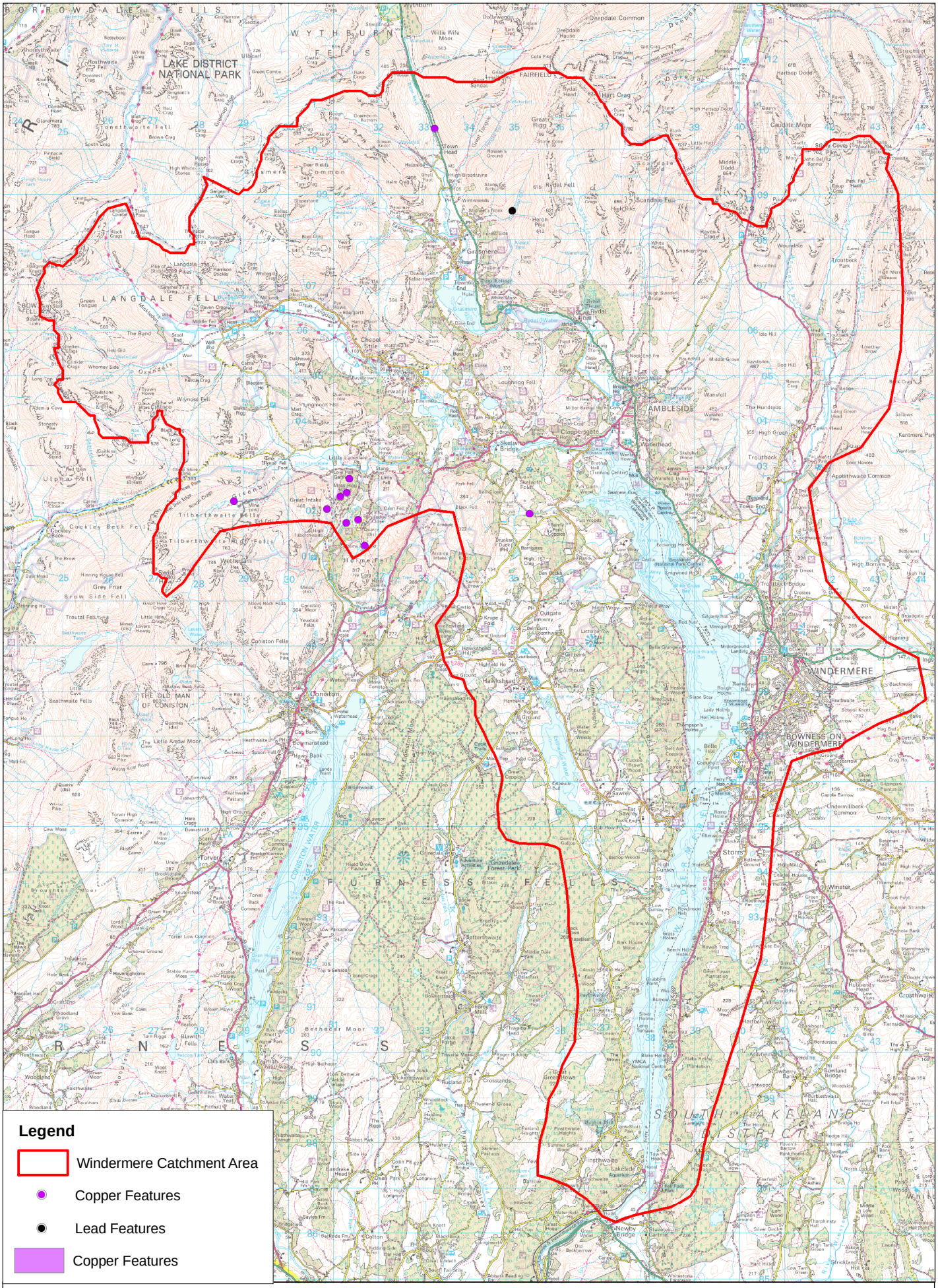

Figure 11: All identified features relating to copper and lead extraction industries

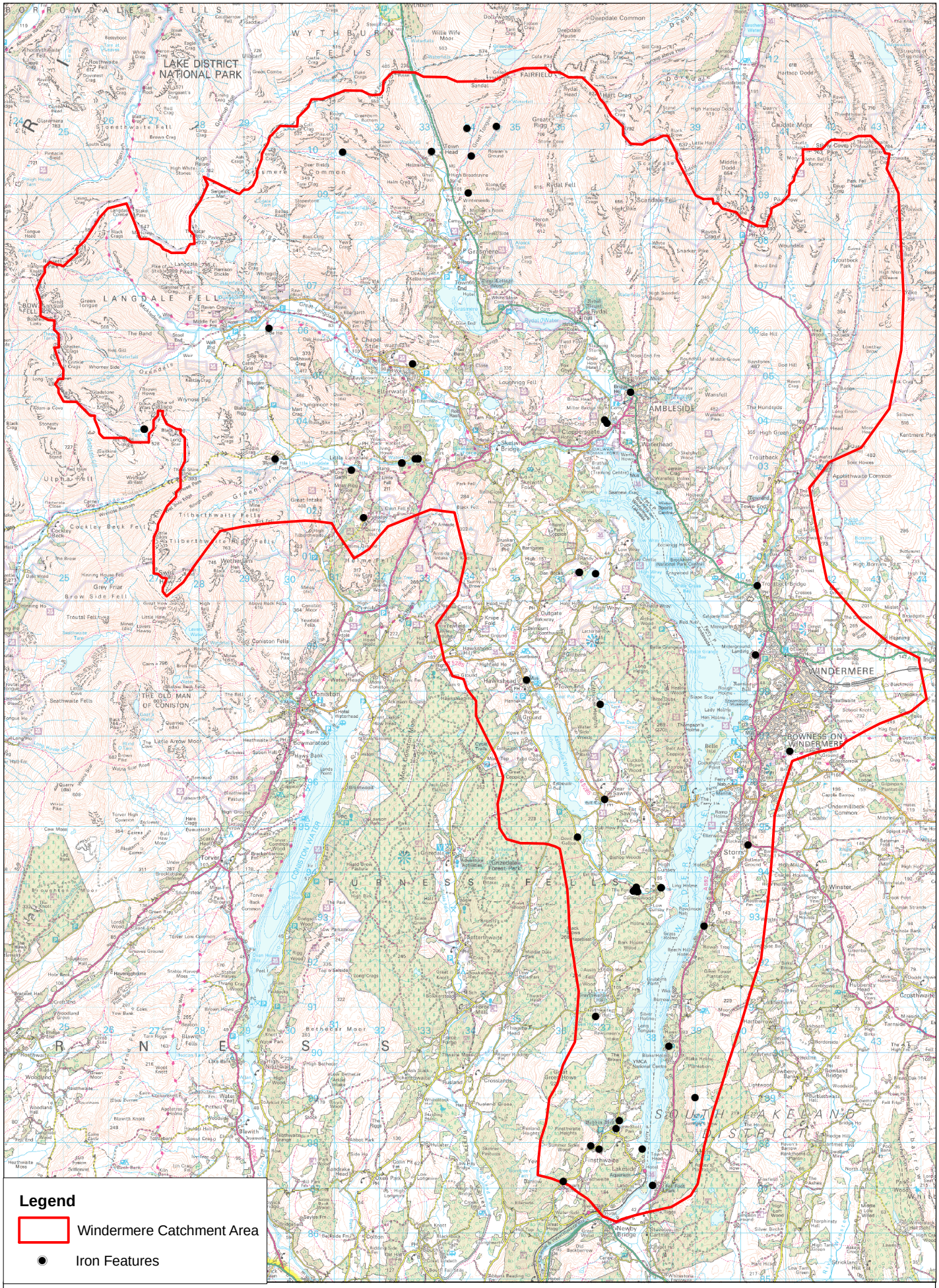

Figure 12: All identified features relating to iron extraction and processing industries

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0 0.9 1.8 2.7 3.6 4.5 Kilometres

N

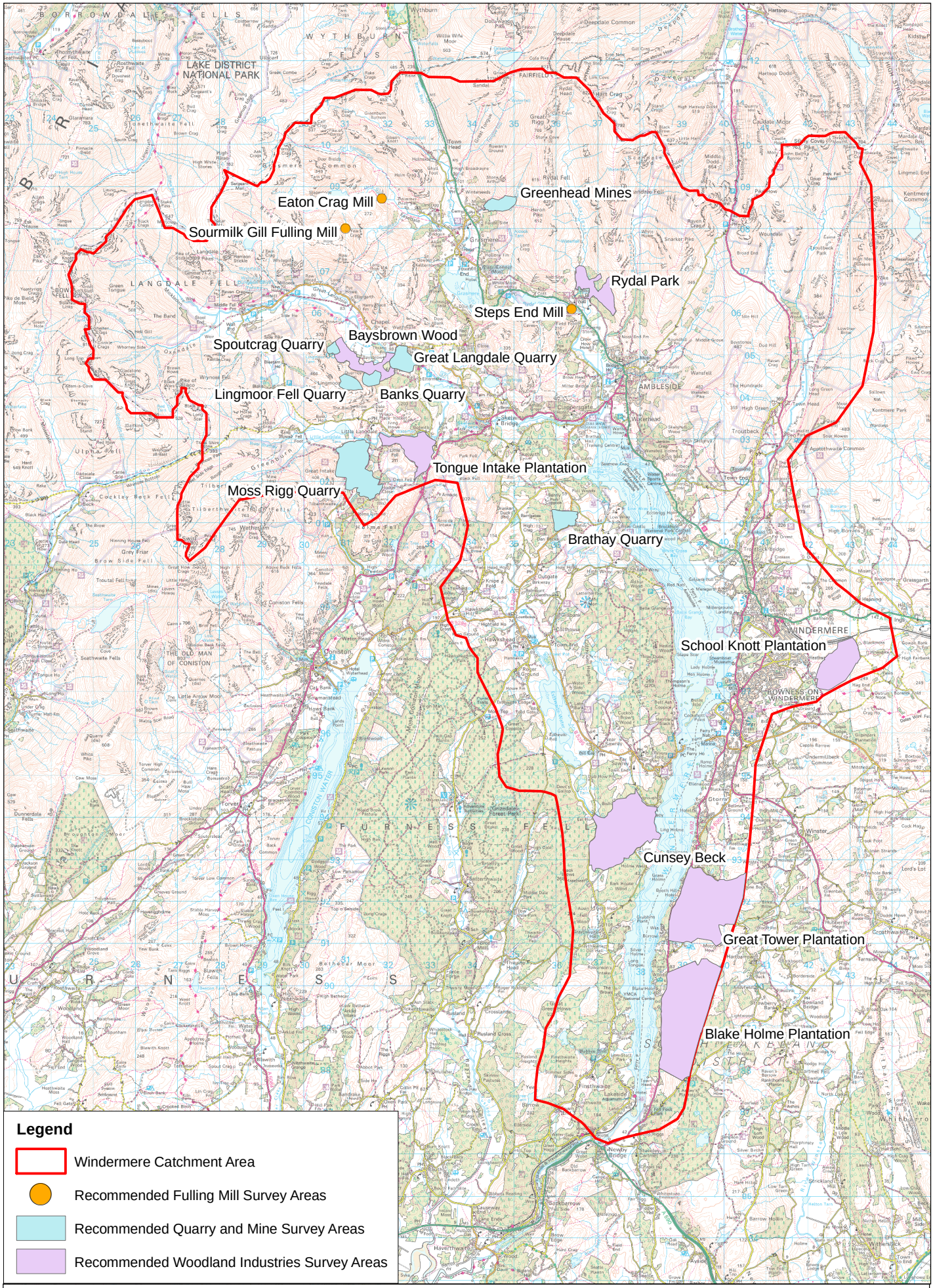

Figure 13: Recommended survey areas for community surveys of quarries, woodland industries and fulling mills

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0 1 2 3 4 5 Kilometres

N