THE IRON AND STEEL INDUSTRIES OF THE DERWENT VALLEY: A HISTORICAL ARCHAEOLOGY

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Abstract

Within the Derwent valley, to the south east of Newcastle-upon-Tyne, lies the Derwentcote Historic Landscape. The site consists of three historical monuments, a forge, a steel furnace and a row of worker's cottages which are in the stewardship of Historic England. This thesis asks how the Derwentcote Iron and Steel works operated within the overall iron working landscape of the Derwent valley. The thesis examines for the first time the archaeology of a pioneering iron industry scattered throughout the whole of a valley which is geographically divided between the counties of Northumberland, Durham and Tyne and Wear.

A multifaceted, interdisciplinary approach has been employed utilising a wide variety of primary sources and drawing on several techniques developed by historical archaeologists. Documentary sources and archaeological data have been integrated in considering the archaeological landscape, while process recording and a modification of the Manchester Methodology have been used to assess technological and social developments. A detailed artefact biography has been carried out on Derwentcote as it is the most complete site in the valley. The results of this research have been georeferenced within a GIS.

The findings of the thesis indicate that within the Derwent Valley three periods of iron working can be identified: a pre-industrial period, commencing historically in 1299, of local landowners producing iron for their own use, the Industrial Revolution, which arrived in the valley c.1687 through external entrepreneurial interests, and the steam-driven Machine Age which exploited new ore seams and technologies from 1840. The research indicates that the Derwentcote may have operated within all three phases. The valley often adopted the latest technologies in ironworking. Physical evidence for each of these phases remains scattered throughout the area today. The case study of the site of Derwentcote has proven to be a technical microcosm of the national industry.

Acknowledgements

I would like to thank Dr Jane Webster, my principal supervisor firstly for her invitation to supervise the Derwentcote Forge Cottages Project 2012-2016, which sparked my interest in the site and the subject of the iron and steel industry in the Derwent valley, and secondly for her help and encouragement throughout the PhD experience. I also thank Professor Sam Turner, my secondary supervisor, for his advice and comments.

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Finally, I should like to acknowledge my family, not only for their support and encouragement but also for practical assistance. Thanks to my son, Henry Bowman, who is also an archaeologist, for accompanying me out onto the high fells around the head waters of the Derwent tributaries to look for bloomery slag and especially to my wife, Dr Rowan Bowman, for her attentions to my manuscript in the run-up to submission.

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Chapter 1. Introduction

1.1 Introduction

The Derwent valley, which lies to the south west of Newcastle upon Tyne, played an important but now almost forgotten part of the Industrial Revolution. At Derwentcote, to the west of Rowlands Gill, stands Britain's most complete 18th century steel-making furnace. Built around 1730 this industrial monument forms part of a historic landscape which includes a forge, documented as having come into production around 1718, and a row of four workers' cottages which are all in the stewardship of Historic England. From 2012 to 2016 the Forge Cottages have been the focus of a campaign of archaeological excavation by Newcastle University working with English Heritage / Historic England. The excavation has refocussed attention on the question at the heart of this thesis: how did the Derwentcote Historic Landscape operate within the economic and social networks of the iron and steel industries of the Derwent valley?

Within living memory, the iron industry for the Derwent valley was associated solely with the Consett Steel Works which closed in 1980. Created in 1840, the ironworks at Consett were once the largest in England and are now mainly recalled by public monuments and street names. To the north-west of Consett lies the village of Shotley Bridge where an interpretation board and a local pub name hint at a tradition of sword making in the area. On the lower Derwent at Swalwell the free-standing brick chimney of a long-demolished paper mill stands over an interpretation board marking the Crowley Iron Works. At Winlaton Mill a single interpretation board informs the public that the parkland in which they are standing was also an ironworks. These, along with Derwentcote, are among the few reminders in terms of public heritage of the once significant iron and steel industry within the Derwent valley. There is, nonetheless, archaeology in the area relating to the iron industry which is often 'hidden in plain sight'. Neither the documentary history nor the archaeology of the Derwent valley has been studied in detail, however, and the present interdisciplinary project transforms understandings of the emergence and development of one of the key landscapes of the Industrial Revolution.

The first part of this thesis (chapters 3 and 4) seeks to place Derwentcote both spatially and temporally within the valley. This is achieved through the production of a historical archaeology of the iron industry within the valley, bringing together for the first time all the known documentary sources and the archaeological data on the subject. This part of the project has produced a complete gazetteer of the sites along the Derwent.

The documentary sources indicate that an iron bloomery was established at Muggleswick near the head of the Derwent in 1299. It is possible iron production in the upper valley area persisted until the mid-16th century. Later that century, the owners of the Gibside estate in the mid-valley began smelting and forging iron for their own use within their coal mining interests on water-powered sites. The Industrial Revolution arrived on the Derwent in the late 17th century with the establishment of a sword blade manufactory at Shotley Bridge by Newcastle and London businessmen. They were closely followed by the Yorkshire ironmaster, Denis Hayford whose ‘Company in the North’ created the blast furnace at Allensford and a steel cementation furnace at Blackhall Mill. A third concern, the largest iron manufactory in Europe, was established on the lower Derwent by the London ironmonger, Ambrose Crowley III. Iron production by these businesses peaked in 1702-1715 and then entered a long decline, ending in early 19th century with most of the sites abandoned. In 1840 local businessmen found ironstone seams at Consett above Shotley Bridge and created renewed interest in the Derwent valley as a major iron producing centre. It was, however, the quiet closure of the Delta Iron Works on the mouth of the Derwent in 1990 which ended iron and steel production in the valley; an event overshadowed by the public loss of the Consett steelworks a decade before. Fieldwork shows that much of the infrastructure of the industry has disappeared, though several sites remain scattered through the valley in various states of preservation.

The second part of the thesis (chapter 5) examines the networks and patterns of economic, technological and social development of the industry in the valley. The data collected in chapters 3 and 4 are employed in modelling the Industrial Revolution in the valley, using an approach known as the Manchester Methodology (see 2.3.1 below). The results of this analysis are then compared with other areas of the country. A second strand to this examination employs process recording (see 2.3.2 below) to analyse the technical processes appearing throughout the valley over time and compares these with examples of other industrial archaeological remains. The results of the research are then integrated into a Geographical Information System (GIS) which is used to demonstrate the inter-relationships of the sites within the Derwent landscape over time and to provide a tool for further interrogation.

The third section of the thesis (chapter 6) assesses the part the Derwentcote steel works played in the industrial story of the valley. Derwentcote's existence and role are assessed by creating an artefact biography which examines the 'life cycle' of the site. This began before the steel works was built, developed throughout the Industrial Revolution and included an 'afterlife' once the works had been abandoned. This section integrates evidence from the National Census with the latest archaeological information provided by Newcastle University's programme of excavation which I have been involved with since the beginning. The programme of excavation has informed the discussion of the built environment of the site which contributes to a discussion of the structuring of the Derwentcote community.

1.2 Research questions

The research questions for this thesis arise from the desire for a holistic understanding of the Derwentcote industrial site. The primary question asked in this thesis is: how did the Derwentcote Historic Landscape operate within the economic and social networks of the iron and steel industry of the Derwent valley during the 18th and 19th centuries? In addition, the thesis asks: how did the iron industry develop in the valley over time and, what archaeology remains of these industries today? Special emphasis is placed on Derwentcote itself, and on the phasing of its buildings, in order to assess how the processes carried out at the site compared or contrasted with trends in iron and steel manufacturing at the other centres within the valley.

1.3 Aims and Objectives

Aim 1: To produce a historical archaeology of the iron and steel industries in the Derwent valley.

Objective 1a: To collate relevant published and unpublished documentary sources on the industry within the geographic limits of the valley in order to identify production sites.

Objective 1b: To collate all available published and grey archaeological data on the industry within the geographic limits of the valley; indicated both by the results of 1a and, where possible, through other landscape archaeological tools, such as naming evidence.

Objective 1c: To carry out level 3 field surveys, using English Heritage guidelines (2006) of all the sites identified to confirm their survival and preserve their current state by record.

Aim 2: To identify networks of economic, technological and social development and assess whether the pattern of industrial development in this area can be considered typical of national trends during the Industrial Revolution.

Objective 2a: To assess whether the growth of the iron and steel industry in the Derwent valley followed the national pattern for the Industrial Revolution, using a modified version of the Manchester Methodology.

Objective 2b: To assess how the appearance of technological processes in the valley compared temporally to the development of these processes nationally. This is achieved by comparing the study area with another major iron and steel production centre: Sheffield.

Objective 2c: To analyse the data gathered under objectives 1 and 2 in order to identify any clusters of sites based on such factors as ownership and technological, social and economic development and present these through a GIS to show the spatial relationships of these clusters and how they change over time.

Aim3: To produce an in-depth case study of the Derwentcote Historic Landscape in order to compare and contrast this site with others in the valley and create a deeper understanding of the location.

Objective 3a: To produce an artefact biography for the Historic Landscape in order to determine how Derwentcote differed from the generic 'life cycle' of ironworking sites in the Derwent valley.

Objective 3b: To analyse the social composition of the community who lived in and around Derwentcote and its ties to other communities within the wider Derwent landscape.

Objective 3c: To carry out a study of the built environment of Derwentcote to determine the relative and absolute phasing of the archaeology of the site.

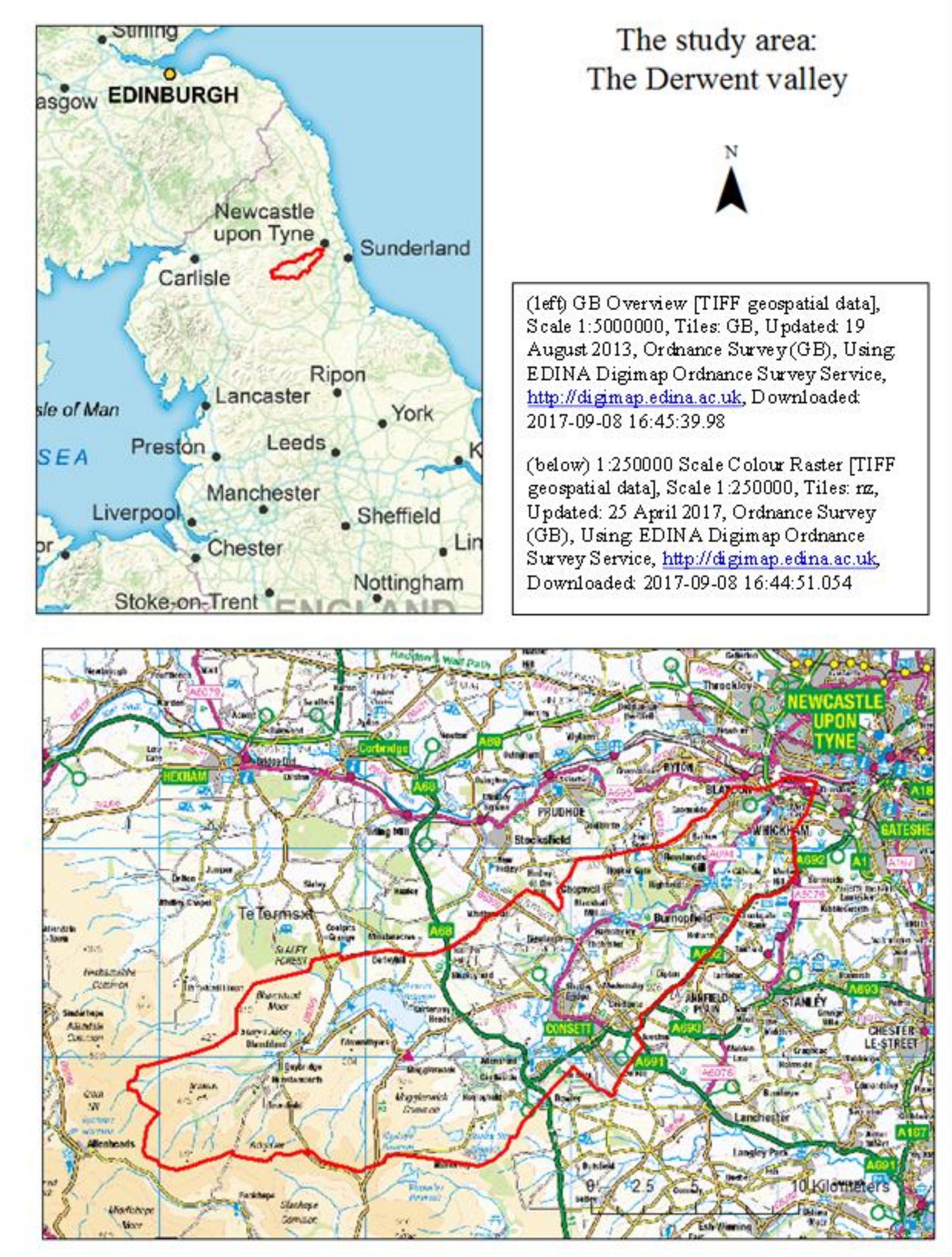

Figure 1.1 Location map of the Derwent valley.

1.4 The Derwent valley

1.4.1 *Location*

The River Derwent begins on Nookton Fell at the confluence of Nookton Burn and Beldon Burn at a point known as Gibraltar. The Derwent valley (fig. 1.1) stretches some 37km in a north easterly direction from there to the River Tyne. The valley terminates where the River Derwent enters the River Tyne opposite the Scotswood area of Newcastle upon Tyne in North East England.

The research area can generally be considered to lie within the watershed of the Derwent valley. A little latitude has been allowed to include the southern and eastern parts of Consett where they spill over into the Lanchester valley because they are bound intimately with the main Consett Iron Works site. The village of Whittonstall lies only just within the Tyne valley but the archaeological features associated with it have all been detected to its south, on the Derwent side of the watershed. Winlaton, overlooking the lower Derwent, straddles the hilltop between the Derwent valley and the Blaydon Burn which runs north and parallel to the Derwent. Its integration with the iron working sites at Winlaton Mill and Swalwell necessitate its inclusion within the project.

1.4.2 *Topography*

The topography of the valley can be viewed by accessing the GIS submitted as part of this thesis.

The Nookton Burn and the Beldon Burn rise in an area of bog, heather and acid grassland with an open aspect and a few small, dispersed stands of coniferous and broad-leafed trees. The confluence of these two tributaries is in broad-leafed woodland which lines the Derwent as it makes its way through the improved grassland which surrounds the medieval village of Blanchland. Some 2.7km below Blanchland the river enters the Derwent Reservoir. To the north of the reservoir lies the rural parish of Healey, to the south Edmundbyres and Muggleswick. To the east of the reservoir the farmland is improved, with arable land on the north side of the valley, while larger areas of broad leafed woodland appear on the south. To the east of Muggleswick village, the river runs through the steep sided Derwent Gorge. The A68 trunk road crosses the Derwent at Allensford, passing along the western edge of Shotley Low Quarter on the northern, Northumbrian side of the valley. The narrow course of the river and steep sided character of the valley is maintained until it runs through Shotley Bridge after which the north bank begins to open out. Shotley Bridge now forms the northern end of an urban conurbation joining onto Bridgehill and Blackhill on the steeper southern valley side, with Consett at the top. Downstream, at Ebchester, the river is bridged by the B6309 which follows the line of the Roman Dere Street. This road rises from the river crossing and follows a minor modern reroute, ascending the valley's north side in a north-westerly direction to Whittonstall, passing through open grassland, arable fields and windfarms, and on to the Tyne valley. At the base of the valley the north bank opens out into a narrow floodplain, known locally as 'haughs'. The haughs remain on the north bank of the river as far downstream as Blackhall Mill. Here, the more meandering nature of the river from this point produces haughs on the inner bank of the bends; the first on the south bank being the Warren Haugh at Derwentcote, adjacent to the forge. To the east of the B6309 a wooded valley contains the Mill Burn which effectively separates Whittonstall from the Chopwell area. Here the north side of the valley maintains its gently rising aspect. The village of Chopwell stands high on the north side of the valley above the riverside hamlet of Blackhall Mill. An almost uninterrupted line of buildings straddles the access road between the two settlements. The landscape here is characterised by grassland, arable and large tracts of woodland of different types. The two largest woods are the Milkwellburn Wood and the former Royal Chopwell Woods. At the east end of Chopwell Woods, just downstream from Lintzford, the valley rises steeply from the river once again. From Shotley Bridge to Lintzford the south side of the valley rises more steeply to the watershed and is also given to pasture, arable and woodland.

Below Lintzford the north bank is dominated by the urban development of Rowlands Gill while opposite, on the south side of the river, stands Gibside, a large National Trust property. Above Gibside is the village of Burnopfield. Gibside was an iron working site in the 16th century and is now a heavily wooded heritage area with haughs lining the Derwent. On both sides of the valley below Rowlands Gill arable land is more common than grassland.

East of the Gibside estate, the valley is fairly shallow-sided until it comes to the New Derwent Bridge which carries the B6317 Hexham Road over the river, a distance of some 2.9km. Woodland lines the riverbanks and stretches for some distance up the valley sides, most notably Thornley Woods which are documented as being in existence by the early 18th century. Above this stretch of the river both valley tops are crested by urban development; to the south sits Whickham which runs down the valley side into Swalwell, one of the most important iron working sites in the project area. On the north valley top is Winlaton which now merges with Blaydon but stood separately during its industrial heyday and turned to

Winlaton Mill and Swalwell for its material needs and transport links. Below Winlaton stands the village of Winlaton Mill. This is a new village created in 1937 to replace the 17th-century namesake which centred on the Winlaton Mill Ironworks that stood on the north bank of the Derwent.

At the end of the valley the Derwent meanders for 1.25km across the Derwenthaugh. In the 19th century the final half kilometre of the river was straightened before its entry onto the Tyne and became known as the Derwent Gut. There have been several iron and steel works established on Derwenthaugh to take advantage of the maritime transport links the area offers. The Derwent was once navigable to Swalwell and the river is currently tidal to the weir across the watercourse some 850m upstream from the New Derwent Bridge. The weir, known as the Dam Head was built in the early 18th century to supply water to power the Swalwell ironworks.

The ability to utilise the fall of the river to create power was fundamental to industrial development in the Derwent valley. The heights above sea-level of several salient points and iron working sites along the valley are given in the table below (table 1.2).

Site name	Height of Derwent above sea level + or – 5m. (Ordnance datum) at project sites
Rise of Nookton Burn Tributaries	550m (High point of watershed = 561m)
Rise of Beldon Burn tributaries	535m
Gibraltar – River Derwent Begins	270m
Into Derwent Reservoir	225m
Allensford	110m
Shotley Bridge	90m
Ebchester	65m
Blackhall Mill	55m
Derwentcote	50m
Linttzford	40m
Gibside	25m
Winlaton Mill High Dam	20m
Winlaton Mill exhaust	15m

Table 1.2 Height of the River Derwent OD at the ironworking sites.

1.4.3 *Geology*

This section highlights where iron ore bearing rocks can be found within the valley. The solid geology for the North East of England rises from beneath the North Sea to the Pennine Fault in the area of the Alston Block in an east-west direction. There are two main rock formations within the study area: the Westphalian to the east, which forms the western edge of the Northumberland and Durham Coalfield, and the Namurian to the west (fig. 1.3). The two formations meet a little to the west of Consett along a roughly north-south geological fault. A brief description of both formations will be followed by a description of the iron ores they bear.

To the west of Consett, beneath most of Muggleswick, Edmundbyres, Hunstanworth and Blanchland, the bedrock is predominantly Namurian. This rock outcrops in several places in Healey parish, mainly to the west of the A68 road, and can be seen on the banks of the Derwent as far east as Shotley Bridge. The Namurian rocks are sedimentary and were laid down in the Carboniferous Period between 327 and 316 million years ago. In this region, they comprise of thick bands of shales, siltstones and sandstones with thin bands of limestone and coal occasionally present. Ironstones appear at several levels within the Namurian rocks (Lawrence *et al* 2004: 36-8).

The Westphalian rocks outcrop to the east of the Namurian rocks. These were also created during the Carboniferous Period between 316 and 306 million years ago. Westphalian rocks are commonly referred to as the 'coal measures' as they contain numerous coal seams. Both Westphalian A, the lower coal measures and Westphalian B, the middle coal measures are present. In addition to coal seams the Westphalian rocks contain clay and iron ore. The iron ores within the coal measures are sedimentary in nature and may have been mined as a principal commodity or as a by-product of the coal mining industry (*ibid.* 4, 139).

Ironstones may occur at any point throughout the study area. Most common are concentrations of clay ironstone nodules (Young *et al* 2010: 18) such as the ones observed at the base of the Whittonstall bell pits. This ore comprises mainly of impure siderite and appears within beds of mudstone. There are three major named ironstone seams present within the geology of the Derwent valley: the Ten Bands Ironstone, the No. 1 Ironstone and the German Bands Ironstone. A fourth higher, and narrower, band of ore within the Maudlin coal seam was mined by the Consett Iron Company on the reverse side of the valley watershed

Figure 1.3 Geology map of the Derwent valley. The Namurian rocks are shaded yellow and the Westphalian blue. The German Band outcrops are indicated in dark blue. (Digimap Geology 2016)

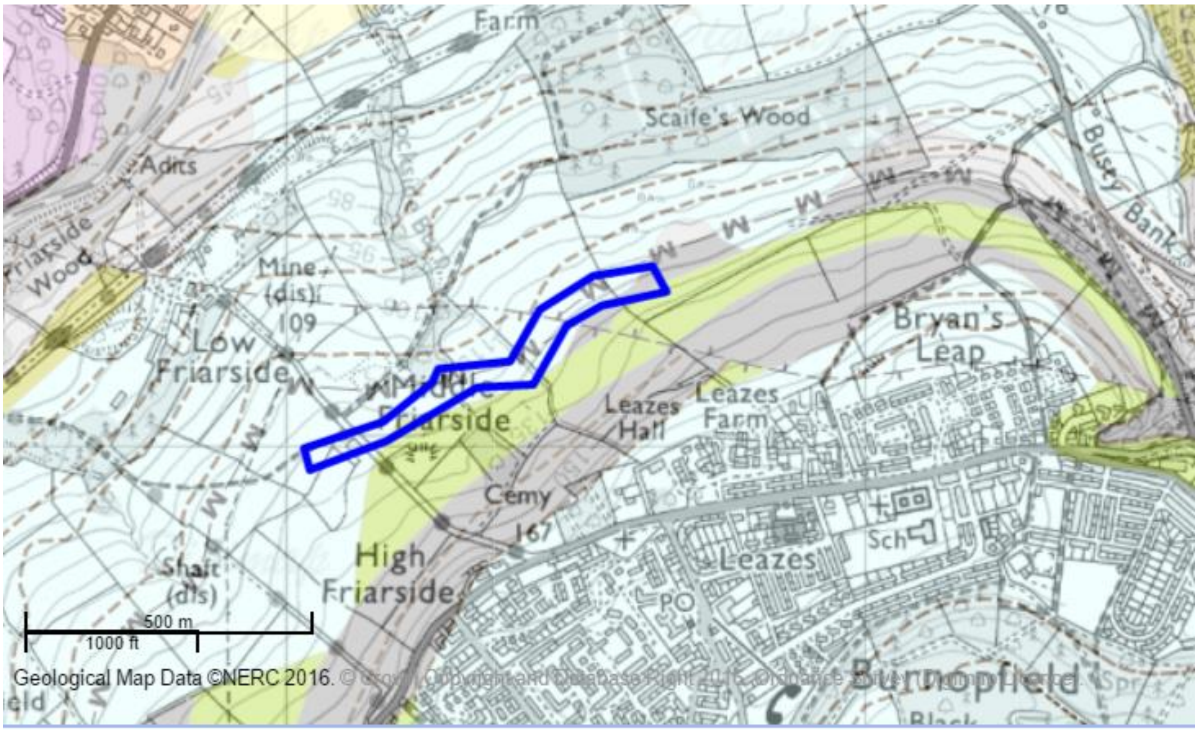

Figure 1.4 Detail of eastern German Bands Ironstone outcrop. (Digimap Geology 2016)

Figure 1.5 Detail of western German Bands Ironstone outcrop. (Digimap Geology 2016)

The Ten Bands Ironstone is present above the Harvey Marine Band of shale. It is a 3.6m thick band of mudstone containing iron nodules and ribs. It was deep mined by the Consett Iron Company below Consett town and its immediate surroundings. Below the Ten Bands, and separated by the Harvey Marine band, is the No. 1 Ironstone Band. This ironstone was named for its discovery while sinking the No. 1 ironstone and coal pit at Consett to mine the first ore for the Derwent Iron Works in 1840. The seam is a 2.5m thick mudstone layer which also has inclusions of iron nodules and ribs (Mills 1982: 4-7). The third seam, the German Bands Ironstone, was through local oral tradition named for the German immigrants of Shotley Bridge who were said to have mined it for use in their sword manufactories (for one such account see Robson 2016). However, the ore is found within the Westphalian rocks which are named after a region of western Germany.

German Bands Ironstone is found beneath the Brockwell coal seam and above the Victoria coal seam which can be traced along both sides of the valley. It is only shown to outcrop at one location within the Derwent valley, a little to the west of the Gibside Estate, around 110m OD above Low Friarside Farm and through the top of Friarside Plantation (fig.1.4). Further west, German Bands Ironstone outcrops just over the watershed with the Tyne valley at 290m OD in the Espershields area of Healey (fig. 1.5).

Within the Namurian rocks the presence of iron ores can be found amongst the spoil heaps of 18th and 19th century lead workings. Limonite is the most abundant mineral on the spoil heaps of the workings along the Healeyfield Vein, following the Horesleyhope Burn [NZ 0630 4840] and there is a probability of siderite present (Dunham 1990: 229). The Healeyfield Vein is within a major geological fault where the Lower Coal Measures of the east meet the Namurian rocks beneath the Derwent's headwaters. This fault extends north-north-west to Greymare Hill on the northern horizon of the valley where an ironstone quarry is marked on old OS maps. Further west, 1.5km north-west of Healyfield Farm, limonite is also found in the spoil of the Silvertongue Mine [NZ 0570 4912] within the Derwent Gorge.

At College Edge to the south-west of Edmundbyres [NY 9940 4910] a slightly iron-stained vein of baryte has been recorded within the First Grit of the Namurian succession (Dunham 1990: 228). Similar heavily iron-stained baryte has been noted at Knucton [NY 9332 4647], high on Hunstanworth Moor (*ibid.* 227), where its vein has been associated with the Felltop Limestone. The Hunstanworth area ironstone is unusual as it is oolithic. This ore contains the iron silicate mineral chamosite and is known as Knucton Ironstone (Young *et al* 2010: 18).

Ore has been observed lying on the surface in the Knucton area (Smith 2016: pers. Comm.) but whether this was indicative of an outcrop or merely surface redeposition is unclear.

The Felltop Limestone is shown on geological maps (Dunham 1990: 221) to outcrop above both the north and south banks of the Beldon Burn, west of Blanchland. On the north bank, as will be discussed in chapter 4, are large mounds of bloomery slag. Their proximity to the Felltop Limestone would suggest that the ore used was Knucton Ironston. The stratigraphy of geology of the Derwent valley is given in table 1.6 below.

Westphalian B
Crow Coal
Ryhope Five-Quarter Coal
Top Ryhope Little Coal
Bottom Ryhope Little Coal
High Main Coal
Five-Quarter Coal
Main Coal
Maudlin Coal contains a narrow band of ironstone
Durham Low RiIain Coal
Brass Thill Coal
Hutton Coal
Ruler Coal
Ten Bands Ironstone
Harvey Marine Band
Westphalian A
No. 1 Ironstone
Harvey Coal
Tilley Group of Coals
Busty Coal (usually split into Top and Bottom)
Three-Quarter Coal
Brockwell Coal (usually split into Top and Bottom)
German Bands Ironstone
Victoria Coal(s)
Marshall Green Coal
Ganister Clay Coal
Namurian Succession – down to the Knucton ironstone
Second Grit
First Grit

Grindstone Sill = Grindstone Limestone
Botany Limestone
Upper Felltop = Top Botany Limestone
Upper Felltop Limestone
Hipple Sill
High Grit sills
Coalcleugh Marine Beds
Coalcleugh Coal
Coalcleugh Beds
Lower Felltop Limestone
Rookhope Shell Beds
High and Low Slate sills
Low Grit Sill
Hunder Beck Limestone
Knucton Shell Beds
Knucton Ironstone

Table 1.6 Stratigraphy of geology of the Derwent valley
(Adapted from Mills 1982: 5 and 7, Lawrence et al: 39)

1.5 Framework of study

This thesis comprises an 'historical archaeology' of an industrial subject set within the geographic location of the Derwent valley. Industrial archaeology and landscape archaeology are both recognised as sub-disciplines of historical archaeology and have developed at a similar pace to the umbrella field. All three archaeologies form elements of this thesis. They are described below to show how and why each facet has informed the methodology adopted here and are explored in more detail in chapter 2. Section 1.5.1 traces the development of historical, or post-medieval, archaeology from its inception in the post-World War Two era through to today. The way in which industrial archaeology has developed over the same time period is assessed in 1.5.2 and, similarly, landscape archaeology is discussed in 1.5.3. All three archaeologies can be seen to have developed through three non-exclusive stages: an amateur phase, a professional phase and an academic phase.

1.5.1 *Historical archaeology*

The archaeologist Charles Orser provides a succinct definition for historical archaeology as it is widely practiced today:

> Historical archaeology is a multi-disciplinary field that shares a special relationship with the formal disciplines of anthropology and history, focuses its attention on the post-prehistoric past, and seeks to understand the global nature of modern life. (Orser 2004: 19)

In Britain, the 'historic' period is often synonymous with the post-medieval era beginning c.1500 AD and continuing into the present day (Hicks and Beaudry 2006: 1). Historic England recognises the post-medieval period as 1540 to 1900. Some writers (Moreland 2001: 105-11, Orser 2004: 4) argue for the historic period beginning with the appearance of written documents within a society. In Britain, this certainly includes the medieval period: though Richard Newman, while recognising the existence of Roman and medieval textual sources in Britain, casts doubt on their usefulness due to their scarcity and elite bias (Newman 2001: 4-5). This thesis takes the former approach and includes medieval texts.

The origins of British post-medieval archaeology stem from concerns over the loss of archaeology during post-war development in the 1950s. Archaeological remains of 'modern' periods were destroyed without recording in order to get to any Roman and earlier material which may have lain beneath a site. Post-medieval archaeology was therefore effectively seen as rescue archaeology: the recording of archaeology in the face of its destruction. It was placed in the sphere of amateur enthusiasts and interest groups (Ralston and Hunter 1999: 1). In 1967 the British Society of Post-Medieval Archaeology was founded to promote the archaeological study of British and Colonial history of the post-medieval period.

Recognition of the importance of the remains of the post-medieval period came in 1986 with the elevation of the Ironbridge Gorge in Shropshire (fig. 1.7) to a UNESCO World Heritage Site (UNESCO 2016). This event indicated that post-medieval archaeological remains have an internationally recognised cultural value which requires preservation. Of the 25 UNESCO-designated sites in Britain today 17 are of the post-medieval period.

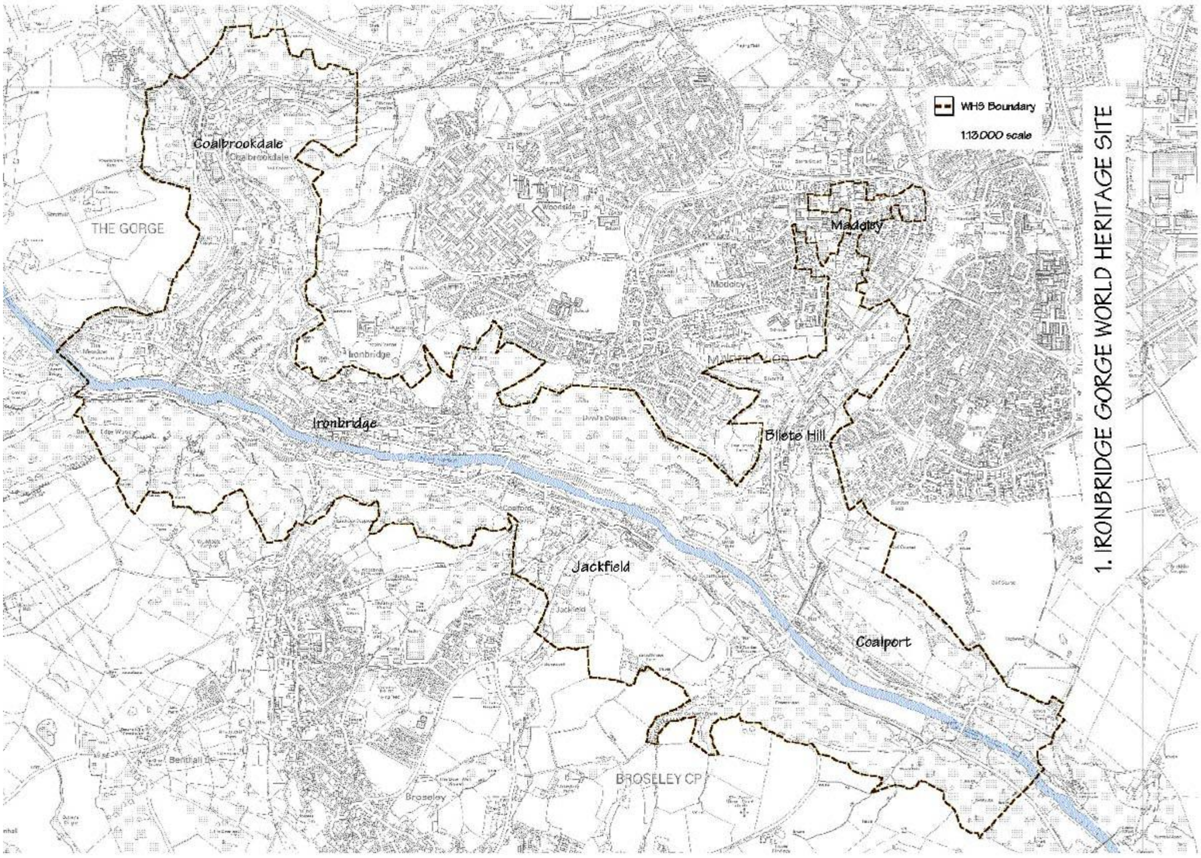

Figure 1.7 Ironbridge Gorge World Heritage Site 2012. The listing of this site lifted the profile of post-medieval, industrial and landscape archaeology (UNESCO 2016)

The professionalisation of post-medieval archaeology originated in 1990 with the production of the *Planning Policy Guidance Note 16*: *Archaeology and Planning* (PPG16), complimented by *Planning Policy Guidance Note 15* (PPG15) (Department of the Environment 1996). These documents were produced to guide local planning authorities in the management of the historic environment. Contractors were obliged to fund and produce an archaeological assessment for the sites they wished to develop. These assessments collated information on the impact that the proposed development may have on heritage assets and their cultural significance (Gould 2009: 43). PPG16 and PPG15 were superseded by the single *Planning Policy Statement 5: Planning for the Historic Environment* in 2010 (PPS5), which was itself replaced in 2012 by incorporation within the *National Planning Policy Framework* (NPPF). Historic England has produced three *Historic Environment Good Practice Advice Notes* to inform local authorities on the NPPF: 1, *The Historic Environment in Local Plans* (2015), 2, *Managing Significance in Decision-Taking in the Historic Environment* (2015) and 3, *The Setting of Heritage Assets* (2015), in addition to which Historic England has also published *Advice Note 2: Making Changes to Heritage Assets* (2016).

Development-led archaeology generates a considerable quantity of grey or unpublished literature in the form of site reports. This legislation placed post-medieval remains on an equal footing to those of earlier periods and created a multi-million pound industry to service the demands of the developers (Newman 2001: 1). A result of this professional work was a greater degree of recording of post-medieval material through both documentary-based desk studies and field observations (*ibid.* 2).

In 1996 English Heritage published *Frameworks for our Past: a Review of Research Frameworks, Strategies and Perceptions* (Oliver 1996). Research frameworks were then produced both on a regional and national level to cover particular periods and themes, to assist commercial archaeologists to focus their work arising through the implementation of the PPGs (Gould 2009: 45). At the same time, the Archaeology Data Service was created by the Council of British Archaeology and a consortium of regional universities in order to receive data volunteered by commercial field units (ADS 2016). The current research framework covering the north-east of England is the 2006 *Shared Visions: The North East Regional Research Framework for the Historic Environment* (Petts and Gerrard 2006), though, at the time of writing an updated version is being prepared (Durham County Council 2016).

The criticism levelled at post-medieval archaeology in the 1990s was that the discipline was too focussed on the typology of objects and that the social relations engendered within those objects were largely unexplored. A need was perceived to apply social theories to post-medieval archaeology. In the introduction to *Post-Medieval Archaeology in Britain,* Crossley (1990: 1) links the work of British post-medievalists to that of the North American historical archaeologists (see also Deetz 1996: 6). From the American perspective, historical archaeology began in 1492 with the arrival of Europeans in the New World, a date broadly matching the start of the British post-medieval period.

In America, archaeology is a sub-discipline of anthropology and as such is considered as both a humanity and a social science. As a humanity, historical archaeology seeks to study the human condition and as a social science its aims 'are to systematically investigate, describe and explain human behaviour' (Little: 2007: 21). American archaeologists apply social theories to their work in order to produce higher-level interpretations of their data. Through the application of social theory, the scope of historical archaeology has been expanded to explore broad, open-ended and interlinked themes within the historic period: scale, agency, materiality, meaning, identity and representation as opposed to the form and function description of single sites (see Hall and Silliman 2006: 7-15, and Orser 1999: 280 for variations on the same themes). The application of such themes may be critiqued for the production of general laws within historical archaeology which 'flatten out interpretation' at the expense of 'diversity of experience' (Gilchrist 2005: 332).

1.5.2 *Industrial archaeology*

Industrial archaeology is a sub-discipline of post-medieval archaeology which originated in the post-war climate of redevelopment. The history of industrial archaeology may be considered to have developed in three district phases, referred to as 'generations' (Cranstone 2005: 79, Gwyn 2009: 21). The salient differences in generational approaches are set out in figure 1.8. The three generations are not sequential as both amateur and professional industrial archaeologists are still active in the field.

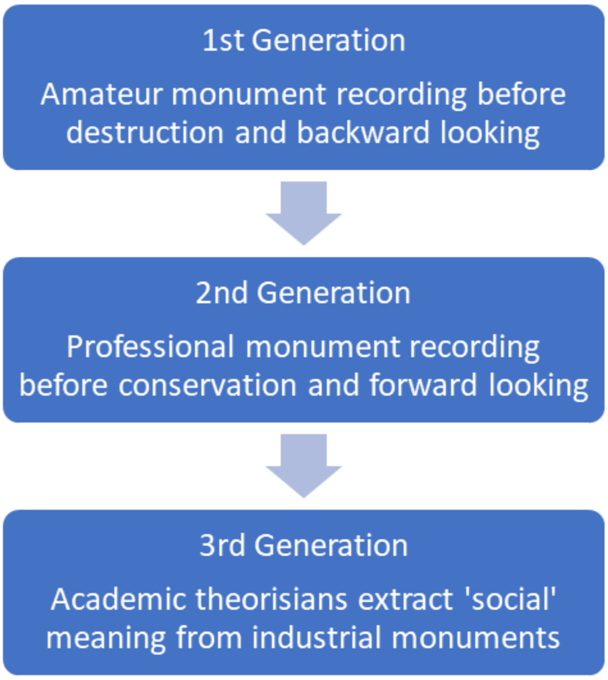

Figure 1.8 Three generations of industrial archaeology

The term 'Industrial Archaeology' was first used in print in Britain in 1955 by Michael Rix in an article for *The Amateur Historian* magazine. The article described a branch of archaeology developed by Donald Dudley only a few years earlier while working as the director of the Extra-Mural Department of Birmingham University (Hudson 1963: 11). The thrust of this early industrial archaeology was to study industrial monuments produced during the Industrial

Revolution of the 18th and early 19th centuries which were, by the 1950s, neglected or destroyed. Angus Buchanan has defined an industrial monument as ‘any relic of an obsolete phase of an industry or transport system, ranging from a Neolithic flint mine to a newly obsolete aircraft or electronic computer’ (1972: 20). Kenneth Hudson wrote of the ‘urgency’ of industrial archaeology; the need to record a rapidly disappearing industrial heritage, illustrating his point with the case of the 1835 Doric gateway to Euston Station, London which was demolished in 1962 (1963: 22-32). Cognitively, industrial archaeology was carried out to understand the process of industrialisation which had taken place in Britain (Buchanan 1972: 19).

The main, first generation, practitioners of industrial archaeology in the early years were extra-mural departments of universities and interested amateur archaeologists. Hudson argues for the precedence of the amateur over the academic practitioner of industrial archaeology in this era (1963: 34-47). The amateurs ranged from engineers and architects to enthusiasts of the Ffestiniog Railway Society, all of whom brought personal experience and expertise to their particular subject of study. The methodology of the early industrial archaeologist centred on recording individual industrial monuments. Buchanan set out the basic techniques as note taking and photography, with measured survey and excavation undertaken should the recorder feel competent (1972: 29-30). In 1973 industrial archaeologists formed the Association of Industrial Archaeologists which went on to promote the *Industrial Archaeological Review* journal (Buchanan 1980: 355-6). The only real framework for recording was in the form of record cards provided by the National Record of Industrial Monuments (Hudson 1976: 189-90, Buchanan 2000: 21). One copy of the card would be forwarded to the Council of British Archaeology and another to the National Monuments Record, now held by English Heritage / Historic England. NRIM card completion was voluntary, resulting in disparities in both quality and coverage from county to county.

The awarding of UNESCO World Heritage Site status to the Ironbridge Gorge was as important to industrial archaeology as to historical archaeology. Barrie Trinder has contended that this award, and the subsequent list of industrial sites submitted to UNESCO by the Department of Culture, Media and Sport, was one of the main drivers for an acceptance of industrial heritage as ‘part of the nation’s history in which pride can be taken’ (Trinder 2000: 40-1). Today, of the 17 post-medieval UNESCO sites noted in 1.4.1, eight are of an industrial nature.

With the publication of PPG16 and PPG15 in the 1990s, industrial remains, where they formed part of a development site, became subject to investigation and recording by professional commercial archaeological practices. The reports generated by the developer-funded investigations informed local authorities of the impact that the proposed development might have on industrial-heritage assets and assessed their cultural significance. Second-generation industrial archaeologists were instrumental in conserving elements of industrial heritage for the future. Marilyn Palmer has explained that industrial archaeology has been 'recognised as a preservation movement concerned to ensure the survival of a significant proportion of industrial monuments from the past' (2005a: 59). She and Peter Neaverson have also noted that 'preservation is only part of industrial archaeology, and its main thrust should be towards the recording of artefacts and structures and illuminating the context of people at work in the past' (1998: 3). From within the heritage industry, Kate Clark, the former monuments manager at the Ironbridge Gorge Museums Trust, has argued that archaeologists need to move beyond the description of technology to look at social and economic issues. This could be achieved by looking beyond individual sites to the historic environment with its networks of supply and connections to markets. This approach may include domestic housing related to industrial sites (2005: 99, 115-116), which is particularly relevant in understanding Derwentcote with its row of workers' cottages.

By the turn of the twenty-first century industrial archaeology had developed from an amateur to a professional field but there remained a recognition that it was not a mainstream 'academic' subject (Buchanan 2000: 33). This has been explained as a failure of industrial archaeology to embrace or connect with the 'new archaeology' emerging in the 1950s (Palmer and Neaverson 1998: 3) which was providing academia with its theoretical perspectives. This situation was blamed on industrial archaeologists, both amateur and commercial, limiting their recording to the physical remains of sites and structures and ignoring artefactual material. When such material is considered as meaningfully constructed by society, this lack of recording then created an absence of data from which social meaning could be extracted (*ibid*. 4).

In 2005 the highly influential *Industrial Archaeology: Future Directions* was published following the 24th annual conference of the Theoretical Archaeology Group in Liverpool, 2002. The papers presented within this book consider aspects of contemporary theory and practice and the 'possible future direction for the study of industrialisation in industrial societies' (Casella and Symonds 2005: xi). Frameworks of inference were called for to move industrial archaeology beyond ‘descriptive site-specific studies’ (Casella 2005: 3) and apply theories of social identity to the industrial era. Through such frameworks an understanding of social constructs, such as class and status, gender and strategies of resistance, could be drawn out from industrial remains (Palmer 2005a: 73). James Symonds argues that archaeologists should spend more time thinking about the people behind the processes traditionally recorded by industrial archaeology (2005: 37).

Many of the contributors to *Industrial Archaeology: Future Directions* went on to develop a research framework for industrial archaeology in Britain through the Association of Industrial Archaeology in a special edition of the *Industrial Archaeology Review* in 2005, titled *Understanding the Workplace* and edited by David Gwyn and Marilyn Palmer. This research framework sought to include social aspects of industrial archaeology: continuity and change, production and consumption, understanding the workplace, industrial settlement patterns, class, status and identity, social control, paternalism and philanthropy, the use of scientific analysis in understanding the significance of artefacts and industrial residues, historic landscape characterisation, and the international context of industrialisation (Palmer 2005b: 16-17).

The extension of industrial archaeology into social archaeology has caused some concern with traditional industrial archaeologists. In the year following the publication of *Industrial Archaeology: Future Directions* and the *Understanding the Workplace*, a letter was published in *Industrial Archaeology News* suggesting that the move to take industrial archaeology in a social direction was a ‘fashion’ (Holden 2006: 11) and that industrial archaeology had been ‘quite rightly’ focused on an understanding of technology and engineering. Ron Fitzgerald wrote ‘that there is now an ascendant social studies faction in the subject and that this is promoting an alignment with conventional archaeology which is serving to undermine further the original basis in industrial technology that gave rise to industrial archaeology’ (2007: 51). He defines the ‘proper focus for industrial archaeology’ as ‘science, technology, the techniques of manufacture, civil and mechanical engineering’ (*ibid*. 53). Cranstone, too, has warned against the ‘great peril’ of losing the mechanical or manufacturing aspects of industrialisation as a key element of industrial archaeology (2009: 216).

An overview of the articles and book reviews within the most recent five issues of *Industrial Archaeological Review* (2014: vol. 36 [2 issues], 2015: vol. 37 [2 issues], 2016: vol. 38 [1 issue] gives an interesting insight into the debate on the technological verses social direction in industrial archaeology in recent years. The subject matter of the articles and reviews can be ascribed to three main themes: heritage, technology and social. Several articles could be described as a mixture of technological and social. These articles went beyond a simple recognition of the existence of a workforce or an account of the ownership of a site, both of which could appear in technological articles as background context. There were two articles which did not fit into any main theme so were termed ‘other’.

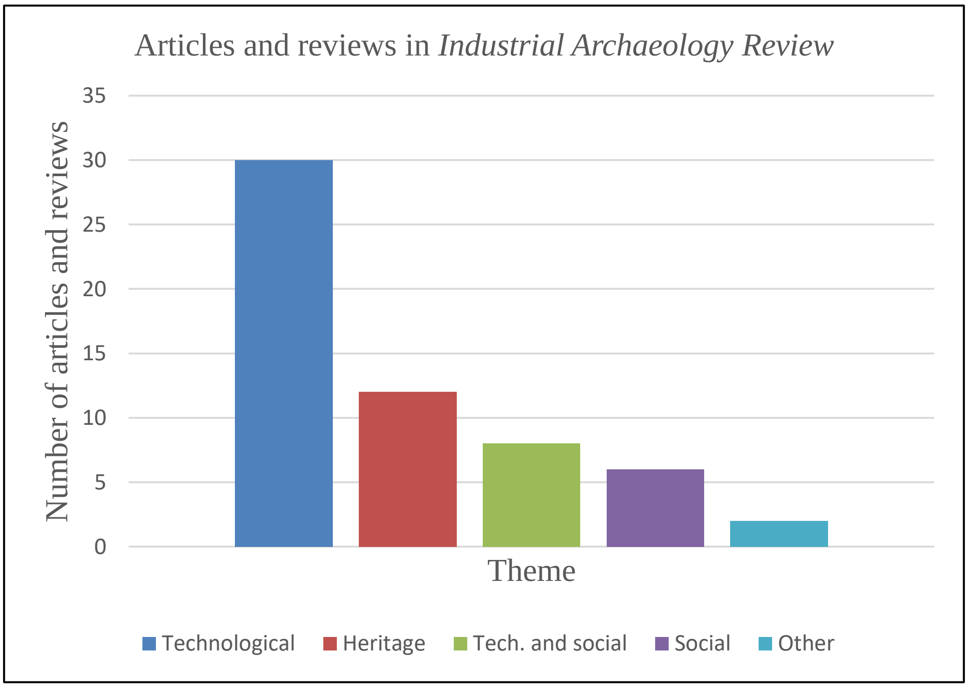

Figure 1.9 Articles and reviews in *Industrial Archaeology Review*

There were 58 articles and reviews in total. Apart from the 2 ‘other’ articles, 30 were technological in nature, 12 dealt with heritage topics, 8 were a mixture of technological and social and 6 were concerned with the social themes arising from industrial archaeology (fig. 1.9). These results suggest that industrial archaeologists have largely resisted moving towards a social archaeology and remain concerned with industrial technology. There were, however, a sizable range of articles which extracted some social data from their subjects thereby enhancing the understanding of their site. It is this approach which has been used in the creation of this thesis. While many of the sample articles contained simple location maps or site maps, four included a greater degree of landscape analysis. This is a combination of industrial archaeology and landscape archaeology, an approach which will be discussed in section 1.5.3.

This project uses all three generational approaches to industrial archaeology. For the archaeology which has been lost through redevelopment a first-generation forensic approach has been taken based on the documentary record. For the remaining archaeology, a second-generation approach complements written sources with a survey of the remains and reports on their current condition. An opportunity to explore third-generation methodologies within this thesis, designed to examine a social approach to industrial archaeology, has been explored using data generated through the earlier approaches.

1.5.3 *Landscape archaeology*

This thesis seeks to place the sites of the iron industry of the Derwent valley both within a physical landscape, defined by geographical features, and also within its economic, technological and social landscapes. This section traces the development of landscape archaeology in Britain from its beginnings in landscape history, through the concept of the historic environment, to the concept and issues surrounding industrial landscape. The section concludes with a consideration of the tools available to the landscape archaeologist.

Following Widgren (2004: 158-9), landscape is defined in this thesis as containing both material and cognitive culture. Landscape can be regarded as a resource, studied through land use, its production, and the capital held within that land; it can also be regarded as scenery, a way of seeing, representation and ideas, and finally it can be seen as an institution, customary law, social order and a way of acting.

Landscape archaeology is the second sub-discipline which has been incorporated into the thesis. The practice has shadowed the development of industrial archaeology in several ways. Like industrial archaeology, landscape archaeology has its origins in the 1950s; in this case through the pioneering work of the landscape historian, W. G. Hoskins, and the publication of *The Making of the English Landscape* in 1955. Hoskins (2005 [1955]) attributes much of the landscape to human processes and the imposition of material culture upon the land. He argues, in this sense, that there is little difference between landscape history and archaeology. Landscapes remind us that much of what archaeologists do involves space and distance (Gamble 2008: 2). Paralleling industrial archaeology at this time, landscape history or archaeology was similarly the domain of university extra-mural courses supported by local interest groups (Palmer 2007: 1-2).

Landscape history took a while to be accepted within academia, and it was not until the 1970s and 1980s that archaeologists began to adopt the discipline (Dyer 2007: xiii). However, since the 1960s anthropologists, or ethnoarchaeologists, recognise the physical environment as being one of the most important factors in determining the human ecological system or culture (Binford 1962: 218). Within anthropological literature the term environment is analogous to landscape (Tilley 1994: 37). Kate Clark has similarly argued for the importance of looking at the historic environment rather than just single sites within industrial archaeology. The value of this approach lies, in part, 'in its potential role as a source of historical evidence which could challenge traditional assumptions about the process and nature of industrialisation, of work, of innovation and continuity' (2005: 115-6). Clark reiterates the argument of Barrie Trinder (1982: 2-3) who mooted that landscape study was a means of gaining an understanding of the experiences of people living in industrial Britain during the Industrial Revolution, as this would move the focus of industrial archaeology beyond the isolated technological and architectural aspects of individual sites. Landscape archaeology aims to facilitate a better understanding both of the physical landscape and people's perceptions of it.

The Ironbridge Gorge World Heritage status award was granted to an industrial landscape. The UNESCO 'brief synthesis' details the physical geography of the 550-hectare site (UNESCO 2016) before listing the archaeological monuments within the landscape: the iron bridge, workers housing, warehousing and public buildings, two groups of blast furnaces, a brick works, and the Hay Inclined Plane which linked two canals. This approach to an industrial subject is similar to the approach adopted here in this analysis of the Derwent valley.

Guidance was given to the heritage-driven stewardship of the historic environment by the newly formed English Heritage in 2000 with the publication of *Power of Place: The Future of the Historic Environment*. Its aim was 'to co-ordinate an important and wide-ranging review of all policies relating to the historic environment – all the archaeology, buildings and landscapes which surround us' (English Heritage 2000).

The course of industrial archaeology and landscape archaeology diverged during the 1980s and 1990s when archaeologists began to look at landscapes through more theoretically-informed lenses. This allowed archaeologists to examine social structure identity and cultural constructs still largely resisted by industrial archaeologists. Marxist archaeologists, for example, regard landscape as a significant medium in the imposition and transmission of dominant ideology: securing relations of dominance by legitimising the sectional interests of a ruling elite (Shanks and Tilley 1982: 130). A second function of landscape within Marxist theory is to naturalise or mask social or environmental inequalities through the aesthetics of visual harmony (Cosgrove 2006: 51). Key examples include the William Paca garden (Leone 1984: 26-29) and Broom County, New York State (McGuire 2000: 233-43). Marxist archaeology directly appeals to people working in the industrial period as it shows aspects of the infrastructure most closely linked to the social relations of capital.

Throughout the last twenty-five years post-processual landscape archaeologists have also embraced reflexive or contextual methodologies, focussing on the ways in which individuals experience landscape. One approach to achieving this is through phenomenology, whereby a landscape is understood and described by a subjective observer, and is a place where experiences happen at a particular moment (Tilly 1994: 12; Greene 2002: 81). Tim Ingold examined the temporality of landscape by analysing Bruegel the Elder's painting, *The Harvesters*. He demonstrated how this landscape can be perceived through analysis of topographical features and material culture, creating and created by practice. He concluded that a landscape is not for looking at but to stand in, experiencing its temporality, in order to take up a point of view (2000: 528). This phenomenological approach relates directly to the use of artefact biography within this thesis and will be discussed in detail in chapter 2.

Landscape archaeology and industrial archaeology come together, practically and conceptually, in the study of the 'industrial landscape'. Paul Belford has argued that 'almost all English landscapes can be said to be industrial landscapes, in that they have been shaped by the forces of industrialisation' (2009: 179) and that the study of the industrial landscapes lies between the sub-disciplines of landscape archaeology and industrial archaeology.

Belford argues that all English landscape of the last 500 years can be considered as industrial landscape. Over this period our understanding of what makes an industrial landscape and its value have changed, while the role of human agency remains a constant and continuing factor (*ibid.* 179-80). To Trinder, the British experience between 1750 and 1850 created the industrial landscape (1982: 3-4). Before this time elements of local 'busy-ness' occurred in the landscape and after this time the industrial landscape was ready-formed (*ibid.* 4, 12-51, 202-244). Palmer and Neaverson (1994: ix) express a similar argument for the limits of their chronology as Trinder (1982:1-2), but allow more time for the creation of the industrial landscape, giving a timeframe between 1700 and 1900.

Landscape archaeology comprises a combination of documentary research and field survey with, where pertinent and possible, contributions of site excavation and scientific reports. Many of the tools for landscape archaeology are the same as those available for historic archaeology and industrial archaeology however certain resources especially lend themselves to the discipline: maps, aerial photography and satellite imagery, and place names.

This thesis considers the industrial archaeological sites within their landscape to illustrate spatial relationships and social, economic and technical networks.

1.6 Previous work and original contribution

1.6.1 *Previous work on the Derwent valley*

Accounts of iron working activities within the Derwent valley have been included in the county histories of Northumberland (Hodgeson 1902) and County Durham (Louis 1907; Sellers 1907) which are the key works for archaeological desk studies in the North-East. The histories are reasonably detailed about the industrial sites they include but are now dated with nearly eighty years of research between their publication and the three most significant works produced on the subject (Barraclough 1984a, 1984b; Cranstone 1997; North of England Civic Trust 2014). These works offer a view of the historic iron and steel industry and selected archaeology within a landscape without restriction of county boundaries.

In 1984 Kenneth Barraclough produced a two-volume study into steelmaking processes at a national level, based on his doctoral thesis for Sheffield University in 1981. The aim of the thesis was to present evidence for the development of steelmaking techniques before the establishment of the bulk processes of Bessemer and Siemens. Volume 1 dealt with blister steel manufacture; the Derwent valley is represented by Shotley Bridge, Blackhall Mill, Derwentcote and Ambrose Crowley's sites (Winlaton Mill and Swalwell) (1984a: 58), and the Allensford blast furnace (*ibid.* 64). As Barraclough's study was specifically steel production certain sites were omitted. His consideration of the national steelmaking scene produced the statement:

> There is no doubt that, through the first three quarters of the [18th] century, the important steelmaking centre in this country was in the North East, particularly along the valley of the Derwent. (Barraclough 1984a: 60)

In volume 2 Barraclough turned his attention to the later crucible steel making process. The Derwent valley played less of a role in this method and the two sites which practised the process, Swalwell and Derwentcote are briefly mentioned (1984b: 175).

David Cranstone's published 1997 report on the Derwentcote steel furnace includes a history of the site (17-25) which expands upon Barraclough's short list of Derwent valley sites, adding a forge to Allensford and introducing Gibside as another forge site. Crowley's first site, Winlaton, which was not involved with steel production is mentioned, as is a cementation furnace built on Derwenthaugh (*ibid*. 8). This cementation furnace is not included in this thesis as it was actually associated with the Blaydon Burn rather than the Derwent. Cranstone provides a map of the Derwent valley from Allensford to the Tyne (*ibid*. 8) showing the location of 18th and early 19th century iron and steel works.

A recent historic environment audit carried out by Cranstone on behalf of the North of England Civic Trust's 'Land of Oak and Iron' project (North of England Civic Trust 2014) focuses on the built heritage of the Derwent valley. Its geographical scope is similar to that of this thesis, though it includes the Blaydon area and terminates to the west at Eddy's Bridge, a little downstream from the Derwent Reservoir. Of the 30 archaeological sites audited for the project only 5 are iron working sites: Allensford, Derwentcote, Winlaton Mill, Winlaton, and Consett. The audit benefits from a written resource assessment (*ibid.* 30-35) detailing the iron and steel industry from the 16th century to the closure of the Consett Steel Works in 1980.

Discussions of the documentary sources concentrating on site-specific themes are presented within chapters 3 and 4.

1.6.2 *Contribution to knowledge and original research*

This thesis expands on the both the chronological and the geographic ranges of the previous studies. It integrates the medieval sites of the upper Derwent valley, above Allensford and Eddy's Bridge, and acknowledges the small independent steelworks which survived Consett on Derwent Haugh. This work provides the most up-to-date assessment of the state and range of archaeological remains of the local iron and steel industries.

Barraclough's study is an example of 'first generation' industrial archaeology, while Cranstone's report and the North of England Civic Trust's audit are both 'second generation' and heritage-centred in nature. This thesis takes the study of the iron industry in the Derwent valley into the area of 'third generation' industrial archaeology by the application of the Manchester Methodology, a first for a North-Eastern location and, as with the methodology of process recording to provide aspects of 'social' archaeology, this is original research. As both the Manchester Methodology and process recording tend to study social structure from a 'top down' perspective, this thesis seeks to incorporate the human, lived experience of the iron industry in the Derwent valley through artefact biography, using Derwentcote as the case study. The adaptation of the Manchester Methodology used in this thesis is an original contribution to knowledge.

A GIS of the iron industry is presented as part of this thesis in an electronic format in order to illustrate the findings of the study across the landscape in a manner which facilitates interrogation. Commentary on this GIS is given in chapter 5. The County Council GIS's present only HLC information within their own county boundaries, however, this thesis shows the iron industry across county boundaries concentrating on the geographical limits of the valley and is an original contribution to knowledge.

Chapter 2. Methodologies

2.1 Introduction

To achieve the aims and objectives of this thesis it has been necessary to employ a multifaceted, interdisciplinary approach, which draws on varieties of sources and techniques developed by historical archaeologists. Facets of the thesis methodology are shown on figure 2.1, below.

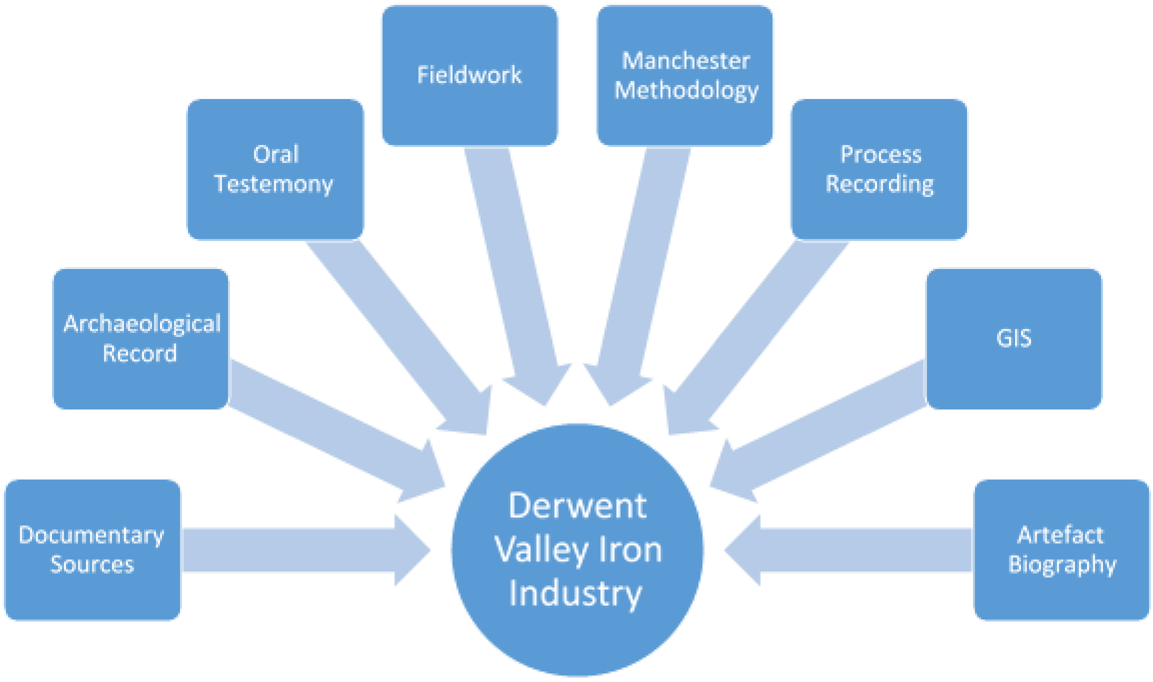

Figure 2.1 Facets of the methodology employed in this thesis

Chapters 3 and 4 comprise an historical archaeology, addressing the documentary and archaeological records respectively. A breakdown of the sources for the material used in the historical archaeology methodology is given in 2.2 below. Together, chapters 3 and 4 provide the most complete overview of the archaeological sites and remains of the iron industry within the valley to date, and provide the chronological context for the Derwentcote iron and steel works.

While chapters 3 and 4 reflect the practices of first and second generation industrial archaeologists, chapter 5 applies three third generation methodologies to the information they generated. Firstly, Manchester University's 'Manchester Methodology' has been applied to the study area to suggest a narrative of local industrialisation through the historic ownership of archaeological monuments by various social groups. Secondly, a programme of process recording has been carried out to create an understanding of the industrial processes which took place at sites throughout the study area. Finally, the results of chapters 3, 4 and 5 are presented as a multi-layered landscape through a Geographical Information System (GIS), appended in an electronic format, which will serve to highlight processual overlap and temporal mobility of the industry along the valley which, along with the photographic record, could form a strategic conservation tool to be used to inform any heritage management policy arising in the future.

Within the temporal, spatial, technological and social ownership context of the Derwentcote iron and steel works established through chapters 3 to 5, the site becomes the subject for an 'artefact biography', which is presented in chapter 6. The technique of artefact biography allows Derwentcote to be studied in greater depth than the other sites in the area as it employs a 'life cycle' approach, allowing the uses of the site before and after its use as an iron working centre to be taken into consideration. Included in chapter 6 is an in-depth analysis of the National Census Returns 1841-1911 which has provided an insight into the social aspect of the ironworks and how it was integrated into the wider local area. Through this work the names and occupations of individuals from the lower, often invisible, social classes can be used to populate the site. The built environment of Derwentcote is examined in chapter 6 to inform chronology, phasing and the choices available to the architects of the site.

2.2 Historical archaeology

2.2.1 *Documentary sources*

Chapter 3 pursues the methodology of documentary archaeology to synthesise archival material. The repositories for the source material are summarised in table 2.2 below. The results of this desk study not only indicate the location of the ironworking sites within the valley they also, where known, describe their periods of operation, the processes which took place, the sources of raw materials consumed and their markets.

Mary Beaudry states that historical archaeologists acknowledge that documentary evidence gives them an advantage over pre-historians (1993: 1). Babits argues that archaeologists have only a limited ability to critically analyse documents as they have not been trained as historians (1993:119). The relationship of archaeology to text has been recognised since the 17th century when historians first used archaeology to provide evidence confirming historical texts (Moreland 2001: 11). This relationship suggests an acceptance of a subservient role of archaeology to text by both historians and archaeologists: archaeology is the 'handmaiden to history' (Hume 1964: 214). In the 1980s archaeologists began to make the assertion that texts were produced by and for the literate, elite of society and demonstrated biases to meet the political and economic needs of those social classes. Some archaeologists, therefore, dismissed texts completely and relied only on archaeological evidence (Moreland 2006: 136-137). Historical archaeologists therefore needed to combine archaeology and text in a manner which satisfied their research requirements.

Archive sources and their addresses
Philip Robinson Library, Newcastle University
Cowen and Society of Antiquaries of Newcastle-upon-Tyne Libraries, Great North Museum, Newcastle-upon-Tyne
Literary and Philosophical Library, Westgate Road, Newcastle-upon-Tyne
Durham County Council, Consett Library, Consett, Co. Durham
Tyne and Wear Council, Winlaton Library, Winlaton, Tyne and Wear
Tyne and Wear Archives, Discovery Museum, Newcastle-upon-Tyne
Northumberland Library Service, Hexham Library, Hexham, Northumberland
British Library, 96 Euston Road, London – via inter-library loans
Royal Collection Trust, York House, St. James's Palace, London
Durham Historic Environment Record, Archaeology Section, Design and Historic Environment Team, Planning Service, Regeneration and Economic Development, Durham County Council, County Hall, Durham
Northumberland Historic Environment Record, Northumberland County Council, County Hall, Morpeth
Tyne and Wear Historic Environment Record, Newcastle City Council, Development management, Civic Centre, Newcastle-upon-Tyne
World Wide Web internet sources

Table 2.2 Repositories of documentary sources consulted.

Moreland (2001: 80-81) seeks to show how both objects and texts were active in the past; they were created and manipulated by people with the intention that their meanings could be 'read' and understood by others of their society. He links archaeology and text as both require a contextual approach as to the circumstances of their creation and use (2006: 142). Wilkie (2006: 25) argues for the integration of archaeology and documentary sources, text and oral histories, to construct more holistic histories by moving 'back and forth' between contexts. Hall (1999: 193-203) looks at the combination of archaeology and text to look at what is not said explicitly by either: a 'third space' of meaning. This is done by identifying contradictions between a source and its interpretation, where that interpretation appears to contradict consistent and mutually supporting strands of evidence (*ibid.* 193).

Giorgio Riello (2009: 37-42) reminds us that not all historical documents portray fact. They may be a work of fiction or a proposal for material culture never physically created. His study of the Victorian 'Aerial Steam Carriage' showed that this object appeared in several texts throughout the 1840s but had never been manufactured. To depend on the textual evidence only would imply the existence of 19th century powered flight. The absence of physical evidence suggests there was none. Between the material culture and the text lies the intention of creating such a machine. This thesis favours the approach of Wilkie and the integration of documentary sources and archaeological data for the creation of a holistic history.

The four main classes of documentary material are civil, personal, church and military records (Babits 1993: 120). Civil documents include probates, wills, National Census returns and newspaper articles, personal documents, letters and account books; the Church can provide parish registers, and military documents may offer details on individual soldiers and procurement orders for commercial items. Civil documents have formed the main basis of research for chapters 3 and 4, whether presented through original research or other academics' work synthesized into the thesis. Use has been made of the available National Census returns in chapter 6 where they have been instrumental in forming a view of the community of Derwentcote during its last phases of steel production.

Historic maps may be available through any of the four documentary classes and can be defined as contemporaneous with the information they depict (Seasholes 1993: 92). There may be, however, issues of accuracy and reliability with historic maps which should be considered by the archaeologist and commented upon if possible. Within artefact biography historic maps can be used to identify lost sites of production and consumption, and relevant settlement patterns. For sites along the Derwent valley the available historical maps are mostly from the civil class. The historical Ordnance Survey maps capture at least one phase of many of the archaeological sites in use and inform on their abandonment, these and maps from other civil sources are discussed in chapters 4 and 6.

To this 'paper' archive of documentary material may be added data from a class of texts which are simultaneously objects. This class of textual object includes such things as inscribed monuments, war memorials and the more mundane manufacturers’ stamps on commercially produced items. Harold Mytum (2004) has produced the biographies of several gravestones from graveyards in Ireland. In his methodology, he stated that 'the single most important category of evidence for the gravestone biography is the inscription' (*ibid*. 113). From the inscription, he could determine the names and relevant dates of those individuals to whom the gravestones had been erected. Focussing on the stone itself, where multiple interments had taken place, the occasions of the addition of text were viewed as events in the stone's life-history which changed the form of the stone and changed or regenerated its function and meaning. Other information from the gravestones was gathered from their condition and present position which suggested episodes of interaction, or lack of, with such social agents as relatives of the deceased and church authorities. In chapter 6 attention has been paid to the stamped bricks found scattered across Derwentcote. Through their analysis information on the phasing of several structures on the site has been highlighted.

David Crossley comments as follows on the data sets available to the historical archaeologist:

> This juxtaposition of the written and physical evidence is a keystone of work throughout the historic periods; it is the basis for interpretation by historian and archaeologist of, respectively, records without related structures and artefacts or, on the other hand, sites for which no records have been found. In addition, by extending the latter point, the evidence of place and time provided by field survey or excavation can give a new focus for documentary research, in which the significance of scattered references may be recognised. (Crossley 1990: 3)

Mary Beaudry (2009: 95-108) produced an artefact biography for several seventeenth century bodkins excavated from North American colonial sites. In the context of her study bodkins were multifunctional long pins/needles. Several of the bodkins were inscribed with initials and were therefore of the class of textual objects described above. Documentary research enabled archaeologists to identify individual owners through the initials and then provide more information on the owners which was added to the biography of the bodkins. In cases where the initials turned out to be makers marks the origins of those bodkins could be researched. As with most archaeological object biographies Beaudry's focus of study is the material culture which is informed by supporting literature.

2.2.2 *Oral history and oral tradition*

Oral history is a primary source material, it is the memories and recollections of individuals who will probably never produce an autobiography. Oral histories are therefore created by interested parties: archaeologists, historians, anthropologists, etc. who interview people who may have been involved with the subject of their current field of study to access this often unique material. Some oral history has been gathered for this thesis through informal meetings with individuals who visited the Derwentcote Forge Cottages during their excavation 2012-2016. The results of these interviews are presented in chapter 6.

It has been suggested that oral histories can only be produced in relation to the human lifespan (Jones 2007: 52; Abrams 2010: 18). The first-hand experiences of, for example, the occupants of the Derwentcote Forge Cottages, especially of those who lived there in the steel production period which ended c.1890-5, have passed beyond the point at which they can be recorded as oral history. Past generations may have passed on their experiences orally, and these may be collected through interview with descendants (see Roberts 1984: 104 for example) who may be using these experiences as comparisons to their own stories and thereby unwittingly pushing the limits of oral history beyond one human life. Such experiences are not first-hand and therefore they can be considered to be oral tradition: information from the past handed on from generation to generation by word of mouth (Renfrew and Bahn 2008: 190). This may be in the poetry and prose of 'legend', or a generalised historical knowledge (Finnegan 1996: 127). Like oral histories, oral tradition only exists in peoples' memories until an oral historian collects them and represents them in print (Orser 2004: 181).

The unpredictability of oral tradition can be seen within the data collected by the Rev. J. Ryan at Shotley Bridge, Co. Durham, in 1841. Amongst these traditions were tales of German immigrants who founded the village in the 16th century and built an iron forge there. This 'Old Forge' or 'German Forge' was said by the locals to have been built a century before 'official' historical sources report the arrival of the German sword makers in the late 17th century (Ryan 1841: 109-110; Sellers 1907: 289-290). The German Forge provided a mnemonic to the locals of Shotley Bridge for the great age of the German community. However, in chapter 4, evidence is examined that suggests the German Forge was not named for the German sword makers but possibly for the German steel maker, Wilhelm Bertram. The mnemonic quality of buildings can be seen as an active agent through which history or legend can be held and transmitted to succeeding generations (Yentsch 1993: 11), but mnemonics depend on the visibility of the building or any material culture. Anne Yentsch (*ibid.* 5-6) considers the value of oral history within the field of documentary archaeology to be its embodiment of folk history encoded in which is ethnographic information about social values and folk ideas about history, society and culture.

Some important sources for accessing oral tradition can be found amongst local history societies and independent local amateur historians. Oral traditions collected by these sources are unique and can often be collaborated by documentation. Some of these traditions may contain truth but others must be erroneous. For example, there persists in Blackhall Mill an oral tradition that iron was brought up the Derwent by boat to the steelworks there (Platt 2016: pers. comm.). In reality the river is knee deep at Blackhall Mill and, as well as having a few natural waterfalls downstream, the river had been dammed in numerous places during the steelwork's period of production.

2.2.3 *Archaeological record*

Chapter 4 assesses the archaeological record. Material has been gathered through the county historic environment records (HERs) for Northumberland, Durham and Tyne and Wear, and through the grey literature available through the Archaeological Data Service. Additional sites, not appearing within the HERs have been suggested through sources in chapter 3 and these have been integrated into the archaeological record. A program of fieldwalking was carried out to verify the current condition of archaeological remains. The on-line versions of each database were searched for monuments: the Northumberland and Durham HERs have been combined into one database (http://www.keystothepast.info/), the Tyne and Wear database's (http://www.twsitelines.info/), and Historic England's database (http://pastscape.org.uk/).

2.2.4 *Fieldwork*

A programme of field survey and recording has been carried out in accordance with the guidelines in *Understanding Historic Buildings: English Heritage Guide to Good Recording Practice* (2006). Many of the archaeological remains of the iron industry within the valley are not buildings so the term 'monuments' has been used for the purposes of this thesis. Field survey was undertaken in order to confirm the existence of the archaeological remains and their current condition and to illustrate the narrative with new photographs. English Heritage surveys have three elements: drawings, photography and written accounts. These are carried out to increasing degrees of complexity through the four survey levels.

For this thesis, elements of a level 3 – analytical record – surveys have been selected. Level 3 surveys would normally include measured drawings of monuments, however, no new drawings were made of standing monuments for this project because the drawings that have been made during the original survey or excavation are still valid records. The photographic element of the survey is expected to contain a general view, or views, of the monument to place it in its wider landscape and record the monuments external appearance. The written element of a level 3 survey is covered by chapters 3, 4 and 6.

An analysis of the documentary and archaeological research carried out for chapters 3 and 4 produced a list of monuments, or sites of monuments, throughout the valley. A Health and Safety risk assessment was carried out to cover the study areas which would be visited using local knowledge of the terrain. Some monuments or sites were known to have been removed over time, only to be known through geophysical prospection, or to be in remote rural areas. In order to find them National Grid co-ordinates were plotted on maps produced through the Digimap service at several scales to determine their precise location. Photographs were taken using a Kodak Pixpro FZ151 16-megapixel digital camera. The results of the survey have been integrated into chapters 4 and 6 of the thesis.

2.3 Industrial and landscape methodologies

2.3.1 *The Manchester Methodology*

The Manchester Methodology was selected for application to this thesis because it was specifically designed to be a tool for industrial archaeology. It was developed by Michael Nevell and the University of Manchester Archaeological Unit (UMAU) to both describe landscape from an archaeological viewpoint and to analyse social structure based on the ownership of the sites (Walker and Nevell 2003: 11, Nevell 2005a: 87). The methodology 'can analyse sites at a micro-level as well as landscapes at the macro-level' (Gwyn 2005a: 129). The present use of the Manchester Methodology contributes a new (and first) case study from the North-East of England to the body of work created through the application of this approach. The methodology was named for the initial study areas around Manchester. As Nevell explains:

> This approach was distinctive in the way it combined three methodologies: firstly, in its emphasis on material remains; secondly in its landscape analysis through identifying new monument types introduced during the period under study and then relating them to the monument type categories as listed in the RCHME's *Thesaurus of Archaeological Monument Types*; and thirdly in the use of geographical, historical and socio-economic evidence to relate these new monument types to the contemporary social structure. (Walker and Nevell 2003: 17)

Nevell maintains that the stress on the combination of methodologies above is 'essential if archaeology is to make a contribution in its own right to the origins of industrialisation' (2005b: 178). The Manchester Methodology is based on three steps: making sense of the archaeological database, assessing the ownership of the archaeological site types, and establishing an archaeological narrative (Walker and Nevell 2003).

The archaeological database is created from entries on the National Monuments Record, now held by Historic England and the local county Historic Environment Record which hold both records of standing archaeological remains and examples of sites preserved by record. The database may contain multiple examples of a particular monument type; the UMAU noted 274 textile sites in its primary case study of Tameside. The Manchester Methodology, however, only takes account of the earliest dated example of a site type (in this case textile sites) reducing the result to one new monument type. A common framework of reference for the new monument types is provided by Historic England's *Thesaurus of Archaeological Monument Types* which gives a schema of monument types within 18 monument categories against which monument types from any database can be ascribed. The UMAU chose the three-hundred-year period 1600-1900 for its initial case study as this covered the period of local industrial development. Prior to 1600 Tameside was essentially rural in nature. Within the 300-year period the UMAU identified over 100 new monument types. These new monument types were plotted on a cumulative graph (fig. 2.3) to show how the total range of sites expanded over time.

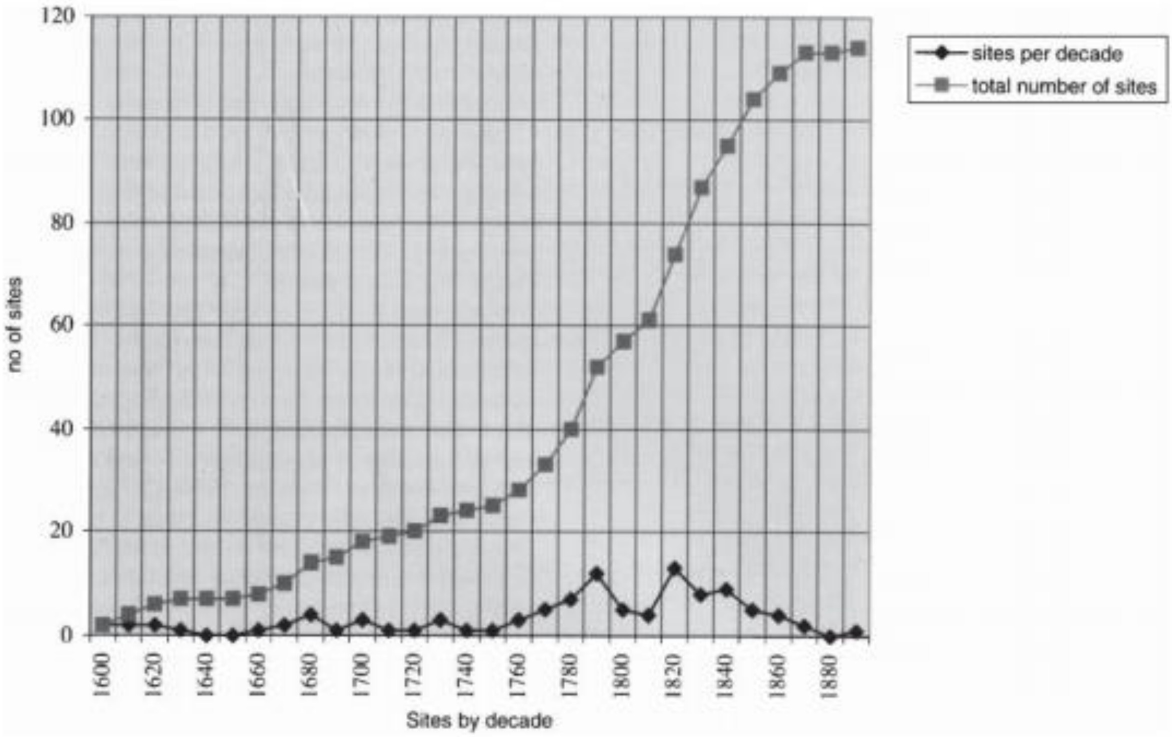

Figure 2.3 Monument types introduced into Tameside during the period 1600-1900

(Nevell 2005a: 89)

The Tameside results produced an S-shaped line on the graph. This was interpreted as evidence for four phases of development: an adaptive phase where change was slow, an expansive phase with rapid growth, a consolidatory phase with less rapid growth and a final maturity phase where development slowed or stopped (Nevell 2005a: 89).

The second step was to ascribe 'ownership' of each new monument to a social class. Ownership relates to the direct or permissive control of landholdings and the creation of the new monument type upon them. This was to determine how different social classes influenced industrialisation. The UMAU recognised a hierarchy of three social classes within the Tameside area: lords, freeholders and tenants. Based on evidence of tradition and contemporary legal documents the new monument types were allocated to one of the social groups and each set of results were plotted as cumulative graphs against time (fig. 2.4).

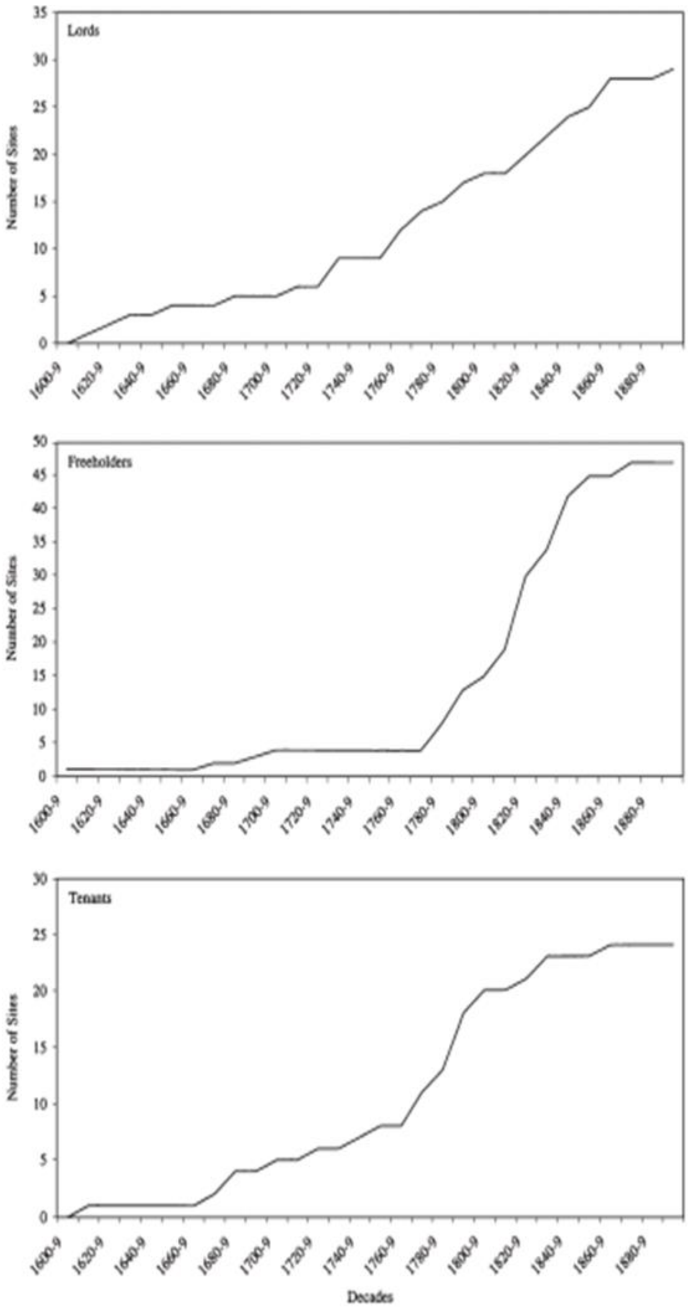

Figure 2.4 The distribution of monument types in Tameside according to social class, 1600-1900. From top to bottom Lords, Freeholders and Tenants monument types. (Nevell 2005a: 90)

Using the data generated in the first two steps, the third step of the Manchester Methodology then creates an informed narrative of local industrialisation. From the Tameside case study, it is suggested that lords generated revenue by exploiting the resources on their land which could then be spent on capital projects. Freeholders appeared to receive their income mainly from agriculture until the later years of the 18th century. Tenants made the first moves into industrialisation by the beginning of the 18th century and expanded steadily until the late 18th century when, joined by the freeholders, both social groups experienced the expansionary phase noted above, with freeholders substantially out-creating tenants with new industrial site types throughout the 19th century.

The UMAU have applied the Manchester Methodology to several other sites in the Manchester area to test its value as a model of industrialisation: the rural manor of Warburton, the rural manor of Dunham Massey - which only began limited industrialisation from the 1850s, and the urban centre of Manchester itself. The results for Warburton (fig. 2.5) show a straight-line growth indicating a constant investment in new monument types by the lords and tenants who populated the manor.

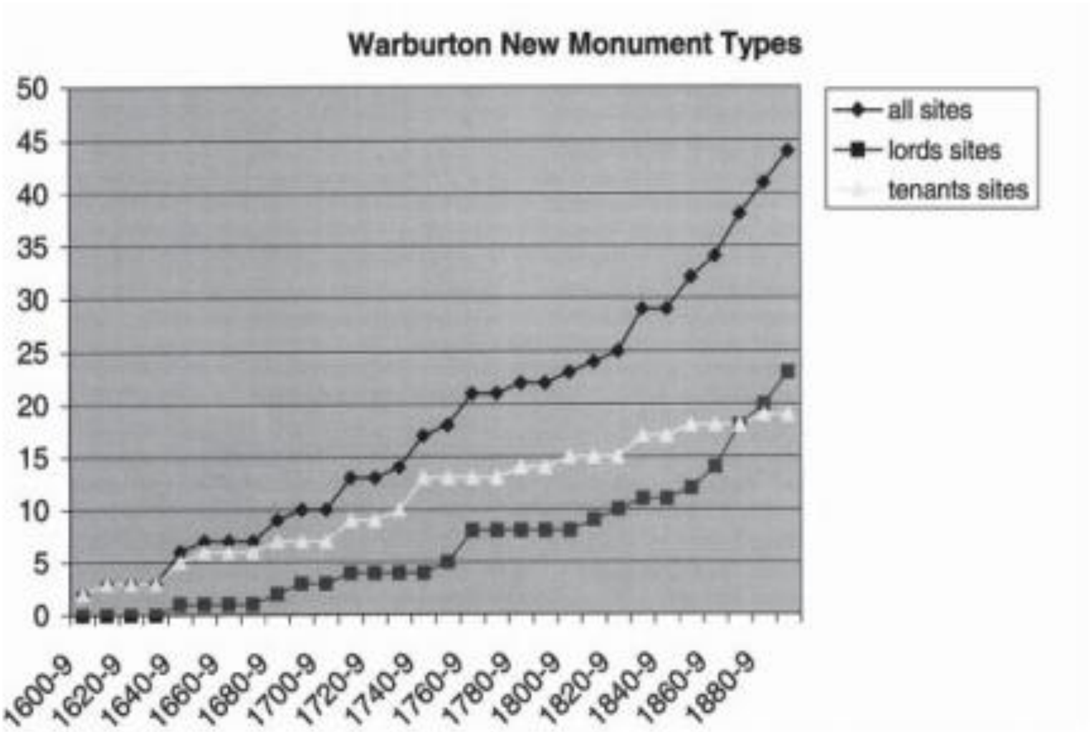

Figure 2.5 Monument types introduced into Warburton during the period 1600-1900

(Nevell 2005a: 92)

For Dunham Massey, the results (fig. 2.6) show a stepped development with the second burst of activity occurring from the industrialisation period of the 1850s, with the tenant class contributing. At Dunham Massey, the tenant class do not contribute to the initial expansionist phase in the 1720s but are active for the industrialisation process. The results for Manchester (fig. 2.7) closely match the development pattern for Tameside with a clearly defined S-curve to the illustrative graph.

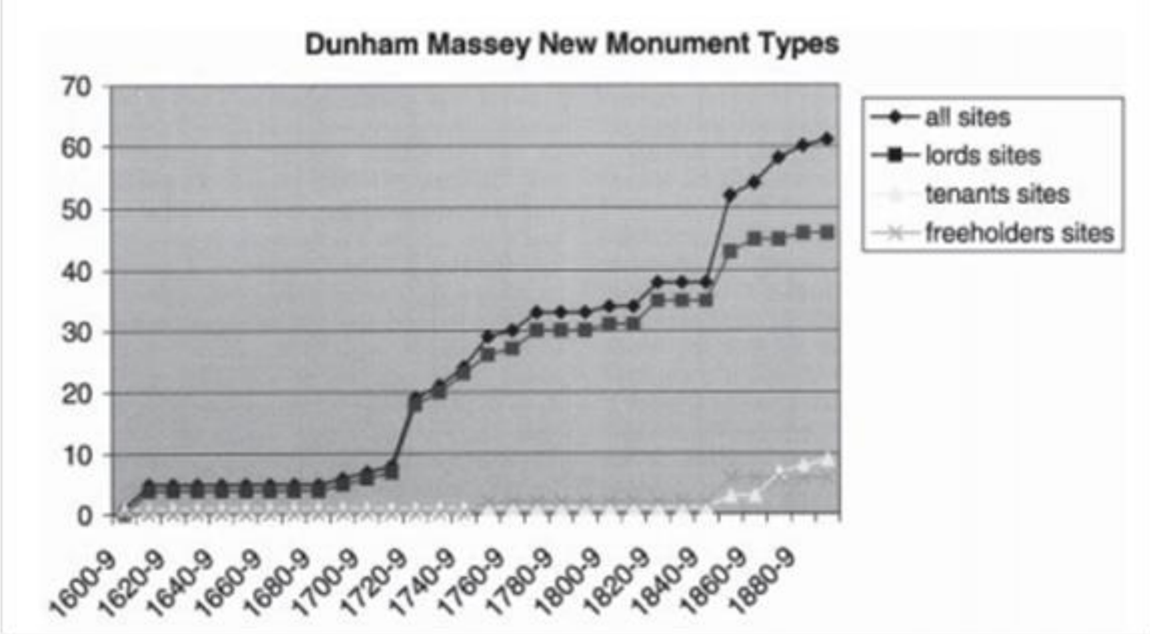

Figure 2.6 Monument types introduced into Dunham Massey during the period 1600-1900

(Nevell 2005a: 92)

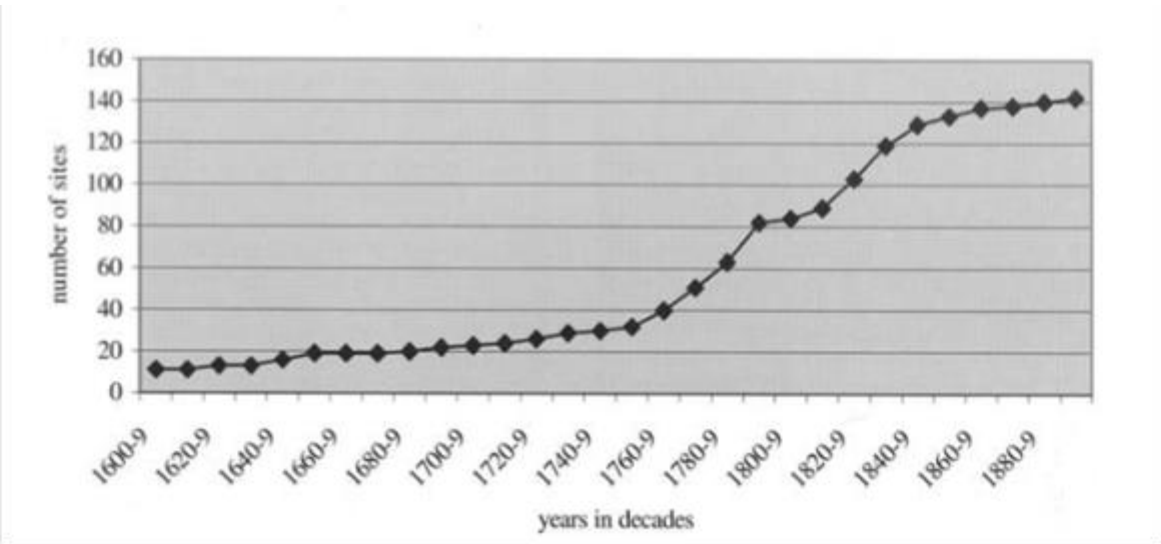

Figure 2.7 Monument types introduced into Manchester during the period 1600-1900

(Nevell 2005b: 182)

The Manchester Methodology has been employed at other locations (Nevell 2005a: 95, 2005b: 180). Colin Rynne carried out an unpublished survey of County Offaly in the Republic of Ireland on behalf of the UMAU and David Gwyn in 2003 (Gwyn 2005b: 129-130). Gwyn has indicated that the methodology was used successfully to explain the limited industrial development created by the construction of a canal in that area but that it required adaptation to make sense of the Irish experience (*ibid.* 130, 138). In Gwyn's own study of the Vale of

Ffestiniog modification was also thought to be required. The social structure of Ffestiniog was found not to fit comfortably within the UMAU's 'lord, freeholder and tenant' framework and Gwyn suggested 'patrician, middling sort and plebeian' as suitable replacement terms plus a fourth class representing landless capital which he named 'citizen or burgess' (*ibid*. 135). Gwyn also questioned the quantitative nature of the UMAU's methodology in taking consideration of only the earliest appearance of a new monument type. Gwyn argued that this approach ignored qualitative changes within monument types which may indicate significant cultural changes throughout a landscape, a point he illustrated by the example of a break with vernacular architecture within chapels. Marking the change of the form of a monument type could reveal shifts in the patterns of production, distribution, consumption, social structures and technology: 'it is these which mediate the cultural space of human society' (*ibid*. 135).

In applying the Manchester Methodology to the Derwent valley the time-span for the survey, 1600-1900, remains the same as that used by the UMAU. This is to allow for ease of comparison between the case-study of the Derwent valley and those published by Walker and Nevell (2003) and Nevell (2003, 2005a, 2005b). From the perspective of the iron industry in the valley, the 1600 start date for the industrialisation period works well as it is contemporary with what has been documented as the first blast furnace site in the valley at Gibside in 1608. The importance of Gibside in this instance is that it introduced the technology which superseded the medieval bloomery smelting process into the Derwent valley.

The first step in the methodology is to search the local HER databases for relevant sites. As will be discussed in chapter 3 below, some medieval and 16th century iron working sites have not been recorded by the HERs and other, recorded sites, have received ambiguous dates. Within the Tyne and Wear database, entries for the Derwent valley are all found under the 'Gateshead' search criteria for *district.* Gateshead covers the north east of the valley from Derwenthaugh, through the iron working sites of Swalwell, Winlaton, Winlaton Mill, Gibside and Blackhall Mill. The Northumberland and Durham entries were found by entering parish and larger place names (Blackhall Mill, Blanchland, Castleside, Consett, Hamsterley, Edmundbyres, Healey, Hunstanworth, Medomsley, Muggleswick, Shotley Bridge, and Shotley Low Quarter) into the 'simple search' box. Care had to be taken not to include entries which fell outside the study area; for example, the Burntshield sites of Blanchland, and some sites in Healey which lie in the catchment areas of the Devil's Water and the Stocksfield Burn, both tributaries of the Tyne.

During this initial search monuments dated to medieval periods or earlier, monuments dated to the 20th century or later, monuments whose date was given as ‘uncertain’ and monuments which were deemed to have been seen on aerial photographs were dismissed as being outside the dating limits of this survey. Within the Northumberland and Durham HERs the post-medieval period is described as being between the years 1540 and 1901 which has been treated as analogous to the Manchester Methodology’s industrial period range of 1600 to 1900; all monuments counted as post-medieval by the HERs have been counted in the database.

Several of the monuments appeared twice. In some instances, where the monuments were on the border of Northumberland and Durham they appeared in each county’s separate HER (for example, Blanchland Bridge and the lead workings at Silvertongue). Some monuments in the Durham HER have two separate numbers: the Edmundbyres youth hostel, the Graham’s Flat lime kiln and the Derwentcote steel furnace have both a three or four-digit number and what appears to be a new five-digit number which links with the site or monuments NMR number. Once double entries were removed a list of 986 sites and monuments remained.

Both Historic England and the Tyne and Wear HER classify their monuments in terms of the *Thesaurus of Archaeological Monument Types* definitions. The Northumberland and Durham HERs apply their own classifications to some of their records but it was simple to convert those classifications to those of the *Thesaurus*. Some monuments were not subsumed under any *Thesaurus* definitions; these included Church land, glebe land and animal shelter. These were discarded, while others were amended slightly in order to become acceptable: a ‘bridge, suspension’ became a suspension bridge. Once all 986 monuments had been ascribed to a monument type which is listed at any level within the hierarchy of the *Thesaurus*, the earliest example of each monument type recorded within the archaeological database was found. This example will hence forth be referred to as the ‘new’ monument type.

There are 214 new monument types identified within the study area. These new monument types fall into 15 out of the 18 monument classifications of the *Thesaurus*: agriculture and subsistence, civil, commercial, communications, domestic, education, gardens, parks and urban spaces, health and welfare, industrial, monument, recreational, religious, ritual and funereal, transport, unassigned, and water supply and drainage. Those categories missing from the Derwentside landscape are commemorative, defence and maritime.

The first adaptation made to the Manchester Methodology addresses the ambiguous nature of the dating of the archaeological sites within the HER databases by providing a method for showing them within the results. Of the 214 new monument types, only 94 have a definite date or can be ascribed to a specific decade. The remaining 120 new monument types have been placed by the HERs into one of 22 broader time periods which are given in table 2.8. Through the research carried out in chapter 3 exact dates for the appearance of new monument types relating to the iron industry have been found and have replaced the broader, and sometimes erroneous, date periods shown in the HERs. General background research suggests that forms of other industrial development were either too limited to form a significant contribution to the survey or, in the case of coal mining, formed a constant presence over the post-medieval period. Neither coal mining nor the other non-iron industries appeared likely to cause 'spikes' of activity within the results. To verify this statement further research into dating HER monuments could be carried out to produce exact dates.

Earliest date for appearance of site type	Number of site types for that date
1600 - 1610	4
1611 - 1620	2
1621 - 1630	2
1631 - 1640	2
1641 - 1650	
1651 - 1660	1
1661 - 1670	1
1671 - 1680	1
1681 - 1690	5
1691 - 1700	7
1701 - 1710	1
1711 - 1720	5
1721 - 1730	4
1731 - 1740	8
1741 - 1750	6
1751 - 1760	5
1761 - 1770	1
1771 - 1780	8
1781 - 1790	6
1791 - 1800	
1801 - 1810	4
1811 - 1820	1
1821 - 1830	2
1831 - 1840	4
1841 - 1850	1
1851 - 1860	3
1861 - 1870	2
1871 - 1880	3
1881 - 1890	2
1891 - 1900	3

Earliest date for appearance of site type	Number of site types for that date
Post-medieval period	10
Pre-1700	1
17th century	4
Early 17th century	1
Late 17th century	1
18th century	22
Early 18th century	7
Mid-18th century	4
Mid to late 18th century	3
Late 18th century	8
18th to 19th century	2
19th century	12
Early 19th century	2
Early to mid-19th century	1
19th century present by 1850 OS map	4
19th century present by 1856 OS map	17
19th century present by 1864 OS map	3
19th century present by 1865 OS map	4
19th century and pre-1860	1
Mid-19th century	3
Mid to late 19th century	2
Late 19th century	8

Table 2.8 Distribution of new sites by decade or broader time period given by HER

For this thesis the number of new monument types which first appear within each of the 22 broader time periods are divided by the number of years for that period suggested by its HER description. As the results of this survey are shown by decade the result of this division is multiplied by 10. For example, the 10 sites dated to the broadest, post-medieval, period were divided by the 300 years of the total industrial period being studied (1600-1900), and that result was multiplied by the 10 years of each decade ((10 / 300 = 0.033) x 10 = 0.333 sites per decade). The number of sites attributed to any one century were divided by 100 and multiplied by 10. This was done in order to prevent loading broadly dated new monument types into any one particular decade and producing a bias in the results. The same process was followed for the early, middle or late periods of a century, each of these periods have been taken to be 33 years in duration. Early-to-mid or mid-to-late century dates were taken to be 66 years. Twenty-nine sites were given a date of the 19th century and were also noted as first appearing on the first edition of the Ordnance Survey map. The published dates ranged from 1850 to 1865. As some sites were marked as ‘old’ on the maps they may have pre-existed the published date. Sites first appearing on the 1850 OS map were divided amongst the first five decades of the 19th century, those on the 1856 map, and one site dated to ‘pre-1860’, to the first six decades, and those on the 1864 and 1865 maps to the first seven decades. It may be that the sites first appearing on these maps were 18th century or earlier but the HERs have given them a 19th century date.

The results of the process are given in 2.9 below. The single site recorded as dating to 'pre-1700' was added to the sites attributed to the '17th century'. Sites '19th century and pre-1860' were added to '19th century present by 1856 OS map' and the sites of the '19th century present by 1864 OS map' were combined with those of '19th century present by 1865 OS map', producing 19 broad periods.

The 120 rounded whole numbers of new sites per decade for table 2.9 were added to the 94 new sites whose actual dates were known, shown in table 2.8 and their total given in table 2.10. Using this process all 214 new archaeological site types could be allocated an appearance date within a decade over the 300-year period of the survey.

The second step, concerning the ownership of the archaeological monument types, also required adapting from the Manchester Methodology's 'lord, freeholder and tenant' social structure. The terms used for the present survey are 'gentry, entrepreneurs and civic'. This is because the 'lord' class is almost invisible in the industrial development of the Derwent valley. Gentry is a preferred term here because many of the Derwentdale estates were essentially held by the same families throughout the survey period, only some members of which were ennobled. The industrial development in valley from the late 17th century for the iron trade was stimulated by investment from 'entrepreneurs' originating from outside the area who took leases throughout the valley. The documentary record indicates a second period of industrial growth in the area. From 1840 the huge Derwentside Iron Works at Consett and other trades such as the Annandale paper mills were also created through entrepreneurial input. The initial entrepreneurs were not tenants in the UMAU sense who, at a cost, were exploiting the lord's resources, but represent concerns who, for various reasons discussed in chapter 3, primarily required land and water for power within the Derwent valley. A third social group, who were unlikely to ever own a monument, were the working class. This group were the largest users of civic or public monument types such as roads, hospital and railway stations. In the 17th and 18th centuries such monuments may have been produced as capital projects by the lords but during the mid to late 19th century such monuments would be the product of Victorian local government which Nevell (2005a: 91) sees as analogous to one-another as controlling bodies. However, by creating a 'civic' social group a division can be made between the monuments created by the gentry for their own use in the hearts of their estates and those which were created for the public good. This sheds light on the improvement of conditions of the working class which is not clear in the original Manchester Methodology. An important change to the Manchester Methodology here is the shift to examining who used or benefitted from each new monument type rather than who owned it.

In order to study how the three social classes benefitted from the new monument types the methodology used by the UMAU was followed; the local tradition and documentary history of the area was considered and used to attribute the benefit derived from each new monument type to a social class. The 214 new monument sites were ascribed to one of the three groups defined above. There was a degree of subjectivity in the allocation of monuments to groups which was ameliorated by guidance from Nevell who suggested that tenants, or in this project's case, leaseholders, would create their own infrastructure and that 'control' of a site was allocated 'to a group whom we could be reasonably satisfied had a combined influence on the building and form of the site that was greater than any other group' (2005a: 90). Of the 214 new sites, 60 were ascribed to the gentry, 115 to entrepreneurs and 39 to the civic group. The apportioning of new monument types to the beneficiary groups per decade where no definite date of creation is known was carried out using the same process as above.

The results of this application of the Manchester Methodology to the Derwent valley are presented in chapter 5. They are accompanied by a discussion of the model of industrialisation created by this methodology for the Derwent valley.

Date	Post-medieval	18th to 19th C.	17th C.	18th C.	19th C.	Early 17th C.	Late 17th C.	Early 18th C.	Mid 18th C.	Mid to Late 18th C.	Late 18th C.	Early 19th C.	Early to Mid-19th C.	Mid 19th C.	Mid to Late 19th C.	Late 19th C.	19th C. by 1850 OS	19th C by 1856OS Pre-1860	19th C. by 1864/65OS	Total	Rounded total
1600 - 1610	0.33		0.5			0.3														1.13	1
1611 - 1620	0.33		0.5			0.3														1.13	1
1621 - 1630	0.33		0.5			0.3														1.13	1
1631 - 1640	0.33		0.5			0.1														0.93	1
1641 - 1650	0.33		0.5																	0.83	1
1651 - 1660	0.33		0.5																	0.83	1
1661 - 1670	0.33		0.5				0.1													0.93	1
1671 - 1680	0.33		0.5				0.3													1.13	1
1681 - 1690	0.33		0.5				0.3													1.13	1
1691 - 1700	0.33		0.5				0.3													1.13	1
1701 - 1710	0.33	0.1		2.2				2.1												4.73	5
1711 - 1720	0.33	0.1		2.2				2.1												4.73	5
1721 - 1730	0.33	0.1		2.2				2.1												4.73	5
1731 - 1740	0.33	0.1		2.2				0.64	0.89	0.27										4.43	4
1741 - 1750	0.33	0.1		2.2					1.2	0.45										4.28	4
1751 - 1760	0.33	0.1		2.2					1.2	0.45										4.28	4
1761 - 1770	0.33	0.1		2.2					0.89	0.45	0.73									4.7	5
1771 - 1780	0.33	0.1		2.2						0.45	2.4									5.48	6
1781 - 1790	0.33	0.1		2.2						0.45	2.4									5.48	6
1791 - 1800	0.33	0.1		2.2						0.45	2.4									5.48	6
1801 - 1810	0.33	0.1			1.2							0.6	0.15				0.8	3	1	7.18	7
1811 - 1820	0.33	0.1			1.2							0.6	0.15				0.8	3	1	7.18	7
1821 - 1830	0.33	0.1			1.2							0.6	0.15				0.8	3	1	7.18	7
1831 - 1840	0.33	0.1			1.2							0.18	0.15	0.64	0.18		0.8	3	1	7.58	8
1841 - 1850	0.33	0.1			1.2								0.15	0.9	0.3		0.8	3	1	7.78	8
1851 - 1860	0.33	0.1			1.2								0.15	0.9	0.3			3	1	6.98	7
1861 - 1870	0.33	0.1			1.2								0.1	0.64	0.3	0.73			1	4.4	4
1871 - 1880	0.33	0.1			1.2										0.3	2.42				4.35	4
1881 - 1890	0.33	0.1			1.2										0.3	2.42				4.35	4
1891 - 1900	0.33	0.1			1.2										0.3	2.42				4.35	4
	9.9	2	5	22	12	1	1	6.94	4.18	2.97	7.93	1.98	1	3.08	1.98	7.99	4	18	7	119.95	120

Table 2.9 Distribution of broad period sites by decade

Earliest date for new site	Number of dated new sites from table 2.8	Number of broad period new sites per decade calculated in table 2.9	Total new sites per decade
1600 - 1610	4	1	5
1611 - 1620	2	1	3
1621 - 1630	2	1	3
1631 - 1640	2	1	3
1641 - 1650		1	1
1651 - 1660	1	1	2
1661 - 1670	1	1	2
1671 - 1680	1	1	2
1681 - 1690	5	1	6
1691 - 1700	7	1	8
1701 - 1710	1	5	6
1711 - 1720	5	5	10
1721 - 1730	4	5	9
1731 - 1740	8	4	12
1741 - 1750	6	4	10
1751 - 1760	5	4	9
1761 - 1770	1	5	6
1771 - 1780	8	6	14
1781 - 1790	6	6	12
1791 - 1800		6	6
1801 - 1810	4	7	11
1811 - 1820	1	7	8
1821 - 1830	2	7	9
1831 - 1840	4	8	12
1841 - 1850	1	8	9
1851 - 1860	3	7	10
1861 - 1870	2	4	6
1871 - 1880	3	4	7
1881 - 1890	2	4	6
1891 - 1900	3	4	7
			214

Table 2.10 Total number of new sites by decade

2.3.2 *Process recording*

Process recording is the second methodological tool to be employed in order to examine the social aspect of the iron industry within the Derwent valley. Matthew Johnson has stated that 'We cannot study social life without a deep understanding of technical processes and we cannot understand technical processes without a deep understanding of social context' (2009: xvii). The importance of process recording at industrial sites has been succinctly presented in the summary of Brian Malaws' 1997 paper in the *Industrial Archaeological Review:*

> Industrial processes whether operational or not, particularly those with local applications, should be recorded as an integral part of any field recording project wherever possible. Such records will not only contribute towards a more comprehensive insight into the nature of industries and their sites, when studied alongside the more usual architectural and historical aspects, but will stand as an accurate historical source of information and as an aid to interpreting incomplete, damaged or long defunct sites. (Malaws 1997: 75)

Malaws suggests that process recording should be the next, or additional, step to the traditional method of recording individual items of machinery which, at the time of his paper, were not necessarily related to a general ground plan (*ibid*. 75). He produced a bullet list of six reasons for the recording of industrial processes (*ibid*. 77) of which the most pertinent to this project are: the production of an enhanced understanding of the operation and architecture of a site, an insight into the reasons for location and their relationship to their environs, and the interpretation of damaged, incomplete or demolished sites. A 'best practice' methodology for process recording was then set out and as a case study Malaws presented the activities carried out at the Taff Merthyr Colliery, south Wales. The favourable outcome of the process recording technique led to other sites undergoing the same treatment although, Malaws acknowledges, 'not so exhaustively' (*ibid*. 80).

Also working in the mid-1990s, Norwegians Rossnes and Naevested attempted to carry out an archaeological survey on abandoned whaling stations on South Georgia. The main constraint for this survey was time on site. The Norwegians developed a 'pragmatic' approach whereby 'instead of surveying every piece of machinery and other artefacts, architectural details, and the history of each building, the focus in the South Georgia survey was to establish and record the functions of the various parts of the stations' (Basberg *et al* 1996: 53). Consequently, some minor buildings were omitted from the survey and measurements may have been compromised (*ibid*. 1996: 55). New maps of the stations were created through applying photogrammetry to images taken from the surrounding hillsides. The individual buildings were sketched and their dimensions surveyed and a full photographic survey of the sites completed. The South Georgia project approached process recording, as described by Malaws, with the realisation that, while existing plans indicated the main use attributed to a building, there may have been multiple floors and other functions carried out within the structure, the recording of which would take significant time. The pragmatic approach required that:

> The degree of accuracy was to be sufficient to make the survey useful as a functional description of the stations in terms of the organization of the production process and the living conditions. The survey was also to be sufficiently detailed to be useful as background material for interviews with former whalers. Consequently, more effort was put into the fixed interiors in the barracks (beds, closets, lavatories, and showers), factories (boilers, cookers, dryers, transport systems, and winches) and workshops (lathes, drilling machines, and work benches of all kinds) than a detailed survey of the exterior of the buildings (*ibid.* 55).

This paper does use oral testimony from retired shore station whalers for the living conditions at South Georgia but stops short of exploring how the employees lived and worked, though it recognises this as a possible future research direction (*ibid*. 59).

Frode Saeland of the Norwegian Mining Museum gained funding to carry out a recording project on an active mining site, the Titania mineral ore mine at Tellnes, and an abandoned Titania ore mine at Sandbekk in the South-West of the country in the opening decade of this century. The Sandbekk site was due for demolition and so required preservation by record. He initially wanted to follow Malaws' methodology but financial and time constraints forced Saeland to adopt the pragmatic approach developed by Rossnes and Naevested. Saeland critiqued Malaws' methodology as being 'more suited for traditional industrial archaeology and architectural history, not industrial sites in operation' (2007). This remark appears to run contrary to Malaws' observation that 'It is important to get in early while the industry is still working in advance of closure' (1997: 93) in order to record primary data defined as 'observing and recording the actual operation as a process at first hand' (*ibid*. 93). The conclusion of Saeland's paper suggests an underlying dissatisfaction with the 'so-called pragmatic approach' (2007), though this may have been due to a disappointment with the Norwegian government's attitude to physical industrial remains.

Within this thesis, the pragmatic approach of Basberg *et al* to process recording has been applied because almost all the machinery, artefacts, and architectural details relating to the ironworking industry in the Derwent valley have been lost. Process reconstruction has been created through historical documentary sources and archaeological reports. The degree of accuracy is sufficient to make the survey useful as a functional description of the production processes within the valley (1996: 55).

2.3.3 *Representation of the industrial landscape*

The spread of ironworking sites throughout the Derwent valley constitute a historic landscape both in terms of geography and in terms of relational links between the sites. To help understand a historic industrial landscape Marilyn Palmer and Peter Neaverson have created a six-point plan which lists the elements that constitute an industrial landscape: the source of raw materials, the form and function of the processing plant, the power sources, the generation of secondary industry, accommodation and transport (1994: 13-17). These elements are discussed in chapters 3 and 4.

Palmer and Neaverson recommended a three-stage process for analysing industrial landscapes. These are: establishing the reasons for the location of industry within the landscape, recording how that industry in those locations changed through time and an analysis of spatial patterns between industrial sites, settlements and transport systems (1998: 16-25). The discussion of the elements of an industrial landscape within chapters 3 and 4 satisfies the first two stages of Palmer and Neaverson's process. The third stage is addressed through the Geographic Information System (GIS) created for this thesis which combines data generated within chapters 3 and 4 with the information produced from the Manchester Methodology and process recording in chapter 5.

As is now widely appreciated, 'Implementing an appropriate GIS should be one of the first undertakings in any major archaeological project' (Rapp and Hill 2006: 130). GISs are used to turn data produced through such projects into usable digital cartographic information. The three prime applications for GIS within archaeology are location analysis, historic resource management, and predictive modelling (Church *et al* 2000: 135). In this study of the Derwent valley, GIS has been used to primarily model and analyse archaeological location. Kenneth Kvamme has outlined the importance of modelling archaeological location: human behaviour, in this case the iron industry, is patterned with respect to the natural environment and culturally constructed social environments; by observing relationships between archaeology and the environment we can learn how people interact with the landscape and GIS provides a tool for mapping what we know (2006: 6). GIS also provides a tool for visualising the historic landscape (Church *et al* 2000: 135).

For a simple GIS, information which is gathered through desk study and fieldwork is entered into a database which gives each entry a unique reference number. Against the unique number such information that has been gathered and is to be displayed is entered: these are called ‘attributes’. At the most basic level the attributes may include a location name but must include a grid reference number. In Britain, it is most usual to use the Ordnance Survey (OS) National Grid. This is so that locations can be ‘georeferenced’ in a standardised manner onto a base map. A wide range of OS base maps of Great Britain are readily available and downloadable through the Edina Digimap service. Data within a GIS is viewed in layers over the base map. Layers can be turned on or off and rendered partially transparent to illustrate various outcomes to research questions. The application of attributes from a database to a base map is called ‘geometry’; creating new geometry within a GIS is called digitising which may take one of three forms: points, lines and polygons. Point data can be used to indicate single sites of find spots (fig. 2.11). It appears on a base map as an icon, such as black or coloured dot, centred on a single grid coordinate. Line data is used to represent linear objects such as rivers and roads; they are created by linking points or vertices within an electronic file where each vertex has its own grid coordinate. Lines can be made to bend by placing a vertex at each change of direction of the line. Polygon data is used to represent closed shapes, whether regular or irregular; they are created in the same way as line data but the first vertex is also the last, with the linked grid coordinates kept in their own file. The geometrical shapes created through geometry are vector information as they are based on the x and y coordinates of the feature data. The second category of data available to GIS is raster data, comprising images made up of cells or pixels. Each cell contains a specific has x and y value for spatial georefrencing and also a numerical z value which may be used to represent topography, soil type or slope (Savage 1990: 24-25) and are used with spatial analysis.

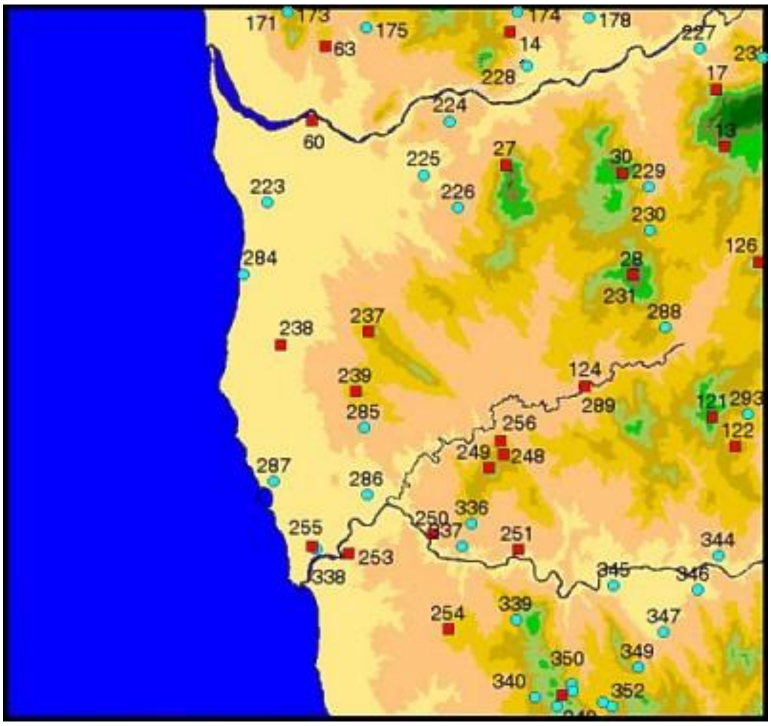

Figure 2.11 Point data within GIS. Between 1994 and 1998 Martin Millett et al carried out a survey of Iron Age and Roman settlement in the Ave Valley, Portugal. Portuguese Iron Age sites in this area are of a type known as 'castros'. The information collected by the survey was presented through a GIS in electronic form within the journal, Internet Archaeology. The parallels between the Ave Valley survey and the Derwent Valley GIS project are that both confine themselves to a discreet valley location and both seek to display location information changing through time. Map of known settlements prior to survey. Red square = castro, blue circle = other site

(Millett et al 2000)

Where the exact location of a site is unknown but its existence has been suggested through historical documentary sources within a broad geographical area, such as within a parish, a form of Historic Landscape Characterisation (HLC) may be used. HLC provides a historic dimension to Landscape Character Assessment (LCA) which is a methodology for understanding landscape holistically. Where LCA concentrates on natural elements, HLC examines the cultural nature of a landscape (Newman 2009: 195). Landscape must continue to change in order to remain cultural, and characterisation recognises what 'matters' from the past while allowing managed change to take place (Schofield and Johnson 2006: 113-114). HLC was developed in Cornwall in 1992-1994 to address issues relating to landscape in archaeological resource management (Aldred and Fairclough 2003: 1). One of the guiding principles for HLC set out by English Heritage states that 'HLC-based research and understanding are concerned with area not point data' (Clark *et al* 2004: 6).

English Heritage has provided a template for creating HLC projects. Following background research the results should be shown ‘by defining and characterising GIS polygons and then ascribing attributes to each polygon, within a related database’ (Fairclough 2002: 10). Polygons will usually be defined to cover areas interpreted by the project design as containing a general historical characteristic on a current OS base map. Once the general characteristic has been allocated to a polygon, attributes such as landscape type and possible or actual date can be added to a database in order to allow analysis based on themes of enquiry, for example, which polygons contain woodland which existed between the years 1700 and 1800?

Below (fig. 2.12) is Graham Fairclough and Pete Herring’s HLC map of Northumberland (2016: 188). It shows how the county has been given 100% polygonal coverage. Each polygon has been given a character represented by a colour illustrated in the key. At the scale reproduced here the detail of the map is difficult to decipher but, when viewed digitally in a GIS, detail of sub-areas can be magnified and individual polygons interrogated for attributes.

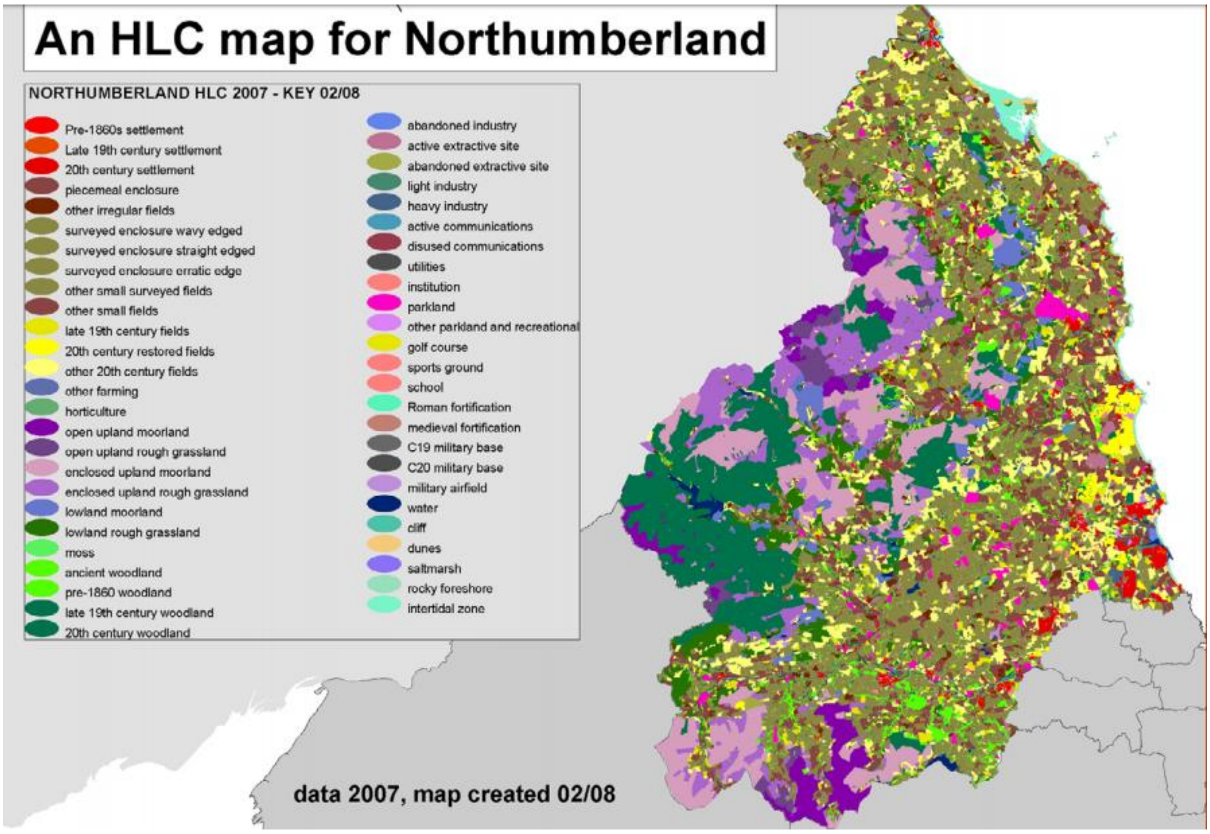

Figure 2.12 HLC map of Northumberland.

(Fairclough and Herring 2016: 188)

The main criticism of HLCs is that they simplify and flatten out the complexity of landscape through morphological classification (Austin 2007: 103-4, Newman 2009: 197). Tom Williamson goes as far as saying that HLCs are ‘actually rather bad at capturing the essence of the historic landscape character’ (2007: 69), as the results are depicted in two-dimensions where details of the boundaries marking the edges of polygons are ignored. However, even as a simplified representation, HLC is a useful tool for identifying and locating patterns of historic land characterisation, which is the primary concern of the landscape archaeologist (Newman 2009: 199).

The purpose of the GIS prepared for this thesis is to provide a visual illustration of the locations of the archaeological sites of the iron and steel industries and to show how they were developed over time. This has been achieved in two ways. Where an ironworking site’s location is known through the archaeological data gathered in chapter 4 and/or by database analysis and fieldwork, it has been presented as point data. Sites only found in the documentary record and described in general terms within an area, which in pre-modern times are usually expressed as parishes or manors, have no definite find-spots. These have been illustrated as a Historic Landscape Characteristic. The ‘Derwent Valley GIS’, was created using ArcGIS 10.3.1. Backdrop mapping (the maps upon which the data generated for this thesis have been superimposed) were downloaded from the Edina Digimap service.

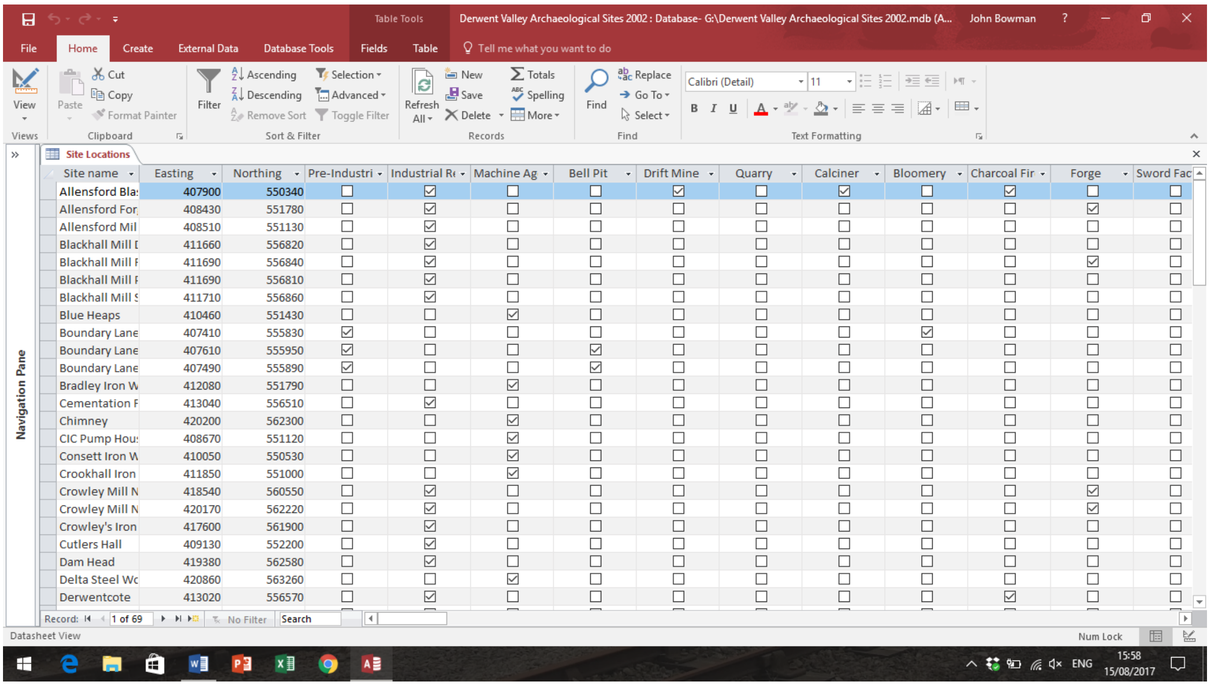

Figure 2.13 Screenshot of Derwent Valley Archaeology database.

The database ‘Derwent Valley Archaeology’ was created in Microsoft Access from information generated from chapters 3, 4 and 5 (fig. 2.13). To display the point data from the database a 1: 25 000 scale Ordnance Survey raster map was selected. This scale allows the ironworking sites to be plotted against considerable background detail including contour lines which help to describe their topology. Within the database the **site name** was selected as the primary key, enabling it to be labelled. The database contains the 6-figure OS coordinates (eastings and northings) for each. This permits the sites to be georeferenced as labelled point data on the backdrop map (fig. 2.14).

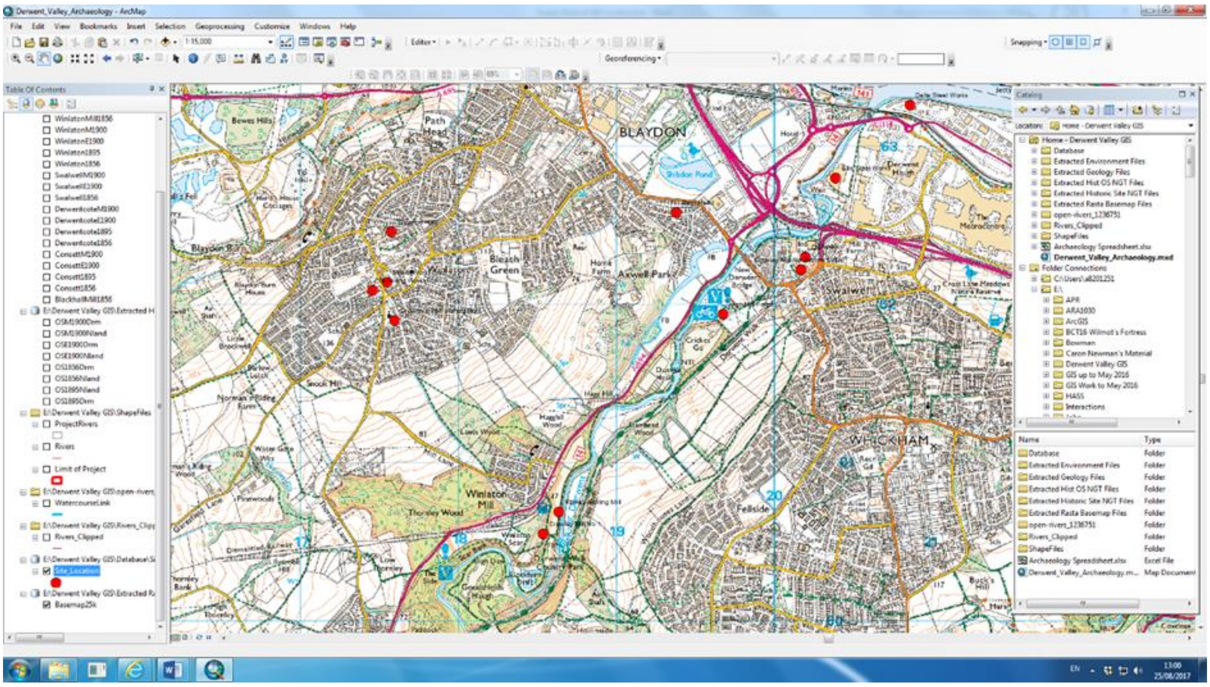

Figure 2.14 Screenshot of labelled site spot locations. This area shows sites belonging to Crowley’s three ironworks and the last steelworks operating on Derwenthaugh at the top-right of the map.

The database also contains numerous fields offering information on the various sites: these fields are filled using yes/no criteria. Sites are identified chronologically as those which appeared in the pre-industrial period (up to 1687), the Industrial Revolution (1687-1840), and the Machine Age (1840-1990). Processes discussed in chapter 5 are attributed to individual sites, as are the names of the site operators. Most of the latter were entrepreneurs but some gentry also appear, their names having been drawn from the data generated in chapter 3. Networks of process types and ownership of sites can also be generated and projected within the GIS. The 300-year period central to this thesis, 1690-1990, have been incorporated into the database as fields at 5-year intervals. It is thus possible to see which sites were in operation at any given 5-year interval or multiple of 5-year intervals (for example 1710-1740). By addressing the database using the usual Boolean commands, combinations of dates, processes and operators can be plotted through the GIS and the result exported as a new layer within the GIS to produce a permanent record. Two further fields within the database indicate whether the site was included in the Manchester Methodology, as applied in this thesis, and whether the site is still in existence with some degree of visible archaeology present.

Four editions and revisions of historical County Series OS maps are available to download through Edina Digimap as national Grid Tiles in two scales: 1: 2 500 and 1: 10 560. The 1: 10 560 scale maps are dated to 1861, 1898, 1923 and 1946; the 1: 2 500 site maps are dated from 1857 to 1939 depending on the location. The historical maps have been incorporated into the GIS as layers named '1856', '1895', as these are the dates given on the paper maps, and 'early 1900s' and 'mid-1900s' as these are the dates suggested by the Edina Digimap 'Historical Roam' database. Most important to the project are the first and second editions of the OS maps, 1856 and 1895, as these show some of the ironworking sites in their last phases of operation and some of the sites created in the Machine Age in their earliest stages. The 1: 10 560 maps have been added into the GIS to give valley-wide coverage (fig 2.15), whereas only sites which survived into the late 19th century have been included at 1: 2 500 to provide detail.

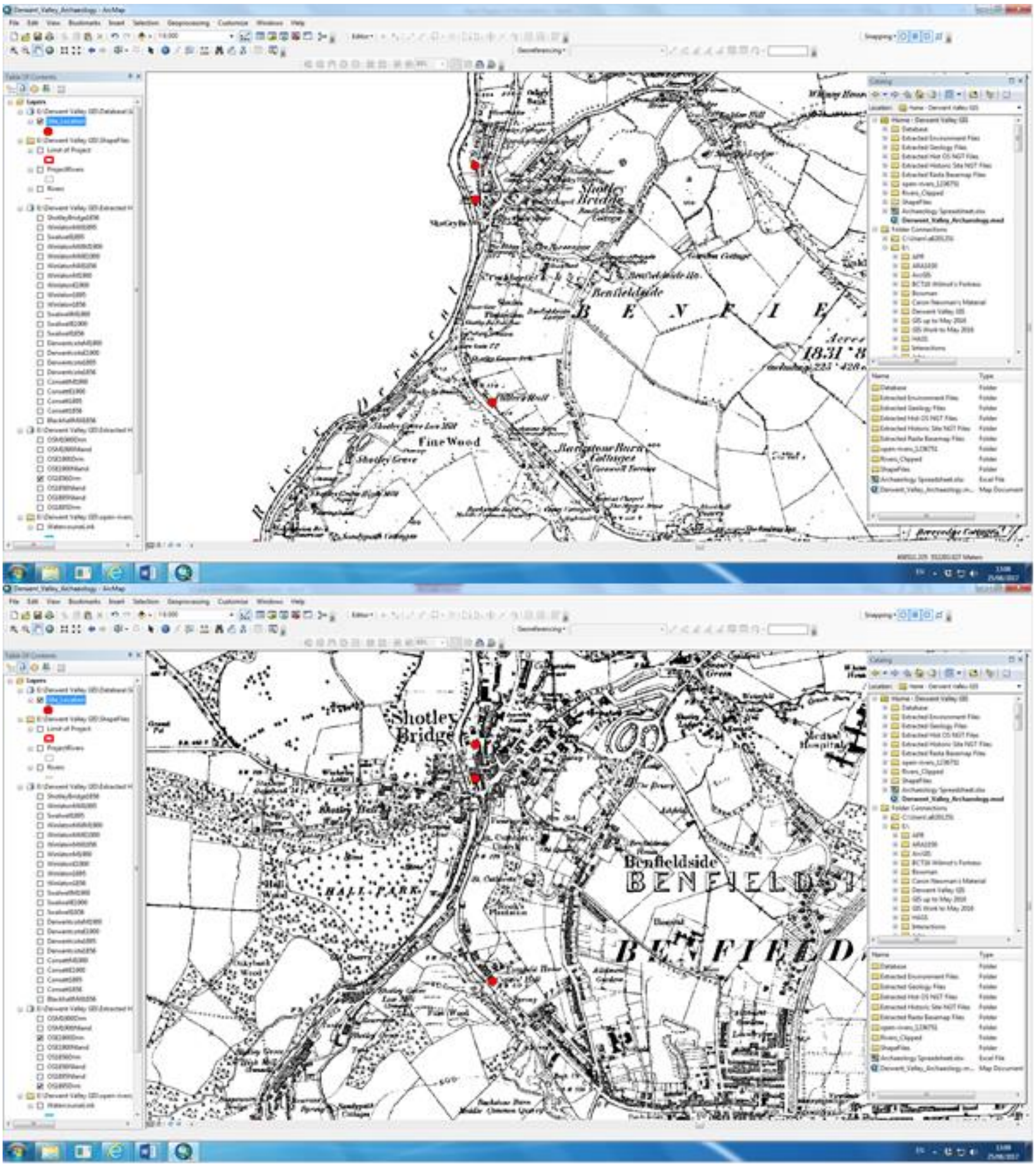

Figure 2.15 Screenshots of historic 1:10 560 OS maps. Top: Shotley Bridge area in 1856. Bottom: exactly the same area in the early 1900s. The red spots are the georeferenced archaeological sites from the Derwent Valley Database. Once the historic map layer is turned off the sites appear against the basemap, as in 2.14.

The HLC created for this thesis helps to visualise the sites noted in the historical record. The units of area chosen for the HLC were parish or chapelry boundaries because these best encompass the areas described in the medieval and early-modern documentary record. To create the HLC a 1: 50 000 scale Ordnance Survey raster map was selected. This scale was chosen because it allowed enough detail to recognise the topographical features which form the parish boundaries whilst being a small enough scale to navigate around the valley easily. Images of modern parish boundaries are available through the website www.achurchnearyou.com and can easily be transposed into the GIS as a polygon layer. However, modern parish boundaries may be slightly different to their historical namesakes, with some parishes being combinations of smaller historical parishes, and others - Consett for example - only having been created in 1862. Where possible the written descriptions of older parish boundaries given by Surtees in 1820 (207, 219, 237, 259, 284, 298, 303, 361, 363, 365) have been used in conjunction with the modern boundaries to create those used within this GIS. The parishes are, clockwise from the west end of the valley following the north bank of the Derwent: Blanchland, Healey, Shotley Low Quarter, Whittonstall, Ryton – then returning along the south bank, Whickham, Tanfield, Medomsley which surrounds the Chapelry of Ebchester, Muggleswick, Edmundbyres and Hunstanworth (fig. 2.16).

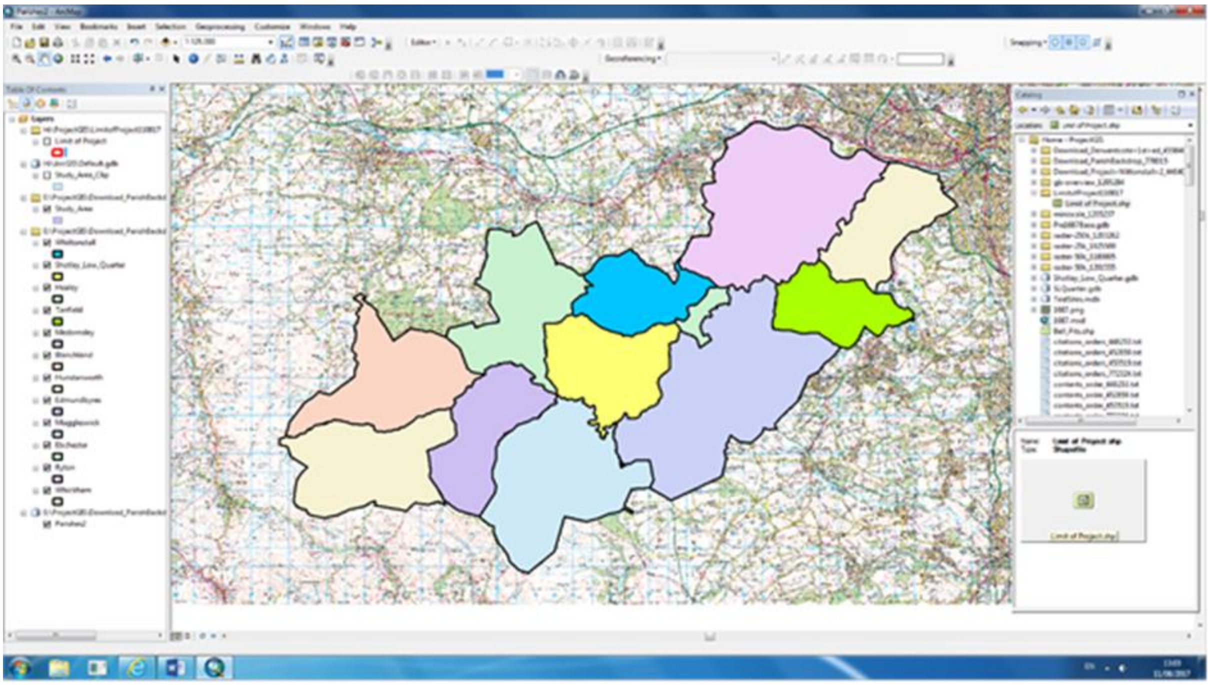

Figure 2.16 Screenshot of HLC polygons created out of parish boundaries. Parish names appear in the Table of Contents on the left side of the screen.

All the parishes, with the exception of the small chapelry of Ebchester, extend beyond the thesis study area. The limit of the study area was superimposed over the mosaic of parishes (fig. 2.17) and the parish areas 'clipped' to the limit of the study area so as to exclude those parts of the parishes which exist outside the study area. In order to view the HLC of the whole valley it was necessary to replace the 1: 50 000 backdrop with a 1: 250 000 map so that the surrounding features would be in focus (fig. 2.18).

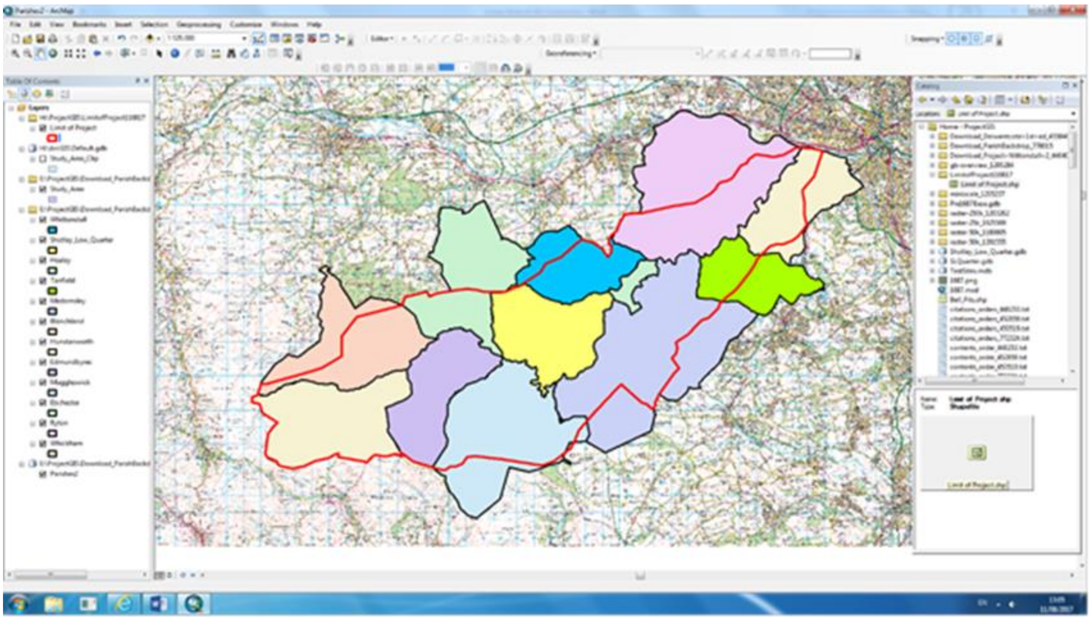

Figure 2.17 Screenshot of the geographical limit of the project. Layered over the parish polygons.

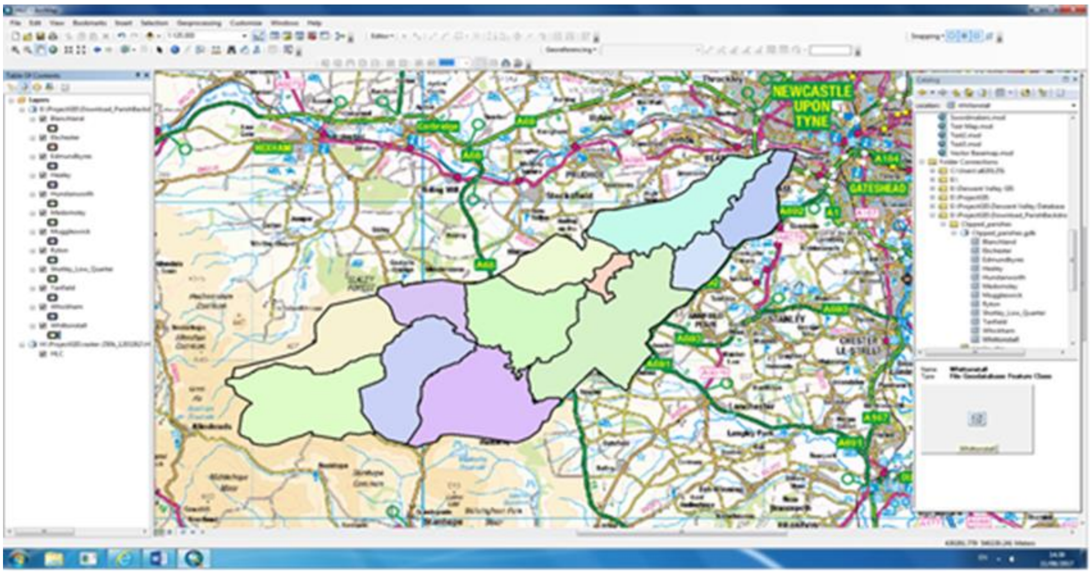

Figure 2.18 Screenshot of the parish polygons clipped to the limit of the project. This is the template for the HLC. It has been projected onto a 1:250 000 OS backdrop to allow the whole area to be viewed.

A further function of ArcGIS is that it allows total station (TST) data to be planned. As part of Newcastle University's Derwentcote Forge Cottages Project a survey was made of the cottages using a Leica Builder TST. The survey data was downloaded from the TST into ArcGIS and displayed as a two-dimensional grid of points (fig. 2.19).

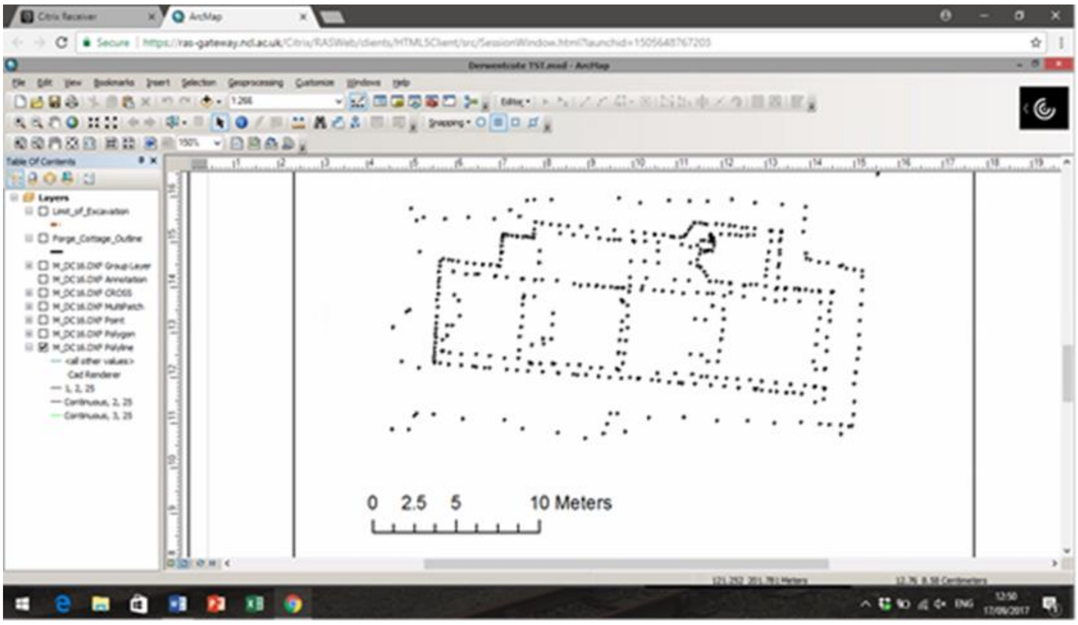

Figure 2.19 Screenshot of TST survey point data.

The TST was set up with reference to site north, 26^{o} to the east of true north, therefore the plotted results show the cottages in a different alignment to OS maps. To produce an outline of the cottages, survey points were joined by polylines within ArcGIS (fig. 2.20).

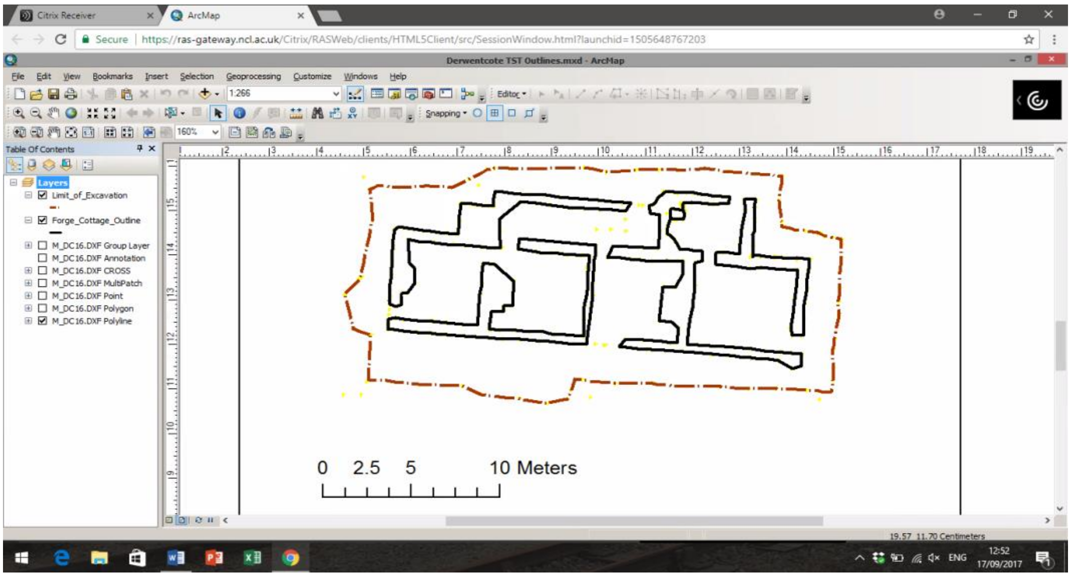

Figure 2.20 Screenshot of TST survey points joined by polylines. The brown dot-and-dash line indicates the limit of the 2012-16 excavations. The solid black line gives the shape of the cottages.

The quality of the figure 2.20 depended on the accuracy of the TST data input. The irregularity of the thickness and line of the walls is down to errors in holding the mirrored prism vertically. The internal detail of the northern lean-to range is incomplete: this is because excavation of the range was incomplete at the time of the TST survey. In order to rectify the errors and omissions within the downloaded data the polylines created between the survey points were redrawn with longer straight lines and detail added from field observations (fig 2.21).

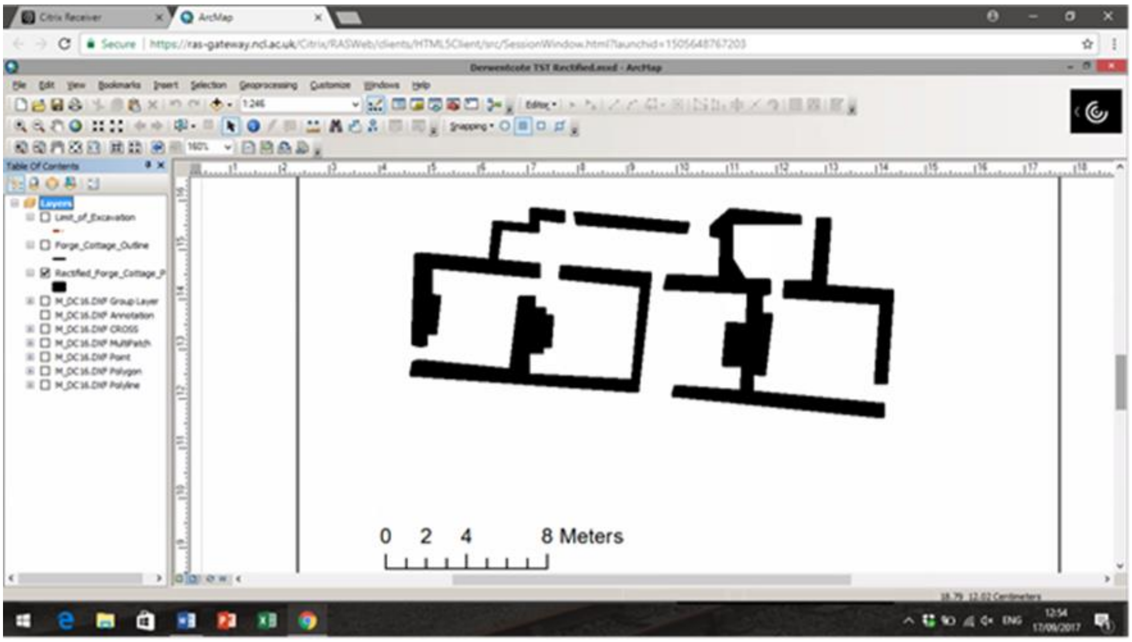

Figure 2.21 Screenshot of rectified TST results.

The Derwent Valley GIS is presented on the DVD appended to this thesis. Once its files are loaded into ArcGIS 10.3.1 (or later version) the GIS allows a comprehensive interrogation of the collected data to give an unprecedented facility to analyse the development of the industry within the valley. Excerpts taken from the GIS have been used to provide illustrative mapping throughout this thesis. The HLC of the iron and steel industries of the Derwent valley will be presented in chapter 5. The rectified TST results are used in chapter 6 as a basis for tracing the development of the forge cottages building.

2.4 Artefact biography

Artefact biography is the approach chosen to produce an in-depth study of the Derwentcote steel works which forms the central focus of the research question in chapter 6. Artefact, or object, biography is a methodology which finds application in many of the social sciences and has been utilised by archaeologists to build up a perspective on past societies through their material remains. This section begins with a discussion of what an artefact biography is, and the underpinning theoretical standpoints which create the framework for its use in revealing the social structures which are reflected in the interaction of people with the object over time. Many object biographies are concerned with single portable artefacts. These artefacts can be linked to broader literature on the object type and similar cultural biographies. These biographies may be both of objects and of individuals created through the objects they use and own (Cochran and Beaudry 2006: 199). The methodology applied to single artefacts is illustrated with two case studies in 2.4.2: Jody Joy's grandfather's Distinguished Flying Cross (2002) and Giovanna Vitelli's (2015) brass Indian bell. For the purposes of this thesis the scale of the object for the biography is larger than the portable category would suggest. The concept of applying artefact biography to buildings, whose meaning is generally constructed over time in a fixed location, is explored in 2.4.3 and illustrated with Joakim Thomasson's historical period case study of a 16th-century Swedish burgher house (2004).

This thesis expands the methodology by constructing an artefact biography for the Derwentcote landscape in its entirety. Elements of this approach to artefact biography have been set out in 2.4.4.

2.4.1 *The approach of artefact biography*

An artefact biography is an account of an object's 'social life'. Here, social life refers to an objects relationship with time, space and its owners or consumers (Hoskins 1998: 8) and as such provides a method of study within the social sciences for the accumulation and transformation of meaning invested within the object (Godsen and Marshall 1999: 172) and through this study arriving at an understanding of the societies which have an association with the object. It was through the collaboration of anthropologists and historians in America in the mid 1980s that the groundwork for the methodology was laid in order to develop dynamic models that combined system with process in long term patterns of sociocultural change (Farriss 1986: x).

One such model was put forward by Arjun Appadurai who introduced the argument that objects had social lives (1986: 1). Relying heavily on Marxist economic terminology, he discussed objects as commodities which have a negotiated economic value and can be exchanged between people. Anthropologists at that time had concentrated on the production of objects and the consumption of objects (*ibid*. 58); Appadurai chose to look at the exchange process and the social relationship dynamics which were revealed. He noted that the knowledge of production of a commodity differed from the knowledge of consumption. The knowledge was the cognitive processes imbued in the object such as technological method, social significance and aesthetics. He suggested that between the production and consumption some commodities had a 'life history' over which the knowledge of that commodity would be distributed and create an idiosyncratic biography (*ibid*. 41-2).

Igor Kopytoff (1986) looked at commodities from a cultural perspective. He argued that in the past people, for whom biographies could be written, had been commoditised as slaves thereby becoming conceptualized as chattels. Therefore it was perfectly reasonable to produce biographies for objects; an object could be questioned as to its origin and creation, its uses and status over time, its career path and any deviations from an expected career path for that class of object, cultural markers for the phases of the objects life and how the object's use changed over that lifetime (*ibid*. 66-67).

The expected career path of an object could be constructed through a 'life cycle assessment' study where the object is studied from the procurement of raw materials, manufacture, distribution, use, re-use and final disposal to produce a generic model for a class of object (Dannehl 2009: 124, see du Gay *et al* 1997: for a generic study of the Sony Walkman). Within the assessment the process of modification of form and utilization of an object can be recorded as its 'use-life' (Tringham 1994: 175). The object is passive in a use-life, things just happen to it. A career path can be thought of as the life of the object category in general without any relationship to the society in which it exists. Artefact biographies move the focus of study from the all-purpose model to the single object or discreet assemblage (Joy 2009: 542).

Kopytoff proposed that all biographies, whether for people or objects, are partial with the biographer selecting the content and focus. Thus a social biography of an object would be concerned about how the object influenced and was involved with the social relations of groups associated with it (1986: 68). An artefact biography is the story of the periods in which the object is not for sale or available for exchange, termed singularisation and of the contextual classification and reclassification of that object over those periods (*ibid*. 74, 90).

The importance of context is drawn out by Karin Dannehl. She attributes a different context to each 'passage', or period of singularisation, of an objects biography (2009: 126). Each passage may be considered a chapter of the artefact's cultural life. Every object can be considered to belong to categories which define it, both formal such as material and function, and socially constructed abstract traits. When an object moves across category boundaries it can be considered to have changed context (*ibid*. 125). For example, a working iron hinge over time will turn to rust and seize up: it moves from the category of iron to rust, from the functional category to non-functional. The social element here is the owner's relationship to the hinge, should the owner have chosen to oil and paint the hinge regularly it may have remained within the categories of iron and functional almost indefinitely.

Time, too, is an important facet of object biography. Tim Dant (1999: 130-151) argues for three 'senses' of time being required for an object biography: firstly, the history of the objects production and consumption, then an account of the aging of the object, and finally its revaluation. This view compliments Dannehl's idea of passages within an artefact biography: for, as an object is revalued at the end of each aging period new meaning within the object may be produced and the object received back into society, and is reacted to in a manner generated by the revaluation and then ages within its newly assigned category. As these senses of time are attached to the object, the object can always be considered to be 'of its time' (*ibid.* 150).

Object identity is not limited to commodities. Appadurai (1986) provided commoditization as a building block for object biography but some objects are recognised as gifts and produce an inalienable relationship network between recipients over time (Gosden and Marshall 1999:172-3). These objects' biographies are made up of the biographies their owners and exchange is the primary context of biographical creation, as opposed to the singularisation of commoditized objects. This is also true of heirlooms and legacies where the object is also imbued with memory of relationships, perhaps transforming a late-mother's everyday fruit bowl into a daughter's sentimentally curated memento of the mother. Identity can also be altered through performance where the meaning of an object; a talisman, ritual sacra, can change depending on whether it is in use or not (*ibid*. 174-176, Hoskins 2006: 74-5, Joy 2002:

141).

Within archaeology the methodology of artefact biology has been applied to both the prehistoric and historic periods. Joy critiques the use of biography for the prehistoric era contending that a recorded history is necessary to produce a full life history (2009: 543). Study of an individual prehistoric object may reveal evidence for its method of construction, use-wear damage and contextual evidence of deposition, but the true number of its life trajectories or recontextualisations can never be known and therefore neither can the object's social relationships. One method of overcoming this is through 'imaginative narrative' (*ibid*. 544). Ruth Tringham (1994) explored prehistoric buildings through a fictional woman's perspective; recently Rachel Crellin has taken the same approach to suggest a biography for a Manx Bronze Age axe (2015). The imaginative narrative can be used in the historic period where documentary support is lacking. John Giblin has produced a biography of a USAID (United States Agency for International Development) tin can photographed in a recontextualised state as part of a house door in Uganda (2015: 103). All that could truly be known about the can was that it had been manufactured in the USA and ended up in the door. Giblin created an object narrative for his can based on a generic trajectory for USAID cans, embellishing the story with such fictional, but theoretically possible, detail as the can 'being driven in an old heavy lorry, with black smoke spewing at every gear change' (*ibid*. 106) through Africa.

2.4.2 *Two case studies in artefact biography for portable objects*

Many object biographies are concerned with 'small finds' for comprehending the construction of personal identity. This is because historical archaeologists can link small finds to a broader literature on the object type and similar cultural biographies of both objects and individuals through the objects they use and own (Cochran and Beaudry 2006: 199).

Jody Joy produced the biography of his grandfather's Distinguished Flying Cross medal, an object from the historical period (2002). Before the biography begins the circumstances for his grandfather receiving the medal were presented. The biography starts with an account of how the medal was a mass-produced object differentiated from others only by the engraved year of presentation and an acknowledgement that the medal had clearly defined social values attached to it. There is a social expectation of the life history of medals: once a medal is deserved it will be made, then presented and then worn with pride by the recipient. There is an element of performance to each stage; the brave act, the presentation ceremony and the display of the medal at socially appropriate occasions.

The medal of this biography was not presented to Pilot Officer Joy, but received through the post which was said to have produced an ambivalent attitude towards the object which led to the medal being hidden, rather than displayed, and then lost (*ibid*. 135). The absence of the medal and the retention of its empty box provoked discussion and created memories of various members of the Joy household. In 1981 P.O. Joy's son had a replica medal made and formally presented it to his father. The replica medal has its own biography of positive association and meanings and also acts as an *aid memoire* to the original medal and its absence.

This historical biography benefits both from first hand documentary evidence and oral history. Joy presents an extract from his grandfather's flight log in which he details the events of one bombing mission in 1944; this serves as a dramatic contextual background for the award of the medal. There are also two photographs presented with the biography, one is a family photograph from (presumably) the 1950s showing the main contributors to the oral history of the medal, Joy's grandfather, grandmother, father and uncle; and one of Joy's grandfather in 1986 with his replica medal. The photographs help the reader envisage the family presenting the oral histories, firstly at the approximate time of the loss of the original medal and later as the family 'story' is resolved. The oral histories gathered from three generations of Joy's family produce a narrative which sets out a network of familial relationships and their memories based on the absence of the biographical object. The biography could be more accurately be centred on the empty cardboard box as the medal had disappeared within a decade of its production: it was the empty box which prompted memories of family problems long after the medal had gone. Joy's paper does successfully illustrate how meaning within an object changes for different generations: for P.O. Joy the medal is a source of disappointment because of the method by which it was delivered to him; to the writer's father the medal, or lack of it, was seen as the source of wider family friction; and to Jody Joy the replica medal acted to strengthen his relationship with his grandfather as it was a means by which he was able to communicate some of his memories (*ibid*. 139).

The object biography does not require a *chaine operatoire* as there is an implicit expectation that as the medal is the product of the modern, industrial, age that the means of its production will be understood by the reader. There is no necessity for a typology study as it is known when both the original and the replica medals were made. This biography, therefore, is concerned mainly with primary documentary research and oral history.

Giovanna Vitelli's (2015) reflection of a brass Indian bell demonstrates how the recontextualisation of an object can enrich the artefact biography. The bell had been in Vitelli's family for three generations. Within Vitelli's lifetime it had been used by the family as a dinner-bell in Europe and America. Family oral history told of how the bell had been bought in colonial India in the early 1900s (2015: 71-3). For Vitelli the bell had a clear trajectory from purchase 'associated with adventure in Hindu temples' (*ibid*. 72) to her own custodianship following the death of her mother.

An Indian colleague of Vitelli pointed out that the bell was not an ancient temple bell but a piece of 'tourist tat' (*ibid*. 73) with a US patent number and maker's name clearly inscribed into the handle. Vitelli's research, based on the bell's inscriptions, indicated that the bell may have been made around 1951. It was made in India but was an export item; its designer and importer was an Indian immigrant in America, entrepreneur Sajjin Sarna, who may have promoted the design as a temple bell in his New York store (*ibid*. 74).

The recontextulisation of the bell from ancient temple bell to relatively modern tat; or colonial to subaltern artefact, opened up the story of the bell's design, creation and early inter-continental journey. It also introduced Sarna as an individual with a significant relationship to the bell and with his own rags-to-riches biography which informed on his choices in its design (*ibid*. 73-5). However, all the stories which Vitelli grew up with about the bell remained. The bell is an example of what Andrew Merion Jones *et al* have termed a 'multiple object' (2016: 126-7), an object with which different groups of people can simultaneously have different relationships.

2.4.3 *Artefact biography for buildings*

While a small such as Vitelli's bell find can find itself transported between locations, and hence may incur a new meaning through a new relationship with space, a building tends to remain fixed to one geographical place although, as will be shown below, this is not always the case. A building's meaning, therefore, must change principally over time and reflect changes in use of the landscape and the social settings which surround it (Thomasson 2004: 165-166).

Tringham (1995: 81, 85) explained the benefits of applying use-life analysis over traditional prehistoric architectural studies. Traditionally archaeologists have focussed on the form and style of buildings as finished artefacts and the spacial organisation of activities within the building. This can be done through analysis of post-hole patterns and hearth positions (see Aren 1995 and Gerritson 1999 for examples). Through use-life analysis the 'procurement of raw materials, techniques of manufacture, utilization of artefacts, and the circumstances leading up to their eventual discard or re-use, all of which contributed to the building's particular manifestation in the archaeological record' (Tringham 1995: 81) can be determined. Such analysis can produce interpretations of buildings in relation to their landscape and the social action which created them. Through life-history, or biography, Tringham explores the humanistic aspects of a building, its duration, buildings which existed on that site before and after the biographic subject, and the memories which are held by people who have some relationship with that building. Artefact biography is used to produce a fluid description of the external appearance and internal organisation, and the building's appearance in the landscape over time (*ibid*. 97-98). Fokke Gerritsen's cultural biography of late prehistoric houses and farmsteads in the Netherlands (1999) more firmly considers the landscape's role in biography: 'the farmland surrounding the house cannot be left out of the picture… as it would be an indissoluble part of the dwelling place' (*ibid*. 87).

Joakim Thomasson's (2004) biography of a Danish 16th century burgher house studies a building which was dismantled in one location and elements reconstructed in another. In its original position in Malmo, the Lembke house was recognised as part of a secular development on a former religious site during the Danish reformation. Historical study suggested that the building was designed as a house for high status townspeople who often held official positions; these same officials may have been instrumental in the establishment of a new marketplace in the town which elevated the house from the periphery of the town to a prominent position on the main thoroughfare to the new market place (*ibid*. 183-4). Thomasson argues that this biography could be described as a web of human-material relations with different chains of social action coordinated through the house (*ibid*. 185). At the end of the 19th century the building was dismantled and elements incorporated into a building conceived as burgher house in a museum of cultural history at Lund. An inscription in the first-person, carved in stone at the entrance to the building, strongly implies that the whole house has moved from Malmo to begin a 'new childhood': the building's afterlife is therefore one of a new function in a new location. However, as only parts of the Malmo building are present only parts can be said to have an afterlife, the implication is that whole building being reconstructed like its new name, The Burgher House, is artificial (*ibid*. 167-8). However, the fact that there is some material from the Lembke house in the Burgher House permits the mnemonic quality of that material to dissipate more slowly than would have been the case of demolition and anonymous disposal (Yentsch 1993: 11).

Thomasson's success in constructing a social life for a single building indicates that up-scaling of artefact biography, from a small find to a building, is possible. Not only is the building considered but the adjacent streets are brought into the narrative; Thomasson looks at the house within its landscape and this will be further discussed in chapter 5.

2.4.4 *Applying artefact biography on a larger scale*

Derwentcote is a far more complicated site than the Lembke house because it contains multiple buildings. In the examples cited above, Tringham, Gerritsen and Thomasson have all linked their building biographies to the landscapes in which they were constructed. On applying artefact biography to Derwentcote the starting Koppytoffian principal has been that the Derwentcote steelworks and its related monuments constitute an industrial landscape which in the context of post-medieval England, landscape is commoditised.

The artefact biography of the Derwentcote industrial landscape can be created through the appearance and disappearance of structures within the freehold estate of Derwentcote over time and their relationships to the freeholders or local gentry, simultaneously considered with both the leaseholding entrepreneurs and their workers. Derwentcote can therefore be explored as a 'multiple object'.

The landscape of Derwentcote may be regarded in the same way as P.O. Joy's medal box because, as will be discussed in chapter 6, the landscape once contained historic structures which are missing from the present archaeological record. The focus of human/object relations for the missing structures can be placed into the landscape which contained them. Using this methodology on this scale has not been considered before, however the site is suitable because it is well-documented, requiring little need for imaginative narrative, and has undergone recent archaeological work which provides information on the layout of the forge area and the worker's cottages. Employing conventional methods of analysis, historical, industrial and landscape archaeological approaches would fail to integrate the human factor, or experience, of this site. This thesis uses artefact biography to view the site as a social entity and discover how its relationships with the people who lived and worked there changed over time.

2.5 Summary

It has been necessary to employ several methodologies in this thesis, historical archaeology, industrial and landscape archaeology and artefact biography. They have been combined and adapted to create a comprehensive picture of the development of the iron and steel industries within the Derwent valley and to fully understand the Derwentcote industrial landscape's place within that milieu. A complete GIS database has been developed that allows the changes over time within the Derwent valley to be easily tracked and interrogated.

This thesis represents the first in-depth study of the iron and steel industries of the Derwent valley and as such is an original piece of research. The adaptation of the Manchester Methodology in this thesis represents its first use within the northeast of England and the inclusion of the lower, non-landholding, classes. Both the GIS database designed for the iron industry in the Derwent valley and the use of artefact biography techniques for an entire site are original contributions to knowledge.

Chapter 3. The documentary history of the iron and steel industries of the Derwent valley

3.1 Introduction

This section presents the results of research into the documented history of the iron and steel industries of the Derwent Valley, undertaken in order to identify known iron working sites. The appearance of each site has been ascribed to three broad time periods (fig. 3.1): a 'pre-industrial period' set before the arrival of major ironworking concerns of the late 17th century: an 'Industrial Revolution' marked by a shift in the local scale of iron working, sourcing of the work force and raw materials, the introduction of technology and new markets, and a 'Machine Age', named for the adoption of steam power within ironworks and transport systems, which commences with the discovery of new seams of iron ore in the valley in 1839 and marks a further shift in scale and methods of production.

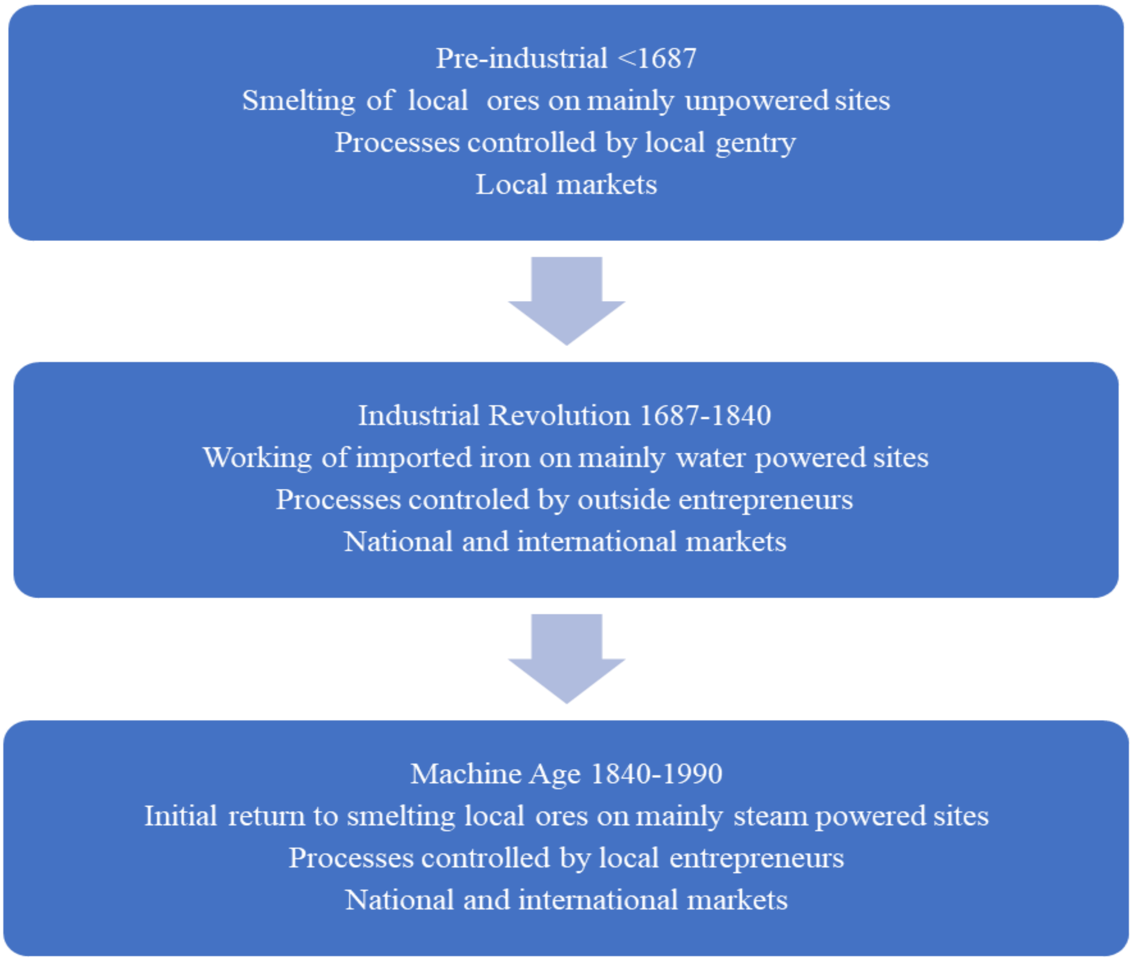

Figure 3.1 Dating periods used for this thesis

The earliest period, though chronologically the longest, is unremarkable in terms of national iron working. For most the period ironstone mining and smelting was carried out on medieval manors, both church and secular, for their own use. The documented iron working centres during this period were: Muggleswick, Shotley Low Quarter, Whittonstall, Edmundbyres, Espershields and the Gibside Estate. The earliest documentary materials available are transcriptions of the Durham Priory manorial accounts for Muggleswick by Richard Britnell (2014). Britnell's work illuminates the produce, purchases and sales of the prior's manors for the period 1277-1310. Within this period, Hodgson's *History of Northumberland* (1902), one of the standard works for desk-based studies, presents evidence for iron mining activity at Shotley Low Quarter in 1307.

Miranda Threlfall-Holmes analyses the bursars' rolls of the Durham Cathedral Priory for the period 1460 to 1520 (1997, 1999, 2005). Her work focusses on life within the priory through its purchases of provisions including iron. One study (1999) focuses specifically on the iron trade in the North-East in this period indicating the sources of domestic material, quantities supplied, prices paid and merchants' names. The merchants are occasionally linked to places within Derwentdale. The major benefit of her work is that it provides a translation into English of the material found on the rolls. Later details from the rolls were gleaned from H. Louis (1907).

Information on ironworks belonging to the Gibside Estate has been sourced from academic work by Clavering and Rounding (1995) on early Tyneside industrialism and Edward Hughes' study of the Bowes manuscripts within *North Country Life in the Eighteenth Century: the North-East, 1700-1750* (1952). The former work details the development of Gibside until 1700, the latter presents evidence indicating that production on the estate lasted until the late 1720s.

It is the second, industrial period which propelled the Derwent Valley to national importance. Three business concerns moved into the valley within a few years of each other: the first Shotley Bridge sword factory, Dennis Hayford's 'Company in the North' and the iron manufactories of Ambrose Crowley III. By the mid-18th century Crowley's works were the largest in Europe, Hayford's company was producing the best quality steel in Britain and the numerous sword makers now established at Shotley Bridge created one of the largest English centres of bladed weapon production. Into this successful commercial environment, the Derwentcote Forge and Steel Furnace were added between 1718 and 1733. The four businesses enjoyed a ‘long 18th century’ ending in depression following the conclusion of the Napoleonic Wars in 1815.

Of special note is the diary of the Swedish industrial spy Reinhold Angerstein (2001 [1765]). Angerstein travelled throughout Britain between 1753 and 1754 visiting ironworking sites and noting their plant and economic details. Angerstein visited the sword factory at Shotley Bridge, Hayford’s former steel furnace at Blackhall Mill, all three of Crowley’s manufactories and the Derwentcote forge and steel furnace. In each case he provided a first-hand account of what he saw and was told and included detailed sketches in his notes.

The history of the Shotley Bridge sword factories was first brought to wider public attention through Robert Surtees’ *History of the County Palatine of Durham* in which he wrote of German sword makers fleeing religious persecution and finding sanctuary in the Derwent Valley (1820: 294, 387). The interest sparked by Surtees’ account led other writers to visit the village during the early 19th century. One, W. Hone, interviewed two of the last sword makers from the prominent Oley family in 1832, who stated that their family had been brought over from Germany by licence from the government (1832: 1341). A discredited account of the Germans’ origins was produced by the Rev. J Ryan in 1841 in the *History of Shotley Spa, and vicinity of Shotley Bridge*, which was written to celebrate a local tourist destination. Ryan collected local oral testimony which included a suggestion that the Germans had founded Shotley Bridge at the end of the reign of Elizabeth I. Later writers, such as the contributor, ‘B’, to the *Monthly Chronicle of North Country Lore and Legend* (1888) continued to dwell on the antiquity of the origins of the German settlement by musing on the possibility of a date as early as 1565.

The first academic history of the sword making at Shotley Bridge was produced by Rhys Jenkins in *The Hollow Sword Blade Company and Sword making at Shotley Bridge* (1935). The account binds the Germans to the ‘Governor and Company for making Hollow Sword Blades in England’ and was vague as to the fate of the concern much after 1703. Jenkins mentions only one sword works at Shotley Bridge and ignored Ryan’s claims of a pre-1687 German presence at here. While there are mistakes in Jenkin’s work, it must be accepted that it represented the most scholarly study of the sword company since Surtees’ and contains many signposts to further study. The discovery of the William Cotesworth papers by Edward Hughes added clarity to Jenkins’ account. Hughes’ *North Country Life* (1952) details Cotesworth’s involvement with Shotley Bridge from 1705 to 1724 and suggests the quantities of equipment, product output and the nature of a relationship with Denis Hayford of Pontefract.

More recent accounts are structured on the work of Surtees, Ryan and Hughes. Amateur historian David Richardson's *The Shotley Bridge Sword Makers: Their Strange History* (1973) adds to their work with interviews with people in Shotley Bridge and Ebchester to compliment the documented history with oral testimony. David Atkinson's *The German Swordmakers of Shotley Bridge* (1987) was the first study to interrogate German source material from Solingen, providing a list of names of craftsmen who were enticed to England. Atkinson points out that the individuals named in the German document are not necessarily the same that appeared at Shotley Bridge. John Bygate's *The Hollow Blade: The Story of the German Swordmakers of Shotley Bridge* (2003) claims to make 'no revelations'. The strengths of this book lie in the degree of interrogation of the known material supported by photographs which had not been published in England before.

Hayford's Company in the North has received less attention than the other arrivals in the late 17th century. The steel works at Blackhall Mill are discussed as parts of works on historic steel making (Barraclough 1984a, 1990) and industrialisation (McCord and Rowe 1977). Its eventual fate appears as a foot-note in a general history of Durham by W. Fordyce (1857). A history for the Allensford forge and blast furnace was collected by Linsley and Hetherington (1978) as background context to their excavation of the furnace.

The involvement of the Crowley's and their successors at Winlaton, Winlaton Mill and Swalwell has received more historical coverage. The Crowley story is covered in the *Victoria History of the County of Durham* (Sellers 1907), another comprehensive history work often utilised for desk-based assessment. Michael Flinn produced both a transcript of *The Crowley Law Book* (1957) and a history of the Crowley family, *Men of Iron* (1962), which set out a useful, though dated, framework for the Crowley's business in North-Eastern England. The most recent and comprehensive study of Crowley's works is by David Cranstone (2011) within the *Industrial Archaeological Review*. This paper draws on a range of contemporary documents and maps unavailable to Flinn. It concentrates on the Swalwell works with references to Winlaton Mill. Contributions from local historians have also been incorporated into this documentary review (Anderson 1973; Brown 2011).

Cranstone's 1997 *Derwentcote Steel Furnace: an Industrial Monument in County Durham* has been used to produce the short account of the forge and furnace presented below. In a similar vein to his later work on Swalwell, above, Cranstone includes a comprehensive historical account of the Derwentcote works to accompany this report, centring on the cementation furnace.

The Machine Age is dominated by development in and around Consett, and later the east bank of the river at Derwenthaugh. Consett was once the largest iron works in England. One of the earliest detailed descriptions was J. S. Jeans' *Notes on Northern Industries* (1877). Jeans writes at great length about the various share issues and the capital tied up in them, perhaps indicating the importance of such matters to his readership. Jeans' notes detail the plant, production, products, workforce and social infrastructure within William Jenkins' period of management. His account of the creation of the Derwent and Consett Iron Co. out of the Derwent Iron Co. is unclear. Within this thesis this matter has been clarified with reference to reports in the contemporary press.

The second description of the Consett Works was nominally written by Jenkins himself. *Consett Iron Co.: Description of the Works* (2008 [1893]) begins with a four-line preface by Jenkins and then goes on to describe the Works from a technological perspective. Expanding Jeans' *Notes* of sixteen years earlier, all the plant is described in detail, sometimes accompanied by photographs, and a site map is provided to indicate how the plant was laid out. Reflection on the workforce is squeezed into a section entitled 'concluding remarks' indicating that social activism was not high on the author's agenda. The trend of cataloguing Consett's plant continued into the 20th century with an updated account in the *Victoria History of the County of Durham* by M. Sellers (1907), with a new set of figures regarding production statistics and infrastructure, presented in such a way as to impress a general readership.

The next tranche of writing on Consett came post-closure. Kenneth Warren's *Consett Iron 1840 to 1980: a Study in Industrial Location* (1990) is an academic economist's case study. Warren makes extensive use of trade journals and trade reports to produce a narrative which, while it is heavy on statistics, brings out details such as the constant renegotiation of rail costs which contributed towards the continuity of the Consett Iron Works. A more accessible telling of the Consett story is provided by Garry O'Hagan in *The Conside Trilogy: a Story of Iron and Coal in North West Durham and the Railways that Linked Them to the Outside World* (2011). This is a local history book written by a former resident of the Consett area and one-time steel worker now relocated to Perth, Australia. The strength on this work is that it clearly lays out how the Consett Iron Works affected the landscape of the Derwent Valley with the development at Consett, acquisition of coal mines to fuel the ironworks and the construction of the Derwent valley railway line to link all its properties together.

The relative lack of information for these companies in the documentary record, compared to that of those discussed above, may be indicative of their size and the recent nature of the demise of these companies, a little over quarter of a century ago. The Derwenthaugh companies have received some attention through local history projects, hosted online by Michael Makepeace (2012a, 2012b, 2013).

3.2 Pre-industrial iron production

3.2.1 *Iron production on the manor of Muggleswick 1299-1304*

Quantities of iron are recorded in the Durham Priory manorial accounts as having been produced at Muggleswick (fig. 3.2) for three years: 541st. in 1299-1300, 264st. in 1302-3 and 312st. in 1303-4 (Britnell 2014: lx). There are 160 stones to 1 ‘UK long’ ton or 157.473 stones to 1 metric tonne. The iron appears to have been produced in *de forgia in parco* (the forge in the park). At this date the forge would have certainly been of the bloomery type. The forge is mentioned in all three years, on six occasions (*ibid.* 146,163,189,190,242,243), by three different manorial managers. The iron was produced implicitly for Muggleswick's own use and for the Durham Priory though other manors are recorded as receiving Muggleswick iron in 1299-1300: 17st. to Bearpark and Houghall [combined manors], 26st. to Bewley, 36st. to Pittington, 13st. to Wardley and one cartload to Dunelm (*ibid.* 125,129, 134, 144).

The source of the iron ore to be processed in the bloomery is unclear. The accounts record small amounts of presumably finished iron being bought in by Muggleswick: 5st. in 1302, 4st. in 1303-4 and 5st. in 1309-10 (ibid: 162, 240, 308). The iron purchase of 1309-10 appears to be fulfilling a contract and, like the other two amounts, there is no indication where this came from but it is clear that the amount bought in was nowhere near that being produced even if this iron was ore. On more than one occasion payments are made by Muggleswick for items *proprio ferro* (from its own iron). These payments appear to be to artisans producing a range of goods listed over the years including a tripod, muck-forks, shovels, parts for carts and wheels, ploughs and nails using iron provided by the manor as opposed to iron provided by the smith. An alternative interpretation is that the artisans may have been using iron sourced and produced from the manorial estate.

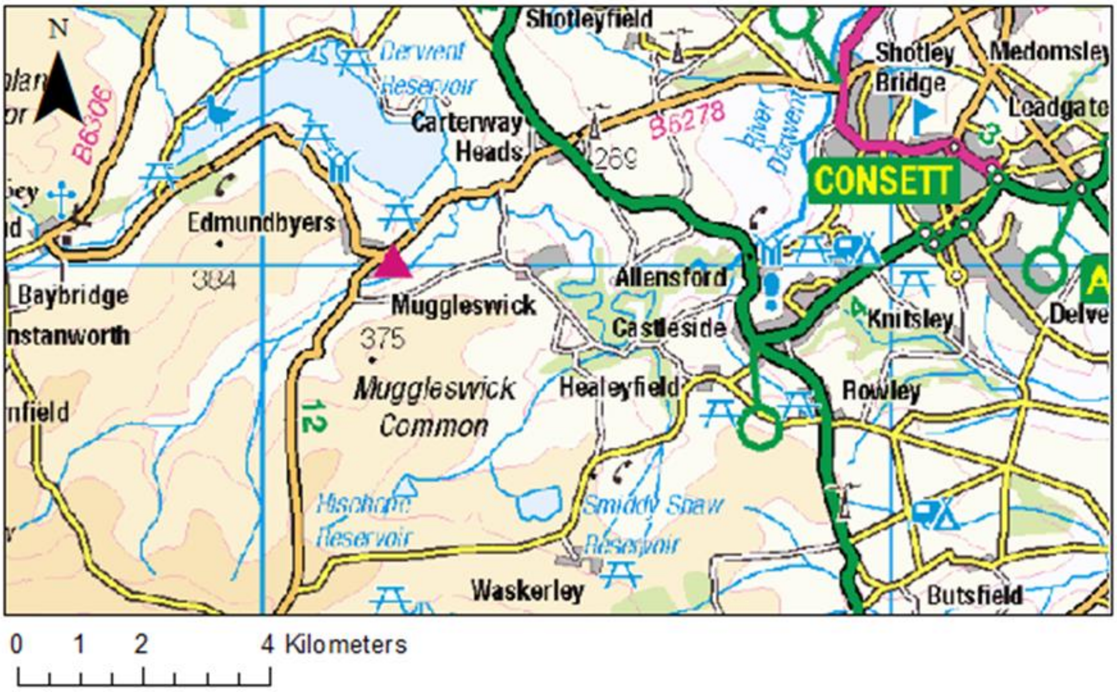

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Figure 3.2 Muggleswick: the medieval park is thought to be analogous to the modern Common

There is a passage for Muggleswick in 1303-4 which indicates how iron production could be affected by the liturgical calendar. A quantity of iron, '132st. [vj^{xx}xij *petris*], was received from the forge in the park in the twelve weeks between the Sunday following the feast of Philip and Jacob and the Sunday following the feast of St. Jacob (3rd May 1304 to 26th July 1304), and no more because the forge did not burn during the week of Pentecost because of the traditional festival (my translation of Britnell 2014: 242).

3.2.2 *Iron mining at Whittonstall and Shotley Low Quarter 1307*

The documentary evidence for iron mining in the parish of Shotley Low Quarter (fig. 3.3) comes from a law suit between Adam de Menevill who held a grant of free warren, or hunting rights, for Whittonstall and Newlands and John of Brittany, lord of the barony of Bywell in the Tyne Valley. The previous lords of Bywell, the Baliol family, had leased their lands at Newlands and Whittonstall to a Roger Darrayns for a period of twelve years. It must be assumed that the lease was still running in 1307. John of Brittany had sent his 'bailiffs' to mine iron ore from the Whittonstall – Newlands area and it was de Menevill's contention that Brittany required a licence from him to carry out the extraction. Though the account is unclear as to what, if any, de Menevill's right to the land other than the free warren was, the inquiry set up to investigate the suit found that no reservation of the mines had been made to the lord of Bywell (Hodgson 1902: 159-62, 190).

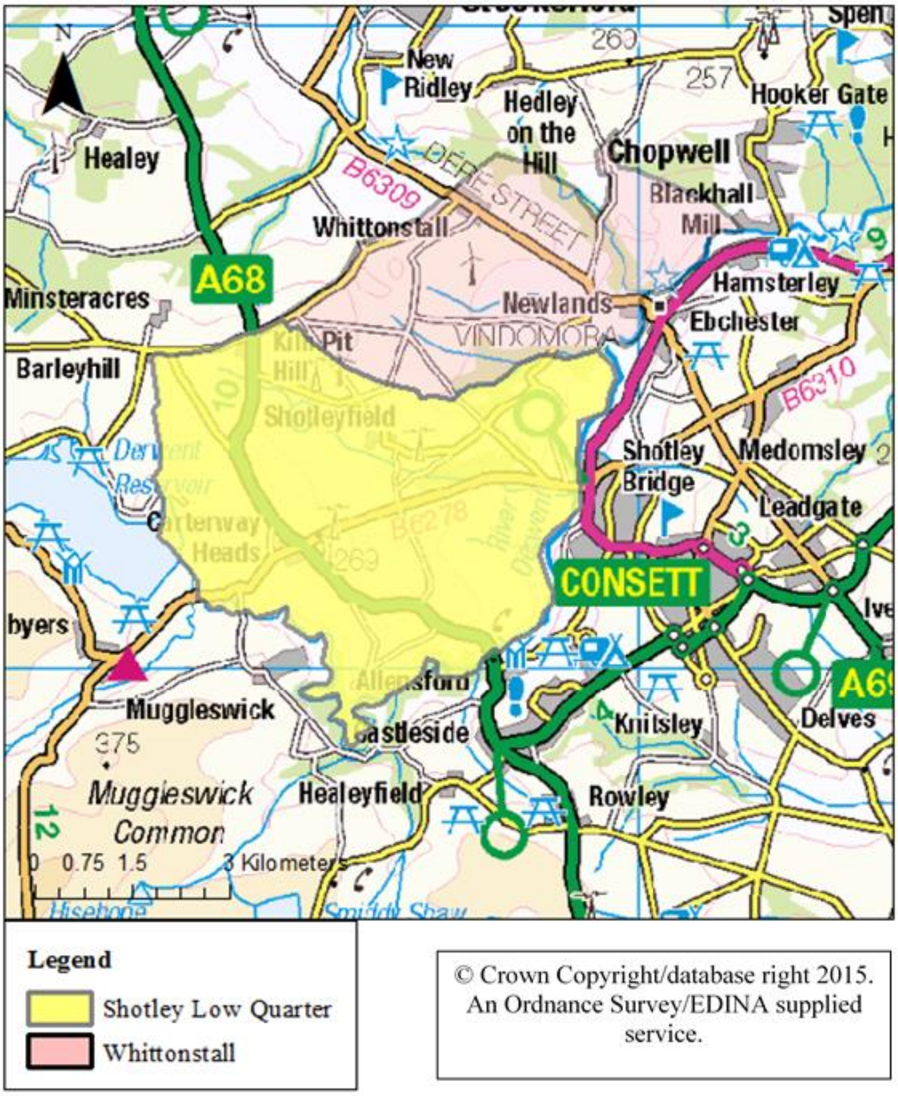

Figure 3.3 Whittonstall and Shotley Low Quarter.

3.2.3 *Iron Merchants operating from the head of the Derwent 1464-1537*

A century and a half later, 1464 – 1520, the Durham Priory bursar's roll indicates that the priory was buying in two categories of iron: 'Spanish iron' and 'Weardale iron'. Spanish iron may have been a generic term for material sourced from Europe or a specific metal as the records for imports into Newcastle-upon-Tyne mention small amounts of iron originating from Osmund, Liege and Westphalia (Wade 1994: 42; Blanchard 1973: 77). Spanish iron was smelted from an ore which contained less phosphorous than Weardale ironstone and therefore produced a less brittle product (Threlfall-Holmes 1999:111).

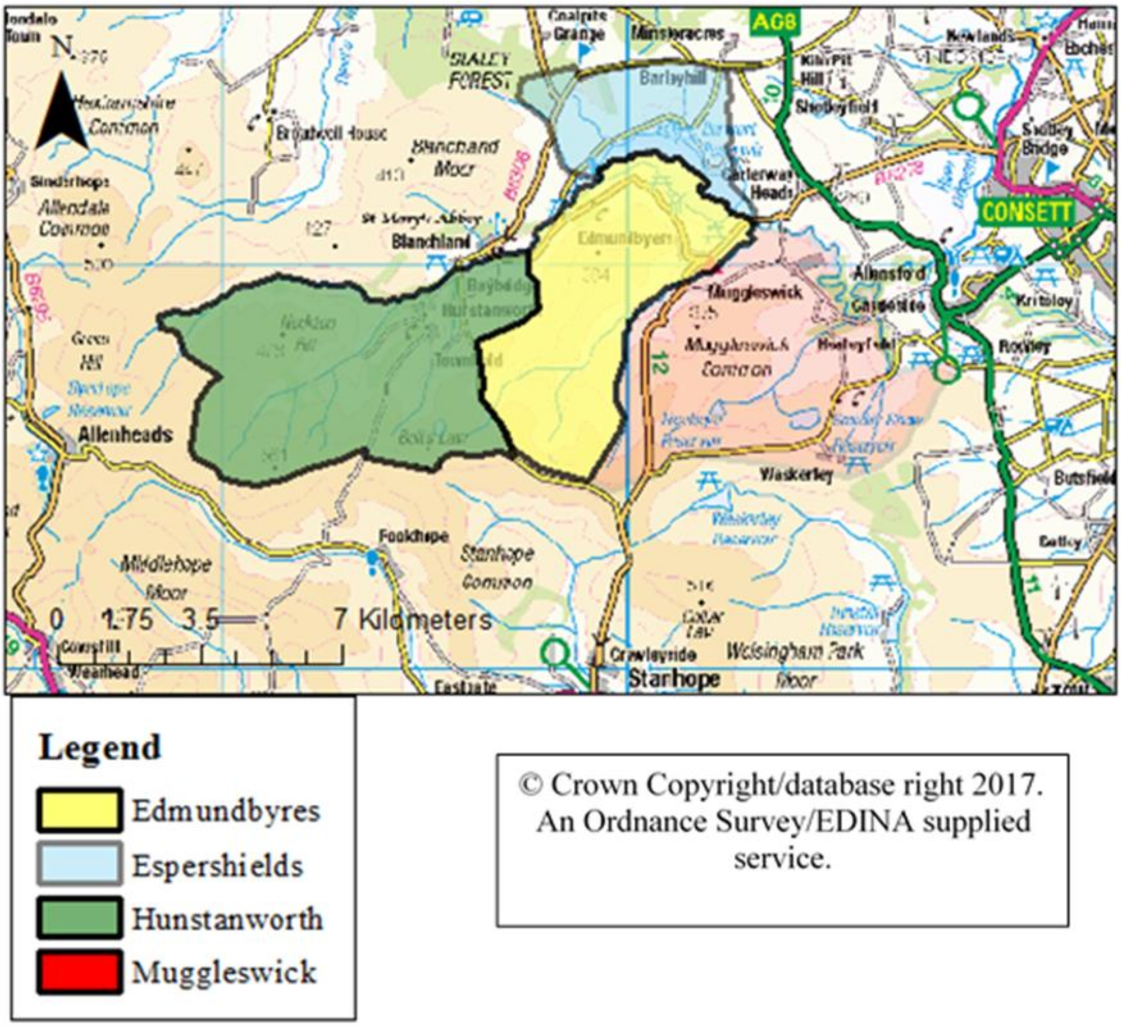

Figure 3.4 15th and 16th century iron supplying areas at the head of the valley.

Weardale iron also appears to be a generic term for iron produced from the lands of Durham bishopric and bought under the tenurial purchasing strategy employed by the priory at that time (Threlfall-Holmes 2005: 136-161). In the bursars' rolls Muggleswick (fig. 3.4) is mentioned as supplying quantities of Weardale iron thirteen times explicitly, and many more times implicitly, through association with the prior, and later the prior's *instaurer* or agent

(Threlfall-Holmes 1999: 116), both of whom are named once in the rolls as supplying the priory with iron from Muggleswick 1504-5 and 1515-16 respectively. In addition, both these offices are also noted as supplying the priory with iron described as *wodhire,* which is thought to be a payment for the right to gather wood for fuel in the iron smelting process commencing in 1488-9 (Threlfall-Holmes 1997: 112-113). *Wodhire* iron is noted as being supplied from Muggleswick in 1511-12 and 1514-15 suggesting that as the prior, his *instaure*r and the regular supply of *wodhire* iron, have connections to that area and each other.

Between 1464-5 and 1478-9 there are quantities of Weardale iron bought at Muggleswick which are recorded without reference to a merchant, and merchants who are recorded as supplying Weardale iron without details of their source. In 1479-80 167st. of Weardale iron were bought from Richard Whitfeld and William Henryson of Muggleswick. A Hugh Whitfeld was recorded the following year as supplying Weardale iron and in 1482 he is listed with Roland Henryson as suppliers. Whitfeld and Henryson appear to be the names of mercantile families from Muggleswick. William Henryson was explicitly from Muggleswick whereas Richard Whitfield is only of that area by implication. Another Whitfeld, Thomas, supplied the priory with iron in 1497-8. His name is linked with a Thomas Kirkhaus of Lanchester, implying that this Whitfeld, at least, was not from Derwentdale. It is this ambiguity which prevents networks of merchants from the upper Derwent Valley being established with any certainty. There was probably more than one merchant at Muggleswick because the entry for 1481-2 notes ‘various men’ from that area. The Henryson name became linked with an Edward Bloomer or Blumer by 1486-7 who, as an individual, appears frequently on the rolls from 1480-1 to 1519-20, often linked to other merchants on the same account.

Suppliers are also noted in Edmundbyres, Espershields (Healey), and possibly Whitehall at the head of the valley, in the parishes adjoining Muggleswick. For the year 1503-4 a Robert Olyid is listed as being at Edmundbyres, and Espershields is given as the address for a Thomas Swynburn. Below Swynburn on the roll, and not linked to a location, is a John Swynburn who also appears three years later. It is not clear whether these suppliers were merchants living in the Derwent valley who were selling-on iron produced in Weardale or ironmasters mining ironstone and smelting their own iron *in situ*. One entry for the supply of iron in the rolls of 1536-7 gives the price paid of 26s.8d. for 80 stones of Weardale product *lucratas apud Mugleswyk* suggesting that the material had been ‘won’ from ‘the works’ at Muggleswick (Louis 1907: 355) and implying a probability that both a bloomery and forge were still in production. However, a larger amount of Weardale iron, 280st. for 5*l*. 16*s*. 8*d* was purchased from a merchant *de tenentibus de Edmundbyrez et pastoribus de Mugleswyk* at the same time (*ibid*. 355). Here the merchant is described as being the 'holder' or 'occupier' of Edmundbyres and with some relationship with the parish of Muggleswick; but there is no implication that the iron was actually 'won' from that area. None of the Derwent merchants are noted as supplying imported iron or other goods, suggesting that the Derwent valley suppliers had a direct or exclusive link with their product.

The priory bursars' rolls refer only to the Weardale iron bought by the Cathedral. There is no way of telling whether the merchants were producing extra iron for secular customers, and in what quantity, or were merely being paid to fulfil the priory's needs. The priory rolls list payments to three main individuals for working the iron: Richard Smyth, Henry Walker and William Randson, with two others mentioned once each throughout the 1464 to 1520 period. It must be assumed that these men were responsible for working both the domestic and imported iron. The end products for the iron can be found amongst the accounts of the individual monks given responsibility for aspects of the day-to-day running of the priory and its estates (Threlfall-Holmes 2005: 17-32). The purchases made by these officers included iron for a new window, a mill-spindle, cart wheel 'tyres' and other fittings, meat roasting racks, horse shoes and ox shoes. Some articles were ordered in the thousands: nails of many kinds, staples, hinges, locks and keys.

3.2.4 *Gibside iron 1545-1728*

The first iron mill recorded within the Derwent Valley was located at Gibside (fig. 3.5) on a lease of 1545 for West Gibside to Richard Hodgeson of Byermoor from the landowner, Roger Blakiston. An appended note to the deed for the sale of five hundred oak trees was dated to the 1520s and may suggest the first furnace had been built then. The Blakiston estates provided timber for charcoal and coal and iron ore for the iron mill and furnace. Hodgeson and Blakiston, operating as partners, found local markets for their products in the collieries, shipyards and the anchor smiths of Gateshead (Clavering and Rounding 1995: 255). In 1608 Sir William Blakiston gave permission for Edward Talbot to build a new forge and furnace in the Mylne Field and implied that the original plant was still in existence at this time. The new forge is shown to have been sited 640m east by north of the Leapmill Burn's confluence with the Derwent (*ibid*. 255-6).

Talbot expanded his business in 1614 by receiving permission from the lords of Winlaton to dam the Derwent at Swalwell to provide water to power the Holme Mill ironworks, which may have already existed as an unpowered venture. On Talbot's death in 1617 Sir William took over Holme Mill and both here and at Gibside iron production increased throughout the 1630s. Sir William was succeeded on his death in 1641 by his son Sir Ralph whose interests lay in the coal industry. Iron production continued at Holme Mill until 1643 when the works burned down. The site with its water-power infrastructure may have reopened for a short while prior to 1660 nominally as a corn mill (*ibid*. 256).

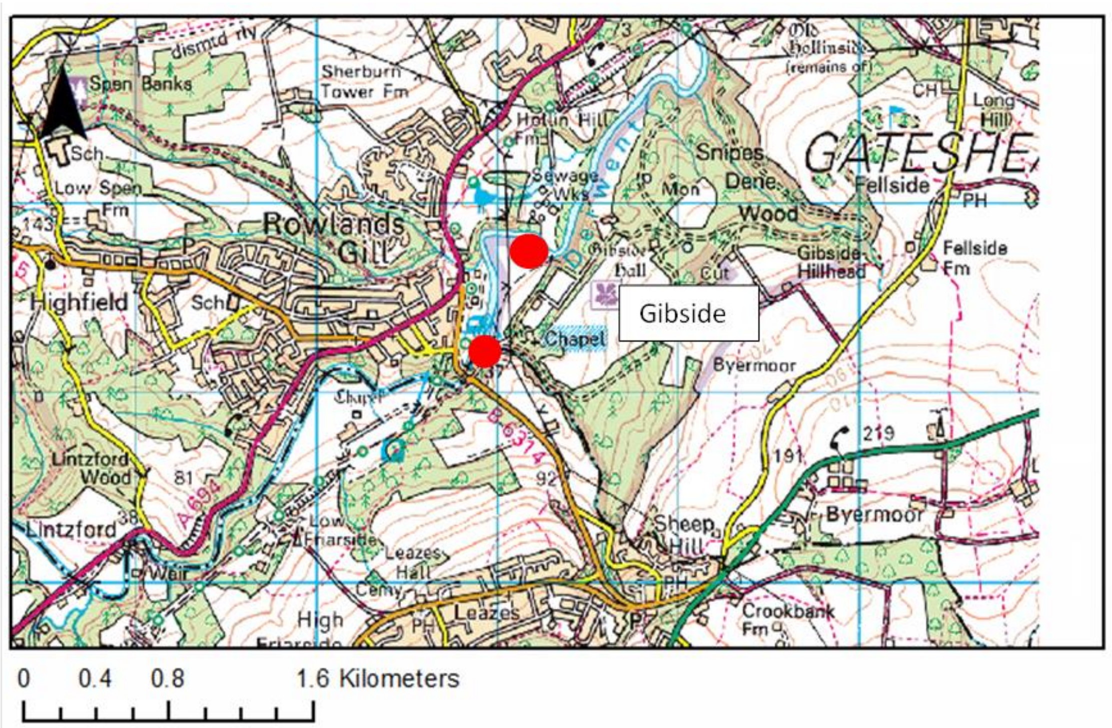

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Figure 3.5 Gibside: the positions of the 16th century bloomery and 17th century blast furnace and forge are shown as red dots.

The Gibside ironworks continued production into the 18th century. In 1728 the Gibside ironworks, then under the ownership of George Bowes, was producing both pig (cast) iron and malleable (wrought) iron (Hughes: 1952: 63) from ore mined from the plentiful supply on the estate. The iron was said to be of the 'hardest sort' and Queen Caroline, is said to have worn a brooch made from the material. The primary source for this information, a letter from George Bowes, a London merchant, to George Bowes of Gibside (Bowes MSS. 40748, 53 in *ibid*) was intended to gain the London Bowes some favour, so there may be bias when he states of Gibside Iron that 'there is none in the world comes up to it'. Some Gibside iron was used inside Gibside Hall; the London Bowes mentions the iron backs and *barr* present there. Two salient points brought up in the letter are that the iron within Gibside Hall had been produced in Sir Ralph Blakiston's day in his furnaces. Since Holme Mill had been lost in 1643 this suggests that either the household iron had been produced between 1641 and 1643, or that two furnaces were still present at Gibside; either the original West Gibside works and the Mill Field works or some new arrangement by the mid-17th century. The other main point which can be drawn from Bowes' letter is the proposal for building of new furnaces on Gibside to facilitate an iron supply for a Mr. Wood, who already operated works in Cumberland. There is no corroborative evidence for these furnaces being built.

All traces of the ironworks and the associated Gibside village were removed during the landscaping of the estate by George Bowes (Clavering and Rounding 1995: 256, 260). An enquiry to the Royal collection, St. James's Palace, London about the existence of an iron brooch revealed that, although there is no artefact in existence, Queen Caroline's financial records note 'bitts of ore', '6 aggets' and 'a little acorn of iron or silver' (Goodsir 2015: pers. comm. quoting from BL.Add.Ms. 20101. F.60).

3.3 The Industrial Revolution

3.3.1 *The Germans of Shotley Bridge*

Sword making at Shotley Bridge (fig. 3.6) began in or about 1687 after four businessmen, John Sandford and John Bell from Newcastle, and Peter Justice and John Parsons from London, identified a shortfall in the supply of swords produced by the domestic industry for the Crown. Sandford and Bell may have known of Shotley Bridge and its extant corn mill, the 'Bishop's Mill', on the Shotley Hall Estate of William Johnson. Douglas Vernon has suggested that Shotley Bridge was chosen as a suitable site because it lay outside the jurisdiction of the armourer's guilds of both Newcastle and Durham (2003: 100-1). It has been suggested that work on the forges and mills at Shotley Bridge may have started as early as 1685 under the supervision of a Newcastle sword-cutler, Thomas Carnforth (Richardson 1973: 19-20), or the 'agent' Clemens Hohemann (Atkinson 1987:3).

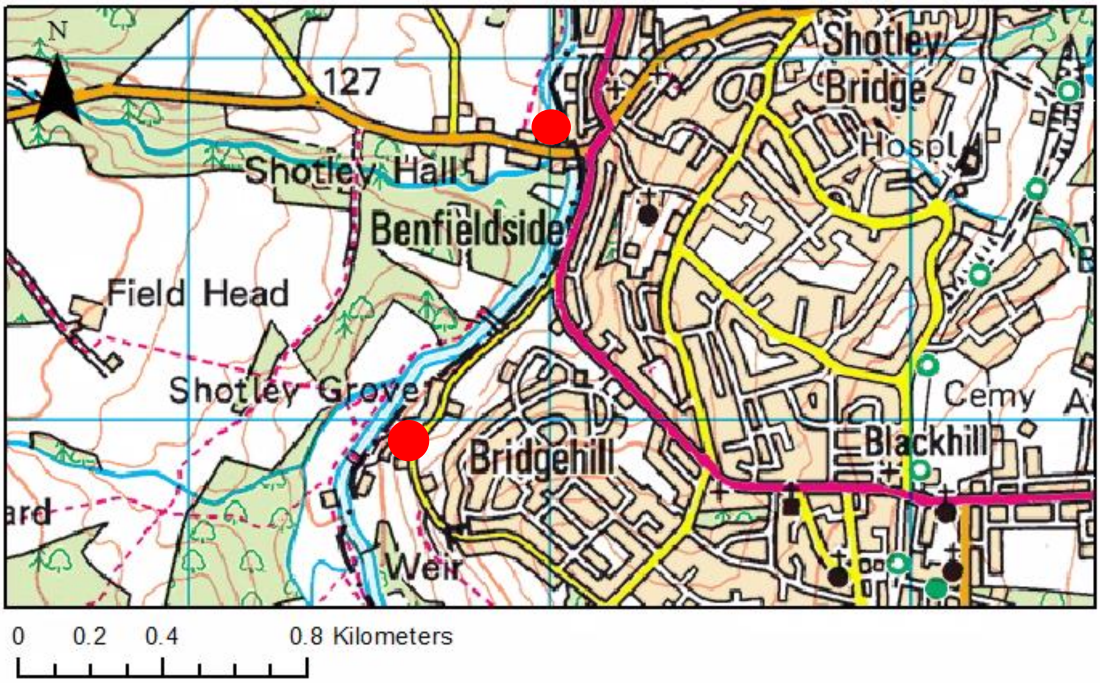

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Figure 3.6 Shotley Bridge: Sites of the sword factories are indicated by red dots.

Hohemann was sent to Solingen in Westphalia in 1686. Solingen was one of the principal sword-producing centres of Europe (Richardson 1973: 7). A list of the workmen that Hohemann recruited was provided in the Solingen Court Order, dated 26th September 1688:

> We, Wilhelm Vassmann, judge to the Court of Solingen, Matheus Wundes, Wilhelm Dinger, Wilhelm Vass, Johann Ganssland, Peter Voess, and the entire court of jurors of the town and parish of Solingen, have become aware of the fact that about a year ago Clemens Hohemann enticed away several craftsmen who have long been established and connected with this area to the Kingdom of England, and furthermore incited several more to depart, and as the infamy has become well-known and as this merits the severest punishment, Clemens Hohemann is accused of being a seducer deserving the severest punishment, along with all the other people involved: Hermann Moll, Abraham Moll, Joannes Clauberg, Clemens' son from Widdart, Clemens Knechtgen, Peter Theegarden, Joannes Voes, Vurckelt, Joannes Voes, Adolph Kratz, Joann Wupper of Feld, Henrich Wupper, Theiss' son, Joannes Wupper, Arnd Wupper, Henrich Keuler,

> Adam Ohlig's son, Joannes Hartkop, Engel Schimmelbusch and Peter Kayser, Peter's son. (Trans. Atkinson 1987: 3-4)

These workmen were said to be in possession of a machine for the milling of hollow sword blades which was unknown in Britain at that time (Jenkins 1934: 186). The partnership produced 'all sorts of sword blades at reasonable prices' (*London Gazette* 25 August 1690: 2) sold from a London warehouse. In 1690 Sandford and Justice formed a partnership with others as 'The Governor and Company for making Hollow Sword Blades in England'. (Jenkins 1934: 187). This Company applied for a Royal Charter to produce hollow blades which was granted in 1691. The hollow sword blade had been conceived at Solingen:

> The hollow blade was of triangular cross-section with the three flat sides hollowed down their entire length – in other words fluted – so that the blade, purely for thrust, was given a new lightness and rigidity whilst still retaining its strength. (Richardson 1973: 13)

In 1694 Sandford took a lease on a corn mill at Lintzford, some 11km downstream of Shotley Bridge. It can only be conjectured that there was a period where this building was converted into a sword mill but by 1703 Sandford was operating a paper mill on the premises. The annual rent charged to Sandford for the mill was £7 and 'one sword blade made well and tempered' (Richardson 1973: 39).

Production appears to have halted in 1702 (Jenkins 1934: 187) and restarted in April of 1703 with a new six-year agreement between The Governor and Company for making Hollow Sword Blades in England and the Shotley Bridge workmen: John and Henry Wopper (Voper), Adam Olligh (Oley), William Schafe and Peiter Tiergarden. Hermann Moll (Mohll) was absent in Europe on Company business. The agreement, for six years, was for the Germans to produce thirty-seven types of swords including the 36 inches long 'Large Latson', 'India Backs', rapiers, scimitars and bayonets. The Germans were to take over the Shotley Bridge workshops, mills, equipment and tools for the period of the agreement and hand them back on its conclusion. The equipment and tools listed by the agreement included 12 anvils, 11 pairs of bellows, 2 tempering troughs, 2 water hammers, 30 double headed hammers, 4 earthen engraving pots, 6 grindstones, rules and compasses (Hughes 1952: 59-60). The right to the use of the Hammer Mill for the making of the sword blades was granted under a separate clause in the agreement. The Company advertised stock produced at Shotley Bridge periodically in the *London Gazette* (the last such advert 2-6 December 1703: 2).

William Cotesworth, a Tyneside merchant and a principal member of the Hollow Sword Blades Company appears to have handled the sales and general business at Shotley Bridge from 1705 (Atkinson 1987: 11). Once the 1703 contract had expired Cotesworth, notionally for the Company then known as the Sword Blade Bank, entered into a new agreement with the Germans to supply him with swords at a price of sixpence per dozen cheaper than previously. Cotesworth's accounts show that for the period of November 1710 to August 1712 the Germans supplied him with 1600 dozen blades (Hughes 1952: 61).

The terms negotiated by Cotesworth placed the Germans in financial difficulty. The sword makers became indebted to Denis Hayford who was supplying their steel (Atkinson 1987: 14; Richardson 1973: 49). Many, if not all, borrowed money to cover the debts from Cotesworth. In 1715 Mohll asked Cotesworth if he and his fellow grinders could take on extra work on Hayford's blades which were also being made at Shotley Bridge. Hayford expressed a desire to buy the works and sent engineers to survey the Company assets. The Germans opposed this buyout. The works were advertised for sale in 1724. The advertisement for the sale of the Shotley Bridge sword-grinding mill (*Newcastle Courant* 30 May 1724:12) indicates that the mill stood on an eight-acre site which contained 'ways', water courses and a quarry. It appears that the property may not have been intended as a going-concern as it was offered as being 'fitting for any business'. Also offered for sale in the same advertisement was a house with a byre, garth and garden in Shotley Bridge; all were said to be in the possession of William Mohll, the son of the late Hermann, and probably fulfilling the same agency roles. Robert Oley, the son of Adam Oley [Olligh] bought the properties.

A second mill had evidently been established, an advert in the *London Gazette* (13-17 November 1733: 1) offered 'estates and mills' at Shotley Bridge. This mill was briefly transferred from the Company to Cotesworth (Hughes 1952: 62-3) but was returned on his death to the Company for disposal in 1733. The second mill was at Shotley Grove, again, this mill was on Johnson's estate. It was known at times as Johnson's mill and Leaton's mill, as the businessman, John Leaton, leased the premises to produce swords during the War of the Spanish Succession (1701-14). Confusion over the pattern of lease holding for Shotley Grove has led modern historians to speculate over the existence of four sword-mills (Atkinson 1987: 14; Bygate 2003: 52-3; Richardson 1973: 59-60).

A copyhold lease on Shotley Bridge, probably Johnson's mill, was in the hands of the partnership of Cuthbert Smith, Thomas Wasse, Ralph Harle and George Blenkinsopp in 1733 (Cranstone 1997: 19). Blenkinsopp is recorded as the manager of the Hollow Blade Sword Company in 1753 and 1758 (*ibid*. 19). Reinhold Angerstein, in 1754, noted that scythes for the local market were also being produced (2001 [1765]: 270-1). Angerstein only refers to one forge at Shotley Bridge and it is thought to have been Leaton's mill (Richardson 1973: 6) which may have come into Blenkinsopp's hands through marriage (Atkinson 1987: 14).

During the latter part of the 18th century the concern was dominated by several branches of the Oley family with some Moles running their own business. The engraver, Thomas Bewick began his career as an apprentice to Ralph Beilby of Newcastle in 1767. One of the first jobs that Beilby set the young Bewick on was etching sword blades for William and Nicholas Oley of Shotley Bridge (Bewick 1975 [1862]: 35-40). By 1810 most, if not all, sword manufacture was in the control of William Oley (1739-1810). His will indicates that by 1810 he owned three operational workshops and two in ruin, these were in addition to the grinding mill, a warehouse and an implied building (which may have been the Hammer Mill) to house the bellows and anvil, all to be divided between his three sons. In 1831 the works were still in production but the two Oley brothers who were at the works at that time reported that there was very little demand (Hone 1832: 1341). At some date prior to 1840 the last of the sword making Mole family moved their business to Birmingham which was becoming an important sword making centre. This departure left only one sword maker at Shotley Bridge, Joseph Oley (1806-96), the grandson of the above William Oley. Joseph Oley closed his workshops in 1840 marking the end of the commercial industry in the village, his claim to be the last sword maker was discussed in Chapter 2.

3.3.2 *Denis Hayford's 'Company in the North'*

Denis, or Dan, Hayford (c.1635-1733) was an iron and steel master from the Ferrybridge area of Yorkshire. In or about 1687 Hayford and partners, William Cotton, William Simpson and John Fell formed the 'Company in the North' for operations in the Derwent Valley. The Company acquired Blackhall Mill in 1687 (fig. 3.7) where it established a cementation furnace to produce steel. (Awty 2004).

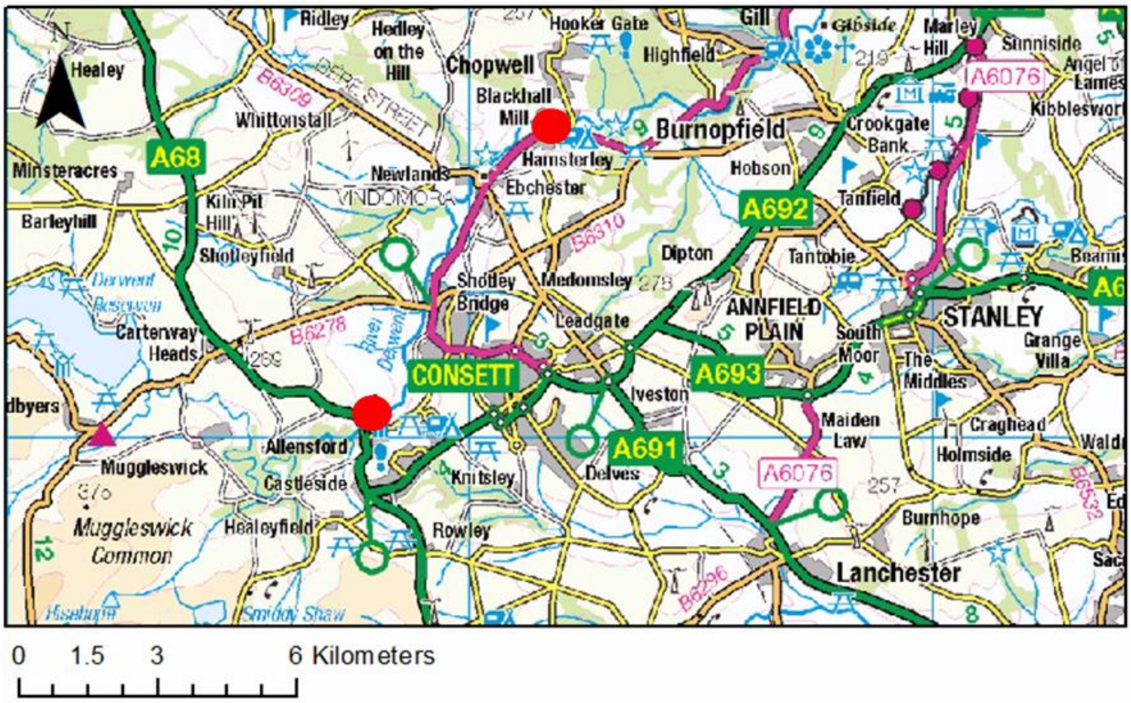

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Figure 3.7 Allensford and Blackhall Mill: The sites of Hayford's blast furnace and steel furnace are shown by red dots.

A German, Wilhelm Bertram, was employed by Hayford at Blackhall Mill as steel master to produce superior ‘German’ or ‘shear’ steel as a proportion of its total output. Bertram may have been responsible for the introduction of Swedish methods of steel production into the country. Shear steel was so-called because of its suitability for use in edged products such as swords, scythes and cutlery. Bertram simultaneously operated from a steelworks in Newcastle, possibly also owned by Hayford (Barraclough 1984a: 64-5). The output from the North-Eastern steel mills sent to Sheffield during the eighteenth century was known as ‘Newcastle steel’ (Cranstone 1997: 18, Barraclough 1990: 27). The market for the steel has always been attributed to the establishment of the Hollow Blade Sword Company at Shotley Bridge some 5km upstream on the Derwent. The contemporaneous appearance of both ventures in the valley and their geographic proximity strongly suggests this to be the case.

At Allensford an iron forge was recorded on a conveyance dated 1670. In 1692 Denis Hayford and partners took on the lease for this forge and a blast furnace at Allensford; this suggests that the furnace may have come into existence during the 1680s (Linsley and Hetherington 1978: 1; Cranstone 2011: 41). Whether the blast furnace was built by the owners or leaseholders of the forge prior to Hayford’s takeover with an intention of supplying the Germans at Shotley Bridge with iron or their own-account is unknown. It is reasonable to propose that Hayford would have mined iron ore from the surrounding area and transported it first to Allensford to have it smelted into cast iron and converted to wrought bar-iron, and then to Blackhall Mill to have the bar converted to German steel.

The arrangement whereby Hayford produced a locally sourced iron for steel conversion to supply the sword factory appears to hold true for at least the period of the first contract or agreement with the Hollow Blade Sword Company to produce swords for the Crown. However, the agreement of 1703 to 1709 stated that the steel for the swords was to come from Hayford's *Roamley* (Romeley) works (Hughes 1952: 62). Blackhall Mill is not mentioned in the contract but it is known that it was operating in 1719 when visited by the Swedish spy, Henric Kalmeter, and in 1753 when visited by another Swedish spy, Reinhold Angerstein, so there is no reason to assume that production ceased in 1703. Denis Hayford's residence was at Romeley, Clowne, Derbyshire at that time, therefore the terms of the agreement may have been a confusion for steel bought from Dan Hayford of Roamley's forge: meaning Blackhall Mill.

The Allensford Forge was conveyed from Hayford and partners to Nicholas Fenwick of Newcastle in 1713. The conveyance included… 'all utensils, Iron, Ironplates, Bellis and other materials and things whatsoever to this forge useful and belonging and now there being' and Fenwick was permitted to 'win and use freestone, quarried at Allensford, for the repairing of the forge and its dam, as well as stone, clay and sand whenever it was needed at the forge' (Linsley and Hetherington 1978:1).

It appears that Hayford no longer required Allensford but he was still interested in the Shotley Bridge site as he attempted a takeover in 1715 (Hughes 1952: 60). In the year Hayford gave up the lease on Allensford he invested £1000 in a rebuilding programme at Blackhall Mill (Awty 2004). The coincidence of Hayford leaving Allensford and rebuilding Blackhall Mill must suggest a decision to produce steel converted from iron from a different source. By the early 18th century Swedish Oregrund iron was being regularly imported into Newcastle, notably to supply Ambrose Crowley's works clustered around the lower Derwent. Oregrund iron provided a superior material for steel production through the cementation process. The Crowleys had taken on the lease for Allensford Forge by 1728 (Flinn 1955: 261). This may have happened during the period 1717 to 1719, when the Government banned all trade between Britain and Sweden leading to an acute shortage of iron and a price rise (Flinn 1958: 145).

The fate of the Allensford Forge may be interpreted from figures given in a collation of lists and anonymous pamphlets (Wyndham Hulme 1928) dating to the early to mid-18th century. The first available data is from the pamphlet, *The Interest of Great Britain, In Supplying Herself with Iron: Impartially Consider'd* of 1736, in which Allensford is shown to 'have made' 130 tons of iron annually, but for the 'do make' entry, the production of 1736, shows 000 tons. A revised edition of the pamphlet renamed, *The State of the Trade and Manufactory of Iron in Great Britain Considered*, produced in 1750, originally did not contain any printed record for Northumberland, but a hand-written entry for the county added later only shows the output for Derwentcote Forge, not far from Blackhall Mill. This suggests that output from Allensford may have stopped c.1736. As indicated in section 3.3.1 above, the relationship of the Shotley Bridge Germans had become strained by 1715. How this affected the purchasing strategy of the Germans is unclear, but following Hayford's death in 1733, the lease for Blackhall Mill had been sold on to a Mr. Hall and Co. by 1753 (Angerstein 2001 [1765]: 267-70). At the time of Angerstein's visit Bertram's son was managing Blackhall Mill, and the steel cementation furnace processed 10 tons of iron in 20 to 24 day cycles. If it is considered that repairs to the furnace would be required in between firings the output of some 150-170 tons of steel may have been achieved annually. In 1753 the output was stated as 100 tons of blister steel and another 30 tons of German steel. Bertram confided to Angerstein that his father had great trouble developing German steel in the early days of the Blackhall Mill venture (2001 [1765]: 269) and that Oregrund iron was used for steel production. It is possible that Wilhelm's early German steel was produced using the local Derwent ore which had a less consistent quality than the Swedish import. In 1767 a workman from Blackhall Mill introduced the method of producing German or Shear steel to Sheffield and thereby broke the North-East's monopoly on the product.

Isaac Cookson (1745-1831) took over Blackhall Mill later in the 18th century and added it to his network of north-eastern ironworks which included the steelworks at Derwentcote. Cookson was one of the largest contractors for government ordnance during the French Revolutionary War (McCord and Rowe 1977: 38-9). Despite the steelworks dam being swept away by flood in 1834 (Dixon 2011), the 1841 National Census return shows two forgemen living at Blackhall Mill. This indicates that Cookson kept the steelworks running after the Revolutionary and Napoleonic wars. However, as the sword manufactories ceased production in 1840 the traditional local market disappeared. A mid-19th century history of County Durham (Fordyce 1857: 679) dedicated only two paragraphs to Blackhall Mill, mentioning that the steelworks had been recently destroyed by flooding. The buildings of the Blackhall mill site were demolished to make way for a school-house in 1916.

3.3.3 *Crowley's Iron Works*

Ambrose Crowley III (1658-1713) (fig. 3.8) was a Midlands ironmaster who was responsible for setting up three ironworks on the lower Derwent between 1690 and 1707, at Winlaton, Winlaton Mill and Swalwell (fig. 3.9). Crowley was apprenticed to an ironmonger in London where, on completion of his apprenticeship in 1681, he founded his own wholesale ironmongery company (Anderson 1973; Price 2004). Crowley's commercial base was in London and he remained there once his North-Eastern businesses were established, controlling the venture by written instruction to his northern management and by frequent visits.

Figure 3.8 Ambrose Crowley III. Memorial relief with his wife Mary (Ballast Quay 2017)

Crowley initially set up a nail manufactory in Sunderland in 1682 (Flinn 1957: xi-xii). In a letter of 1684/5 he set out the economic advantages of manufacturing in the North-East (Crowley 1684/5 reproduced in Flinn 1962: 35-8). Crowley's decision to commence operations in the North East was possibly influenced by Samuel Pepys. Pepys and associates were granted permission to begin a trade in copper sheathing ships hulls at Newcastle-upon-Tyne in 1682. Crowley would have been ideally located to supply Pepys with nails (Clavering and Rounding 1995: 260-1). However, Pepys found employment in Tangiers before trading could commence. Sunderland offered excellent maritime links to the London market but the site proved problematic. The waterpower available from the Wear was insufficient and there was no local timber fuel supply. Due to the lack of a local workforce with knowledge of ironworking Crowley employed some specialists from Liège which caused violent unrest amongst the indigenous population. Crowley applied for a Royal Warrant to protect the foreign workmen from attack (Sellers 1907: 281; Clavering and Rounding 1995: 261). Crowley abandoned the troublesome Sunderland site c.1690 and relocated to the village of Winlaton.

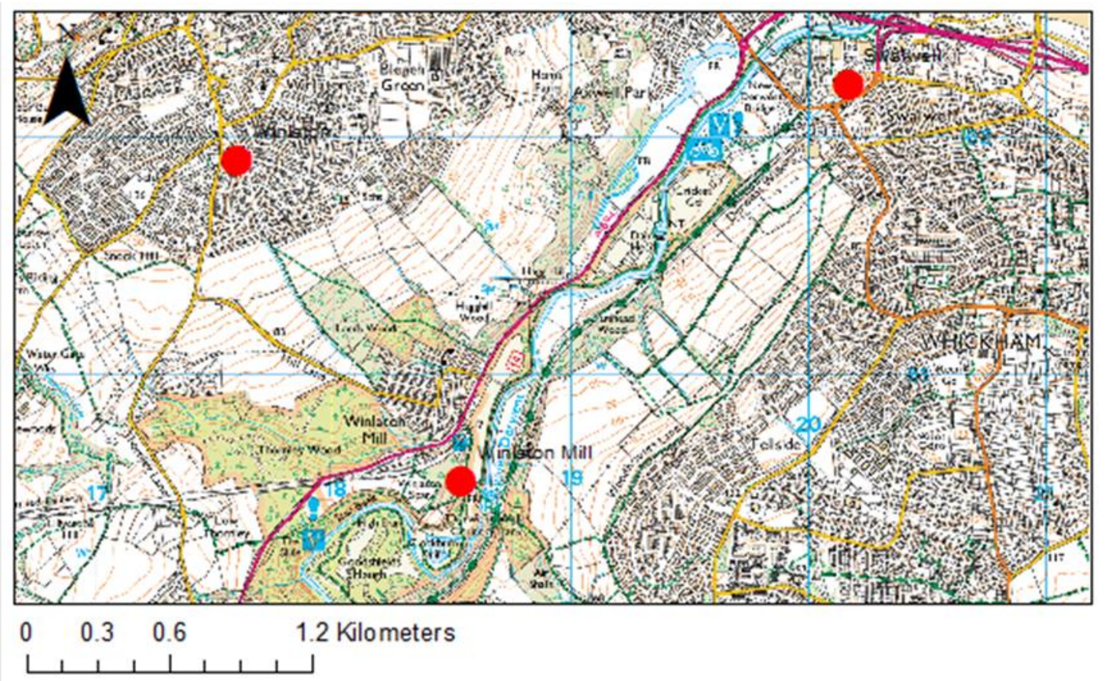

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Figure 3.9 Ambrose Crowley's manufactories.

Winlaton is about a mile from the Derwent, high on the west valley side and may have been a move of expediency to establish offices and nail makers' workshops in the valley before a powered location could be found. Crowley leased some four acres of land with a disused corn mill and a few deserted cottages. Crowley's move to Winlaton may have been facilitated by Sir William Bowes of Gibside. A letter from Crowley to Bowes in 1702 thanks Bowes for the enabling of the establishment of the manufactory (Anderson 1973). Workshops were constructed in ‘squares’. Crowley advertised for employees in the London press:

> Mr. Crowley at the Doublet in Thomas Street, London, Ironmonger, doth hereby give notice that at his works at Winlaton, near Newcastle upon Tyne any good workmen that can make the following Goods, shall have constant Imployment, and their wages every week punctually paid (viz) Augers, Bed-screws, Box and Sad Irons, Chains, Edge-Tools, Tiles, Hammers, Hinges, Hows for the Plantations, Locks, especially Sto-Locks, Nails, Patten Rings, and almost all sorts of smiths ware. (*Post Boy* 23-25 August 1698:2)

Similar advertisements were placed periodically. In 1702 workmen were offered one penny per mile to make the journey to Winlaton (*Post Man and Historical Account* 23-25 April 1702: 2) and in 1709 labourers as well as skilled workmen were offered sea-passage from London (*Post Boy* 5-8 February 1709: 2). These adverts suggest that Crowley’s workforce could not be raised in the North-East alone.

In 1691 Crowley acquired the southern part of the Winlaton corn and fulling mill on the north bank of the Derwent to establish an ironworks. The valley could provide a plentiful supply of wood fuel, notably from Gibside and Thornley (Hughes 1952: 63-4), and the river supplied the waterpower missing at Winlaton. By 1696 Crowley had become a major supplier to the Navy (Cranstone 2011: 41) allowing him to lease the rest of the Winlaton Mill site. From 1700 to c.1711 Crowley carried out a massive programme of development at Winlaton Mill commencing with a new slitting mill and a steel furnace which were in service by 1701. Two further steel furnaces were built and, under the steel maker Thomas Kirkup, Crowley began developing his own brand of blister steel utilising Swedish bar iron (*ibid*. 41-2).
An ironworks was founded at Swalwell in 1702-3 by a partnership of Edward Harrison, William Bayliss and John Wood who took on the leases for the Bishops Mill corn mill, Holm Mill, Holm Close and High Mill along with their water rights. Holm Mill was the former ironworks of Talbot and Blakiston in the early 17th century. By 1707 the partnership had built a slitting mill with power supplied from Dam Head, built across the Derwent and possibly nailers’ and patternmakers’ workshops and an office (*ibid*. 42). In the same year, Harrison and Wood assigned their leases to Sir Gregory Page of Greenwich but it was Crowley who controlled the ironworks with no known record of transfer of title (*ibid*. 42). In 1707 Ambrose Crowley received a knighthood.

In 1711 Sir Ambrose Crowley turned his attentions from Winlaton Mill to Swalwell. His son, John (1689-1728), was present in the North-East to supervise the works. It was known that by this date an anchor smithy and a Half-Forge had been added to the buildings listed in 1707. The 1711 Swalwell programme was for the Grand Warehouse, which was completed by August 1712 (*Newcastle Courant* 13 August 1712:4), and two steel furnaces, one of which at least was not in operation until after the beginning of 1714. Sir Ambrose Crowley died in October 1713.

The period of near constant warfare against the French came to an end as John Crowley took over the business and with it the lucrative admiralty contracts. However, Swalwell continued to expand as Crowley increased production of hardware destined for the Americas and the plantation agriculture trade. John died in 1728 and the Company was placed in the hands of his widow, Theodosia. With the addition of the Team Valley ironworks in 1735, Crowley's North-Eastern business became the largest iron manufactory in Europe employing over 1000 workers (Flinn 1962: 74-6). Two of Theodosia's sons, Ambrose and John, came to head the company when they came of age from 1739 until they predeceased their mother in 1754 and 1755 respectively. The company then returned to Lady Crowley. A news report of 1756 confirms her as 'proprietess' (*Gazetteer and London Daily Advertiser* 16 December 1756: 1).

Angerstein visited all three of Crowley's works on his journey up the Derwent in 1754. Steel manufacture had ceased at Winlaton Mill (2001 [1765]: 263). Angerstein had almost nothing to say about the technology used at Crowley's, which would suggest that all the above mills, furnaces and forges were of a familiar model. The one exception was a pair of what appear, from Angerstein's sketch (fig. 3.10), to be portable hand powered bellows which featured vertical cast-iron cylinders.

In 1782, following Lady Crowley's death, the business Theodosia Crowley and Co., was dissolved and the assets taken over by Isaiah Millington, a former manager of Crowley's at London (*London Gazette* 7 December 1782: 3), and others. A lease of 1802 indicated that there had been some building expansion at Swalwell, such as a new anchor workshop, but the growth was limited in comparison to that of the Crowleys. Isaiah's grandson, Crowley Millington, took over the company in 1816, renaming it Crowley Millington and Co.

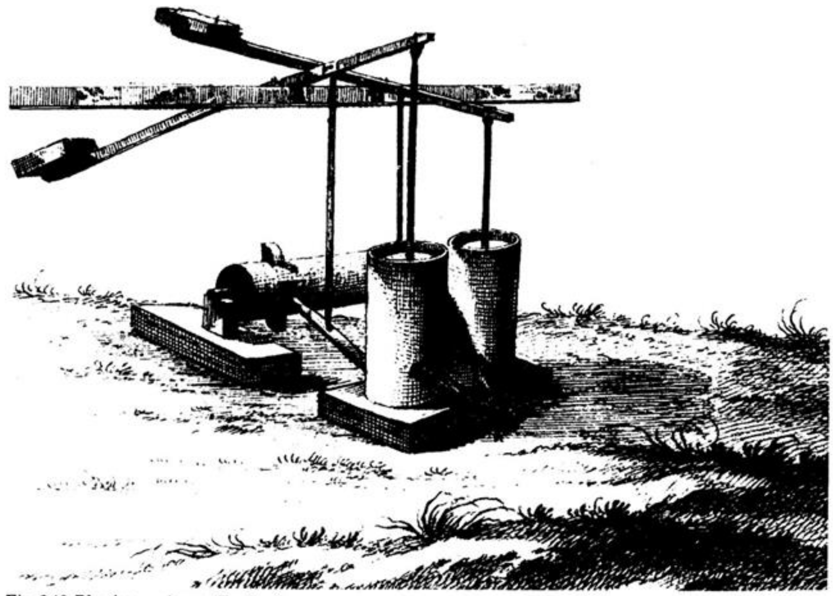

Figure 3.10 Crowley's blowing engine.
(Angerstein 2001 [1765]: 260)

Crowley Millington's accession coincided with a downturn in the iron trade following the end of the Napoleonic wars in 1815. His response was to lay off a proportion of the workforce. Winlaton was largely closed down as were the High Forge at the High Mill and possibly the foundry at the main Swalwell works and many of the workshops (Cranstone 2011: 47). Some former Millington employees took on workshops at Winlaton (Veitch 2012). A report on an industrial dispute at Winlaton in 1838 indicates that Millington had retained enough workshops to employ at least 11 named nail makers (*Northern Liberator* 25 August 1838: 3). It was, however, the smaller independent companies which continued into the 20th century; the last ironware produced at Winlaton was a chain in the Nixon and Whitfield works, 1966 (Veitch 2012). Millington added a new chain-making works to Swalwell in 1819. Subsequent site plans of Swalwell under Millington show redevelopment within the site, with some buildings repurposed and others rebuilt, but they also show dereliction. A contemporary description of the Derwent Valley stated that 'Winlaton Mill is comparatively a deserted village and its communication with the Tyne instead of the direct and level line down the vale, is by a mountainous ascent and descent, by way of Winlaton' (Sopwith 1832).

Crowley Millington's death in 1849 saw the management of the steelworks pass to the Company's partners. In 1851 the Swalwell lease was sold to a former manager, John Laycock, who also took over part of Winlaton Mill. The Swalwell leasehold was returned to the partners in 1857 and then sold again in 1858 to the London-based Thomas Fergus Graham, Millington's last manager, and Robert Graham who continued trading as Crowley, Millington and Company. Graham and Graham went bankrupt in 1862 and the lease returned to Crowley Millington and Partners who put the business up for sale in 1863. The sales advertisement (*Newcastle Courant* 6 March 1863: 4) implies that Graham and Graham had been renovating when they became insolvent. A crucible steel furnace was described briefly with reference to a 'Steel Cast House, with Six Pot Furnaces' in place and a small amount of 'Ingot Steel' amongst the sale-stock. Swalwell and Winlaton Mill were bought in 1863 by Henry William Fawcus and Charles William Scorer who carried out a steel-making and iron founding business at Swalwell for fifteen years before filing for bankruptcy (*London Gazette* 29 January 1878: 502). The Winlaton Mill works were temporarily closed in 1863 then reopened by the Raine brothers as the Winlaton Rolling Mill. The site operated in this form until 1915 when Raines relocated to the new Delta Works at the mouth of the river (Brown 2008).

Fawcus found another partner named Common and continued production at Swalwell for another two years. Common and Fawcus may have quit the site in 1880 by sub-letting to the steel makers, Ridley and Company (Cranstone 2011: 52). A lease of 1883 made Swalwell over to William Grace and Co., papermakers, with Ridley's as sub-tenants of the southern part of the site comprising of the forge building and a rolling mill. Grace and Company levelled the rest of the old Crowley works to build their paper mill. In 1884 James Ridley was the sole proprietor of the Company and remodelled the company as a compact steel and engineering works which specialised in high quality tool steels which it produced through the crucible process. Ridley continued trading at Swalwell until 1912 when he surrendered the lease to the (scrap) metal merchants, David and Thomas Gallon Adams, who had taken on the primary lease from Grace's. The OS map for 1914 shows the Steelworks as disused.

3.3.4 *Derwentcote forge and steel cementation furnace 1718-1895*

As indicated in 2.1 above the Derwentcote forge and steel cementation furnace will be the subject of a detailed artefact biography in chapter 6. The following section, a precis of David Cranstone's *history* chapter within his report on the steel furnace (1997: 17-25), serves to indicate the position of Derwentcote (fig. 3.11) within the historical narrative.

Derwentcote may have been first set up as an iron forge in or about the year 1718, as evidenced by the purchase of cast-iron forge plates in that year from Sheffield, by a partnership of Ralph Reed, William and Richard Thompson. This partnership operated other ironworks at Skinnerburn and Teams outside the Derwent valley. The Thompsons survived Reed and sold the lease of Derwentcote in 1733 but there was no steel furnace mentioned in the particulars. The lease was bought by a partnership which included Cuthbert Smith and George Blenkinsopp, proprietors of two of the Shotley Bridge sword mills. This partnership evidently built the steel furnace as it appears in particulars for an aborted sale in 1742.

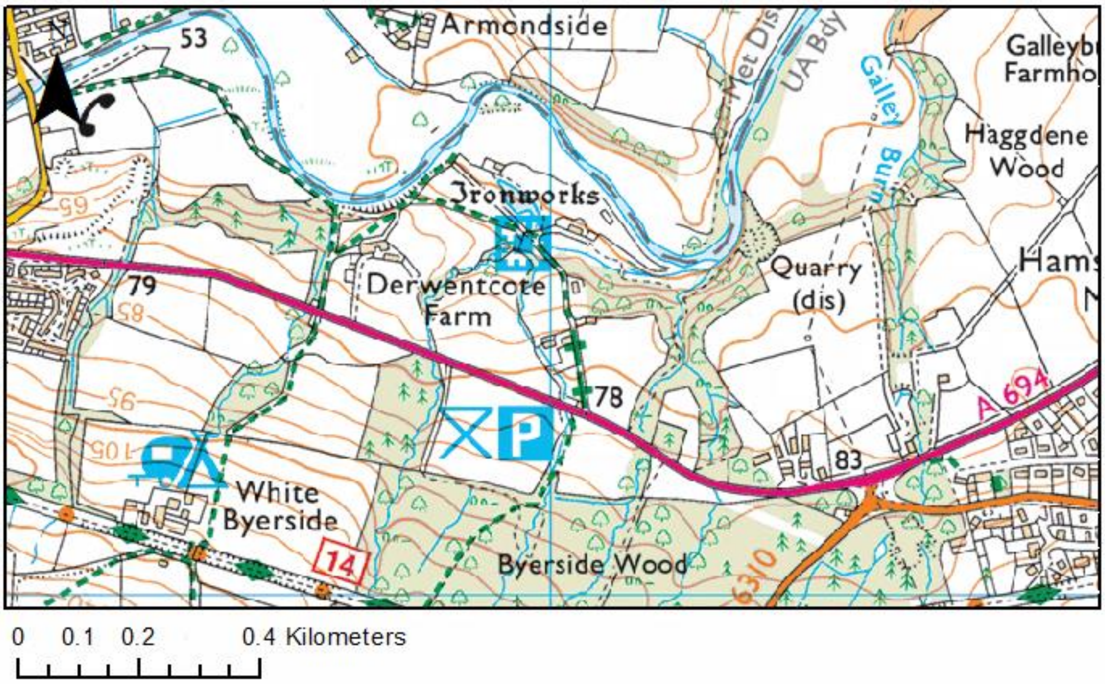

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Figure 3.11 Derwentcote: Ironworks are marked by OS as a Historic England site.

By the time of Angerstein's visit to the Valley in 1753, Derwentcote was operated by a man named Hodgson of Newcastle and was producing high quality German steel. John Hodgson was involved in many business networks some of which included the Cookson family. By 1767 the Cooksons had an interest in the Blackhall Mill steelworks higher up the Derwent and perhaps by that time Derwentcote too, through a partnership with Hodgson. Hodgson became bankrupt in 1782 and the Derwentcote lease passed through several partnerships until the Cooksons eventually took it on at some time between 1788 and 1794. One of the controlling partnerships, Landell and Chambers, applied to Henry Cort for a licence to use his puddling process for iron purification in 1784.

The Cooksons operated the steelworks until 1872 and introduced the crucible steel production method which superseded the cementation process on the site. The works were then run by other short-lived partnerships until their closure under Charles Winter c.1895.

3.4 The Machine Age

3.4.1 *The Derwent Iron Company 1840-1857*

In 1839 the area now known as Consett (fig. 3.12) was a rural landscape. Known at various times in the past as *Consil* or *Conside* it has been estimated that at that time there may have been as few as three houses of note and a small handful of cottages in the area (Jenkins 2008 [1893]: 11). The Stanhope and Tyne Railway had opened in 1834 for transporting lime from Weardale to South Shields, passing just to the east of Consett in an area now called Villa Real, but at that time Consett was too insignificant to warrant a station.

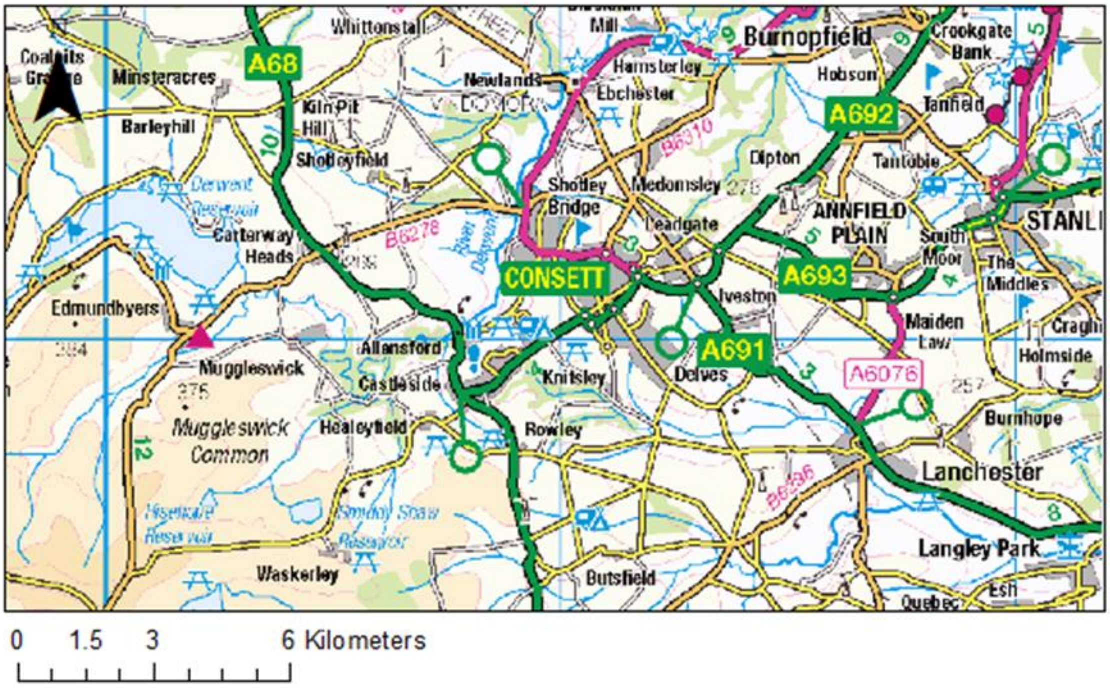

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Figure 3.12 Consett

In 1839, John Nicholson, 'a cartwright of speculative nature' (Sellers 1907: 291), also described as 'a local mining expert' (Warren 1990: 6) discovered an outcrop of ironstone at Consett. Nicholson met William Richardson of Sunderland when Richardson was visiting the health resort of Shotley Spa at Shotley Bridge. The two men prospected the local ironstone together and presented samples to Johnathan Richardson, proprietor of the spa and a Quaker banker. Both Richardsons became partners (O'Hagan 2011: 14) with the Bishopwearmouth Quakers in the Derwent Iron Company with Jonathan Richardson as principal partner or managing director. By 1840 and the forming of the Derwent Iron Company Nicholson appears to have played no further part in the iron industry.

The Derwent Iron Company took mineral leases for both iron and coal at Conside, Delves and Hown's Gill, in general the area prospected by Nicholson. The venture began with the building of two blast furnaces at the Blue Heaps (fig. 3.13) and some rolling mills. Production began in February 1842. The ironstone was extracted from mine shafts immediately to the east of the Blue Heaps; the shafts were simply sequentially numbered 1 to 8. By 1845 six furnaces were in operation, producing 400 tons of pig iron per week; a proportion of which

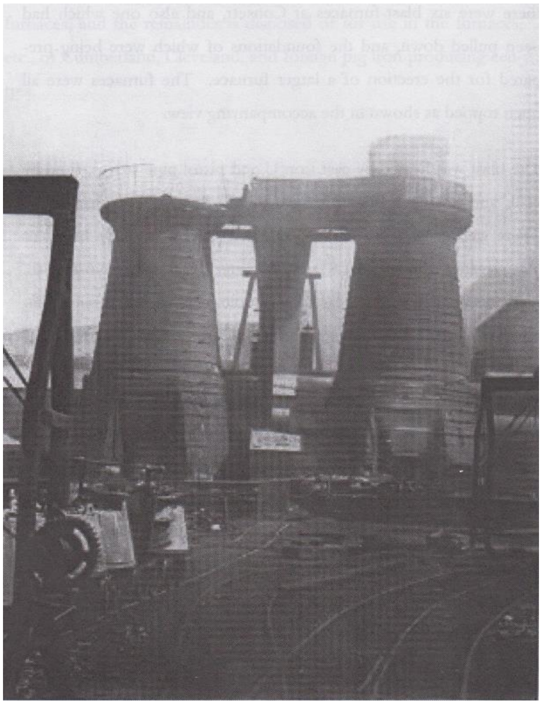


Figure 3.13 Original blast furnaces.
(Jenkins 2008 [1893]: 24)

would be reworked in seventeen puddling furnaces to produce malleable iron suitable for rolling down into rails. In 1846 there were eight furnaces in blast and six more awaiting commissioning. In 1849 one furnace produced 218 tons in six days, over two and a half times the average amount of production for furnaces in the Northumberland and Durham area (Warren 1990: 9).

At the same time as the founding of the Derwent Iron Company at Consett a local businessman, Edward Richardson, opened ironworks at Crookhall and Bradley, with seven

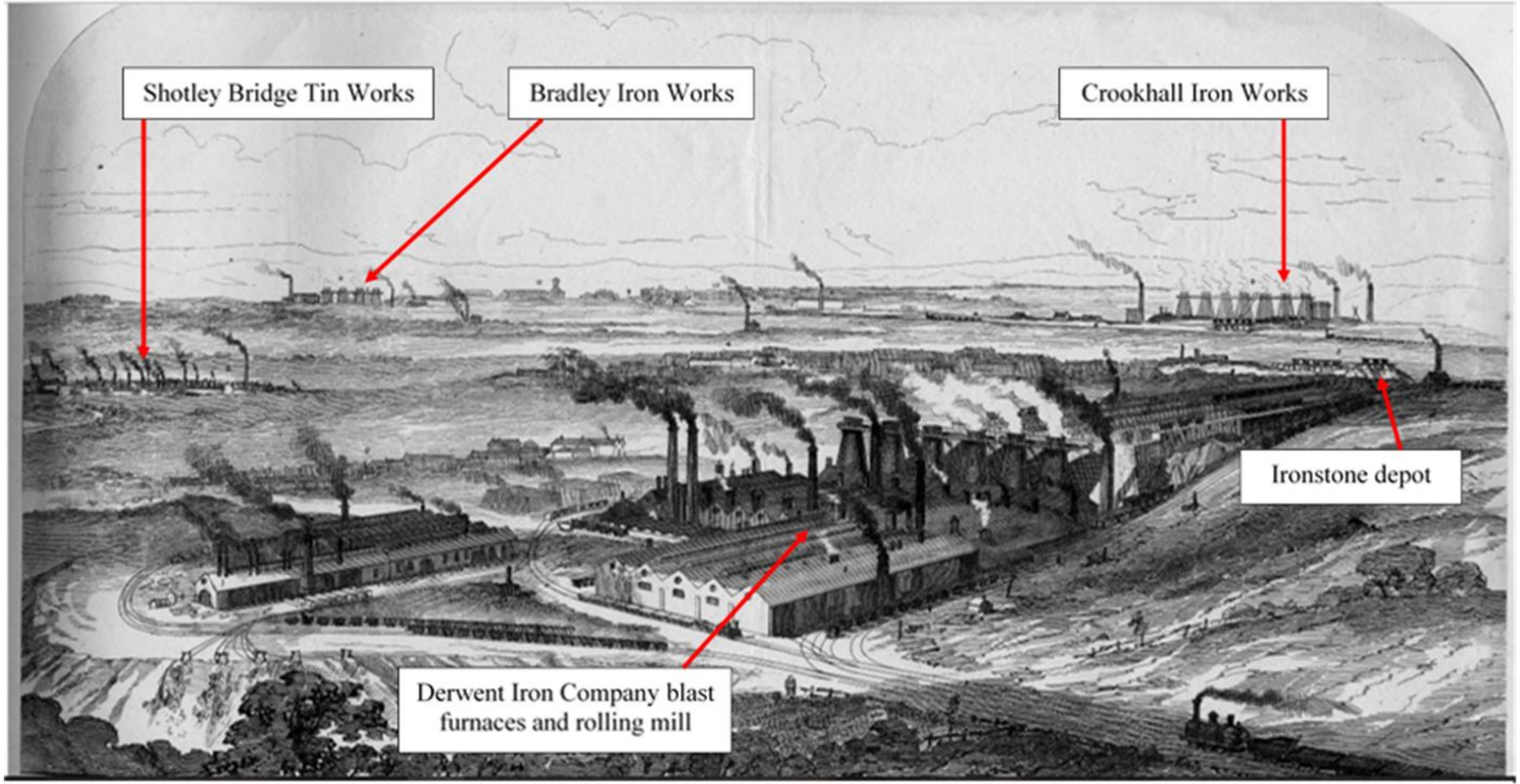


Figure 3.14 the Derwent Iron Co,'s works. Viewed from the south

(after M. and M. W. Lambert 184?)

and four furnaces respectively, and worked the No. 1 ironstone seam at Billingside. Richardson sold out to the Derwent Iron Company and became a partner in 1846 creating the largest iron works in England (fig. 3.14). The enlarged company's assets included eighteen furnaces in blast, suggesting that some early furnaces had been decommissioned, and thirty-five mines to supply the ironstone, coal and limestone. These included the limestone quarries at Stanhope and the western portion of the Stanhope and Tyne Railway, purchased in 1842, to guarantee a supply of limestone flux for the smelting process. This railway was leased to the Stockton and Darlington Railway [S&DR] in 1845 in an agreement where for the consideration of this lease the S&DR would bring a new railway line to the outskirts of Consett in order to carry the Company's limestone and finished iron products to markets in the south. The limestone quarries were also leased to the S&DR with a very low price set for the supply of limestone to Consett. In 1848 the combined Consett concern produced 29,000 tons of pig iron. Around the same time the Company bought out the Bishopwearmouth Iron Works and the Chesterhouse (Redesdale) Iron Works at Ridsdale, Northumberland. A tin mill called the Shotley Bridge Iron Company was established in 1850 to the north of the Consett works by E. O. Tregelles in a partnership with Jonathan Richardson, trading as J B Richardson and Sons.

The ironstone reserves at Consett soon proved less plentiful than first thought. After only a few years the local supply was augmented by ore from Cumbria accessed by the Newcastle and Carlisle Railway. An experiment using 7000 tons of Weardale ore in 1847 proved unsuccessful as the quality was found to be inconsistent. In 1849 the Company turned to the Whitby Stone Company and Messrs. Clark of Grosmont in the Esk Valley in the North Riding of Yorkshire for a dependable supply of ore and abandoned the Ten Bands ironstone workings. In the following year, 1850, massive ironstone deposits were discovered at Cleveland, and the Company took leases on ironstone mines at Upleatham. Even with the transport costs by rail the ore from Cleveland was cheaper than the local No. 1 ore to extract and smelt at Consett at 7/- per ton compared to 10/- per ton. An application was made to the landlord of Upleatham, the Earl of Zetland, to build calciners at Cleveland but this was refused, and 60 calcining kilns were built at Consett. Cleveland ironstone and No.1 ironstone were mixed at Consett until 1852 when local extraction ceased altogether (O'Hagan 2011: 15; Warren states a date of 1857: 1990: 13) and dependency fell on the Cleveland ore which, by 1856 was being mined by the Company at the rate of 1000 tons per week.

If the Derwent Iron Company had depended solely on the sale of pig iron it may have hit financial difficulties by the late 1840s with the depletion of the local ore. Even though Cleveland ore was cheaper than Consett ore for the Company, it provided a much cheaper raw material for the Teesside ironworks allowing them to produce a competitive product: the Company benefitted from excellent supplies of its own coking coal and its own limestone delivered on its own railway. Moreover, from the outset the Company added value to the pig iron through puddling and rolling processes. By 1849 the Company had a weekly output of rolled material, rails and plate, of some 1500 tons. Throughout the 1850s they were the only large-scale producer in the region, developing markets in the Clydeside shipyards and with the Admiralty yards at Chatham.

By 1855 the capacity of the iron works at Consett had reached 125,000 tons per annum and the venture was an apparent success. The Redesdale Ironworks failed in 1857 (Warren 1990: 15; O'Hagan states production ceased in 1849: 2011: 16) because its remote location raised its production costs too far. In the November of the same year the Northumberland and Durham District Bank failed and it was discovered that the Derwent Iron Company owed the bank £947,922 (*Morpeth Herald* 4 April 1858: 5).

3.4.2 *The Derwent and Consett Iron Company (Limited) 1858-1864*

The Derwent Iron Company was an early example of a business which was too big to fail. The Company was the sole means of support for a population of 30,000 and provided income for both the North Eastern Railway and Stockton and Darlington Railway companies who transported over 1,000,000 tons of raw material and finished product to and from Consett per year. One of the Bishopwearmouth Quaker partners of the company, William Backhouse, asked a Jonathan Pease to produce a report on the state of the Company for the liquidators of the Bank and make recommendations for its future. Pease recommended that the company should continue, being of the opinion that the Company could trade itself out of debt.
A scheme was devised for transferring the Derwent Iron Works to a new company initially composed of fifty-four shareholders of the District Bank. A price of £966,731 for all the works, collieries and housing was set. The liquidators had earlier made a call of £5 on the shareholders of the Bank, this amount was deducted from the price for those fifty-four shareholders wishing to form the new company leaving £930,000 outstanding which would be paid in instalments at six month intervals. The initial payment was set at £175,000, though £250,000 may actually have been paid (*Morpeth Herald* 7 August 1858: 5, Jeans 1877: 123).

More money was invested in the new venture by independent shareholders and shareholders of the North Eastern Railway creating a joint stock company: the Derwent and Consett Iron Company.

The new company operated between 1858 and 1864. Jonathan Priestman of Newcastle was appointed joint managing director, replacing Jonathan Richardson. Priestman's family was one of the largest shareholders in the venture. His co-manager was David Dale (fig. 3.15) who represented the interests of the railways. The S&DR constructed the Howns Gill Viaduct. It was completed in 1858 and permitted limestone deliveries to the ironworks without the need of each truck being winched through the Gill. One of the first actions of the new Company was to dispose of the lease of the Upleatham ironstone mines to J and J W Pease and Partners, under favourable terms for supply to the Company.

Figure 3.15 David Dale.
(Jenkins 2003 [1893]: 19)

In 1860 there was a slump in the iron trade. The company initially responded to the slump by closing down several blast furnaces then, as the slump continued, the decision was taken to reduce the wages of the puddlers who operated the ninety-nine puddling furnaces at Consett in August 1861. This resulted in strike action by the puddlers which in turn forced the Company to shut down more blast furnaces at Crookhall, leaving eight out of eighteen blast furnaces in operation, and also to close the Bishopwearmouth works. By 1862 the Company's creditors, including the S&DR, called for the Company to be sold. To counteract these calls an attempt was made to upgrade the plant by demolishing one old blast furnace at Consett and building a new model with three times the capacity. Once completed, the construction of a second large furnace began. In 1863 the Bishopwearmouth works were put up for sale, but due to the ongoing slump there was no interest. This state of affairs meant that the Company could not make any more payments to complete the purchase of the business and offered the assets for sale. The Derwent and Consett Iron Company (Limited) was voluntarily wound up at an extraordinary general meeting held at Newcastle-upon-Tyne on the 9th July 1864 (*London Gazette* 2 August 1864: 3845).

3.4.3 *The Consett Iron Company Ltd. 1864-1967*

The assets were bought by the Consett Iron Company Ltd for £295,318 from an initial start-up share capital of £400,000 (Jeans 1877: 123). Priestman, was again managing director. Other directors included David Dale. Probably under the guidance of Dale, the North Eastern Railway commenced the building of the Blaydon and Conside Branch, known as the Derwent Valley line in 1864. The new line provided a direct route to the Newcastle and Carlisle line of the Tyne valley and then to markets on Clydeside and North West England, it also permitted easy access to high quality West Cumberland iron ore. The line opened in 1867.

Several major reorganisations took place in 1865 and 1866: the Bishopwearmouth Iron Works were sold and the Shotley Bridge Iron Company was bought and converted to malleable iron production; this added forty puddling furnaces, replacing those lost at Bishopwearmouth, plus plate mills and a drift colliery to the Company's assets. All the blast furnaces at Crookhall and Bradley were decommissioned. These actions concentrated activity at Consett with six furnaces in blast. The larger furnace, of 1862, produced 340 tons per week while the five smaller furnaces could produce some 1000 tons per week between them. By the end of the 1860s Consett appeared profitable with a good reputation for quality.

In 1869 the Company commissioned a report on the current state and future strategy of the business. One major finding of the report was that the Company's profit came from the output of its eight collieries while the iron production side of the business made a small loss. The fuel profit would not be so great if the Company sold their coal on the open market so instead economies in the iron making processes were required. Stung by the criticism Priestman resigned. Dale and his fellow directors advertised for a general manager for the works and appointed William Jenkins of Dowlais in August 1869 (fig. 3.16).

Figure 3.16 William Jenkins.
(Jenkins 2008 [1893]: 94)

Throughout the 1870s Jenkins applied the report's recommendations. The old blast furnaces were demolished and replaced by new larger models with efficient Whitwell air heating stoves, the number increasing to seven by 1880. The Company had seven rolling mills by 1873, four making plate mainly for a regional market, while three produced rails for overseas trade including Russia and America (Warren 1990: 37). Ovens were built to provide all the coke they needed, and which also produced waste heat for brickmaking. Company agents were sent to Spain where they discovered a high-grade haematite near Bilbao which could be mined, shipped to England, and delivered to Consett cheaper than domestic ore.

The use of steel rails within the British railway network began in the late 1850s and expanded at such a rate as to cause a near collapse of national iron rail production in 1876. Consett's iron output was initially reduced by a third, but demand for iron ship plates counteracted the loss. Jenkins demolished one old rail mill to build a new plate mill. By 1882 the Company could produce up to 1,900 tons of iron plates per week (O'Hagan 2011: 21). Jenkins realised that steel was the future and built the West Melting Shop, which opened in 1882 with two 13ton Siemens furnaces. It was soon joined by another six, each of 17 tons capacity, producing acid grade steel.

The advent of steel production instigated a new era of development at Consett. New general offices were built in 1884 and the East Melting Shops in 1887. In 1888 many of the old puddling furnaces were demolished as the Siemens Martin process had no need for puddled iron and were replaced with an Angle Mill to supply the shipbuilding industry. Puddling furnaces were retained at the Shotley Bridge Ironworks which continued to make iron plate (Jenkins 2008 [1893]).

In 1889 the Company bought the Chopwell and Garesfield Collieries from the Marquis of Bute, the appendages to the latter included the Garesfield Staith at Derwent Haugh on the southern bank of the Tyne. From here the Company intended to export its surplus coal, coke and finished product to both foreign and domestic markets. Jenkins resigned in 1894 due to ill health and died in the spring that year. The staith was improved and connected to the Derwent Valley line in 1898 (O'Hagan: 2011: 24) and renamed Derwenthaugh Staithes. From 1896 to 1899 the Company management considered several economic strategies incorporating development on Derwent Haugh including serious thought to moving the main iron production facilities from Consett (*North-Eastern Daily Gazette* 1 July 1899:2) but the economic argument was not sufficient to implement the move.

From the advent of the twentieth century and throughout the Great War the Consett Iron Company increased capacity and developed its infrastructure which included new larger blast furnaces, electrification of the Consett works and enlargement of the Derwenthaugh Staithes to handle the greater output. The 1920s saw a downturn in demand as the steel industry entered a decade long period of depression. The Company responded to the fall off in demand by taking the opportunity to demolish the old steel melting shops with their twenty 35 ton furnaces and plate mills, and build new mills including one to produce chequer plate. Nine 75 ton furnaces replaced the older models and the efficiency of the electricity supply was improved. A new 60 oven coking plant was constructed and a new brickworks for silica bricks was built at Templetown (O'Hagan 2011: 26-7). The downturn was worsened by the General Strike of 1926 and a Government economic policy which resulted in a strong pound which depressed exports and the ship steel market. In 1927-8 the Company built the Derwenthaugh Coke Works between Winlaton Mill and Swalwell to convert coal from its Chopwell and Garesfield collieries.

From the outbreak of the Second World War the Company worked with the assistance of the Ministry of Supply which provided investment to add an acid steel furnace and four ingot annealing furnaces. The Company financed a sinter plant in 1942. In 1943 a new generation blast furnace was blown in, and another two were planned. Two old furnaces were demolished in early 1945 to make room for the second which was only completed after the war ended. The third new furnace was constructed in 1947.

The general election of 1945 returned a Labour Government who, in 1947, nationalised the coal industry including the collieries of the Consett Iron Company. This resulted in a loss of control over their coal reserves and a loss of income for the Company, however, the Company kept investing in plant and added 54 coking ovens to the Fell works at Consett, which entered operation in 1950. In February 1951, the Labour administration nationalised the iron and steel industry. Under nationalisation the running of Consett remained under the control of the former management but pricing strategies were carried out by the Iron and Steel Board. The Conservative Government of 1955 returned the iron and steel industry to its former owners. Under the Board, Consett had received investment in the form of a slabbing, blooming and continuous billet mill and had received its first two Bessemer Converters to run alongside the open hearth furnaces in the *duplex process* for steel making (O'Hagan 2011: 34-40).

In the late 1950s the Company decided to manufacture steel plate. The plate mill of the 1920s was considered inadequate for the projected output and so a new plant covering some 70 acres at Hownsgill, Consett, was commissioned. The first new plate was produced in September 1960 in what was considered the most up to date plate mill in Europe *(ibid*. 41). However, from the plants commission in 1958 to its completion in 1960, demand for ship plate had fallen by 10% and would never recover.

The Company then began producing Oxygen Steel, a cheap-to-manufacture bulk material which had been developed in Europe and had already been introduced into some steelworks around Britain. There were two systems available to produce oxygen steel, the *Linz Donawitz* or *LD* process from Austria and the *Kaldo* process from Sweden. The differences between the processes lay in their relative abilities to handle impurities in the ore which, in the case of Consett, was now being sourced from all over the world, notably Africa and Sweden. Consett became the first British company to run both processes in tandem with a new steel plant being built from 1959 containing two 100 ton LD convertors and two 100 ton Kaldo convertors. The oxygen steel plant could produce 750,000 tons per year. The open hearth furnaces were considered redundant and all decommissioned by 1966 resulting in 250 job losses (*ibid*. 41-5).

3.4.4 *British Steel Corporation 1967-1980*

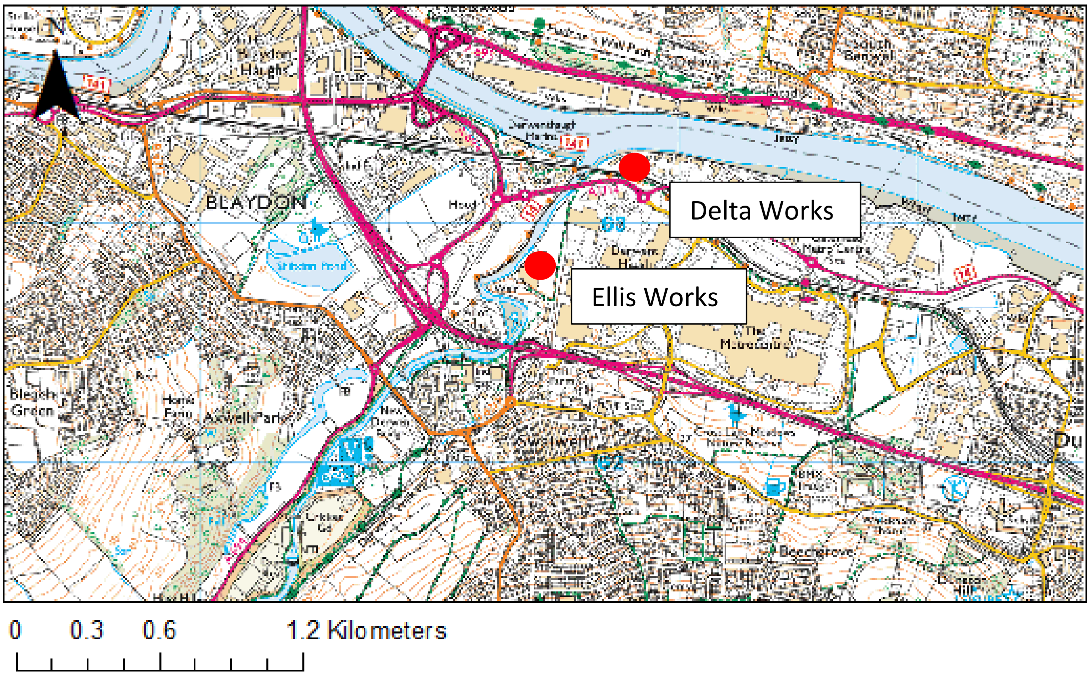
The Labour Party were returned to power in 1964 and 1966 and presented the Iron and Steel Act which was duly passed on 22nd March 1967. Under the Act the majority of the nation's iron and steel production, including Consett, passed into State ownership. The British Steel Corporation (BSC) was formed on 28th July 1967 and commenced a systems analysis of the fourteen plants which constituted the new Corporation. In three years the analysis identified four divisions within British Steel which corresponded to the individual plant's main product. Consett was placed into the General Steels Division. Unlike 1955, the Conservative election victory of 1970 did not return the steel industry to private ownership.

Government investment in Consett virtually stopped in the early 1970s. The management of Consett produced a plan named 'Conquest' to show how further investment in the plant could be used to reduce costs, but this was ignored (O'Hagan 2011: 49). The final investment in Consett came from BSC in 1977-8 with a finishing section for the slabbing and blooming mill; nothing that was outlined in 'Conquest'. By this time national shipbuilding output was less than a quarter of its 1963 level (*ibid.* 49) and consequently the demand for plate was falling too. The new Conservative administration of 1979, the Thatcher Government, introduced a policy of fiscal non-intervention with failing state-sector businesses. The immediate result of this policy was that the Hownsgill Plate Mill, which had never run at anything like capacity, was closed down. In December 1979 the BSC announced that the Corporation's smaller plants would be closed down and Consett, once the largest ironworks in England, fell into this category.

The Consett Steel Works closed on 12th-13th September 1980. Demolition began in December with the material, equipment and scrap being taken away by rail which was itself taken up two years later when the work was complete. All traces of the plant were removed.

3.4.5 *Steel works on Derwent Haugh 1885-1990*

With the demise of the Consett Steel Works it would be tempting to imagine that iron and steel production ended in the Derwent Valley. There were, however, two companies which, due to their relatively small size, remained in private hands when the larger steelworks were subsumed into the British Steel Corporation in 1967: the Ellis Steel Works and Raine and Company Limited, who occupied the Delta Iron and Steel Works. Both companies were established on Derwenthaugh at the mouth of the river (fig. 3.17).



1:25 000 Scale Colour Raster [TIFF geospatial data], Scale 1:25000, Tiles: nz15, nz16, nz24,nz25 nz26, nz06, ny84,ny85,ny86,ny94,ny95,ny96,nz04,nz05,nz14, Updated: 7 June 2017, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <http://digimap.edina.ac.uk>, Downloaded: 2017-09-22 15:46:32.216

Figure 3.17 Derwenthaugh

The Ellis Steel Works were established prior to the Second World War by (Major) J W Ellis on the site of the former Hannington Engineering Works on the east bank of the Derwent (fig.3.18). The site benefitted from an existing railway infrastructure for the transport of their goods. The company handled scrap metal and specialised in the production of girders. During World War Two the company also made Bailey Bridges for the army and employed female welders on this war work, consequently Ellis had to build new toilets, originally designated for ‘Ladies’. The Major had the sign changed to ‘Women’ (Makepeace 2012a). The Ellis company lasted until the early 1980s. The company offices, built in the 1950s at the south end of the site, were used by the local radio station ‘Metro Radio’ from 1984.

Figure 3.18 The Hannington (Ellis) Works at Derwent Haugh, Swalwell, 1948. The Ellis Steel Works on the east bank of the Derwent viewed from the south west in the foreground. In the background, with the Tyne beyond, stands the Delta Iron and Steel Works.

(Britain from Above 2017)

The Delta Iron and Steel Works were founded in 1891 by the brothers Benjamin and George Raine under the name Raine and Company Limited. It was located on the east bank of the mouth of the Derwent and benefitted from deep-water berths for shipping on the south bank of the Tyne. The company first appeared in the Derwent valley when it took over the rolling mill at Winlaton Mill in 1885. The company advertised itself as having been formed in Newcastle in 1771 (Gateshead Library GL002125). A rail link was created between Winlaton Mill and the Delta works. Raine and Co. apparently specialised in melting down and recasting scrap-metal. Their riverside location, with a rail link to the Derwenthaugh Staithes across the Derwent, provided easy access to supplies from Consett, Middlesbrough, Belgium and Iceland (Makepeace 2013). Their main domestic markets were in shipbuilding, railways and coal and the company exported to the Colonies/Commonwealth *(ibid)*.

The works were expanded during the Great War with new presses and furnaces being installed to keep up with wartime demand. During the Second World War the company held contracts from the War Office, Admiralty and the Board of Trade amongst others (fig.3.19) and employed 800 men. This may have marked the employment high point because following the war, during the 1950s and 1960s, the company's traditional markets began to contract (Makepeace 2013).

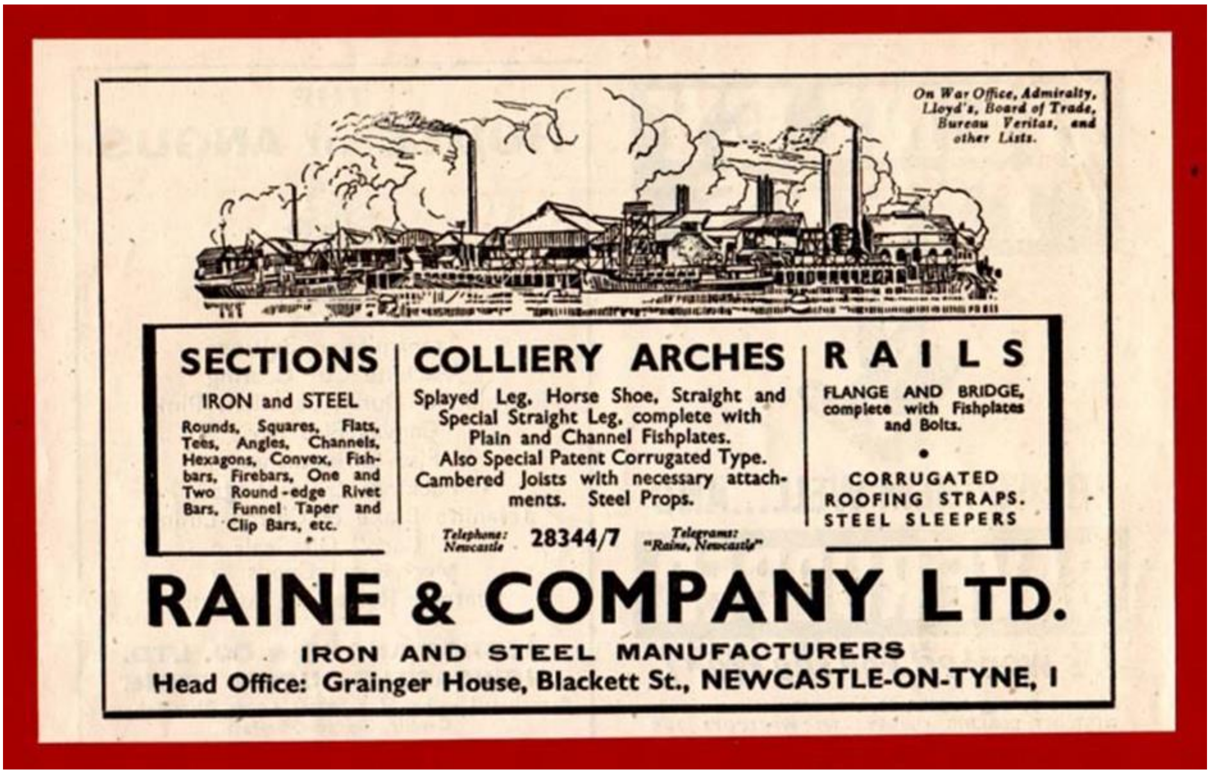


Figure 3.19 Raine and Co Ltd Advertisement 1944

(Thumbs2 2017)

Raines continued to make steel sections for the National Coal Board until the 1980s and produced steel for the use in earth-movers, tractors and forklift trucks (Makepeace 2012b). The company closed in 1990.

3.5 Summary

The textual sources available for the iron and steel industries in the Derwent Valley show a trade which endured for almost seven hundred years. Iron working probably took place in the valley before this date but there is a lack of documentary evidence for this.

The documentary account has suggested 27 iron working sites set out in table 3.20 below. Lintzford has been included though it is not certain it definitely operated as a sword factory.

Holme Mill, Swalwell and Winlaton Mill both appear twice as there were breaks in their periods of use.

'Iron production' sites are those which are primarily known or thought to have smelted iron. The later 'Steel production', however, refers to the remelting of scrap metal into billets and rolling into new products. 'Ironworks' indicates that the exact processing taking place at Holme Mill, 1614-43 is uncertain; it may have been more than a 'Forge' which here indicates a plant for converting pig iron into wrought iron. The 'Blast furnace' at Allensford is thought to have been separately sited from the Allensford forge, otherwise the two would have been combined into an iron production site. 'Steel furnace' is a site primarily known for the conversion of wrought iron into blister steel through the cementation process. 'Manufactory' is a term applied to the three Crowley sites which specialised in making a variety of finished iron products. 'Iron mine, sword factory, hammer mill and rolling mill' sites are self-explanatory. A 'tin mill' was rolling mill which specialised in producing thin iron sheets. Only the documented primary function for a site has been entered into the table. Chapter 5 describes the processes which occurred on the 27 sites.

The historical record can only provide some details of the industry: dates, places, technologies and actors - those who created, manipulated and moved within the events which created and exploited the iron resources of the study area. What historical evidence cannot show are the details which can emerge from studying the artefacts of the industry, including, most specifically, the exact locations of many of the 'lost' sites. The following chapter will explore the archaeology of the valley and see what remains of the iron and steel works in the archaeological record. By synthesising the historical record and archaeological data it is intended to present as full a picture as possible of the industry.

Section	Location	Site description	Date
3.2.2	Muggleswick Park	Iron production	1299
3.2.3	Whittonstall and Shotley low Quarter	Iron mine	1307
3.2.4	Muggleswick	Iron production	1464-1537
	Whitehall	Iron production	1499-1500
	Edmundbyres	Iron production	1503-1504
	Espershields	Iron production	1503-1504
3.2.5	West Gibside	Iron production	1520s-1545
	Mill field, Gibside	Iron production	1608-1728
	Holme Mill, Swalwell	Iron works	1614-1643
3.3.1	Shotley Bridge	Sword factory	1687-1840
	Lintzford	Sword factory	1694-1703
	Shotley Bridge	Hammer mill	1703-1840
	Shotley Grove	Sword factory	1703-c.1812
3.3.2	Blackhall Mill	Steel furnace	1687-c.1850
	Allensford	Forge	1670-1736
	Allensford	Blast furnace	1692-1713
3.3.3	Winlaton	Manufactory	1690-1966
	Winlaton Mill	Manufactory	1691-1863
	Holme Mill, Swalwell	Manufactory	1702-1912
	Winlaton Mill	Rolling mill	1885-1915
3.3.4	Derwentcote	Forge	1718-1890
3.4.1	Consett	Iron production	1840-1980
	Crookhall	Iron production	1840-1846
	Bradley	Iron production	1840-1846
	Blackhill	Tin works	1850-1865
3.4.5	Derwenthaugh, Ellis	Steel production	<1940-1960s
	Derwenthaugh, Raine	Steel production	1891-1990

Table 3.20 Summary of sites located through the documentary record.

Chapter 4. The archaeology of the iron and steel industry of the Derwent valley

4.1 Introduction

This section collates the known archaeological data located through modern industrial activity and archaeological investigation to expand discussion of the sites identified in chapter 3. The findings from the latter are archived in archaeological databases: the local Historical Environment Records (HERs), the National Monuments Record (NMR) held by Historic England and the Grey literature stored by the OASIS scheme of the Archaeology Data Service. The locations of several sites have been suggested through oral tradition presented within 'local history' publications. All the sites identified from the above sources are presented in table 4.1 below which summarises the 69 archaeological sites identified in all the documentary sources discussed in chapter 3 and/or via the archaeological data bases utilised in the present chapter. The sites are arranged in a chronological order from medieval to the steelworks established in the 19th and 20th centuries.

Within the table the sub-section numbers broadly reflect the documentary history sections of chapter 3. The 'site' column is designed to produce a concordance with table 3.17 above. The fifth column contains the HER number of a site. Sites entered into the Northumberland HER are prefixed with a 'N', Durham HER with a 'D' and Tyne and Wear HER numbers are without a prefix. National Monument Record numbers are given in the sixth column. The right-hand column indicates the sources of the information used within the discussion of the archaeological sites below; it includes some detail of the site(s) where this aids comprehension of the entry. Where a site has been discussed in chapter 3 as being known primarily through documentary sources, it is indicated as such.

The fieldwalking programme visited all the sites in table 4.1 in order to verify their existence and to assess their current condition. One new site was found during the fieldwalking; this was of bloomery slag on the north bank of the Milkwell Burn, to the west of Blackhall Mill. Table 4.1 is followed by a full discussion of the sites. Where a HER source is cited in the text it may be viewed by entering that number into the search criteria of that HERs website.

The archaeological sites of the iron industry of the Derwent valley						
Sub-Section	Site	OS Map ref.(NY)	Description	HER no.	Monument no.	Source
4.2.1	Muggleswick Park		Bloomery forge			Documentary sources
	Muggleswick		Iron production site			Documentary sources
	Edmundbyres		Iron production site			Documentary sources
	Espershields		Iron production site			Documentary sources
	Whitehall		Iron production site			Documentary sources
	Hunstanworth	9329 4923	Iron slag	D6432		Cranstone, D. (1993) *Nookton Area Survey* deposited with Durham HER.
	Hunstanworth	9232 4906	Iron slag	D6433		
	Hunstanworth	9000 4600	Iron slag	D8098		
		OS Grid ref.(NZ)				
4.2.2	Shotley Low Quarter	0690 5690	Bell pits	N9852		Whittonstall bell pits recorded by the Tyne Industrial Archaeology Group (Higgins 1971: 3-4).
	Shotley Low Quarter	0741 5583	Furnace and slag	N24189		A possible bloomery furnace with associated slag deposits and two possible pits were located during geophysical prospection by Archaeology Services of Durham University in 2010 prior to a planning application for the Boundary Lane Wind Farm on behalf of Wind Prospect Development Ltd. (Hale 2010).
	Shotley Low Quarter	0749 5589	Possible pit			
	Shotley Low Quarter	0761 5595	Possible pit			
	Shotley Low Quarter	0537 5220	Ironstone workings	N9867		The Greymare Hill 'Old workings (ironstone)' were noted on the 1st edition OS map, 1856.
	Shotley Low Quarter	0774 5702	Bell pit	N24182		Mineshafts and pits located to the north-east of the Whittonstall bell pits during geophysical prospection by Archaeology Services WYAS on behalf of UK Coal Mining in 2009 prior to planned opencast mining at Hoodsclose, east of the B6309 (Harrison 2010). The report for this work was deposited in OASIS. In 2011 Tyne and Wear Museums Archaeology carried out excavation on several of the earthworks and concluded they were suggestive of medieval bell pits (Liddell 2013:7).
	Shotley Low Quarter	0820 5700	Mineshaft	N25177		
	Shotley Low Quarter	0770 5680	Mineshaft	N25178		
	Shotley Low Quarter	0781 5738	Mineshaft	N25184		
	Shotley Low Quarter	0866 5659	Mineshaft	N25166		
	Shotley Low Quarter	0853 5700	Mineshaft	N25169		
	Shotley Low Quarter	0792 5725	Mineshaft / bell pit	N25180		
	Shotley Low Quarter	0730 5620	Possible pit	N25120		
	Shotley Low Quarter	0855 5638	Possible pit	N25172		
	Shotley Low Quarter	0862 5632	Pit	N25163		
4.2.3	Ravenside	0973 5781	Iron slag			Local history sources: (Consett Lion's Club 1963; Richardson

						1973: 35).
	Milkwell Burn	1079 5745	Iron slag			Discovered through fieldwalking for this project.
4.2.4	Gibside	1690 5820	Bloomery forge	12395		Identified by H. Beamish (1993) and entered into the Tyne and Wear HER.
	Gibside	1706 5862	Blast furnace and forge	5121		Identified by National Trust (n.d.) desk assessment and fieldwalking. Deposited in OASIS
	Gibside	1770 5760	Mine	12394		West Wood shallow workings. Identified by H. Beamish (1993) and entered into the Tyne and Wear HER.
	Gibside	1750 5770	Mine	3665		West Wood Grove Drift. Identified by H. Beamish (1993) and entered into the Tyne and Wear HER.
	Gibside	1829 5921	Mine	3653	22488	Snipes Dene Pit. Identified by H. Beamish (1993) and entered into the Tyne and Wear HER. Appears on 1st edition OS map 1855.
	Gibside	1785 5875	Mine	5112		Snipes Dene coal workings. Identified through English Heritage Monument Protection Program assessment and entered into the Tyne and Wear HER.
	Swalwell	2017 6222	Forge	13586		Clavering and Rounding (1995)
4.3.1	Shotley Bridge	0908 5280	Sword factory	D2350		Site entered into the Durham HER based on documentary sources. Stafford Linsley made a photographic record of the derelict factory in 1985 which was deposited in Newcastle University's SINE archive. Durham County Council made a photographic record in 2007 which is presented within the HER
	Shotley Bridge	0853 5156	Sword factory	D61507		Site entered into the Durham HER as Shotley Grove High Mill, a post-closure use of the building as a paper mill.
	Shotley bridge	0908 5290	Worker's housing		511513	43-46 Wood Street. Granted monument status from documentary sources.
	Shotley bridge	0913 5220	Worker's housing		1356664	Cutlers Hall. Appears on 1st edition OS map, 1856.
	Shotley low Quarter	0653 5298	Hammer forge			Desk based map work for this project.
	Lintzford	1505 5717	Sword factory	1808		Site entered into the Tyne and Wear HER as Paper Mill, a later use of the building. Recognised through documentary sources.
4.3.2	Blackhall Mill	1171 5686	Cementation furnace and mill race	1017		Furnace identified through the 1st edition OS map and other documentary sources. Mill race survives as a pond.
	Blackhall Mill	1169 5684	Hammer forge	5192		HER entry is based on a flawed desk based assessment element of watching brief by A H Reed (1993: 13-17).
	Blackhall Mill	1166 5682	Revetment and dam	5666		Discovery of the retaining wall and dam during groundworks in 1998 was reported to Tyne and Wear HER by field

						investigators I. Ayris, 1998, and R. Sullivan, 2010
	Blackhall Mill	1169 5681	Posts/quay	12961		Reported to Tyne and Wear HER by field investigator R. Sullivan, 2010
	Allensford	0843 5178	Forge	N13054		Listed as 19th century Forge Cottage. Shown on 1st edition OS map, 1856, as 'The Forge'.
	Allensford	0851 5113	Millrace bridge			Located by photographic posting on Google Earth by 'John H'.1st edition OS map, 1856, indicates a wear and revetment works to serve the millrace to the south
	Allensford	0790 5034	Blast furnace and calciner	N9914		Excavation by S. Linsley and R. Heatherington. Published in the *Journal of the Historical Metallurgy Society* (1978: 1-11). Grade II listed
	Allensford	0856 5079	calciners			Oral tradition suggests presence of iron roasting oven and kilns in Hole House Woods, in Richardson (1973: 35)
4.3.3	Winlaton	1760 6190	Iron manufactory	5987		Documentary sources
	Winlaton	1758 6246	Worker's housing	1814	22952	Winlaton Hall. Documentary sources
	Winlaton	1746 6209	Workshop	1820		Documentary sources. Grade II listed.
	Winlaton	1755 6214	Workshop	1809		Entry to HER via field investigator B. Jarvis 1978
	Winlaton Mill	1854 6055	Iron manufactory	1006	1021272	Crowley Mill No1. Documentary sources. Excavations by D. Cranstone 1991-2, interim report in *Archaeology North* (1991: 22-4). Final report, *Winlaton Mill Archaeological Investigations 1991-2* (1992), deposited at Gateshead Library. NMR listing includes the High Dam
	Winlaton Mill	1864 6069	Raines rolling mill			Shown on 2nd edition OS map 1895
	Swalwell	2017 6222	Iron manufactory	5979		Crowley Mill No. 2. Documentary sources. Excavation by Allan Williams Archaeology in 2005 found evidence for one of the cementation furnaces. Archaeological Research Services Ltd (ARS) and Pre-Construct Archaeology Ltd (PCA) excavated the Grand Warehouse area in 2005. Details of ARS' work are hosted on their company website. The PCA report is archived with the Tyne and Wear HER (PCA 2007) with a summarising paper presented in the *Industrial Archaeology Review* (Procter *et al* 2011). David Cranstone (2011) provides a comprehensive site history and map regression in the same volume
	Swalwell	1938 6258	Dam head			Shown on 1st edition OS map, 1856
	Swalwell	1968	Iron mill			High Mill. Documentary

		6194				sources. Shown on 1st edition OS map, 1856, as High Forge
	Swalwell	2020 6230	Chimney	1619		Standing monument on the site of Crowley's ironworks.
	Lintz Green	1525 5630	Workshops			Out-worker nailer's workshops. Documentary sources
4.3.4	Derwentcote	1302 5657	Landscape	D387	1015522	Listing includes cementation furnace, cottages, finery forge, water management system and later Forge Drift mine. Appears on 1st edition OS map 1856. Millpond Damhead area partially excavated by Wessex Archaeology in 2010. Report produced 2012. Wessex Archaeology's excavations were filmed for an episode of Channel 4's TimeTeam, *The furnace in the forest* (2011).
	Derwentcote	1304 5651	Cementation furnace	D36395		Excavation by David Cranstone in early 1990s on behalf of English Heritage. Report published (1997).
	Derwentcote	1312 5654	Hammer forge		948809	Partially excavated by Wessex Archaeology in 2010. Report produced 2012.
	Derwentcote	1300 5660	Worker's housing		948808	Exploratory trenches dug by Wessex Archaeology in 2010. Report produced 2012. Extensive excavation by Newcastle University 2012-2016: unpublished.
4.4.1	Consett	1005 5053	Iron works	D5869		Consett Iron Company. Appears on 1st edition OS map 1856.
	Consett	1046 5143	Blast furnace	D4714		Blue Heaps. Appears on 1st edition OS map 1856.
	Consett	1185 5100	Iron works			Crookhall Iron Works. Appears on 1st edition OS map 1856.
	Consett	1208 5179	Iron works			Bradley Iron Works. Appears on 1st edition OS map 1856.
	Consett	0996 5115	Ironworks			Shotley Bridge Tin Works. Appears on 1st edition OS map 1856.
	Allensford	0867 5112	Pump house			Consett Iron Company. Fieldwalking. Appears on 1960s revision of 2nd edition OS map
4.4.2	Derwenthaugh	2039 6280	Steel works			Ellis Steel Works. Appears on the 2nd edition OS map, 1930s revision, as the Hannington Works.
	Derwenthaugh	2086 6326	Steel works			Delta Steel Works. Appears on the 2nd edition OS map, 1895.

Figure 4.1 The archaeological sites of the iron industry of the Derwent valley

4.2 Pre-industrial sites

4.2.1 *Iron production in the upper Derwent*

The area of the upper Derwent has been taken here to incorporate Muggleswick, Edmundbyres, Espershields and Hunstanworth. Documentary evidence indicates that the manor of Muggleswick operated a bloomery forge within its park (3.2.1 above). If the 14th century park corresponds with the modern Muggleswick Common, the forge would lie to the south-west of the hamlet. Fieldwalking the Common along the Feldon Burn, Burnhope Burn, Coalgate Burn and the Hisehope Burn (all considered as suitable locations for a bloomery forge) yielded no results. Geological evidence (1.4.3 above) would suggest that the bloomery may have been 1.5km to the east of Muggleswick and the modern Common, in or above the west side of the Derwent Gorge, as evidenced by 19th century deposits of limonite ore amongst lead mining waste. The area of the Gorge and the Silvertongue Mine (fig. 4.2) where the deposits are located is now managed by Natural England and is thickly wooded and overgrown making the recognition of a forge or its waste impossible.

Figure 4.2 Silvertongue lead mine. Masonry structure standing above fenced off and buried entrance shaft. Photographed from the south-east.

(Photograph: J. Bowman 2017)

The lost medieval village of Espershields lay on the modern north bank of the Derwent Reservoir. Fieldwalking on the south bank near Pow Hill located a deposit of ironstone lying on the surface. If this is significant it may represent the source of iron ore for both Espershields and Edmundbyres. A geological fault runs North-North-West from Edmundbyres up through Espershields Farm and the top of the Valley, on the reverse side of which is the German Bands outcrop (1.4.3 above). A bell pit has been noted on the Derwent side of the watershed within the farm land (Anderson 2016: pers.comm.).

The most remote evidence for iron working in the valley is the iron slag recorded at NY 9000 4600. This site sits at the confluence of two tributaries of the Nookton Burn high on Nookton Fell (fig. 4.3). A field-visit found no trace of slag. The local gamekeeper, who was checking the area at the time of the visit, had never seen slag in that vicinity, though he was familiar with the two slag heaps on the lower slopes of the Fell to the north. However, a range of new grouse butts had been built on the site, as indicated by the HER.

Figure 4.3 Nookton Fell. Photographed from the south-west from NZ 9000 4600
(Photograph: J. Bowman 2016)

The two slag heaps to the north, one on Nookton Back Fell (NY9232 4906) and the other in Nookton East Park (NY9329 4923), both overlooking the Beldon Burn, are marked as 'Mounds' on OS maps. They are clearly visible shallow heaps of dark grey, glassy bloomery slag with little vegetation cover. Both have been heavily disturbed by animal activity with lumps of slag spread for many metres around. The western heap (fig. 4.4), on the east bank of the Silly Syke water course, is approximately 6.0m x 4.0m x 0.6m in size with its long axis running parallel to the direction of the Syke. A slightly larger eastern slag heap, approximately 10.0m x 6.0m x 1.0m, lies just over a kilometre away, set within a ruinous park enclosure (fig. 4.5). Some individual pieces of slag from these mounds are as large as 250mm across and 50mm thick (fig.4.6). Close to both slag heaps are several 'Shafts (dis)'. There are three within 100m of the western heap, one within 100m of the eastern shaft and more scattered across the lower slope of the fell. These shafts, which are some 2.0m across, may be the ironstone bell pits from which the ore was mined at the time the slag heaps were created. The missing element from the iron production process here are the bloomery sites which would be expected to be close to the slag heaps.

Figure 4.4 Slag on Nookton Back Fell. Photographed from the south-east.
(Photograph: J. Bowman 2016)

Figure 4.5 Slag in Nookton East Park. Photographed from the south-west.
(Photograph: J. Bowman 2016)

Figure 4.6 Detail of Nookton Slag.
(Photograph J. Bowman 2016)

4.2.2 *Iron production in Shotley Low Quarter and Whittonstall*

The Greymare Hill ironstone workings have now been completely ploughed out. At the time of the field-visit for this thesis the site (fig. 4.7) was laid to grass and no undulation indicating surviving earthwork was discernible.

Figure 4.7 Greymare Hill ironstone workings. Photographed from the north.
(Photograph: J. Bowman 2016)

2.5km to the north-east of the ironstone workings, below Whittonstall, evidence was gathered for bell pitting in the 1970s augmented by further evidence in recent years. Rodney Higgins of the Tyne Industrial Archaeology Group gives a brief description of the bell pits cut into by opencast activity:

> Pits spaced fairly close together c.10m centres. Mostly of the same form but dimensions varied. Pits taken down to the lowest band of ironstone nodules and belled out just sufficiently to prevent the shale collapsing from above. No attempt made to extract coal from the lower seam. Diameter at the base varied between 3 and 4m, depth to the base between 4 and 4.5m, diameter of the entrance about 1.2m. Pits appeared to have been back-filled with shale, presumably from the excavations of new pits. Outline of the pits can be discerned at the surface after the topsoil is stripped, off. Sides of the pits were clean and have stood up very well over the course of time. (Higgins 1971: 3-4)

Figure 4.8 Bell pits in Shotley Low Quarter. Photographed from the west.
(Photograph: J. Bowman 2017)

Though the Whittonstall bell pits have been destroyed, evidence for many possible pits has been gathered in recent years mainly on the top half of the northern valley side through geophysical prospection funded by the proposed Hoodsclose opencast coal extraction viability study (Harrison 2010: 3-5) (fig. 4.9). Tony Liddell (2013: 7) has described the appearance of these pits as ‘rough circular mounds with central hollows which retain water after rainfall’. The possible pits to the north-west of Whittonstall Farm (HER no. N25178: NZ 0779 5687) are clearly visible from the B6309 (fig. 4.8). Evaluation work by Tyne and Wear Museums Archaeology in 2011 on several pits found that they filled with nineteenth and twentieth century waste material (in Liddell 2013: 7). No dating evidence for the excavation of the bell pits themselves has been obtained. Their form suggests that they are contemporary to the mining activity discussed in 3.2.2 above.

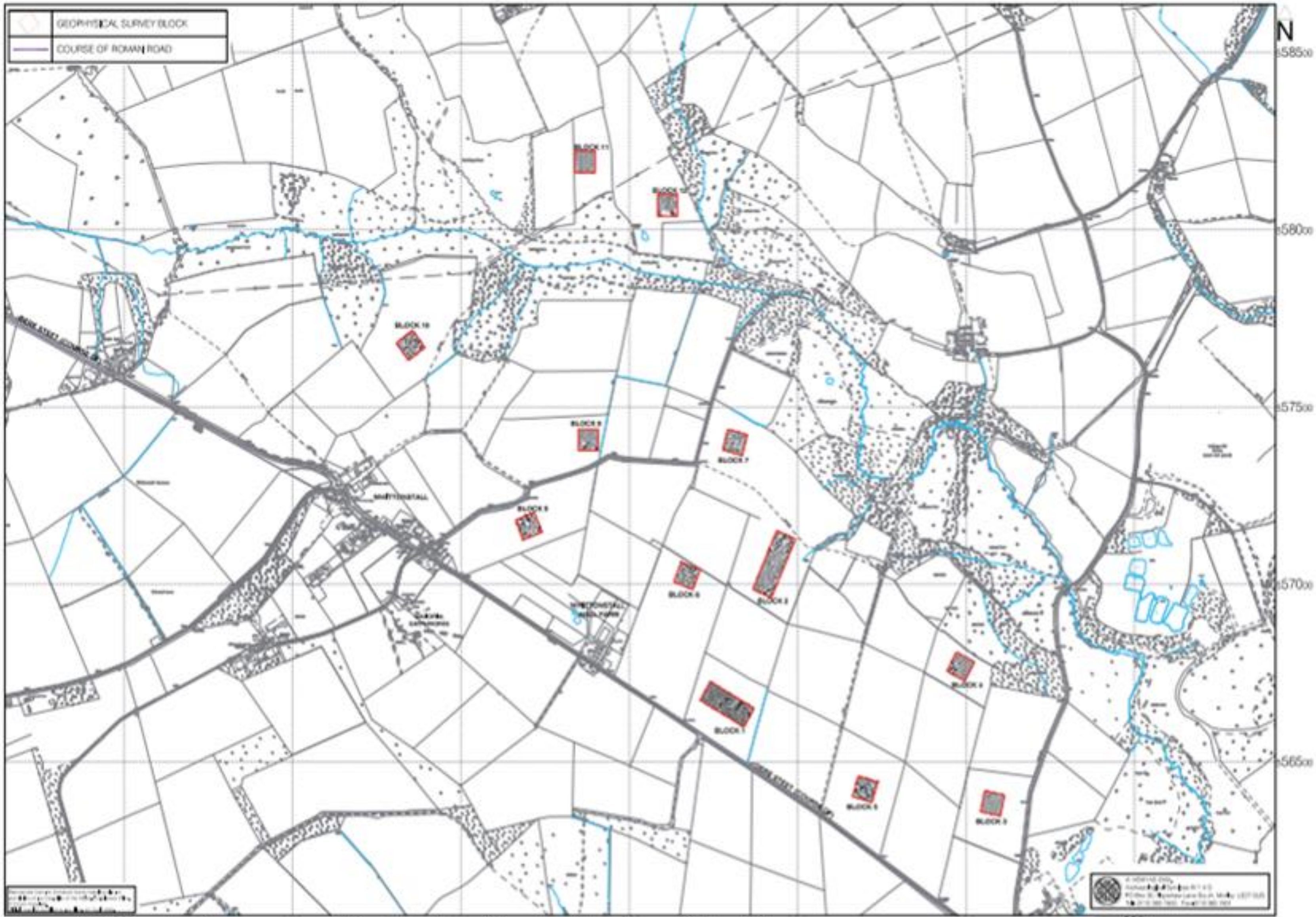


Figure 4.9 Geophysical survey of Whittonstall (Harrison 2010: 12)

The Boundary Lane survey (fig. 4.10), carried out in advance of the siting of a wind farm, may have located a bloomery furnace at NZ 0741 5583, about 100m east of the southernmost wind turbine of the Boundary Lane Wind Farm, Whittonstall. Initial fieldwalking located a spread of iron slag c.20m x c.10m suggestive of tipped material. The geophysics extended the spread of the slag to c.40m x c.20m and indicated the possible presence of a 2.0m diameter furnace base (fig. 4.11).

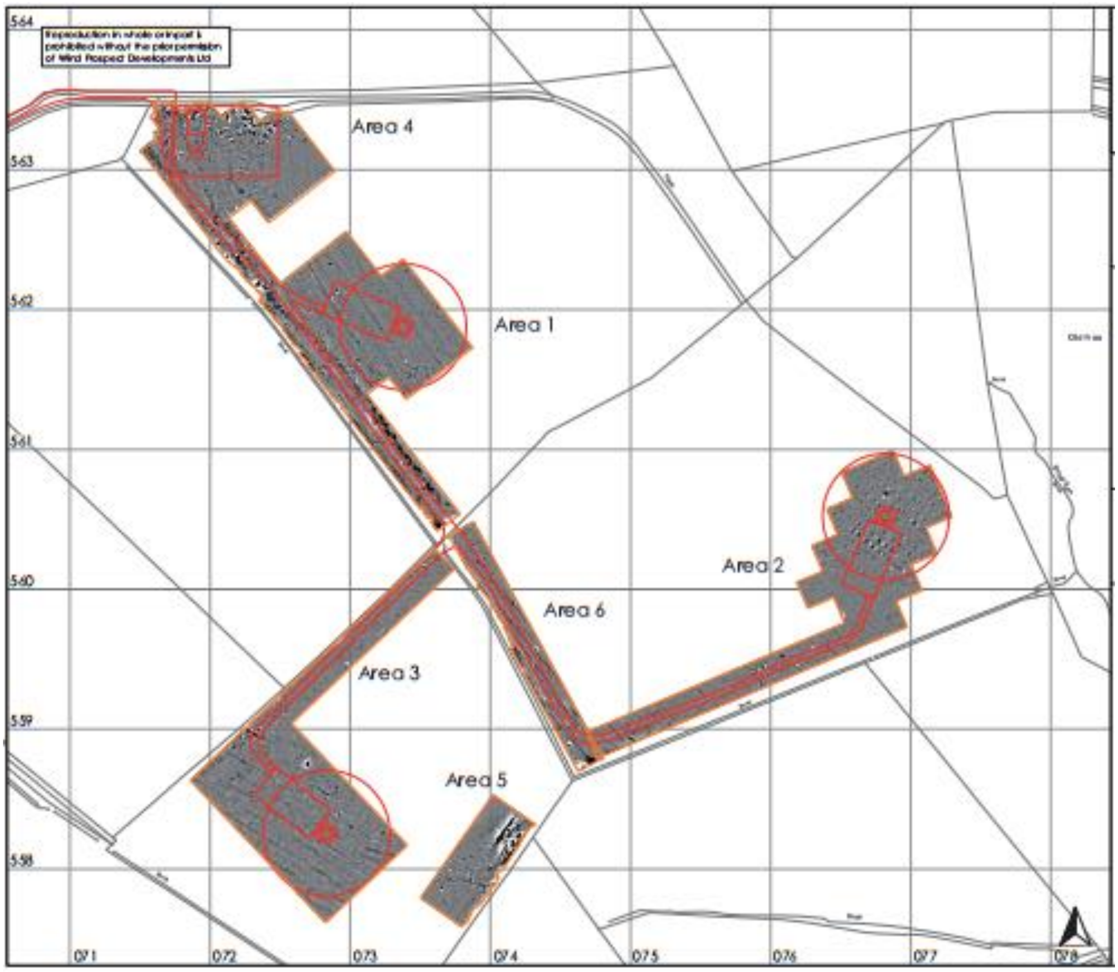


Figure 4.10 Boundary Lane geophysical survey. Circles indicate positions of wind turbines (Hale 2010: 17)

Further magnetic anomalies were interpreted as possible structural material such as the remains of a windbreak running to the south-west to the north-east on the north-east side of the furnace and a channel to divert water from the west through the ironworking area; a channel still carries water away from the area of the furnace into the Small Burn a little to the east. Analysis of the slag revealed that it had a low sulphur content, indicative of charcoal as the fuel for the smelting process, suggesting a pre-18th century date of production (Hale 2010: 5, 10).

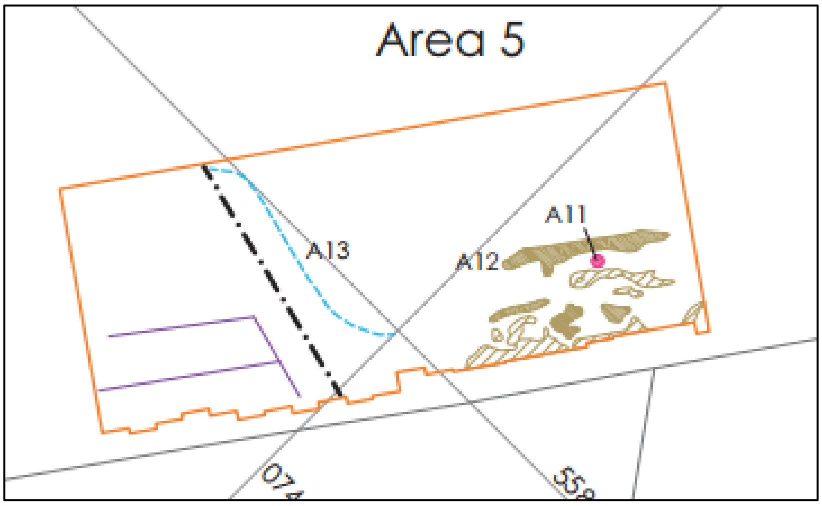


Figure 4.11 Archaeological detail of Boundary Lane area 5. Feature A11=possible furnace, A12=windbreak, A13=former water channel.

(Hale 2010: 20)

4.2.3 *Iron production at Ravenside and Milkwell Burn, Chopwell*

Fieldwalking undertaken for this thesis verified the existence of heaps of iron slag in the vicinity of Ravenside, formerly noted in local history works (Consett Lions' Club 1963; Richardson 1973: 35). The two large slag heaps (fig. 4.12) are located at NZ 0973 5781, filling the woodland between the narrow path running along the south-western boundary of Ravenside Farm and the Milkwell Burn, and lie just south of the footbridge which carries the path across the burn and into Hollings Hill Quarry. The heaps are both between 6.0m and 8.0m long x 4.0m and 5.0m wide and 1.2m and 1.8m high. The southern heap tumbles down into the burn. At the time of fieldwalking part of the northern side of the northern heap had been dug away, exposing the slag, several pieces of which were found on the path leading off to the south-east. Samples of the slag from these heaps have been identified as waste from the bloomery process (Cranstone 2016: pers. comm.).

One other small deposit of slag was located on the northern bankside at NZ 1078 5745 (fig. 4.13) whilst fieldwalking the lower Milkwell Burn. This deposit was about 1.0m wide x 1.0m deep and extended north beneath the modern forestry trackway. Samples of slag from this source were also identified as bloomery waste (Cranstone 2016: pers. comm.).

Figure 4.12 Slag heaps at Ravenside. Photographed from the north-east. The northern heap rises just beyond the track and is partially obscured by trees.
(Photograph: J.Bowman 2016)

Figure 4.13 Slag deposit at Milkwell Burn. Photographed from the south.

(Photograph: J. Bowman 2016)

4.2.4 *Gibside iron*

The development of the Gibside estate into pleasure grounds for George Bowes (1701-1760) between 1729 and 1760 all but obliterated the visible remains of the Gibside ironworks. Gibside estate is now a National Trust property which is promoted as an 18th century pleasure ground, with no acknowledgement of its ironworking past.

The earthwork remnants of a mill pond and a short section of mill race which have been ascribed to the 16th-century Hodgeson/Blakiston forge (HER 12395) remain at NZ 169 582 (fig. 4.14). These remains are easily accessible from the car park to the west of the estate entrance (formerly part of the West Wood). The alignment of the pond suggests that it was fed by the Leapmill Burn which enters the Derwent a little to the north of the forge site. The earthwork which forms the pond element of the site is small for its ascribed purpose; though overgrown with vegetation it appears to be some 6.0m in length and 2.0m wide with only a short length of 'head-race' bending towards the river. This arrangement would give a forge a precarious existence, right on the river's south bank. It is possible that the earthwork could be the remains of the forge wheel-pit with the short channel being a tail-race.

Figure 4.14 Earthwork of West Wood forge, Gibside. Photographed from the south-east showing the west, north and east sides of the feature. (Photograph: J. Bowman 2017)

The site for the Talbot/Blakiston iron works (HER 5121), documented as being on the 'Milne Field', is thought to be in the north-eastern corner of the present Warren's Haugh (NZ 1706 5862), now an area of riverside pastureland (fig. 4.15). Evidence for this site comes from historic map evidence and the recovery of iron slag from the area. The map is a 'Plan of Winlaton Lordship copied from a plan surveyed in 1633 and now in the possession of Charles Towneley' (DRO D/St/P7/7). It indicates that the forge was some 640m north-east of the confluence of Leapmill Burn and the Derwent. The plan does not show Talbot's furnace nor a dam across the river. The position of the forge indicated by the plan appears to have been confirmed through field observations (National Trust n.d.). Fieldwalking the area by the National Trust produced pieces of ironworking slag which was tested in the Metallurgy department of Newcastle University c.1994 and found to be probably from a charcoal fuelled extraction furnace. A field visit for this thesis verified the National Trust observations on the spread of slag on the north-east corner of the haugh through recovering a single small piece from a molehill (fig. 4.16).

Figure 4.15 Site of Milne Field forge, Gibside. Photographed from the south-west looking towards River Derwent. Depression along fence line to the right may be a filled in water channel. (Photograph: J. Bowman 2016)

Figure 4.16 Iron slag recovered from Warrens Haugh. Approx. 20mm x 20mm.

(Photograph: J. Bowman 2016)

It was further observed that the slag had been recovered from a low-lying area of Warren's Haugh which was interpreted as possibly containing a filled-in water channel to the ironwork's wheel pit. Aerial photography shows a channel running from east-west across the land contained within the meander which curves around the northern end of Warren's Haugh. On the western side of the Haugh, some 40m from the Derwent, the channel enters a pond and from there heads in a north-easterly direction to the area where the slag was recovered. The channel and pond could be post-ironworks artefacts but their relationship with the find spot of the iron slag cannot be overlooked.

As noted in 4.1 above the coal working sites at Gibside may have also been worked for ironstone. There are two areas of coal workings on Gibside, the West Wood which lies along the western edge of the estate, and Snipes Dene to the east.

The West Wood contains the earthwork remains (HER 12394) of shallow coal workings (NZ 1770 5760) which are some 1000m south-east of the 16th century ironworks site. The shallow workings have been interpreted as medieval or post-medieval shafts, which would have been of the bell pit type. The area of the workings is away from any paths and, due to the nature of the undergrowth, difficult to interpret (fig. 4.17). These workings are at a similar height above sea level OD as the ironstone outcrop to the west. On the north bank of the Leapmill Burn, some 840m from the works (NZ 1750 5770) is the West Wood Grove drift mine (HER 3665).

Figure 4.17 West Wood shallow workings. Photographed from the south-west.
(Photograph: J. Bowman 2016)

The mine (fig. 4.18), ascribed to the 18th century, is accessed from a narrow track running along the bank of the burn. The adit is cut into the base of a cliff at about 80m OD: possibly too deep for the iron ore. The Snipes Dene Coal Workings (HER 5112) are located at the south-eastern end of the dene. The HER erroneously places the workings at NZ 1785 5876: the actual site is further east at NZ 1885 5876 (Beamish 2017: pers. comm.). Dated to the 17th century, the workings are indicative of bell pits and at 130-5m OD may have accessed ironstone deposits. The Snipes Dene Pit (HER 3653) (fig. 4.20) is situated on the western side of the Dene (NZ 1829 5921). This pit closed in the later 19th century but may have been worked from the 17th century. At 65m OD this pit may be too low to extract iron.

Figure 4.18 West Wood Drift. Photographed from the west.
(Photo: J. Bowman 2016)

Figure 4.19 Snipes Dene Pit. Photographed from the south-west.
(Photograph: J. Bowman 2017)

4.3 The Industrial Revolution

4.3.1 *The Germans of Shotley Bridge*

The sword making manufactories of the Shotley Bridge area have left little archaeological trace, especially after the redevelopment of the Wood Street area of the area of the village within the last ten years. The Durham HER designates one site as ‘Site of Shotley Bridge Sword Factory, with extant later mill’ (D2350). This was Oley’s mill based on documentary evidence, before that it was one of the Hollow Sword Blade Company’s mills. The address of the workers housing is given by Historic England as 43-46 Wood Street (Monument no. 511513). The mill coordinates are given as NZ 0908 5280, and the housing as NZ 0908 5290: the south and north ends of Wood Street.

The sword mill was bought c.1849 by the Annandale family who converted the site to a corn mill which in turn was sold to the Federation of Co-operative Societies in 1872 who, as the Derwent Flour Mill Society Ltd., began a program of redevelopment on the site. The flour mill survived as a functioning building until 1933 when the Co-operative Wholesale Society vacated the premises and reduced the structure to a shell. The site was then used as a builder’s yard by J.R. Surtees whose family firm became insolvent and vacated the premises c.1994/5 (Linsley 1995). This site was levelled in the early 21st century to make way for a new housing development.

A photographic survey by Durham County Council (DCC) in 2007 shows the flour mill structure prior to its demolition. Figure 4.20 shows the south end of the site photographed from the Derwent bridge. The office building facing the viewer still survives, behind which stands the Victorian flour mill with rows of small square windows and a taller structure which appears to have truncated gables facing east. Figure 4.21 shows this tall structure from the north and what appears to be a single storey northern building of a superior construction. The fabric of this building was irregularly coursed but of faced stone, all showing masons’ horizontal ‘peck’ marks on the visible surface. This west wall was divided into three bays by four faced buttresses which appear to be part of the original build. The photographs (figs. 4.21-4.23) show that outer bays had windows and the central bay a doorway all framed in well-dressed stone topped by semi-circular arches. The quality of the material of this building, the use of the plain Romanesque arch, and the apparent symmetry of this building, suggest a Georgian date for its construction, albeit later than the accepted c.1697 foundation date, and points to it having been either a sword manufactory or possibly the Bishop’s Mill.

Figure 4.20 Shotley Bridge Flour Mill 2007
(Photo: DCC 2007)

Figure 4.21 Shotley Bridge Flour Mill northern buildings.
(Photo: DCC 2007)

Figure 4.22 Detail of masonry.
(Photo: DCC 2007)

Figure 4.23 Detail of arches and buttresses.
(Photo: DDC 2007)

A coloured lithograph (fig. 4.24) dated to 1839 (Richardson 1839: plate 6) shows a row of three white painted chimneys, each topped with a single black pot rising up from behind a tree line. To the right of these is a tall white painted, red roof tiled, building which is suggestive of the tall remains photographed by DCC. The chimneys are indicative of forging processes (see chapter 5). The print may be contemporary with the final year of sword production.

Figure 4.24 Shotley Bridge sword factory 1839. Detail from Richardson's Shotley Bridge.

(Richardson 1839: plate 6)

The homes of the German sword makers were situated on the river side in Wood Street and are now only preserved by record. It is unknown how many houses were originally built on the site but last three were demolished in 1959 (Pastscape n.d.) or 1961 (Bygate 2003: 72). A photograph (*ibid*. 72) shows that one and possibly all the workers houses were three stories high with mullioned windows and moulded door jambs (fig.4.25). The buildings are constructed of rough coursed rubble.

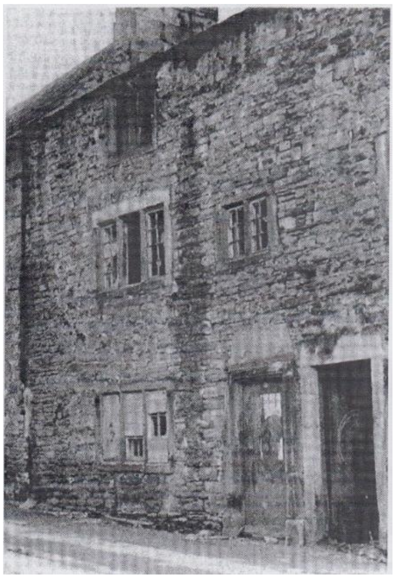


Figure 4.25 Sword makers' housing.
(Bygate 2003: 72)

At least three of the houses had inscriptions carved onto the lintels above the doors. One, the central subject of the photograph above and confirmed in an undated drawing by Paul Brown (in Richardson 1973:25), was carved into a trapezoidal lintel. It begins with a passage from Proverbs 10:22:

DES.HERREN.SEGEM.MACHET
REICH.OHN.ALLE.SORG.WAN
VO.ZVGLEICH.IN.DEINEM
STAND.TREVW.VND.FLESIG
BIST.VND.DVEST.VAS.DIR
BEFOHLEN.IST; 1691

The blessing of the Lord makes
rich without care,
so long as you are
industrious in your vocation
and do what is
required of you.1691

The second, more fragmentary, inscription appeared to be a statement of the origin of the sword makers:

DEVTSCHLAND…………VER
VATTERLAND.SOL.CL…...IST
DIE. STADT.GEN………………
HERR.BEHVTE……....R……VS
UND.EINGANG…………………

Germany……. (VER)
Fatherland Solingen (CL)….is
the city (GEN)…
The Lord keep…(R)…(US)
and enter…

A third inscription was only reproduced in one journal (Smith 1882: 780), it is essentially the same as the first:

GOTTES.SEGEN.MACHET
REICH.OHN.ALLE.SORG.WAN
OV.ZVGLEICH.IN.DEINEM
STANDE.TREVW.VND.FLEISIG
BIST.VND.DVEST.WAS.DIR.BE-
FOHLEN.IST

An unnamed contributor to Hone's 'Year Book' of 1832 observed that two houses at Shotley Bridge had inscriptions above their doors attesting to the Germans leaving their homeland due to persecution (1832: 1340). It is not made clear whether this refers to another two houses or a free interpretation of any of the inscriptions given above.

Two buildings relating to the sword makers remain standing today. Cutlers Hall (fig.4.26) was originally a two-storey stone-built house and cottage and is now two houses, nos. 22 and 24 Cutlers' Hall Road. It was built by William and Ann Oley in 1787. It has been suggested that the date marked the centenary of the original emigration (Richardson 1973: 60; Bygate 2003: 54). The house name, date and a monogram, W:^{O}A:, are incised into a rectangular stone plaque above the main door (fig. 4.27). There is an oral tradition that Cutlers Hall acted as a meeting place for the local guilds involved with the sword manufacturing and cutlery trades (Atkinson 1987: 15). Should this be the case, Cutlers' Hall would represent a focus for ritual activity associated with the industry.

Figure 4.26 Cutlers Hall. (Photograph: J. Bowman 2017)

Figure 4.27 Detail of dedication plaque. (Photograph: J. Bowman 2017)

The Hammer Mill mentioned in the sword makers' agreement with the Company in 1703 has been identified through map analysis. Hammermill Cottage, now a private dwelling, stands on the north bank of the Shotleyfield Burn some 2.5km east of Oley's mill (fig. 4.28).

Figure 4.28 Hammermill Cottage.

(Photograph: J. Bowman 2016)

In addition to Cutlers Hall and Hammermill cottage, the mill race to the Shotley Bridge factory is largely intact. 300m of the structure survives above the east bank of the river to the south of the bridge under which it is culverted. At points the stone fabric is visible, occasionally with brick repairs (fig. 4.29). Much of the surviving length has been reinforced with a concrete skim poured between the masonry and shuttering. At the southern end of the millrace evidence of a large timber dam across the Derwent is shown by linear alignments socket holes c.300mm square (fig. 4.30)

Figure 4.29 Shotley Bridge millrace. Photographed from the north. Only 1.1m in height is visible above the current soil level

(Photograph: J. Bowman 2017)

Figure 4.30 Socket hole for Shotley Bridge dam. Local tradition says that the holes were the result of extracting the grinding stones for the sword mill. The hole above is the deepest at 200mm. Many of the others are 20mm or less deep. Photographed from the north-east

(Photograph: J. Bowman 2017)

The second sword factory at Shotley Grove, converted to a large papermill by Annadale in the 19^{th} century, has been largely been largely cleared away and remaining elements converted for domestic use. The clearest evidence for a mill of any kind at the Grove are the earthworks of waterways in the garden of no 6, the Grove (NZ 0853 5184). These are in a clear alignment with a major weir across the river (NZ 0851 5164). This wear may be a 19^{th} century replacement of the 18^{th} century dam.

There are two classes of portable artefacts which remain from the sword making period of Shotley Bridge, a glass vessel and examples of the swords themselves. The drinking glass was last heard of as being in the Wilkinson Sword Company boardroom (Bygate 2003: 53). It had been made by the Beilbys, Thomas Bewick's employers. On one side of the glass is inscribed 'Succefs to the Swordmakers', opposite which is the monogram of William and Ann Oley:

O
W . A
1767

The monogram is largely as it appears above the door of Cutlers Hall, though the date is twenty years earlier. It may be possible that the glass was a gesture of gratitude from the Beilbys for a contract to etch sword blades.

The largest class of remaining artefact is composed of Shotley Bridge swords. Several examples are held by the Laing Art Gallery, Newcastle-upon-Tyne. None of the swords produced at Shotley Bridge appeared to have been the triangular hollow ground type produced at Solingen; the surviving swords are flat-hammered with hollows ground into either side of the blade which may have been described as 'hollow ground' at Shotley Bridge. Those swords which do survive are identified by the word SHOTLEY or more often SHOTLE on one face of the blade and BRIDG on the other with the last letters missing and the Solingen 'Flying Fox' on one face only. Angerstein's visit to one of the Shotley Bridge sword factories in 1753 produced sketches of a three-sided sword and some of the equipment he viewed (fig. 4.31).

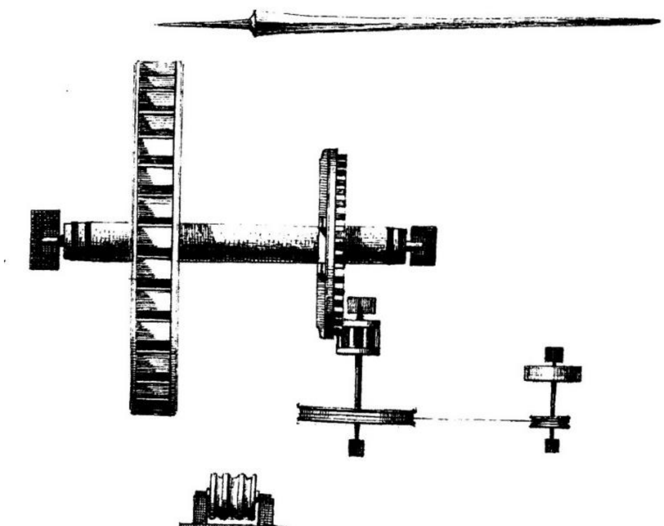


Figure 4.31 Sword blade, grinding train and grinding stone.
(Angerstein 2001 [1765]: 270)

4.3.2 *Hayford's Works*

The archaeology of Denis Hayford's Derwent Valley operations is concentrated in two areas: Blackhall Mill and Allensford. Much detail comes through preservation by record though in both areas there are some physical traces of the infrastructure of the industry.

R. Angerstein produced a written description and sketches of parts of Blackhall Mill on his visit in 1754 (2001 [1765]: 267-71). He mentions a steel forge with three hearths, one for the manufacture of German steel, one for chafing and the third was for chafing blister steel. The last two could only be operated when there was sufficient water. The presence of the chaferies without a mention of a finery suggests that by 1754 there was no conversion of local pig iron taking place. There was a medium-sized helve hammer at the forge to carry out the chafing processes.

Angerstein's sketch of Blackhall Mill from the south-west (fig. 4.32) shows the forge as a large two-storey rectangular building. If the door of the building is in roughly correct proportion to the other dimensions of the wall in which it appears it may be estimated that the forge had a length of some 13.5 – 15.0 m. The west face of the forge depicted in the sketch shows a single door centrally positioned on the ground floor with eight symmetrically placed fairly large windows, four to a floor. There are two chimneys visible on the forge, it is not clear whether they are coming out through the roof-ridge or are perhaps rising from the eastern side of the building. They do, however, only appear to account for the positions of two of the three hearths listed by Angerstein.

Attached to the south gable end of the forge is the cementation furnace with its conical chimney. The building in which the furnace is enclosed is called a 'teasing house' because it was from this shelter that workmen would tend or tease the fire. The furnace was described by Angerstein as having its outside walls built of dressed sandstone. The two cementation chests, one either side of the furnace fire-grate, were each 11'-0" long, 22" wide and 32" high. The chests would each be loaded with five tons of Oregrund iron for their conversion cycle.

Figure 4.32 Angerstein's sketch of Blackhall Mill.
(Angerstein 2001 [1765]: 267)

Angerstein's contemporary sketch shows the steel works at Blackhall Mill as being set a little to the north of the Derwent. In the foreground of the drawing, a suspension foot-bridge spans the river from the natural south bank to a north bank which has been partially built up with large dressed stone blocks which can be estimated, by comparison to the height of the eaves of a single story building neat to the bridge, to stand 3.0 - 3.6 m high of the river at its west end, tapering down to water level at a point which appears to be level with the gable end of the steel furnace.

Evidence for this wall was uncovered during ground works in 1998 (Tyne and Wear HER 5666). The HER account, based on the observations of Ian Ayris, indicates that there were angled 'buttresses' visible pointing towards the river and some of the stones had a slot which Ayris suggested was to hold a wooden beam. Angerstein's drawing shows something structural in the foreground which could be interpreted as an angled buttress. Today the wall or revetment is still partially visible (fig. 4.33). The angled return of the wall shown by Angerstein's sketch is to the left of the photograph and more wall can be seen beneath the three trees on the river bank.

Figure 4.33 Revetment work at Blackhall Mill

(Photograph: J Bowman 2016)

The field visit made to obtain a photographic record followed winter storms which had eroded both the river bed and the southern river bank. The HER notes posts in the river which were suggestive of a quay (Tyne and Wear HER 12961). A full row of these posts was visible at the time of the visit backed, on the upstream side, by large foundation blocks suggesting a dam face (fig. 4.34-4.35).

Figure 4.34 Line of dam at Blackhall Mill. Photographed from the west.

(Photograph: J. Bowman 2016)

Figure 4.35 Detail of dam face. Stakes and masonry blocks photographed from the north bank.

(Photograph: J. Bowman 2016)

The line of the dam face can be traced onto an earthwork on the south bank. This earthwork covers a stepped structure which was visible several decades ago and had been incorporated into a council lido (Platt 2016: pers. comm.). Further upstream as much as 3.0m of riverbank had been lost revealing a high masonry wall which was well faced when it was first exposed but received further damage as the period of high water levels continued (fig. 4.36). It appears that the Derwent may have been dammed to create a significant reservoir for the steelworks.

Figure 4.36 Structure on south bank, Blackhall Mill. Photographed from the north bank, note faced blocks to the right.

(Photograph: J. Bowman 2016)

The steelworks had a millpond to its north which remains *in situ* (fig 4.37). It is now fed by issues from the Blackhall Farm area. When the steelworks was operating, water from the Derwent was culverted north to the pond from where it was stored and culverted back south beneath the forge to power the chafery hammer. One culvert was discovered during the construction of the new housing in the Moraine Crescent/Millrace Close area and was filled with concrete for safety (Platt 2016: pers. comm.).

Figure 4.37 Blackhall Mill forge millpond. Photographed from the south-west.
(Photograph: J. Bowman 2016)

Photographs of the furnace building prior to its demolition in 1916 shows the remains of a building resembling Angerstein's drawing. In the view from the west (fig. 4.38) it appears that the roof has been extended over ancillary rooms built along the west side of the teasing house. This may suggest a redevelopment of the industrial building for domestic use post-c.1850. The view from the east (fig. 4.39) shows a building extending east from the east face of the teasing house. Its function is unclear but its position would suggest it was not a powered workshop. The 1841 National Census Return names two workmen living at the forge and it may be that this was their lodging house.

Figure 4.38 Blackhall Mill cementation furnace from the west.
(Photograph: Beamish Museum neg. NEG15397)

Figure 4.39 Blackhall Mil Cementation furnace from the east.
(Photograph: Beamish Museum neg. NEG6110)

Of Hayford's subsequent purchases of Allensford Forge and Allensford Blast Furnace only the location of the blast furnace has been positively determined. Excavations took place in 1977 and concentrated on the three areas which contained walls, the furnace and the kiln (fig. 4.40). Area one of the excavation contained walls, named as the west wall and the east wall. The west wall was interpreted as a possible retaining wall for a mill pond which would have stretched off to the west of the excavation area and the east wall interpreted as the western wall of the furnace blow-house, where the bellows would have been.

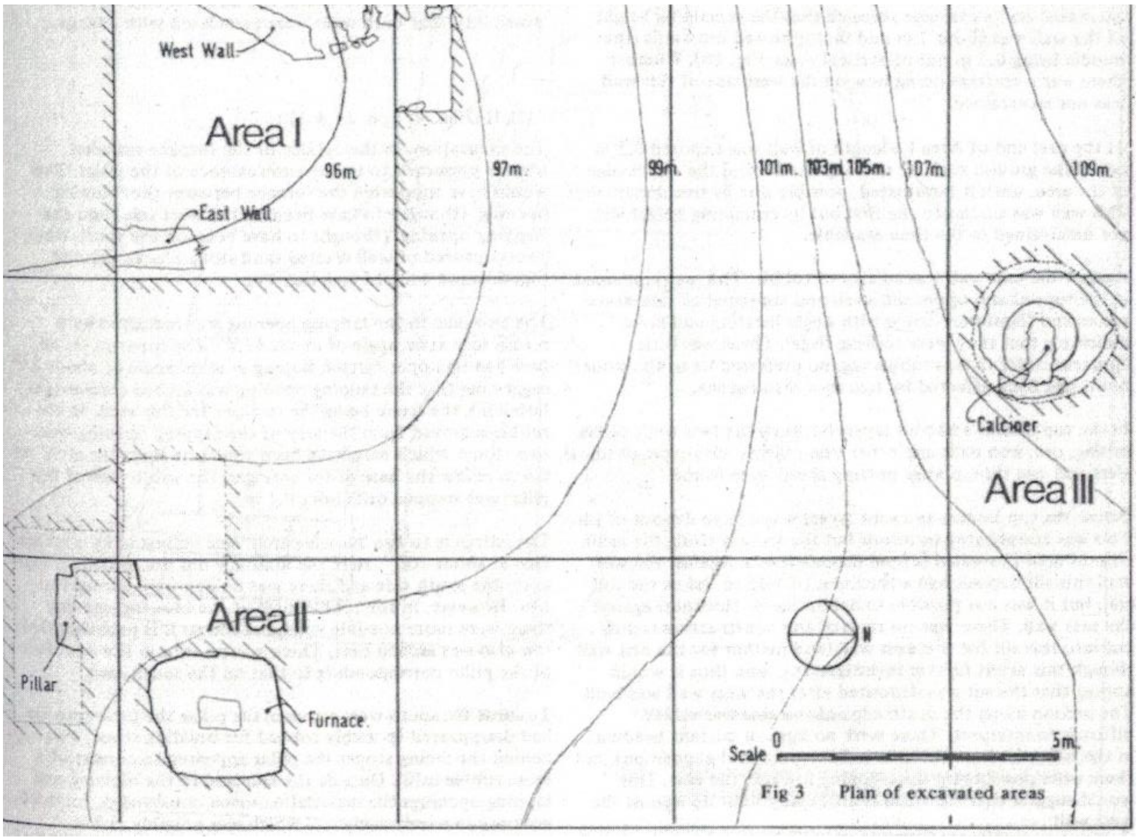


Figure 4.40 Excavations at Allensford.

(Linsley and Heatherington 1978: 3)

Area two surrounded the furnace. To the south-east of the furnace a pillar of well-dressed sandstone was uncovered. This would have supported the furnace and allowed access to the blowing hole, assumed to be on the west side of the furnace (fig. 4.41), and the tap hole, thought to be on the south (fig 4.42). Remaining evidence heavily suggests that both holes would have had arched entrances. The remains of the furnace itself consisted of the stack and the hearth. The north and east faces of the stack remained in situ, the south and east had fallen but were still discernible where they lay. The stack was of slightly rectangular plan, with the long axis to the north-south, built of coursed sandstone blocks with a green glaze on the inner face. The internal faces had a slight curve and the stack tapered by some 10^{o} to the vertical. At the bottom of the stack a burnt clay or sandstone surface sloped down to a rectangular crucible of sandstone blocks lined on three sides with refractory clay. The stack was found to descend below the top of the crucible and the gap had been possibly filled with rubble. At the base of the crucible the 0.5m wide tapping hole to the south was found to have a lintel.

Figure 4.41 Allensford blast furnace west face.

(Photograph: J. Bowman (2016)

Area three concentrated on the calciner (figs. 4.43-4.44). Once excavated this proved to be an inverted cone of flat sandstone blocks, crudely dressed and coursed. It had been built into the hillside on the north and west sides. The east elevation contained an arched access of 1.3m from the floor high by 0.45m wide for the fuelling of the calciner during the ore roasting process. At the bottom of the calciner the sides sloped into a rough sandstone block 'well'. On an east-west axis, the well stretched from the archway with parallel vertical sides for about 1.0m to terminate at a semi-circular end. The base of the calciner is slightly higher than the estimated top of the stack which would have aided the top-loading of the furnace.

Figure 4.42 Allensford blast furnace south face.

(Photograph: J. Bowman 2016)

Figure 4.43 Allensford calciner from above. Photographed from the north-east.

(Photograph: J. Bowman 2016)

Figure 4.44 Allensford calciner arch. Photographed from the east.
(Photograph: J. Bowman 2016)

Figure 4.45 Allensford adit. Photographed from the south.
(Photograph J. Bowman 2016)

A mine adit, or entrance (fig. 4.45), exists within 100m of the furnace site but was not explored during Linsley and Heatherington's excavation. The passage is c.1.0m high (fig. 4.46). There is evidence for roof collapse at the entrance and a water flows out of the workings making further examination difficult and dangerous.

Figure 4.46 Allensford adit entrance. Photographed from the south. 1m scale.
(Photograph: J. Bowman 2016)

When fieldwalking the Allensford West Wood area, formerly Hole House Woods, on the south bank of the Derwent, a deposit of stone rubble was discovered against a bank where a wooded plateau above the Derwent rises steeply to open fields to the south (NZ 0856 5079). The scatter (fig. 4.47) is c.10m wide and fills the height of the embankment. There are no other such spreads to the east or west and the width of spread may be suitable for three calciners and other preparatory structure. However, there are no faced stones within the rubble, nor any which appear to have been exposed to heat, however, there is a resemblance to the rubble stone on the bank behind the Allensford calciner where the lining stones have fallen away.

Figure 4.47 Allensford West Wood rubble scatter. Photographed from the north-west.

(Photograph: J. Bowman 2016)

The location of the Allensford Forge is less clear. Linsley and Heatherington found no field evidence for the forge to be present at the blast furnace site (1978: 11). The forge may be the Old or German Forge noted by Ryan (1841: 109-110) and shown by Cranstone (1997: 8) to be c.1km north-east of the furnace (NZ 0842 5178). The 'German' refers to Bertram rather than the Germans of Shotley Bridge. The site today is occupied by Forge Cottage (fig. 4.48). Some 640m south of the forge (NZ 0851 5113), on Holerow Haughs, are the remains of a stone structure thought to be a bridge over the mill headrace (fig. 4.49). water for the mill was drawn from the Derwent from a dam at NZ 0857 5110 (fig. 4.50). The curved masonry outlet from the dam, though filled with silt, is well preserved (fig. 4.51).

Figure 4.48 Forge Cottage. Victorian building photographed from the south-east. (Photograph: J. Bowman 2016)

Figure 4.49 Allensford forge millrace bridge. (Photograph: J. Bowman 2017)

Figure 4.50 Allensford forge dam. Remains of the dam photographed from the north.
(Photograph J. Bowman 2017)

Figure 4.51 Outlet into the millrace photographed from the east – standing on top of the dam.
(Photograph J. Bowman 2017)

4.3.3 *Crowley's Works*

The three iron working sites set up by Ambrose Crowley III within the Derwent Valley, Winlaton, Winlaton Mill and Swalwell have been largely obliterated by development throughout the 20th century.

When Crowley began to develop Winlaton at the turn of the 18th century he set up his workshops in four squares: Belts Square, Hood's Square, Hanover Square and Commercial Square. Belts Square may have been named for Anthony Belt, one of Crowley's managers (Roots Chat 2010). The sole remaining workshop in Winlaton (fig. 4.52) stands on the site of Hoods Square (NZ 1746 6209). Dated to the late 18th century, the single-storied building is of sandstone rubble with a pantiled roof over stone slates at the eaves. Each gable end contains a chimney, the south-eastern flue served the adjoining workshop for which the fireplace remains, though it is now obscured by a mill-stone (fig. 4.53). Internally the building is divided into 3 bays with earth floors (HER 1820).

Figure 4.52 Last workshop at Winlaton. North-east elevation.

(Photograph: J. Bowman 2016)

Figure 4.53 South-east elevation of workshop. A mill stone is covering the hearth of the demolished joining workshop.

(Photograph: J. Bowman 2016)

A historic photograph of Hoods Square shows Richard Hurst, a hinge maker, standing at the door of his workshop in the 1920s (fig. 4.54). To the right of Hurst's workshop stands the surviving building above.

Figure 4.54 Richard Hurst, blacksmith. Hood Square, Winlaton.

(Photograph: Gateshead GL002137)

Luke Biggins Whitfield was photographed outside his forge in 1926 (fig.4.55). The smithy was said to be in Church Street, though no map evidence can be detected. The building in the photograph confirms the vernacular architecture for Winlaton workshops.

Figure 4.55 Luke Biggins Whitfield, blacksmith, Winlaton, 1926
(Photograph: Gateshead GL001122)

It has been suggested that the offices and warehouse for Crowley's Winlaton works were incorporated into Winlaton Hall, demolished in 1928, at NZ 1759 6245 (Anderson 1972). From c.1702 the Crowleys used part of the Hall as a chapel and later as a residence when members of the family were visiting the works from London. It is thought that either Ambrose or John Crowley added a façade of battlemented corner towers joined by a Dutch gable (Meadows and Waterson 1993: 25). Around 1830 two Belt sisters operated part of the Hall as a shop. In 1835 Joseph Laycock, the grandson of the Joseph Laycock who had come to Winlaton in the early eighteenth century to manage the works, rebuilt the residential part of the Hall which passed through several hands before 1928. A stone in a gable, probably the Dutch gable, carried the inscription 'Crowley and Belts Castle 1864' (HER 1814).

Crowley's philanthropic establishments are also preserved by record. A street named Knowledge Hill indicates the area in which Crowley opened a school which adopted the name given to it by the local families. There are two photographs of Crowley's Poorhouse (Gateshead Council images GL001112, GL005879), a building set up at the southern end of North Street, Hood's Square (NZ 1746 6227), to look after Crowley's employees who had fallen on hard times. The date of the images is unknown.

Figure 4.56 Poor House, Winlaton, west face.

(Photograph: Gateshead GL001112)

One photo shows the building's western elevation (fig. 4.56). This was of one storey in coursed rubble walls and pantiled roof. The one clearly visible window is small with a dressed lintel and sill. The other image shows both the whole east elevation and the southern gable end of the structure (fig. 4.57).

Figure 4.57 Poor House, North Street, Winlaton, east face.

(Photograph: Gateshead GL005879)

The last workshop in production was operated by Nixon and Whitfield for chain making. The last chain was made in 1966 and the last link to be forged was photographed for posterity (fig.4.58). The blacksmith chain maker was Jack Hunter and his assistant 'striker' was Brian Kyle (Veitch 2012). The forge stood on the site of 24 Front Street (NZ 1764 6229).

Figure 4.58 Blacksmiths forging the last chain. Winlaton Forge, 1966.
(Photograph: Gateshead GI001115)

The ironworks at Winlaton Mill and their associated buildings were demolished in 1937. Following a period when the site was dominated by the coal industry it was landscaped into a country park during the 1990s. A single interpretation board stands beside the riverside path overlooking the area occupied by the powered forge, slitting mill and later rolling mill. At present the archaeology of the ironworks is essentially one of documentary record. Excavation work carried out on the site in the early 1990s stripped the overburden away from the main ironworks to the north of the site exposing water races and wheel-pits indicates that there are many sub-surface remains. Cranstone contends that this area may be largely architecturally complete to final floor level (1991: 24). These remains were reburied during the landscaping and remain unexcavated.

Some features are still visible. At the south end of the site, masonry of the High Dam, its wear, and the top of the Low Dam remain *in situ.*

Figure 4.59 High dam at Winlaton Mill. Photographed from the south. The pier wall is in the right foreground.

(Photograph: J. Bowman) 2016)

The wear in the Derwent and a stone pier of the High Dam on the east bank (fig. 4.59) are clearly visible from a path running through the Country Park. To their east, the north facing, stone revetment, of the dam and the area of the top of the Low Dam are heavily overgrown with vegetation. In 1991, however, these features were exposed (fig. 4.60). Cranstone noted three phases of construction (*ibid*. 23), the earliest attributed to the 1690s.

Figure 4.60 Winlaton Mill excavations 1992. Photographed from the north-west, visible are the race from the high dam (foreground right) and the curved top to the low dam.
(Sunnyside History 2016)

Water from the Derwent would be diverted by the High Dam. At the eastern end of this dam water would be drawn off into the 3.6 wide, stone lined millrace and diverted to the north-east. Crowley's *Map Book* (Warner 1718) shows the race feeding two ponds, the southern millpond or 'Square Pool' and the northern millpond or 'Great Pool'. Overflow water was channelled east to re-join the Derwent via the Low Dam at its northern end. The Square Pool had been filled in by the time of the 1st edition OS map, and the Great Pool filled in by the 1930s.

Crowley's *Map Book* (*ibid*.) shows the Winlaton Mill ironworks was originally set out in an area bounded by the Great Pool to the south, the Thornley Burn (now culverted) to the north, the Derwent to the east and the Thornley road to the west. Within this area workshops and houses were set out in two squares, the northerly 'Old Square' and the southerly 'New Square', in the same manner as Winlaton. There was a linear group of buildings lining the west side of the Thornley road opposite the squares. The most northerly of these buildings was set within its own gardens and was marked to suggest that this may have been the manager's house. Other buildings appeared on the eastern side of the Great pool. These included the 'Steel Warehouse' which was built on its banks. To the east of this warehouse and stood a block of buildings with a further block of 'Finer's Houses' beyond. These houses stood against the ironwork's eastern boundary wall overhanging the Derwent.

The earliest edition of the Ordnance Survey map, surveyed in the 1850s and published in the early 1860s, shows that by the mid-19th century there had been linear development along the Thornley road, with three more blocks of buildings fronting the track. Photographic evidence suggests that the form of the buildings within the groups was too irregular to be considered terraces. Opposite the southernmost group of houses the track turned east to bridge the mill race. Many of the buildings to the east of the Steel Warehouse row had been demolished. The 1870s revision of the first edition map definitively marks the position of the Iron Works at the north end of the Great Pool, the 1880s revision marks a reservoir. New Square is labelled 'Smithies' suggesting that the workshops within the square were still in production in the 1880s.

The second edition OS map shows Winlaton Mill during the period that it was occupied by Raine and Co. The Iron Works was then marked as Winlaton Rolling Mill and covered a larger foot print that the former Iron Works. Parts of the Old Square and all of the New Square had been demolished in order to facilitate a railhead or siding of the Garesfield and Chopwell Railway which could transport Raines' rolled product directly to their Delta Works on Derwenthaugh. It appears at this time that all the major buildings built to the east of the row along the east bank of the reservoir had been demolished, leaving a scattering of small, perhaps ancillary structures.

Several photographs have been found of Winlaton Mill (for example fig. 4.61). Most of the building stock is two stories high. The exceptions are the former Steel Warehouse and several of the buildings of the southern block on the old Thornley road, all of which appear to be of three stories. In several photographs the whole village appears to have been whitewashed. The whitewash was applied on an annual basis for at least the closing decade of the nineteenth century and up to 1929 (*Evening Chronicle* 2013: online edition). However, photographs which show west or north facing elevations suggest that whitewashing did not necessarily extend to all sides of a building. The whitewashed eastern elevations of the buildings all faced the Derwent Valley railway line.

Figure 4.61 Winlaton Mill village, 1929.

(Photograph: Evening Chronicle 2013a)

The Steel Warehouse (fig. 4.62) built on the eastern bank of the reservoir was constructed of well coursed sub-rectangular rubble with substantial quoin stones at the corners. The one visible kneeler stone on the south-west corner of the roof has a bulbous profile suggesting that it dates from the 17th century. The windows had lintels but no sills. The east face of the building contained a single central arched opening on the ground floor. This had been split vertically into two by the date on the photograph, 1929. On the first floor was a single small window, positioned centrally above the doorway. The roof was of pantiles: a tinted photograph of other buildings on the site would suggest that the tiles were red in colour.

Figure 4.62 The steel warehouse, Winlaton Mill. Raine's rolling mill is visible at the north end of the millpond.

(Photograph: Evening Chronicle 2013b)

Figure 4.63 Entrance to Crowley's ironworks c.1937. Photographed from the west with ruins of the rolling mill in the background.
(Photograph: Mills Archive 2017a)

A photograph of the entrance to Crowley's ironworks at Winlaton Mill (fig 4.63) shows the track between the buildings nearest the Huntley Burn on the left and the buildings which formed the northern side of the Old Square on the right. The buildings are a mixture of one and two storey structures. The commentary to *Crowley's Map Book* (Warner 1718) indicates that the squares appear to have originally been a mixture of domestic and industrial units.

Figure 4.64 Raine's rolling mill, western building. Photographed from the north-west showing a waterwheel in its pit.
(Photograph: Mills Archive 2017b*)*

The western building of Raine's rolling mill occupied the area of Crowley's slitting mill (fig.4.64). Fabric of the slitting mill was retained in the rolling mill as some masonry is visible in the photograph. The eastern building, on the site of Crowley's hammer forge was largely a new construction as can be seen by the brickwork in figure 4.65.

Figure 4.65 Raine's rolling mill eastern building. Photographed from the north-west.
(Photograph: Gateshead Libraries GL001082)

A bronze bell thought to be the one used at Winlaton Mill as a curfew bell by Crowley, Millington and Company, and later as a factory Bell by Raine and Company, is curated at Winlaton Mill Village Hall. The bell is cast with the date 1799. The bell may have come from a captured French warship and only been brought to the Ironworks in 1813. The bell was said to have been in use at the Ironworks throughout the nineteenth century and taken by Raine and Company to their Delta works when they abandoned Winlaton Mill in 1915. The bell was found in an old forge at Winlaton in 2005 by a local historian, Christopher Hamilton, and is now owned by Gateshead Council (Sharma 2005).

The third and most impressive of Ambrose Crowley's ironworks was at Swalwell. Crowley took on the works from a partnership of businessmen in 1707. The partnership had taken on the leases to the Bishop's Mill, Holme Mill, Holme Close and the Swalwell High Mill to establish the ironworks and the rights to dam and extract water from the Derwent. Holme Mill was also the site of Edward Talbot's and Sir William Blakiston's ironworks from 1614 though nothing of this venture or its dam has been recovered.

The only standing remains associated with the Swalwell works is the Dam Head also known as the Lady's Steps (fig. 4.66). This structure once diverted water from the Derwent along a 4.0m wide mill race to the High Mill and on to the Swalwell works, with a branch feeding the Holme Mill adjoining the ironworks which was retained by Crowley as a corn mill. The

Lady's Steps, named for Lady Clavering of Axwell Hall, were built around the year 1702, and were altered with the addition of a fish pass on their western side in 2012. The dam provides a barrier which marks the tidal reach of the river (Makepeace 2014).

Figure 4.66 Dam Head or Lady's Steps. Photographed from the north-west.
(Photograph J. Bowman 2016)

To the north-east of the Swalwell Visitors Centre, which is built on the site of the High Mill, the course of the mill race can be traced as a raised earthwork. Flowing water can be seen at the southeast corner of Swalwell Rugby Club's grounds (between NZ 19934 62049 and NZ 20058 62121) where it is channelled under the Square Bridge, named for Crowley's Square, at the foot of Swalwell bank and piped underground to the Derwent.

The High Mill (fig. 4.67), described as the Old Forge – a title which agrees with the 1895 second edition OS map. On the map the High Forge is not shown as disused. The condition of the Mill buildings in the photograph looks good. The fabric of the buildings is unclear. The

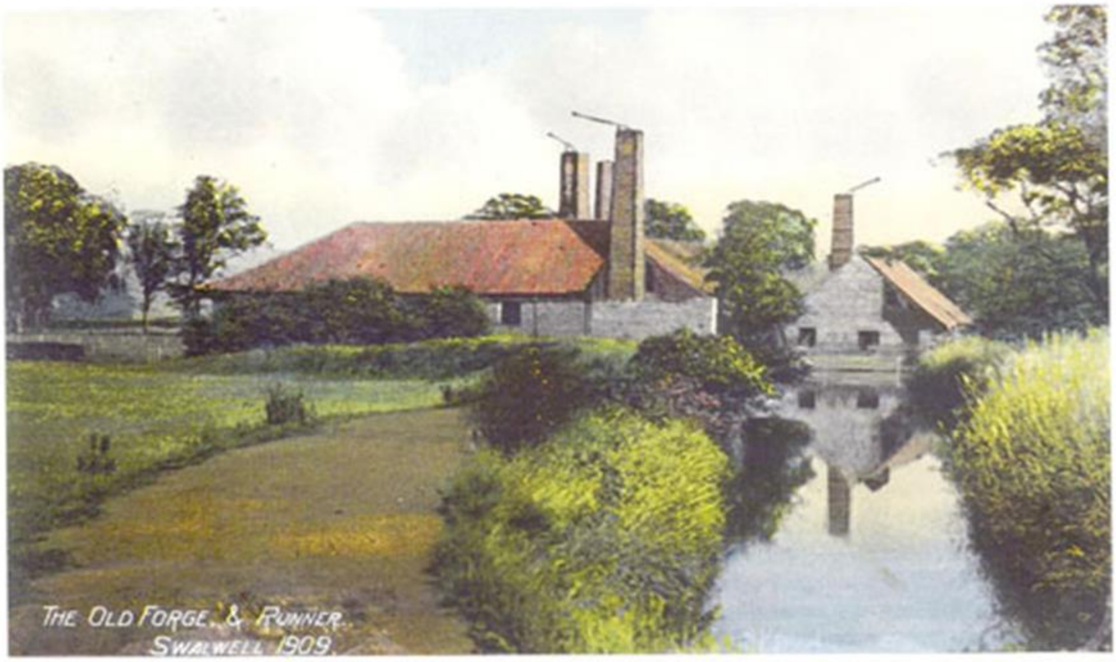


Figure 4.67 Swalwell High Mill 1909. Photographed from the south-west.
(Photograph: Swalwell On Line 2017a)

roofs on the postcard have been tinted red suggesting the use of red pantile. Based on analogy with Winlaton Mill the gable wall of the Mill building straddling the mill race or ‘Runner’ as it is referred to on the card, may be constructed from horizontal timber boards.

Figure 4.68 shows the mill race entering Swalwell ironworks under the Square Bridge and the main road entrance to Crowley’s Works. The building on the left is the south end of houses converted from, or built on the site of, Holme Mill. To its right, on the far bank mill pool, is the gable end of building which is present on all the plans of Swalwell from 1750 and appears to have been for domestic use throughout its lifespan. Beyond this building is Ridley’s Steel Works. The photo shows the Works as the wide building which covered the width of the yard between the Mill Race and the Hexham Road shown on the OS revision of 1895. The railway line shown on the same map entering the Crowley’s Works area is missing, suggesting the photograph is dated to after 1870 and before 1895. Of the three tall chimneys on the left side of the picture, the central, thin chimney served the Foundry, the chimney to its left served the Steel Forge and the one to the right appears to stand in the location of the Engine House in a plan of 1870 (Cranstone 2011: 51).

Figure 4.68 Swalwell ironworks. Photographed from the west. (Photo: Newton 2016)

To the north-east of the Steelworks, within Holme Close, stood West View Terrace (fig. 4.69), one of the two rows of Crowley's 'Cottage Houses' (Warner 1718). Later OS maps indicate that there were 12 properties in the terrace, however, the 1718 plan which shows the site in detail suggests that the western terrace of cottages originally comprised 14 units and these appeared to have been paired off with their entrances accessed from passageways which ran from east to west through each pair of cottages. West View differs from this model by each unit having its own west facing door. This suggests that the cottages were redeveloped at least once since their original construction. The cottages appear to be stone built with roofs of an indeterminate material. The size and shape of the windows suggest a Georgian date. The use of dormer windows in the first-floor rooms is reminiscent of the second floor windows of the southernmost block of houses on the Thornley Road at Winlaton Mill which are known to have been built later than 1718 on the evidence of the plan of those works of that date.

Figure 4.69 West View Terrace, Swalwell. Photographed from the south during demolition in the 1950s. (Photo: Web Wanderers 2017)

Work by Pre-Construct archaeology in 1992 revealed the eastern wharf of the Grand Warehouse (fig. 4.70) and the Half Forge building to its east (fig. 4.71) plus evidence of the filled in water courses which served them both.

Figure 4.70 Eastern Wharf, Grand Warehouse. Photographed from the south.

(Photograph: Swalwell On Line 2017b)

Figure 4.71 Half forge furnace chimney. Photographed from the east. (Photograph: Swalwell On Line 2017c)

Figure 4.72 Keel berth, Grand Warehouse. Photographed from the north. 1.0m scale. (Photograph: ARS 2012a)

The ARS excavations covered the western portion of Grand Warehouse and the ground to its north. It was noted that the 'basement had substantial sandstone walls which were still surviving to heights of over 1 metre, and had retained its cobbled floor surfaces' (ARS 2017). Figure 4.72 shows what may be the keel-boat berth located between the east and west wharfs within the warehouse. Keels would navigate up the Derwent, then continue using a canal formed by the tailraces of the works and enter the berth from the north.

The crucible furnace (fig. 4.73) was built within the Grand Warehouse. The remains are of the row of ash pits beneath each charge hole. Their function was to allow the ash that fell from the furnace above to be cleared and to allow a supply of air to be drawn up. The six visible piers suggest either a five-charge furnace, or six, if the gap between the northern pier and the wall could be utilised.

Figure 4.73 Crucible furnace, Swalwell. Photographed from the east.
(Photograph ARS 2012b)

Remains of the anchor shop were uncovered to the north of the Grand Warehouse, aligned at 45^{o} to the north face of the Warehouse (fig. 4.74). Timbers were set into the floor of the anchor shop, one with a pair of socket holes in its upper surface, suggesting a vertical timber could have been present at some time. A possible function for these timbers could be as skids to aid the handling of heavy anchors within the workshop.

Figure 4.74 Anchor workshop, Swalwell. Photographed from the north-east. 1.0m scale. (Photograph ARS 2012c)

One possible Swalwell anchor was identified by Flinn in 1962. It is one of the large anchors displayed in the grounds of the National Maritime Museum at Greenwich (Flinn 1962: 191). A request for verification of this artefact was made to the Museum. The reply indicated that Finn's anchor is an Admiralty Pattern anchor (fig. 4.74), with an accession no. of EQS0014 (Ball 2015: pers. comm.). This anchor dates from 1750 +/- 50 years and was recovered from the anchorage off Sheerness, Kent. Its size, with shank length of 4.92m and amplitude of the arms 4.0m, suggests it was lost from a larger type of Man-of-War (Beattie-Edwards 2009).

Figure 4.75 Possible Swalwell Anchor. (Photograph: M Beattie-Edwards 2009)

Several iron objects were recovered during the Pre-construct Archaeology excavations of 2005. These were mostly fragmentary in form inviting speculative function based on their morphology. One object appeared to be a wrought iron 'spine' for a straw knife 800mm in length. It was found in demolition material near to the furnace chimney in the Half Forge. From the same context a part forged bar of iron of steel, 590mm long was recovered; analysis suggested that it had been produced by the crucible steel manufacturing process. Three other objects were recovered from within the Wharf building: a small offcut from the end of a wrought iron bar which showed signs of being produced through the puddling process, a piece of iron 50mm x 22mm x 22mm which proved to contain phosphorus producing a hard material suitable for nail making - the object may have been an offcut of a nail-bar, the third object resembles a truncated cone 53mm high has been interpreted as the feeder or in-gate of an iron or steel casting (*Proctor et al* 2011: 30-33).

No archaeological investigation has been carried out on the nailer's colony at Lintz Green. It may be assumed that the workshops were on or near the site occupied by Lintz Green Farm and its associated township, less than a kilometre south of Lintzford.

4.3.4 *The Derwentcote forge and steelworks*

Archaeological investigation at Derwentcote has been focussed at three main locations across the site: the cementation furnace, the forge area including the crucible furnace and millpond dam, and the worker's cottages.

Prior to 1991 the Cementation Furnace survived as a derelict roofless set of structures. The cone of the Furnace was largely intact and the northern and southern buildings had enough integrity remaining to allow sound interpretation for reconstruction. Photographic evidence from the 1960s indicates that the southern building had been partially roofed at that time and the remains of that roof were covered by pantiles but this had fallen in by the time of Cranston's work (1997: 47). Even in this condition the ruins represented the most complete 18th century cementation furnace remaining in Britain, if not Europe and 'as such is one of Britain's most important industrial monuments' (*ibid.* 1).

David Cranstone's investigation and excavation of the cementation furnace in the early 1990s produced a report of a four-element structure: a cone shaped furnace, a northern abutted building, a southern abutted building (teasing houses) and a small lean-to building on the eastern side of the main structures. Excavations were carried out within and without the buildings to expose any surviving floors and historic external ground levels. The larger, southern teasing house was found to contain a manual charcoal mill where the material used to fill the cementation chests was prepared. A small rectangular building was discovered 29 metres south of the Furnace which may have had an administrative function for the steelworks.

Today the Cementation Furnace stands in a consolidated state with a complete pantiled roof producing a watertight structure (figs. 4.76, 4.77). The northern and southern buildings provide open interior spaces from which elements of the furnace can be inspected; the southern building also houses a range of interpretation boards for the monument around its walls. Remains of the two 14-ton sandstone cementation chests are stored in the small eastern building accessed from the southern house.

Figure 4.76 Derwentcote cementation furnace. Photographed from the north-west showing arrangement of the cone and teasing houses.

(Photograph: J. Bowman 2016)

Figure 4.77 Detail of the cone. The door in the cone allows access to the interior of the chimney. The two smaller holes below are for the loading of iron-bar and charcoal into the cementation chests within the furnace.

(Photograph: J. Bowman 2016)

Angerstein's sketch of the Derwentcote furnace (fig. 4.78) differs from its later form. The major differences are that in 1753 the cone was enclosed within the teasing houses and the small eastern structure had not been built. The larger, southern, teasing house, appears shorter than the building today. An absence of vertical joints on the long walls suggests a complete rebuild since the date of the sketch. The earlier roof appears to be of timber.

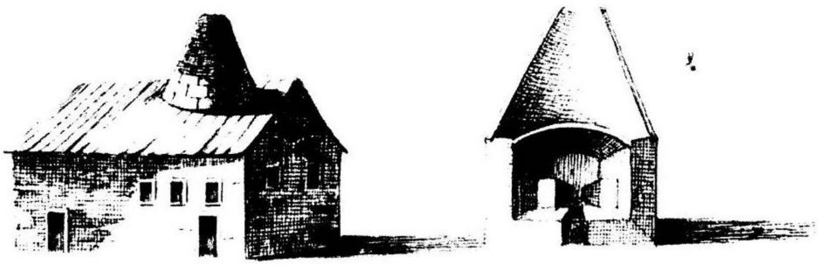


Figure 4.78 Angerstein's sketches of Derwentcote cementation furnace 1753.

(2001 [1765]: 272)

Wessex Archaeology's 2012 excavations at Derwentcote are shown in figure 4.80. The crucible furnace was identified by two firebrick lined refractory chambers and their associated flues (fig. 4.79). The furnace is located between the northern and southern ranges of forge buildings as shown on historic Ordnance Survey maps. Without applying absolute dates Wessex Archaeology identified three phases of construction around the crucible furnace indicating it had succeeded an earlier building.

Figure 4.79 Crucible furnace bays. Photographed from the south. 2.0m scale.
(Wessex Archaeology 2012: Figure 5)

To the north of the crucible furnace evidence for the forge was revealed (fig. 4.81). The forge would have held a water-powered hammer. The tailrace for the forge was excavated and found to be brick lined. A general observation made for the Forge area was on the deposition of industrial waste in all the trenches.

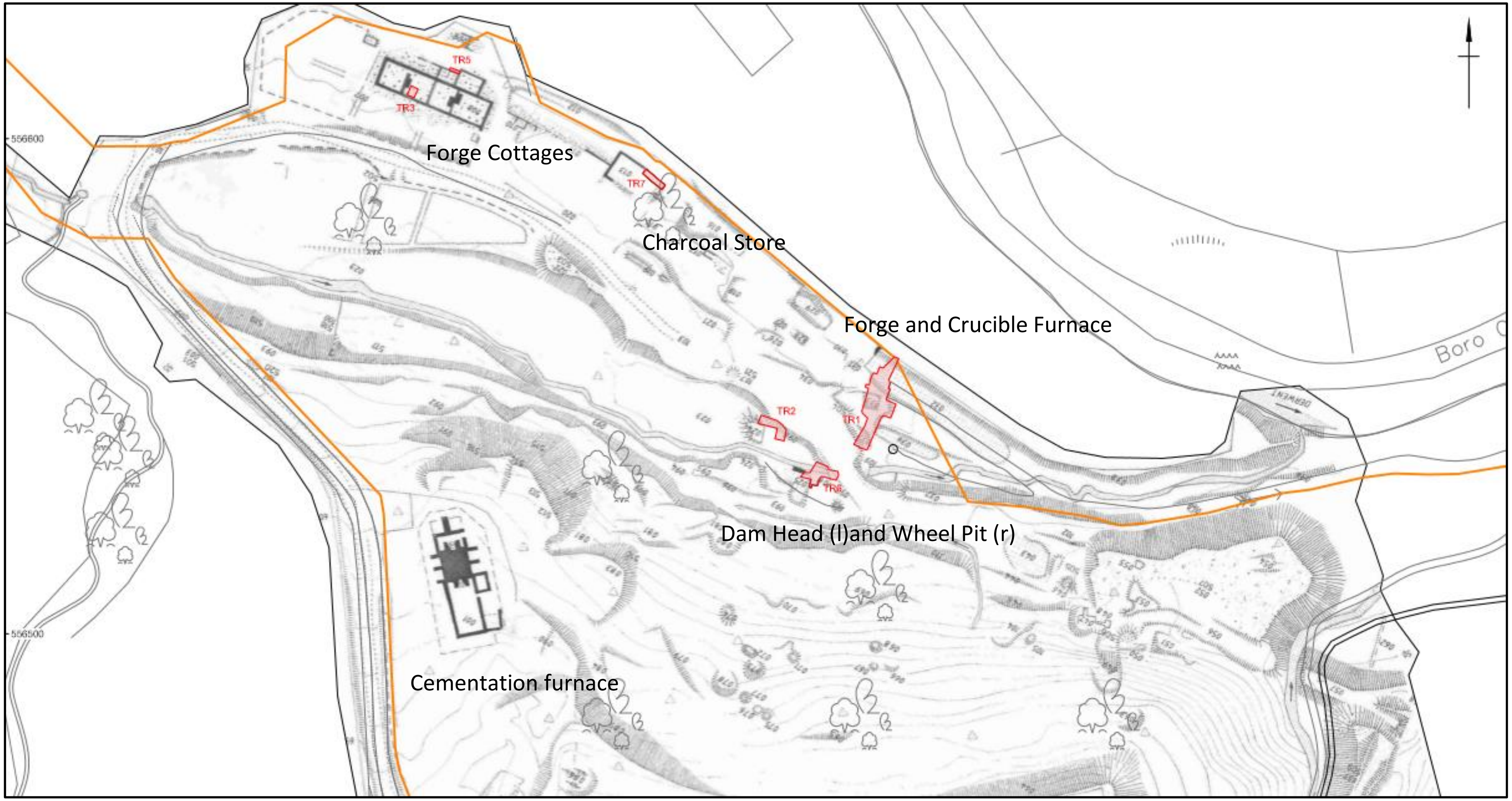


Figure 4.80 Site plan of Derwentcote. Showing positions of the excavation trenches of Wessex Archaeology's 2012 season. (Wessex Archaeology 2016: Figure 2)

Figure 4.81 Forge to north of crucible furnace. Photographed from the south-west. 2.0m scale. (Wessex Archaeology 2012: Figure 4)

Examination of the millpond dam head (fig 4.82) produced the conclusion that, due to the presence of slag within the rubble core and the material used to consolidate the dam, that the structure may have had a previous use as a blast furnace. To the east of the dam head a stone lined water-wheel pit was uncovered, agreeing with the map evidence for the southern range of Forge buildings.

Investigation of a building (fig. 4.83) located near to the north boundary of the site between the worker's cottages and the Forge produced evidence for at least two sequential structures on the site with a suggested function, during its later life, as a charcoal store.

The trenches at the workers' cottages both produced information as to the condition of the buildings' remains and allowed for a provisional phasing based largely on the visible structure. A fuller understanding of the structure and phasing has been created through the Newcastle University excavations 2012-2016.

Figure 4.82 Derwentcote millpond dam head. East (external) face photographed from the north-east. (Photograph: J. Bowman 2016)

Figure 4.83 Charcoal store, Derwentcote. Photographed from the east. (Photograph: J. Bowman 2016)

The Wessex Archaeology report concludes that there is far more work to be done at Derwentcote to fully understand the industrial complex and the cottages. The great hurdle to this work was pointed out to be the undergrowth covering the site. As at October 2014 discussions into the clearing of the undergrowth as part of the woodland management aspect of the proposed 'Oak and Iron' project by the North of England Civic Trust have commenced between all interested parties.

The fieldwork carried out by Newcastle University on the Forge Cottages is nearing completion at this time (fig.4.84). The entire floor plan of the cottages has been uncovered revealing a four-cell arrangement which agrees with the plan of the cottages given in the 2nd edition OS map. The three easterly cells have ancillary buildings to their north side. The plan differs from that shown in the 1st edition map which indicates three cells with a large central cell. The fabric of the cottages is a mixture of sandstone and brick, and shows signs of several periods of construction. The first element of the cottages may have been the long east-west sandstone wall which runs from the north-west corner of the western cell to the north-west corner of the eastern cell, forming the north wall of the two central main cells. Though this wall has been 'knocked through' in several places (and in some cases blocked up again) the structure has a slight 'step' in its vertical construction suggesting one build throughout its length.

The western most cell has walls of stone to all four sides; the east and west walls are built on foundation stones whereas the north and south are built without foundations suggesting that they were later infills. Broken pantiles were found forming part of the rubble core of the north wall, they have not been found within the east or west walls. A doorway was discovered at the south end of the western wall of the cottage with the remains of the wooden door lying beneath a layer of pantiles, themselves beneath a layer of red bricks. There was no floor present in the western cottage though its height may be determined by the hearth stone of the fireplace superimposed against the western wall. The fireplace is constructed from a smaller brick than has been found elsewhere on site suggesting a mid-18th century date or older for the bricks themselves, but not for the date of the installation of the fireplace. Beneath the floor level there is a drainage system; the main gully, running north-south was partially constructed with crucible lids.

Figure 4.84 Derwentcote Forge Cottages. Photographed from the south-west.
(Photograph J. Bowman 2014)

The eastern cottage has stone walls to the north and east, and brick to the south and west. A fireplace is built into the west wall and as such is the only fireplace not to be superimposed onto a pre-existing wall. The difference in the shape of this cottage between the 1st and 2nd edition OS maps can be traced with vertical joints in the west wall. Evidence for a staircase to a second floor was found against the west wall. The remains of a porch were found opposite the entrance in the west wall. Within the ancillary building to its north both a fireplace and a solid-fuel water heater were found.

The central two cottages appear to be of one build with a southern brick wall filling the gap, and butted up to the southern stone wall of the western cottage and the southern brick wall of the eastern cottage. Both cottages appear to have been accessed from the south, though the doorway to the centre-west cottage has been blocked up at some time. Both central cottages have exits into the ancillary, brick built, structure which runs along the north side of the main buildings. The centre-west cottage has a quarry tiled floor which was first spotted by Wessex Archaeology and can now be seen to be mostly intact. The centre-east cottage has no surviving floor save for a rectangle of concrete adjacent to the south wall. The two cottages were initially separated by a single thickness brick wall, with the bricks bonded along their string edges. The single thickness wall later had a double thickness wall built up against it. Both cottages have a superimposed fireplace against the opposing east and west walls. These Fireplaces are of similar build and dimension suggesting that they were introduced to the cottages at the same time. Lying to the south of the centre-west building was the south wall which had collapsed almost intact, allowing an estimation of the height of the central cottages of about 3.0m to the eves, suggesting a two-storey building.

Wherever excavation could take place at a sub-surface level, mostly on the exterior of the cottages and in the sub-floor level of the western cell, quantities of a green glassy slag were encountered (fig. 4.85). There is an account of an early puddling furnace being set up at Derwentcote c.1785 (Cranstone 1997: 24). It was considered that the slag may have indicated that the cottages may have originally housed this unpowered process. However, the slag has been identified as being blast furnace residue (Cranstone 2016: pers. comm.). As such it supports Wessex Archaeology's contention that a blast furnace existed on the site at some time. The fire place of the eastern cell contains an inaccessible smaller chamber to the south of the main hearth. This two-chamber arrangement is suggestive of a reverberatory Air or Balling furnace which has been repurposed for later domestic use. An Air furnace was known to have been operating at the same time as the puddling furnace, and a balling furnace in 1794 (Cranstone 1997: 24).

Derwentcote is discussed further in chapter 6.

Figure 4.85 Blast furnace slag collected from Derwentcote.
(Photo: J. Bowman 2016)

4.4 Machine Age sites

As noted in 4.1 above**,** the relatively recent closure of the ironworking sites that originated in the 19th century has resulted in little archaeological interest prior to redevelopment.

4.4.1 *Consett*

The Blue Heaps, the site of the Derwent Iron Company's first blast furnaces has been incorporated and landscaped into the east end of Consett Park. There are no visible structures remaining of the plant, however, during the 19th century, before the park land was donated to the local authority by the Consett Iron Company, large quantities of slag from the iron production processes were dumped there. The colour of these heaped deposits gives the name to the site. Several massive lumps of slag can still be found concealed amongst the park shrubbery.

The site of the main Consett ironworks lies to the south-west of Genesis Way, which is part of a partial ring-road system around the town of Consett. The ongoing redevelopment of the ironworks is mostly housing, with retail and hospitality clustered at its southern end. The locations of the smaller ironworks that were subsumed into the Consett works are clearly visible on the 1st edition OS map. The Crookhall Iron Works were at NZ 1185 5100, Bradley Iron Works at NZ 1208 5179, and the Shotley Bridge Tin Works at NZ 0996 5115. Today the Shotley Bridge and Bradley sites are small industrial estates and Crookhall is a chemical factory.

Only two of the Consett Iron Company buildings survive. One is unit E4 of the Park Road Industrial Estate on the site of the Shotley Bridge Tin Works, currently repurposed as a motor trader's. It has survived because the level of redevelopment grant available to demolish the building and replace it with a new structure made the project unviable (White 2015: pers. comm.). There is a short length of railway line set into its yard. The second building is the former, and now derelict, water pumping house on the banks of the Derwent (NZ 0867 5112) (fig. 4.86). This is a brick built structure with some ornamentation, built to pump water from the river up to the ironworks. The stone dam across the Derwent used to create the reservoir for the pumphouse is known locally as the Groyne.

Figure 4.86 Consett Iron Company's pumping house. Photographed from the south
(Photograph: J. Bowman 2017)

The Consett Iron Works has been monumentalised. In 1996 the abstract *Terris Novalis* stainless steel sculpture by Tony Cragg was erected at the southern end of the former ironworks site (4.87). This was followed in 2002 by *Steel* by Andrew McKeown, a series of steel plaques set into the ground at Consett Park. Each plaque commemorates a process which took place at the works. Over recent years several other memorials have appeared around the town, the most conspicuous of which is the large mural of the ironworks at the entrance of the 2014 Tesco supermarket built over the site.

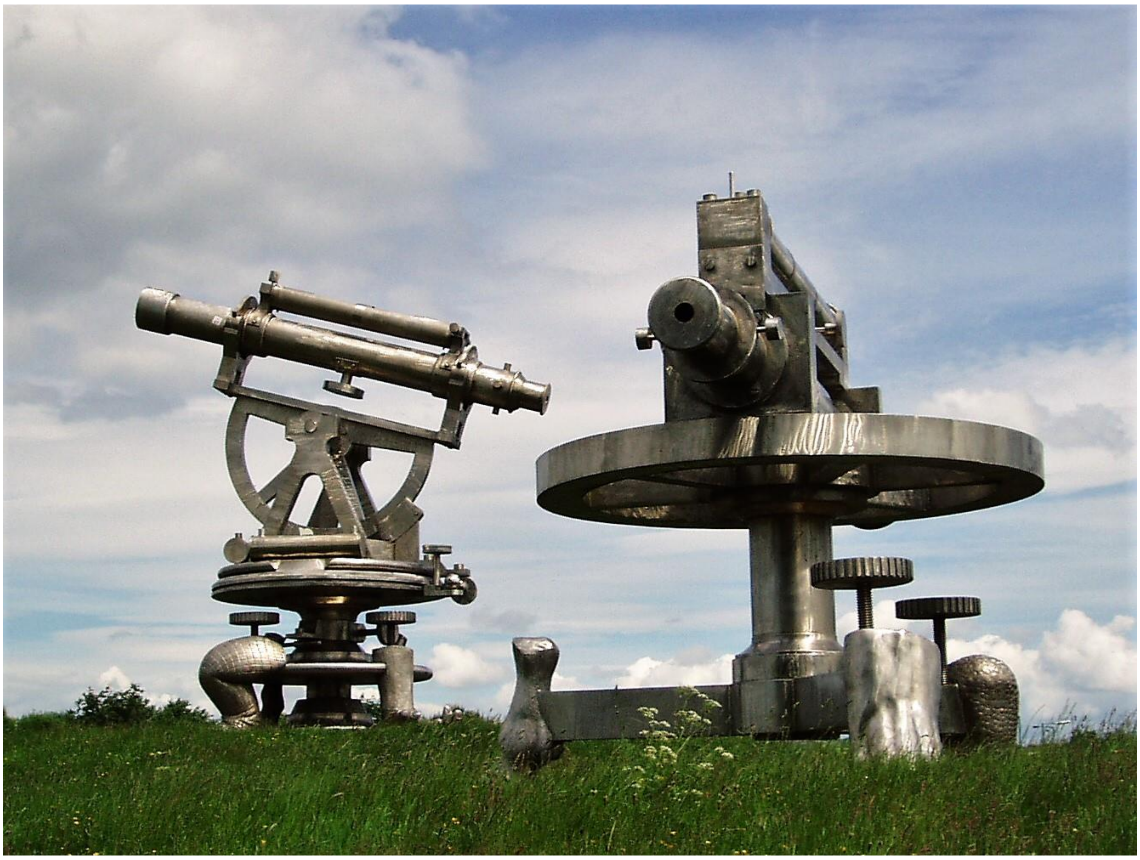


Figure 4.87 Terris Novalis

(Photograph J. Bowman 2014)

British Steel left pieces of equipment around the town. Two crucible rail wagons have been set on rails, one (fig. 4.88) is sited at the entrance to the Park Road Industrial Estate (NZ 1014 5120) and the other at the junction of the Consett and Sunderland Railway Path and the Lanchester Valley Railway Path (NZ 0993 4941). There are two steel tubs set amongst the paths of the amenity land to the east of Genesis Way (NZ 1023 5119).

Figure 4.88 Crucible wagon, Consett

Photograph J. Bowman 2014)

4.4.2 *Derwenthaugh*

Nothing remains of the Delta Ironworks. The site is commemorated in street names: Delta Bank Road and Delta Park. The latter is a business park which was developed on the steelworks site following 1990. No archaeological investigation appears to have taken place prior to the redevelopment.

Ellis's steelworks have been largely redeveloped into industrial units. The 1950s brick office block at the entrance to the works on Longrigg Road remains. During the 1980s it became the offices of the local radio station *Metro Radio.* Following refurbishment in 2006 it is now used for various business purposes.

4.5 Summary

The interrogation of the HERs and other archaeological data sources combined with a programme of fieldwalking has added to the number of iron working sites found through the documentary record, either confirming their locations or suggesting their position within the landscape, and allowed their current condition to be assessed. A total of 69 sites or visible components of sites have been identified throughout the valley.

Several early sites described in the Durham Priory's Bursars' accounts remain unlocated and therefore have been omitted from table 4.1. There is still uncertainty surrounding the iron production sites of the upper Derwent area, though their early date from the start of the 13th century to the Reformation of the 16th century suggests a small-scale technology which simply left fewer traces when compared with later production methods. Where bloomery slag has been found, at Nookton, there are no obvious furnaces nearby. Similarly, at Ravenside, in the mid-valley there are no bloomery remains.

When the archaeological data is added to the documentary evidence three more documented sites may be revealed. In 1497-8 William Palyser of Unthank was amongst a group of merchants who supplied the Durham Cathedral Priory with iron. Threlfall-Holmes postulated two possible locations of Unthank based on their proximity to suitable water sources for power (1999: 116), one in Weardale and one on a tributary to the Wear near to Durham City. However, there is a farm named Unthank (NZ 0413 5446) 1.25km from the Greymare Hill ironstone workings which is far closer to Muggleswick making this the most likely candidate. Another merchant from the group was Robert Kirkley of Knytheley (Knitsley). There is a place called Knitsley in the Hown's Gill valley, to the south of Consett (NZ 1100 4880). A kilometre to the north-west of Knitsley lies the area of Delves Lane, named for the delve pits, or bell pits, which are said by tradition to have been mined by the Shotley Bridge Swordmakers for iron. The proximity of Knitsley to Delves Lane opens the possibility of Kirkley operating from this location. Threlfall-Holmes suggested that the merchant William Andrews' Whitehall address was in the proximity of Whitelees farm (NY 9258 4700) at the foot of White Hill (*ibid.* 116). Whitelees overlooks Nookton Fell and is within some 2.5km of all the record slag sites in 4.2.1 that may corroborate the theory that the Weardale merchants were supplying iron mined on their own land during this period.

It has been decided not to include the recent monuments to the Consett Iron Works within the results for this chapter as they are post-industrial artworks—though *Terris Novalis* has a NM record (1509341). Table 4.1 provides the foundation for the analysis of social structure, the process recording presented in chapter 5, and the database which has been created to build a GIS to allow interrogation of the data generated by this project.

This chapter shows that a combination of documentary sources and archaeological investigation is necessary to contextualise the vast and varied amount of data available to the historical archaeologist.

Chapter 5. Industrial and landscape archaeology methodologies applied to the Derwent valley

5.1 Introduction

This chapter applies the Manchester Methodology and process recording to the Derwent valley. The results of these two industrial archaeology methodologies, described in chapter 3, are added to the GIS created for this thesis. The latter part of this chapter describes how this GIS is used within the dissertation for illustrative purposes.

The outcome of the application of the Manchester Methodology to the Derwent valley is presented in 5.2 below. The results are presented in the same cumulative graph form employed by the UMAU. The beneficiaries of the monument types are also presented as an aggregated graph demonstrating the dominance of different social groups by decade. The discussion describes the Derwentside model of industrialisation and provides criticism of the methodology. One criticism, concerning the use of qualitative over quantitative data, has been tested by presenting 100% of the valley's monuments appearing between 1600-1900 and comparing the results with the qualitative model.

Process recording is used in this project to achieve three objectives: firstly, to facilitate an enhanced understanding of the operation and architecture of a site, secondly, to give an insight into the reasons for a site's location and its relationship to its environs, and finally to allow an interpretation of incomplete, damaged or demolished sites. As demonstrated within chapters 2 and 3, all the Derwent valley sites are incomplete, damaged or long demolished. The historical documentation indicates that there was a degree of collaboration between many of the iron working sites during the valley's Industrial Revolution, therefore a valley-wide campaign of process recording is appropriate. The methodology is forensic; the processes known to have taken place at sites through the documentary and archaeological records are described through mainly analogous secondary sources. Wherever relevant, primary eye-witness accounts are used, notably Angerstein's observations of 1754.

Process recording for the Derwent valley presents, in some detail, all the iron working processes which took place in the valley up until 1915 in 5.3. As previously discussed in chapter 4, this date has been chosen because all technical competition to the Consett Iron Works ceased at that date. The only other ironworks left on the Derwent was Raine's Delta

Works at the mouth of the river, which specialised in scrap melting for forging and rolling into new products. Some scrap was supplied from Consett. A short list of processes adopted by Consett after 1915 has been included for completeness.

Information from sections 5.2 and 5.3 information has been added to the *Derwent Valley GIS.* A 'yes/no' field indicating whether a monument contributed to the Manchester Methodology was added to the GIS database. The 29 separate processes detected in the valley were each given their own 'yes/no' field in order that they can be viewed in relation to the iron working sites where they took place. Though the results of the GIS have been uploaded onto the DVD appended to this thesis and should be viewed within ArcGIS 10.3.1 or later versions. The use of the Historic Landscape Characterisation created through the GIS is discussed in 5.4.

5.2 The Manchester Methodology applied to the Derwent valley

5.2.1 *Analysis of the HER data*

The graph of the results produced for the Derwent valley (fig. 5.1) indicates a gradual increase of the appearance of new monument types throughout the 17th century until the 1680s when the graph increases in slope, indicating an increase in activity which is maintained at an almost constant rate until the end of the period. Of the 214 new monument sites, 55 are industrial. Of these, 15 can be dated to the seventeenth century, 9 of which are related to the iron industry: the bell pits of Whittonstall, the Allensford blast furnace, the Allensford calciner, the furnace at Blackhall Mill, the iron furnace at Shotley Low Quarter, the iron working site at Gibside, the iron works at Winlaton, the Blackhall Mill steel works and the Shotley Bridge sword factory. Overall, there are only 12 new categories of monument directly relating to the iron industry from 1600 to 1900 suggesting that it had been largely established by 1700. There are only 33 new sites recorded for the 17th century as a whole. Iron-based industrial sites represent 27% of this total. However, within other monument classes of the 17th century, new sites can be directly attributed to the iron industry, increasing the presence of the iron industry sites to 33% of the recorded new sites. For example, the appearance of a dam within 'water supply and drainage' refers to Crowley's Low Dam at Winlaton Mill, and the worker's house in the 'domestic' class is the sword maker's housing in Wood Street, Shotley Bridge. Other industries recorded in the 17th century are coal, lead, paper and corn-milling. The recorded coal industry sites pre-date the appearance of the iron industry during the study period.

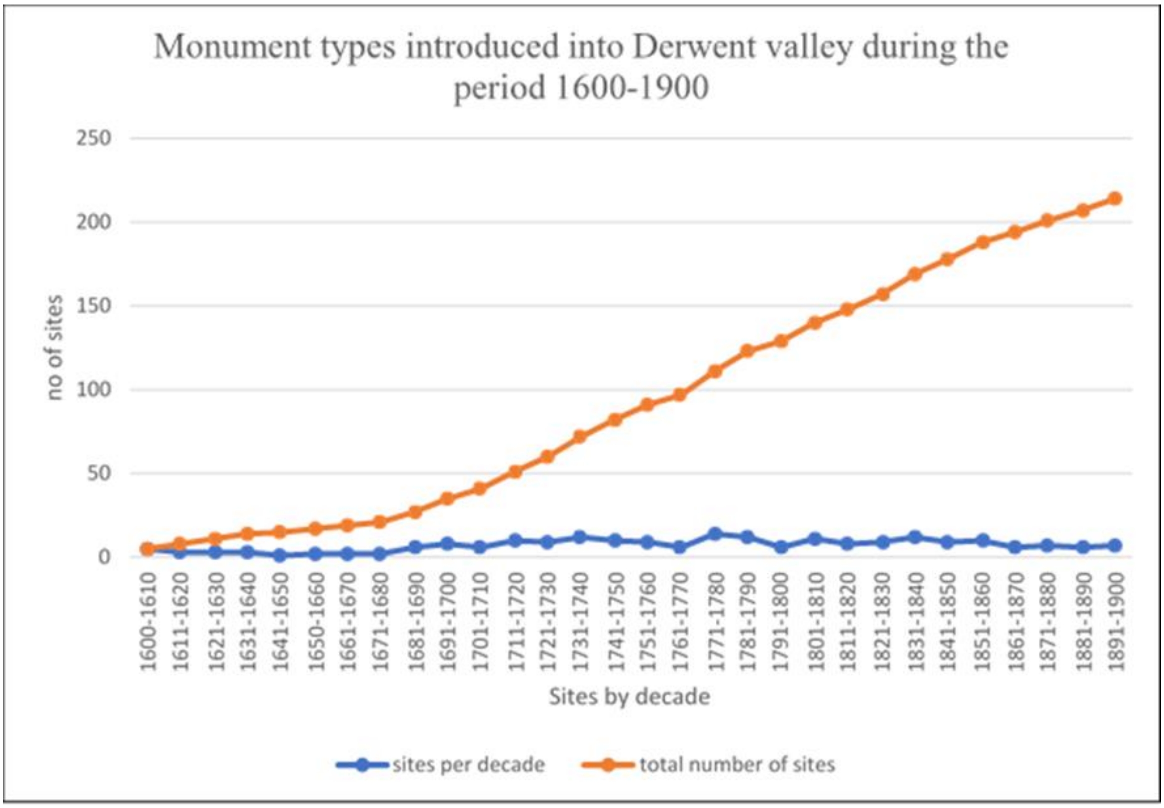


Figure 5.1 Monument types introduced into the Derwent valley 1600-1900.

The second largest classification of new sites for the 17th century is 'domestic' with *country house* and *manor house* both appearing in the first two decades. Some domestic sites, *bastle* and *longhouse*, are agricultural in nature and may be placed within the 'agriculture and subsistence' classification to suggest a strong agricultural element in the landscape. Both the Church of England and the Quakers are represented through a vicarage and a Friend's burial ground. The 'transport' classification includes a wagon way which is linked to the coal industry.

The 18th century contains 88 new monumental site types, making it the period in which the greatest number of new sites was recorded. Industrial site types relating to the iron industry continue to appear in some strength: a blacksmith's workshop, Derwentcote forge and the mill race for High Mill, which fed the Swalwell ironworks, represent 27% of the total industrial sites. The overall proportion of new types of industrial sites appearing over the century is down to 12.5%. A brewery is first recorded at this time, as are the first 'commercial' sites of inn, public house and shop. The largest single classification for the 18th century is 'gardens, parks and urban spaces' which largely represents the improvements at Gibside by Sir George Bowes and Axwell Hall by Sir Thomas Clavering. Though involved with the iron industry, it was money from Bowes' coal interests which funded the improvement of Gibside, similarly, Clavering's fortune was partially through his leasing out of his coal fields. Sites within the classifications of 'agriculture and subsistence', 'recreation', 'water supply and drainage' and 'monument' also belong to these two landscaping ventures.

Social developments in the 18th century are suggested by the emergence of a variety of places of worship within the 'religious, ritual and funereal' classification. A Friend's meeting house, Methodist chapel and Presbyterian chapel were established in the valley and a Church of England rectory was built. The 'transport' classification showed several kinds of bridge appearing in the landscape and the appearance of a toll road with some of its administrative infrastructure in evidence. These may indicate the need for a greater mobility within the valley. A first staithe is recorded at Derwenthaugh at this time, demonstrating a requirement for exporting local materials. The staithe may be considered to be primarily for industrial use. In the 'domestic' sphere, the first ice-house was recorded at Whickham. There are four times as many new agricultural site types recorded in the 18th century than the 17th, suggesting investment in this sector.

In the 19th century, most of the site-classifications which appeared in the 18th century contain fewer new sites. The number if industrial site types recorded, however, increases to 32% of the total sites. As there are 81 new site types recorded for the 19th century, it would appear that there has been an industrial renaissance in the valley. However, of the 26 recorded new industrial site types 65% have been identified by their appearance on the first edition OS map so they could have been built at any time before c1856 and are therefore not-necessarily 19th century.

While some industrial monument types, such as *brick fields*, *brickworks*, *coal-depot*, *fertilizer works*, *fireclay works* and *gas holder* are probably of 19th century origin, as suggested by the HER, others could be 18th century or earlier: *clay pit*, *clay mine*, *gravel pit*, *ironstone workings*, *quarry*, *sand pit*, *sawmill*, *tile works*, *water mill*, *water wheel and supply*, and *works*. The Consett Iron Company, while a huge concern, is omitted from the results as it contained updated versions of technologies which appeared in the 17th century. Its presence is felt through the 'transport' classification which contains several sites connected to the Derwent Valley Railway, built to take CIC products to its staithe on Derwenthaugh.

While the classification 'health and welfare' did appear with a ***spa*** in the 18th century, the 19th century saw entries of types of *hospitals* and *workhouse*. 'Recreational' sites became quite a large category in the 19th century; it included such egalitarian new site types as: *billiard hall*, *cricket ground* and *working men's club***.** This may be compared to the single 'recreational' site of the 18th century, an amphitheatre built on the Gibside estate, probably intended for a more select audience. More religious sects appear in the 'religious' classification evidenced by a *Non-conformist church,* a *Primitive Methodist chapel* and a *Wesleyan chapel*.

In the 19th century two new site classifications appear: 'education' and 'civil'. The education classification includes several types of *school* sites and an *observatory* at Whittonstall. The civil classification contains *town hall* and evidence of the changing face of law and order within the valley, with stocks being recorded to the 1820s and a *police station* appearing in 1877.

The results of the distribution of new monument types by social class are shown on the cumulative graph below (fig. 5.2). The entrepreneurial class are shown to have been active from the beginning of the period with early entrepreneurs engaging mainly in the coal trade, though Edward Talbot's lease for a forge and furnace at Gibside in 1608, from Sir William Blakiston, is represented. In the late 17th century the numbers of new monument types created by entrepreneurs show a short, steep, rise. This rise can be attributed to the presence of monument sites owned by the three principal actors of the iron industry for that period: the Hollow Sword Blade Company of London, Denis Hayford's Company in the North and Ambrose Crowley's works. Entrepreneurs developed agricultural sites, some domestic sites and coal, clay and brickmaking sites in the 18th and 19th centuries.

The gentry create monuments at their greatest rate from the early to mid-18th century. The two most notable estate owners of this period are the Bowes of Gibside and the Claverings of Axwell, both of whom embellished their estates, hence the many monuments within the 'gardens, parks and urban spaces' classification. The timing of the floriation of new gentry monument types may reflect a financial return on the leases granted to successful industrial concerns. The development of Gibside estate marks the dismantling of the Blakiston/Bowes ironworks suggesting that the iron industry was not the source for this conspicuous display of wealth.

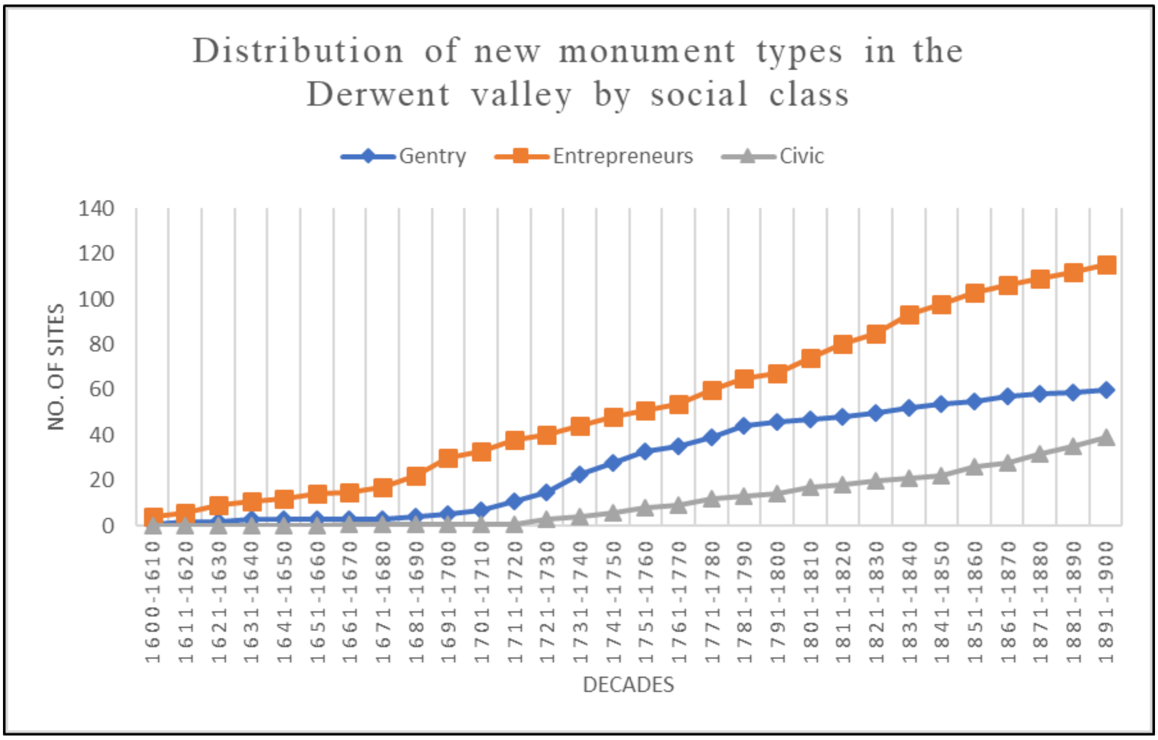


Figure 5.2 Distribution of new monument types in the Derwent valley by social class.

The temporal relationship between the relative increases in gentry, entrepreneurial and civic classes' creation of new monument types can be clearly seen in the following graph (fig. 5.3). Both fig. 5.1 and fig. 5.2 show an introduction and a development of the civic class of monument types from the 1720s onwards. The early civic monument types include examples of non-conformist religious establishments, various types of bridges and a toll road. Bridges and roads would benefit all social classes. By the end of the period many 'recreational' sites such as a cricket ground and billiard hall suggest an increase in free time for leisure activities. In the 1860s several new site types of site attributable to the Derwent Valley Railway appear. This railway, though created to carry finished goods from the Consett Iron Works to Tyneside, also carried fare-paying passengers.

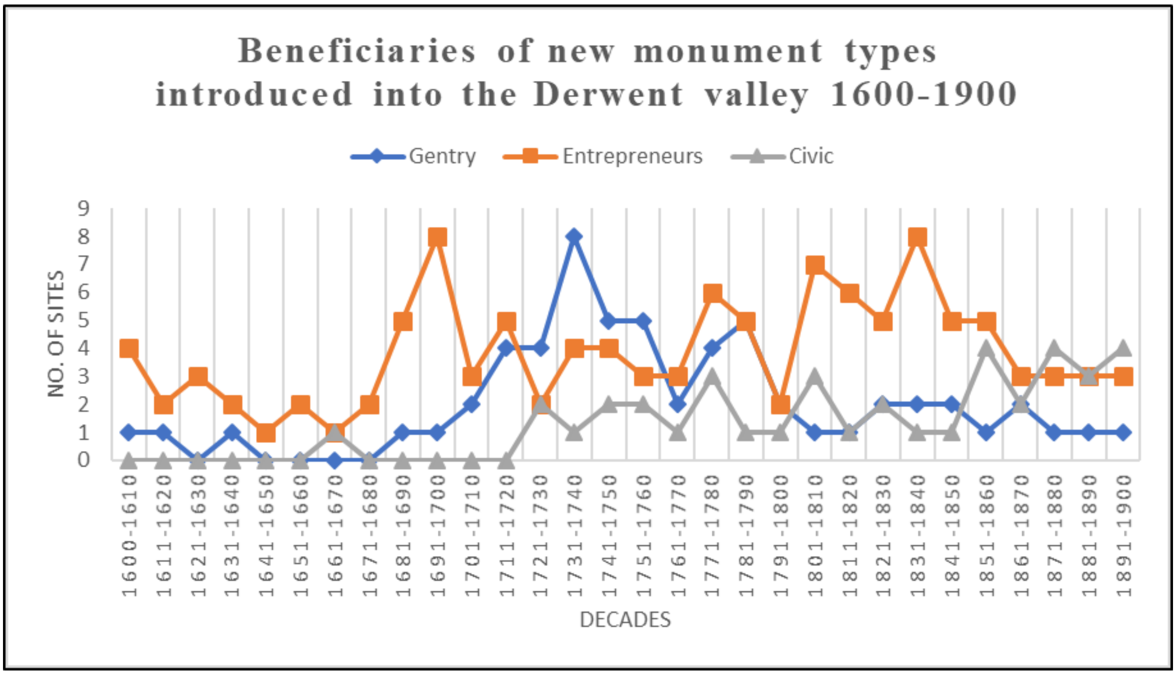


Figure 5.3 Beneficiaries of new monument types introduced into the Derwent valley 1600-1900.

5.2.2 *The Derwentside model of industrialisation*

Using the Manchester Methodology, it appears that in 1600 industrialisation was already underway in the Derwent Valley with leases being granted for coal workings and the creation of waggon-ways for the transport of the coal to the Tyne. Some coal extraction at this time was being carried out by the gentry: the Blakiston's built Gibside Hall with coal-money.

At the end of the 17th century the Derwent valley attracted several ironworking concerns which almost exclusively create the 'expansionary' phase of the Manchester Methodology. The expansionary phase lasts until 1760, or 1790, should the short dip in the graph line between the two dates be ignored. The expansion of the 18th century up to 1790 does include some iron working sites but expansion is not as rapid as the end of the 17th century and is maintained by many other types of new sites.

Following 1790, until 1880, the Derwent valley may be considered to have entered the 'consolidatory' phase, indicated by less rapid growth. Industrial growth is still present through the lead industry and new kinds of industrial sites, such as coke oven, oil distillery and fertilizer works.

It is a matter of conjecture whether the model of industrialisation in the Derwent valley reaches maturity. Following 1880 the cumulative graph line dips slightly then recovers suggesting that consolidation may have continued into the 20th century. However, the increase in new monument types for the last 20 years of the 19th century is dominated by those of the civic class. This may indicate that society as a whole was at last benefitting from industrialisation.

5.2.3 *Criticisms of the Manchester Methodology applied to the Derwent valley*

In assessing the Manchester Methodology as applied to the Derwent valley it would appear that the Industrial Revolution for this area really began with the arrival of the iron working concerns at the end of the 17th century. This appearance is partially due to the HER ascribing so many differing terms to the industry: *blast furnace*, *furnace*, *iron furnace*, *iron works*, *steelworks* and *sword factory*. The terms are apportioned in such a way that almost every iron working site created during the late 17th century is ascribed a presence in the Methodology when it is applied to the Derwent valley. Perversely, coal industry terms: *colliery* and *coal workings* and the more ambiguous *mine shaft* can only be used once each to represent a far larger industry. This means that the iron industry has a disproportionately large presence compared to the coal industry in the results.

The largest iron working site, Consett, which had a huge affect on the industrial landscape of the valley is absent from the results of the Methodology. This is because when it was created in the 1840s the Derwentside Iron Company used pre-existing technologies, such as ‘blast furnace’, or else the particular monument did not have a *Thesaurus* term ascribed to it, for example ‘rolling mill’. Should the *Thesaurus* or the Durham HER have distinguished between charcoal-fuelled blast furnace and coke-fuelled blast furnace, then Consett would have appeared within the results.

Within the HER evidence, weight has been placed on new sites as they appeared on first editions of the Ordnance Survey map, however the true date of the appearance of many of these sites, as discussed in 5.2.1, is unknown. This inflates the numbers of new sites which appear within the 19th century and perhaps artificially maintains the consolidatory phase of industrial development and delays a more obvious maturity. Should a study of other historical maps be carried out and entered into the HER, it may have the effect of moving the date of the appearance of many of these sites back to an earlier period. For example, the Tyne and Wear HER ascribes the *Thesaurus* term ‘sluice’ to the 19th century and appearing on the 1850 OS map, but sluices appear on the 1718 Crowley map of his works (Warner 1718).

The Manchester Methodology can only take account of sites which have been added to the HERs. The Damhead, or Lady's Steps, between Winlaton Mill and Swalwell is absent, as are the slag heaps at Ravenside. These omissions beg the question: what else is missing? Without knowing this, any effect they may have upon the results cannot be reasonably estimated.

5.2.4 *Expanding on the Manchester Methodology*

When all 986 monument records are taken into consideration, and all instances of each site type are given equal weight, it is apparent that the Derwent valley was a fairly heavily industrialised area with 301 entries, (30.5% of the total number of sites recorded by the HERs). The next largest category are the domestic sites with 138 (14%) entries, agriculture and subsistence with 132 (13.4%) entries and transport with 100 (10.1%) entries. Of the industrial sites only 27 (9%) are related to the iron industry, and a similar number to the lead industry with 25 sites. These industries are dwarfed by both the coal industry with 109 (36%) of the recorded industrial sites and the 63 (21%) quarrying venture sites. Some of the coal related sites recorded at Shotley Low Quarter may have been bell pits for iron extraction; the HER description has therefore been retained. The results for the appearance of all monuments in the Derwent valley is presented in the graph below (fig.5.4).

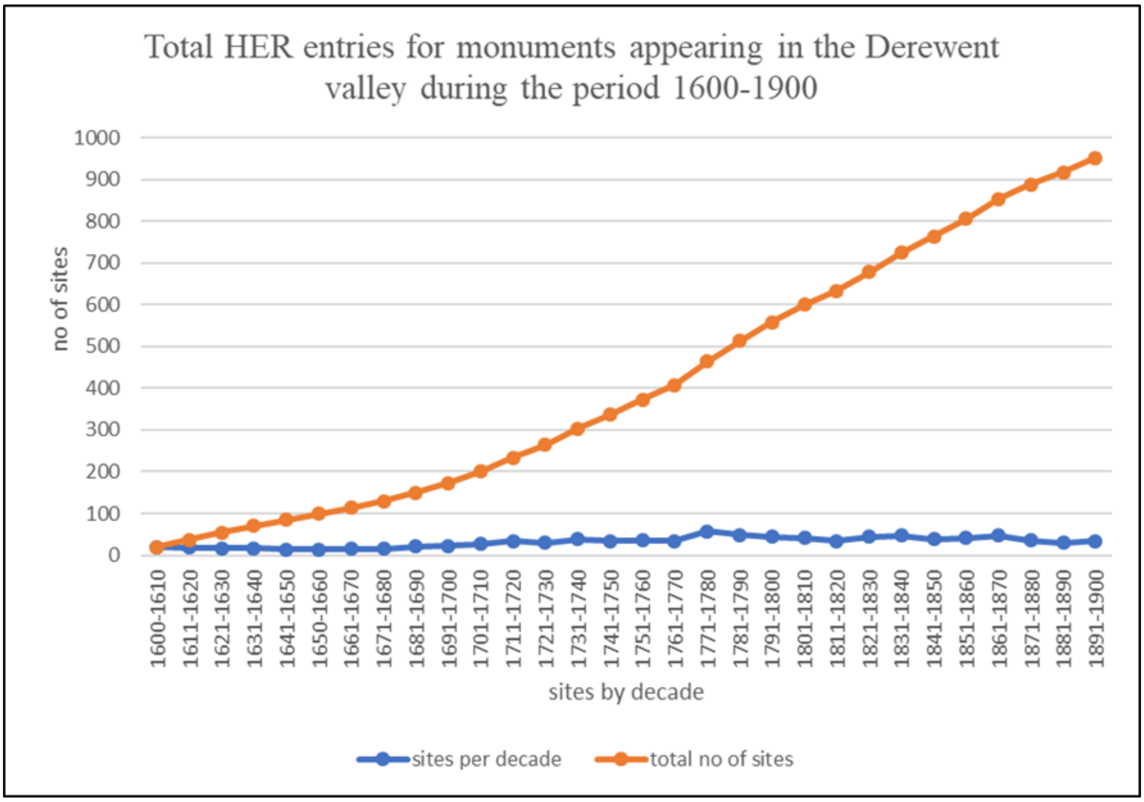


Figure 5.4 Total HER entries for monuments appearing in the Derwent valley 1600-1900.

These results broadly agree with those obtained by following the UMAU model of the Manchester Methodology. The expansionary phase again seems to emerge in the late 17th century, the consolidatory phase begins 1790-1800 and the maturity phase once more subjectively appears in the 1880s, or is absent indicating its appearance in the 20th century. The results created through the Manchester Methodology for ownership of sites by social class show that gentry were responsible for 28% of new sites, entrepreneurs 54% and the civic class 18%. The results derived through analysing the full range of HER entries are broadly similar with gentry creating 32% of sites, entrepreneurs 58% and the civic class 10%. The number of sites owned by gentry is proportionally higher in the full HER due to the large number of 'boundary stones' recorded by the Northumberland and Durham HERs which mark the limits to landholdings and are often spaced quite closely. The similarities between the two monument graphs and the analysis of ownership class suggest that for the Derwent valley the Methodology provides a reasonable model for total monument appearance and ownership.

A benefit of considering all HER entries is that the geographic locations of the monuments can be analysed by local authority boundaries or parishes. The Tyne and Wear archive covers the area from the mouth of the Derwent upstream to Blackhall Mill on the north bank and Gibside on the South under the title 'Gateshead'. The combined Northumberland and Durham HER breaks its monument locations down by parish which helps to analyse distribution of sites within the valley. From the mouth of the Derwent to Allensford, industrial sites outnumber agricultural sites whereas in the upper valley at Muggleswick, Edmundbyres and Blanchland the opposite holds true. This indicates that the Industrial Revolution was more active in the areas of the valley with easy access to the Tyne. In the upper valley, to the west of Allensford, there is still industry, with the dominant forms being in lead and lime production. It is important to note here that here is no evidence in the HERs of any iron production in the Muggleswick, Edmundbyres, Blanchland or Healy (which includes Espershields) areas during the industrial period, whereas by using the methods in chapters 3 and 4, these areas are shown to have been the cradle of iron production during the medieval period. It is therefore necessary to use the full range of data sources to fully understand the pattern and nature of industrial development.

5.3 Process recording within the Derwent valley

The documentary sources indicate that 29 separate iron-based industrial processes have taken place within the valley from medieval times to 1915. Four processes deal with the extraction of iron from the earth: bell pit extraction, drift mining, quarrying and deep mining. The remaining 25 processes are concerned with the preparation of iron ore, smelting techniques, wrought iron and steel production and the manufacture of various kinds of iron objects. Extraction processes must have been carried out on a fairly small scale during the pre-industrial age, for supplying bloomery smelters. Similarly, there will have been only modest extraction during the Industrial Revolution. Documentary evidence suggests that both pig iron and bar iron were readily importable through the Baltic trade with Sweden and Russia, supplemented by American and English iron through maritime links into the Tyne and then the Derwent. It is unclear how often the periods of use, or campaigns, of the charcoal blast furnaces at Gibside, Derwentcote and Allensford took place. None appear to have been in use after the first third of the 18^{th} century. The processes have been presented by grouping them in the three broad periods of iron working adopted throughout this thesis.

5.3.1 *Iron processes of the pre-industrial period 1299-1687*

Iron processing of the pre-industrial era (fig. 5.5) looks at early methods of ore extraction, preparation and smelting. Until the 17^{th} century, smelting was carried out by the bloomery process, from then the local gentry who smelted their iron built blast furnaces. The resulting iron types required forging before they could be of practical use, except when cast iron mouldings were required which could be made directly from the blast furnace.

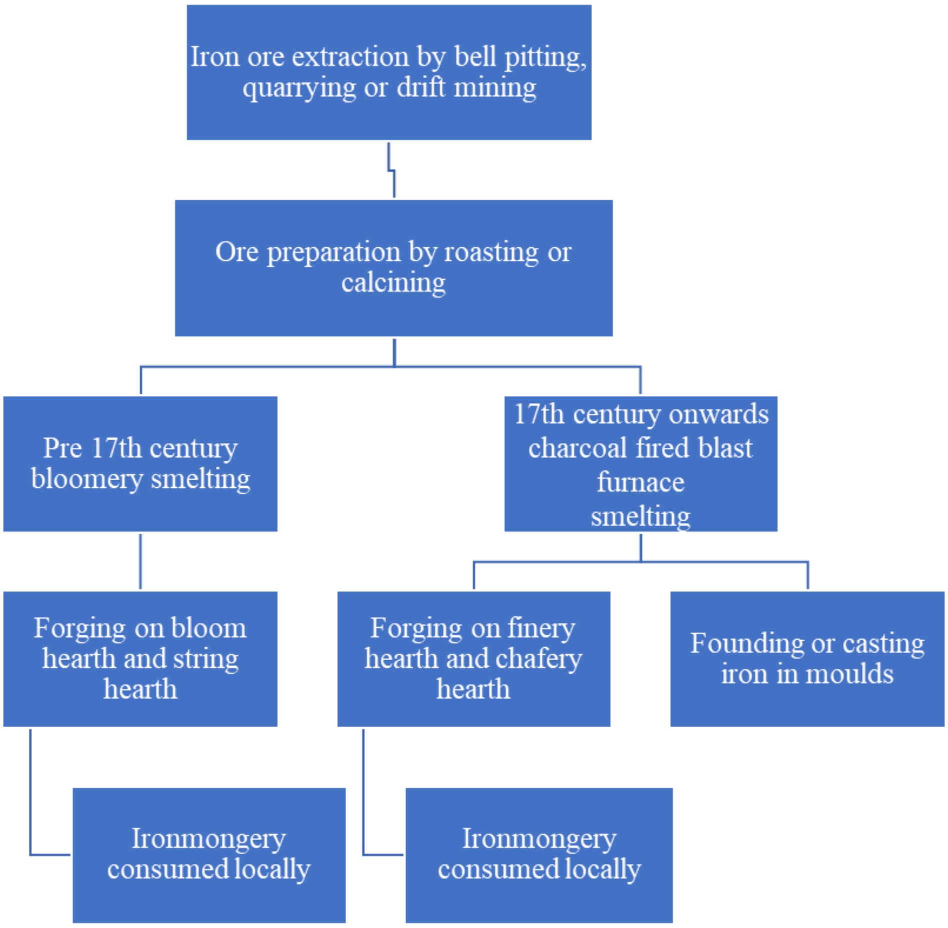


Figure 5.5 Iron processing in the pre-industrial period.

Ore extraction methods for this early period were bell pitting, quarrying and drift mining. Bell pits existed at Whittonstall, documented during their destruction during opencast mining in the 1970s. Recent archaeological prospection in the area has indicated the possible existence of more shafts (fig. 5.6). Earthworks adjacent to the slag heaps on Nookton Fell may indicate the presence of bell pits. Naming evidence suggests the presence of delve pits at Delves Lane, Consett. At Gibside, earthworks in the West Wood may be the remains of bell pits.

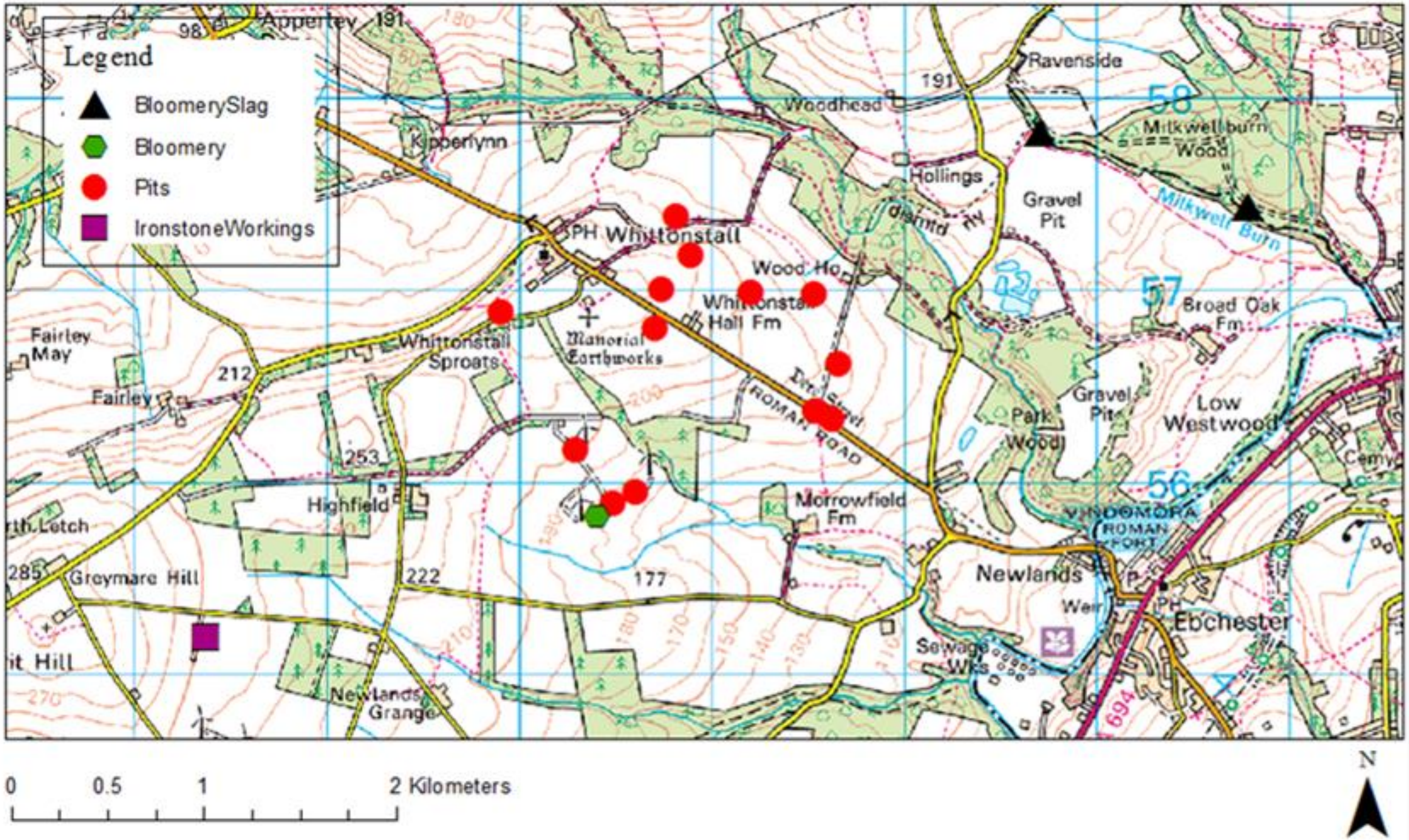


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Figure 5.6 Spread of bell pits across Whittonstall and Shotley Low Quarter.

Bell pits (fig. 5.7) were used to reach mineral deposits within dipping seams beyond those which naturally outcropped in the landscape. They were a vertical alternative to drift mining. A bell pit would seldom be driven down to a seam deeper than 10.0m from the surface. From the vertical shaft a bell-shaped chamber would be dug out into the surrounding mineral. The size of the chamber depended on the condition of the surrounding geology and they were seldom more than 4.0–5.0m in diameter. The use of bell pits endured until the exhaustion of shallow seams. Bell pits were still being used at Tankersley Park, Yorkshire for coal and iron extraction in the second half of the 18th century (Crossley 1990: 204).

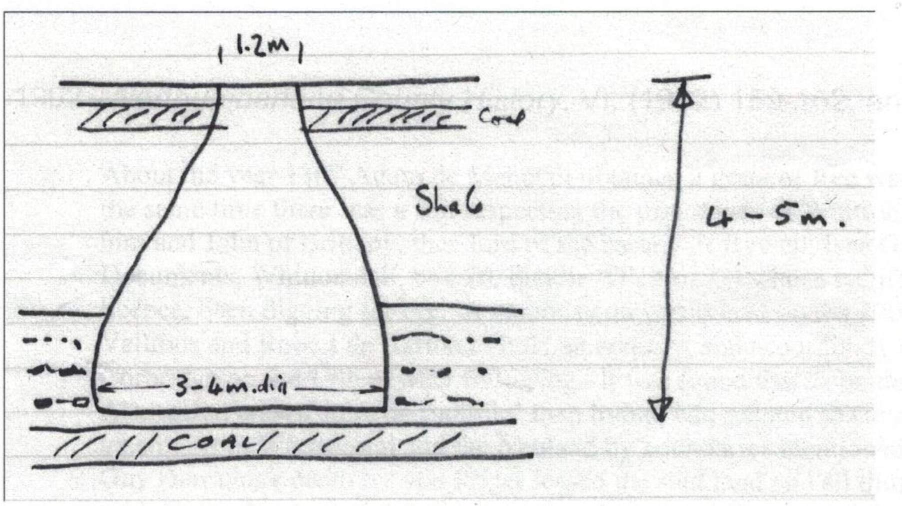


Figure 5.7 Sketch of Whittonstall bell pit. Made on a visit to the open cast mining operations.

(Anon. 1971: 4)

The one ironstone quarry in the Derwent valley was marked on old OS maps as ‘iron stone workings’ at Greymare Hill in Shotley Low Quarter. The quarry may be of some antiquity as there is no record of it being worked during the 19th century revival of local ore exploitation. In quarrying the ore is either out cropping or immediately sub-surface allowing an open excavation of the material.

Drift mining for ironstone has been conjectured at Gibside and at Allensford at the transition into the Industrial Revolution. A drift mine follows a horizontal or sub-horizontal mineral seam from its surface outcrop into a hillside. Drift mine entrances are known as adits. The adits visible both at Allensford and Gibside are remarkably similar in terms of size and geology. Following the opening of the deep ironstone mine shafts at Consett in the 1840s it was discovered that the iron seams could be accessed by drift mining to the east of the town.

Once extracted, iron ore must undergo calcining or roasting. Calcining is the process by which moisture, organic and chemical impurities are driven out of iron ore prior to smelting by heating. This reduces the sulphur content in the ore, as it combines with oxygen and is released as sulphur dioxide gas. The calcining process also causes the formation of micro-cracks within the material matrix which assists with the penetration of reducing agents into the ore during smelting (McDonnell 1985). In the simplest form, often associated with the bloomery process, calcining involves placing the ore onto an open-air wood fuelled hearth and stirring the ore with a rake like tool called a 'rabble'.

At Allensford there are the remains of a stone-built calciner, or roasting oven, immediately to the north of the blast furnace, positioned so that the calcined material can be dropped straight down into the furnace stack. Across the Derwent, in West Wood, is a spread of stones across the back of the flood plain which may be interpreted as the remains of more roasting ovens. These may have been of the open topped cone type. An arch of course lumps of iron ore would be created over the hearth which would support a charge of more finely crushed ore. A wood fire would be lit beneath the ore arch through which heat and oxygen would pass to react with the finer material. A good operator of such a roasting oven was said to be able to produce a high quality oxidised ore for smelting (Overman 1854: 42-43).

Bloomery smelting sites within the valley are known through the documentary record at Muggleswick Park and Gibside and through archaeological evidence at Whittonstall and on Nookton Fell. The bloomery process is also known as the direct method of producing a workable iron product. Iron oxide ore was heated in a bloomery furnace using charcoal as a fuel until the ore reached such a temperature that the carbon in the charcoal combined with the oxygen in the ore and drove it out, or 'reduced' it. This would leave a globular mass or bloom of iron mixed with impurities, or slag, within the furnace. When the iron master judged the bloom to be ready the furnace was broken into and the bloom pulled out and hammered on a flat stone to break off as much of the slag as possible. If the bloom was left in the furnace too long the oxygen within the ore would still be removed but excess carbon would combine with the iron producing a brittle, useless material.

The bloomery furnace was an enclosed space in which the process could take place. The simplest bloomer furnace was the 'bowl' furnace, in use since the dawn of the Iron-Age. These could be scrapes or dips in the ground lined with clay or other fire-resistant material which would also be used to make a dome shaped enclosure over the bowl. The furnace had a hole left in the top through which the charcoal fuel and the iron ore would be dropped and the carbon monoxide gas produced in the reduction process could escape. There would also be an aperture at the base of the dome on an accessible side, referred to as the forepart, through which the tuyere, a pipe of wood or clay, ran from hand or foot pumped bellows to the centre of the furnace floor or hearth. This aperture would be closed up with clay or ashes. When a firing was over the aperture would be unblocked and the bloom pulled out. A variation on the form was of a short chimney built up from ground level out of a fire-resistant stone lined with clay.

The next stage of the iron production process was to improve the quality and shape the bloom. This could be done on the hearth of the bloomery furnace. The bloom was reheated on the hearth and hammered on an anvil to drive more slag from the iron matrix and to weld together the iron within the bloom. After several heating and hammerings, when the iron master judged the quality of the iron to be suitable, the iron was shaped either into some finished product or a transportable form for selling or passing on to other forges. The workable product was referred to as wrought iron. The rate of production through the direct method was a few pounds of iron for several hours firing after which the furnace would have to be cleaned out and repaired before refiring (Gale 1969: 13).

Later bloomeries such as the early fifteenth century one at Bedburn in Weardale could use water powered for the bellows for the hearth if not a tilt hammer (Sellers 1907: 279). The bloomery sites at Muggleswick Park and Gibside may have been of this later type. A millpond and race, possibly reinterpreted as a wheel pit, remain at the conjectured forge site at Gibside. These bloomeries may have had two hearths: a bloomhearth for the smelting process and a stringhearth for forging the bloom.

The charcoal fired blast furnace (fig. 5.8) was the technology which superseded the bloomery for the smelting process. Within the valley they are known through the documentary record at Gibside and through archaeological evidence at Allensford and Derwentcote. Blast furnace technology was introduced into Britain around the year 1500 into the Sussex Weald and was adopted by some areas outside the Weald some sixty years later, becoming more common from the 1580s, though bloomeries persisted into the eighteenth century (Crossley 1990: 156, 162). Remains of a blast furnace attributed to the 16th century are visible at Wheelbirks to the north-west of Whittonstall (Hodgson 1902: 161-2; Northumberland HER no. N9797), though the recorded furnaces of the Derwent valley are all of the 17th century.

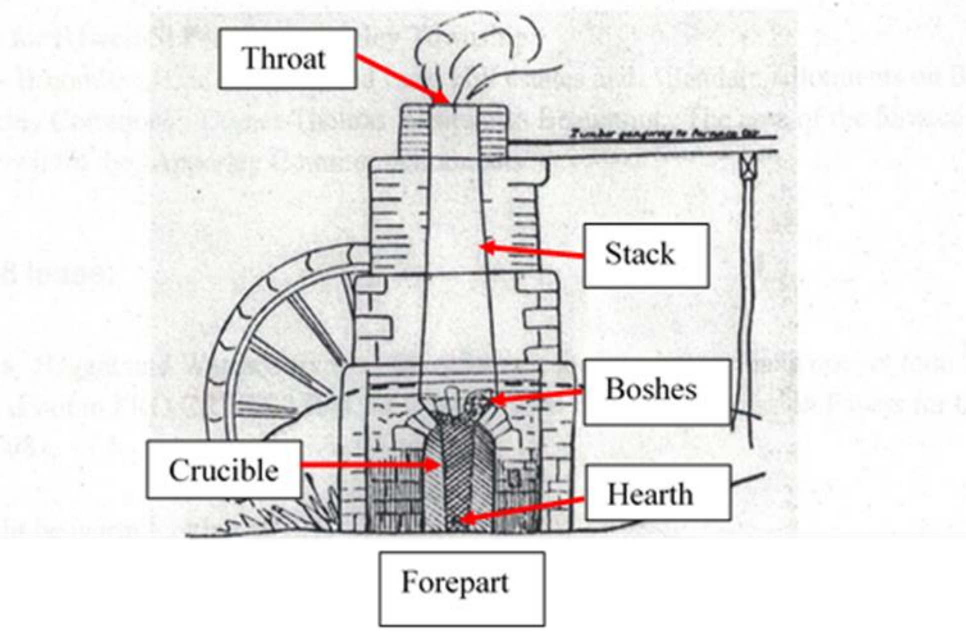


Figure 5.8 Elements of a charcoal fired blast furnace.
(after Richardson 1904-7: Northumberland HER N9797)

Blast furnaces of the 16th and 17th centuries were masonry structures standing to a height of some 6.0m. At the base of the furnace there would be two arches one at the forepart for tapping the molten iron and another to carry the tuyere to the hearth. Later blast furnaces would have more arches to carry more tuyeres. Above the taphole in the forepart was another small hole called the slag notch which was used to remove accumulations of slag at intervals from the surface of the molten iron.

A blast furnace produced wrought iron by the indirect method. Here, due to a continuous blast of air produced by water powered bellows higher temperatures were achieved within the furnace than in a bloomery. The production of iron from a blast furnace is known as a campaign. A campaign began with the lighting of the charcoal fire on the hearth through the taphole and the introduction of the blast. The taphole would be sealed up with a clay plug and the fire built up gradually over some days to avoid damaging the furnace, with more charcoal being poured in through the throat. This part of the process was known as 'blowing in'.

Eventually a little iron ore was added to the charcoal with the amount increasing over time until the ironmaster judged the ratio of ore to charcoal to be correct then additions of both would continue in those proportions and the furnace was 'producing normally'. Should the iron ore not naturally contain a proportion of lime to bind with other impurities present to form slag then a limestone or dolomite flux will have to be added through the throat. As the temperature rose the iron melted out of the ore and trickled down through the charcoal to collect in the crucible. The slag, also in a molten or semi-molten state. descended through the charcoal and floated on the heavier iron. Every twelve hours or so enough molten iron had settled in the crucible to warrant it being removed. The clay plug was then broken out of the forepart and the molten iron ran out into a mould scraped into a bed of sand which initially was formed as a central channel with short terminated channels leading off it at right angles. From above the mould resembled a sow suckling piglets which gave the cast iron bloom the common name of pig iron. Once the molten iron had run out the taphole would be stopped up with clay again and the collection process recommenced. The smelting process was continuous requiring a shift system for the iron workers. The campaign could theoretically last years (later period blast furnaces could campaign for thirty years (Gale1969: 16)) but in practice the period of firing was limited by the volume of ore collected, the reliability of the water supply in the summer months and the expenditure of the stock of charcoal collected for the firing. An interruption for any of these reasons would necessitate the furnace shutting down and the lining cracking as it cooled down which would require repair before the next campaign could start. A blast furnace, when producing normally, was capable of producing 1,200kg per day in 1500 and 2,000kg in 1700 (Mokyr 1990: 62).

Iron from both bloomery and blast furnaces had to be processed in a forge to create a usable product. From bloomeries smelted iron would have to be forged, or worked under a hammer, in order to drive slag and other impurities out of the iron bloom. Bloomery forges are recorded at Muggleswick Park and Gibside. Blast furnaces produced brittle cast iron which needed to be converted into malleable wrought iron. This was done in a finery forge where an open charcoal-fired hearth with a water-powered air blast re-heated the bloom. Once hot, a secondary air blast was played on the metal where the oxygen combined with the carbon in the iron and forced it out of the material as carbon monoxide (Gale 1969:19). The resulting product, a ‘loop’, was shaped under a water-powered tilt-hammer into a rough bar shape called a ‘half-bloom’ or ‘ancony’. The anconys were originally finished into wrought iron bars in the finery but this caused a bottle-neck in the production process resulting in the introduction of a second furnace, the chafery, in which anconys were shaped into merchantable wrought iron bars called ‘bar iron’. The arrangement of blast furnace, finery and chafery became a common combination for ironworks by 1600. Blast furnaces could produce more cast or pig iron than one forge could comfortably convert into wrought iron bar. The blast furnaces at Gibside and Allensford had their own forges whereas a forge for the blast furnace at Derwentcote is less certain.

Tilt hammers may have been used at the later bloomeries at Muggleswick and Gibside. They were certainly present at the Hammermill in Shotley Low Quarter, Blackhall Mill, Derwentcote, Winlaton Mill and Swalwell. Tilt hammers became widely used in Britain during the 16th century, mirroring the development of the blast furnace. They consisted of an iron hammer head, typically of 50kg (Gale 1969: 20), mounted on a wooded shaft or helve which was pivoted near the centre. The head was positioned over an anvil and the wooden tail bound in iron bands. The tail was struck by cams mounted on a shaft driven by a water-wheel causing the head to lift and drop under gravity to the anvil. Extra power could be added to the down stroke of the hammer if the helve was sprung. One method was to mount a wooden 'spring beam' above and parallel to the helve below the maximum upstroke height of the hammer head. When the cams lifted the head it would strike the beam on the upstroke and bend the beam upwards. When the cam released the helve the energy of the spring would be added to gravity on the down stroke. Alternatively, a recoil block was set into the forge floor at the tail end of the helve. As the cams forced the tail end down the helve bent over the recoil block, providing the spring for the down stroke of the hammer.

The brittle iron straight from a blast furnace was suitable for directly moulding or casting iron items, usually cast with a mixture of pig iron alloyed with scrap iron. In Britain the earliest cast iron objects were cannons and cannon balls manufactured in 1543 (Gale 1969: 115). The earliest casting would have been into moulds formed into the course sand before the forepart of a blast furnace. An impression of the item to be cast was pressed into the sand bed with a wooden model. Molten iron from the tap hole either poured directly into the mould or was ladled in some manner.

5.3.2 *Iron and Steel processes of the Industrial Revolution 1687-1840*

Though Denis Hayford smelted iron at Allensford at the beginning of the period, the bulk of the iron entering the valley from the beginning of the 18th century was imported from outside the area, both from home and abroad. The first new process established in the valley at the end of the 17th century was sword manufacture on an industrial scale, however, the first new technology was the steel cementation process, introduced to supply the sword factories. Ambrose Crowley instigated many new processes within his manufactories (see fig. 5.9).

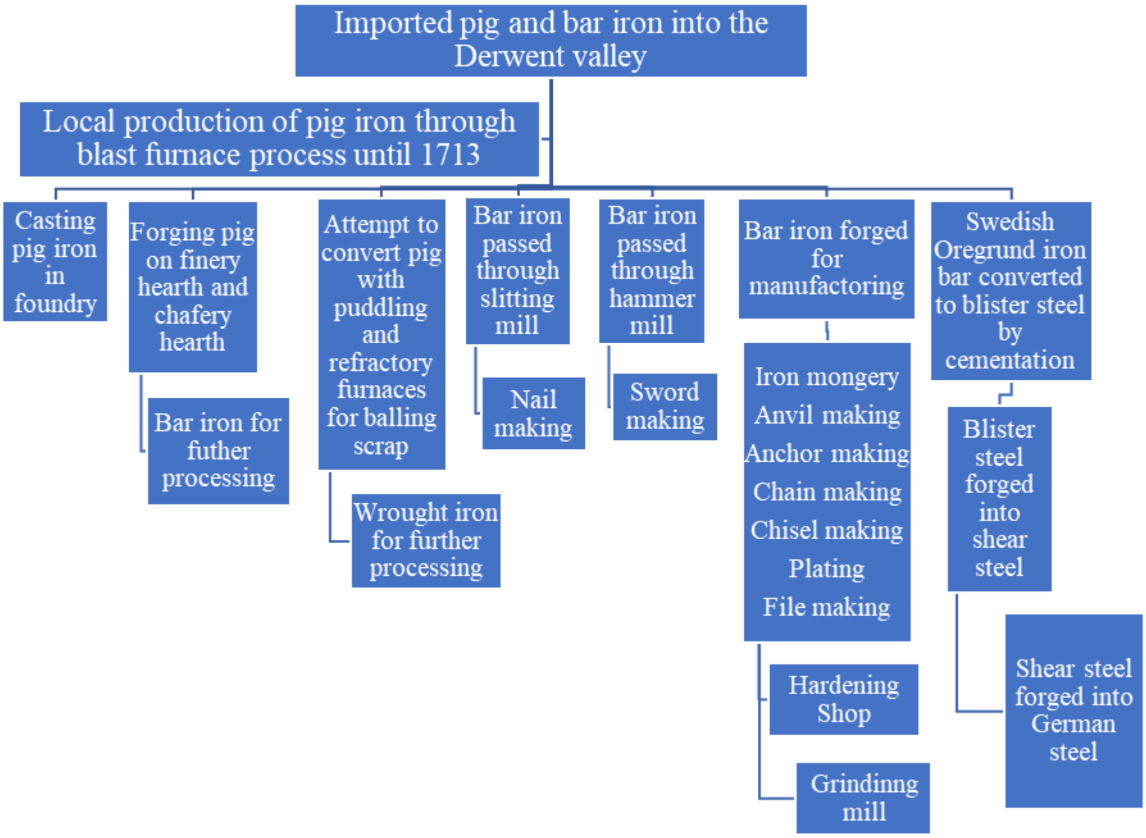


Figure 5.9 Iron processing during the Industrial Revolution.

Sword making took place at Shotley Bridge, Shotley Grove and possibly Lintzford. The process for mass producing swords was described by Angerstein during his visit to the Derwent valley in 1754 (2001 [1765]: 270-1). The swords that he witnessed being made were described as being the 'three-cornered kind'. Anvils were cut to form dies. Into this die a heated sword blank would be hammered to form a partially shaped blade and then, with the blank still in the die, stamps would be hammered into the exposed part of the iron to complete the shape. Angerstein discussed in detail the grinding of the swords; this was done on shaped grinding wheels with three ridges and two grooves (see 4.3.1). The swords were ground into shape without water touching the stone. The steel to provide the cutting edge for the swords is only mentioned in terms of the small amount supplied from nearby Blackhall Mill. This steel would be hot welded along the cutting edges of the iron swords prior to the grinding process; the addition of steel to an edge in this manner is known as 'steeling'. Angerstein does note that some of the sword blades were decorated with the etching solution being sulphuric acid and Spanish Green. What is not made clear is whether all swords were steeled and there is no mention of the Flying Fox stamp into the blade or the blades being cutled, having their grips added, at Shotley Bridge. The sword blanks may well have been made from bar iron at the

Hammer Mill at Shotley Low Quarter with the sword mills harnessing water-power from the Derwent for the grinding process.

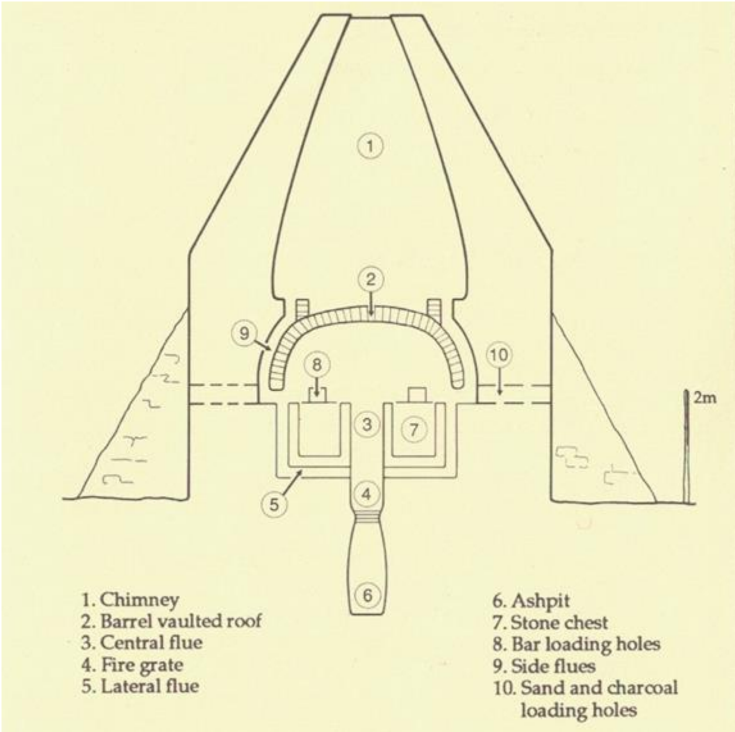


Figure 5.10 Elements of a cementation furnace.
(English Heritage n.d.)

Steel cementation furnaces were introduced into England in the Forest of Dean in 1614 and had reached Yorkshire by 1650. The process appeared in the valley at Blackhall Mill in 1687 followed by Winlaton Mill, Swalwell and Derwentcote, allowing a product of a constant quality to be produced in quantity. The process began with production of the purest bar iron possible. It required either the thorough forging of domestic pig iron until the carbon content was judged to be as near absent as possible or the importation of higher quality Oregrund bar iron from Sweden and Russia, which was certainly used throughout the Derwent valley. The bar iron was packed into large sandstone chests built into an elevated chamber in the structure of the furnace (Fig, 5.10). Archaeological evidence suggests that Derwentcote and Blackhall Mill were of stone construction lined with firebrick. A report by the Swedish industrial spy, B. Q. Andersson, in the 1760s confirms that this was the case and that Stourbridge bricks were used in the lining. Another spy, Gabriel Jars, provided evidence that Crowley’s furnaces were built entirely of brick (in Barraclough 1976: 74-6).

The chests were lined with charcoal powder and more powder would be packed around the bars so that the iron bars were separated from each other and surrounded by charcoal. Once filled nearly to the top, the final few centimetres of the chests would be capped with sand. As the gases let off from the fire below did not come into contact with the iron and carbon within the chest it was possible to use cheap coal as a fuel. Teasing houses protected the stokers, fuel and the fire from the elements. The firing of the furnace would take some six or seven days during which oxygen would be reduced around the outer surfaces of the bar iron and replaced with carbon from the charcoal. Once a steel master judged that the iron had been converted firing ceased and the furnace was allowed to cool for 10 to 12 days or longer in the summer months. A cycle of steel conversion would take between three and four weeks. Once the steel had cooled the bars were unloaded from the sandstone chests.

The product from the cementation furnace was known as blister steel because of the pocked appearance of the exterior of the bars. The bars were bound in small parcels called faggots and heated and hammered in a forge, normally water powered, in order to diffuse the steel throughout the faggot and produce a material of regular quality. This steel was often used for edging iron tools, giving a durable cutting surface and was referred to as ‘shear steel’. ‘German steel’ was superior to shear steel and used a secret Swedish process brought to Britain by Wilhelm Bertram. Bertram first produced German steel in the 17thcentury at Blackhall Mill and the process remained exclusive to the Derwent valley for almost a century. By Angerstein’s visit in 1754 (2001 [1765]: 272) it seems certain that an apprentice of Bertram’s had been making small quantities of German steel at Derwentcote for some time. Angerstein mentions that some of Bertram’s smiths had ‘run away’ to Crowley’s works, carrying the secret with them. Angerstein’s observations suggest that Crowley did produce German steel, but outside the Derwent area. The secret of German steel was to reforge shear steel. In general, the more forgings blister steel was put through the higher its quality became.

Ambrose Crowley III introduced nail making on an industrial scale to the Derwent valley in 1690 at Winlaton. Further workshops were later opened at his Swalwell works and a colony of out-workers became established at Lintz Green. The production process is described by Flinn (1962: 192-3): each nail making workshop would be operated by one nail maker, usually with a hammerman and sometimes an apprentice. Each workshop had a hearth in which the nail rods would be heated. The hot end of the rod was roughly beaten to a point on an anvil and then the nail was cut from the rod by placing the newly pointed end at the required length onto a chisel and giving the rod a blow with the smith’s hammer to create a weak spot in the nail rod. The point of the rod would then be inserted into a hole or 'bore', presumably through the anvil, which was narrower than a nail rod, so that it jammed and could be twisted off at the weak spot. The short length of nail rod which remained proud of the bore was then hammered flat to form the nail head. The nail was removed from the bore and the shortened nail rod returned to the hearth in order to repeat the process, until the rod became too short to be practically worked.

Nail makers needed iron nail rods of 12mm thickness or less. It was difficult to produce bar iron less than 18mm square under the tilt hammer so slitting mills were set up at Winlaton Mill and Swalwell, the former site to supply Winlaton and Lintz Green. The slitting mill was the first piece of machinery since the tilt hammer to be introduced to the iron industry and may have been introduced to the south of England in 1588, only reaching the Midlands by 1624 (Gale 1969:21). A typical slitting mill consisted of two horizontal iron shafts mounted one above the other in an iron frame. The distance between the shafts was governed by screws. Numerous rotary cutting discs were fixed on the shafts so that their cutting edges met at the appropriate distance desired for a particular size of nail rod. Gearing between the shafts insured that they simultaneously turned in opposite directions. A heated strip of iron was pushed up against the counter-turning cutters and drawn through the mill where it would be slit between the blades. The strip of iron was created by a secondary feature of the slitting mill: rollers mounted on the same powered shafts. A piece of heated bar iron would be passed through the rollers and squeezed thinner by each pass as the shafts were screwed towards each other until it reached the required thickness. Bands of iron could also be produced on slitting mills such as those used to bind barrels.

In addition to nails, (mainly) the Crowley works produced a wide range of iron ware through the forging of wrought iron in unpowered workshops (fig. 5.11). The ironware produced at Winlaton, Winlaton Mill and Swalwell was recorded at different times as edged-ware: hoes for export to the Americas, axes, machetes, hatchets chisels, sawblades, harpoons and whaling equipment. These would probably undergo the hardening process once forged. Smith-ware encompassed: bed screws and rods, iron bolts and screwbars, screws, forks, scrapers, balances and lifting jacks, fire irons, tongs, braziers, bellows, hammers and blacksmith's tools, carpenter's tools, builder's trowels, augers, box and flat irons, locks, pattern-rings, hinges, fittings for sugar-mills, curtain rods, staples and hollow-ware: pots, pans, ladles, shovels and spades. The only other ironware known to have been produced in the Derwent valley were the scythes manufactured at Shotley Bridge to supplement the sword making and some few items, sock moulds, shovels and boiler plates at Blackhall Mill (Bailey 1810: 288).

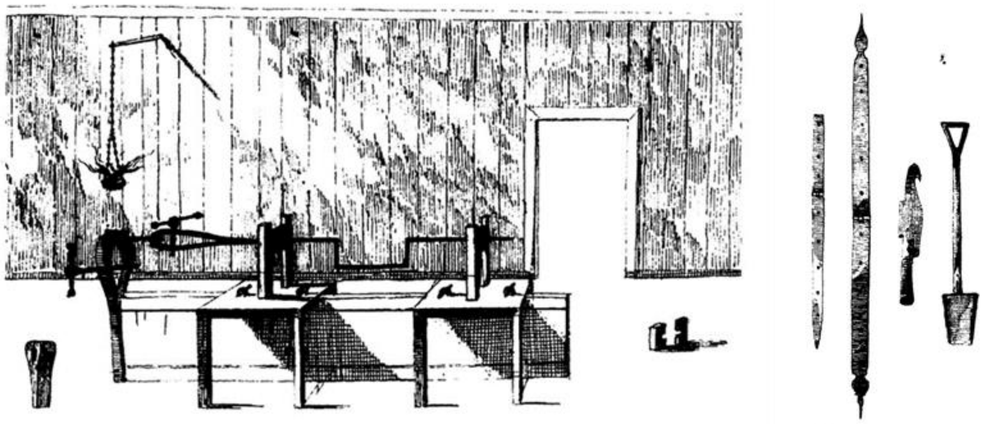


Figure 5.11 Interior of a Crowley workshop. With drawings of hinges, billhook and shovel.

(Angerstein 2001 [1765] 262, 264)

Chain making was process which did not require powered machinery. It took place at Winlaton from the 18th century into the latter half of the 20th century, and at Swalwell in the 19th century. The labour required to forge a chain depended on the size of its links; a small chain could be made by a single smith but larger pieces might require one or two strikers to hammer the links. A piece of wrought iron rod or bar was heated on a hearth and cut off to the required length of the link. It was reheated and bent over an anvil into a 'U' shape and the ends flattened out or 'scarfed'. The 'U' would be threaded through the previous completed link and the scarfed ends hammed around until they overlapped each other. The new link would be placed back on the hearth until it had been brought to welding heat (1300°C), then withdrawn and placed on the anvil for the scarfs to be hammer-welded together. Large links may have had to have been welded through two heatings.

Anvil making took place at Winlaton Mill. The process would have been carried out using the built-up method. Blocks or billets of wrought iron were heated on a hearth to a temperature at which the blocks could be shaped and forge welded together; each joint would require grinding off in a powered grinding mill. Creating anvils through this method was manpower intensive (Dempsey 2015). At Swalwell cast anvils were produced in a foundry.

Files were produced at Winlaton Mill. A wrought iron bar was forged into shape and then the teeth cut into the surface with a chisel or a swaging tool. The iron could then be hardened by quenching and tempering, but there is documentary evidence that Winlaton Mill contained a specific ‘small (work)shop where files are hardened’ (Warner 1718: 5), suggesting that the files were hardened as per below, in a separate building to the file cutting forge. The chisels for producing the teeth on files produced at Winlaton Mill for the iron works’ own account. It may also be assumed that the hot chisels required for the nailers and other workshops were also produced here for distribution across the iron works. Specific chisel rods were noted as being stored at Winlaton Mill (*ibid.*) and may have been of steel.

Low-carbon wrought iron was hardened in hardening shops found at Winlaton Mill and Swalwell’s High Mill. In a similar process to cementation, iron objects were packed into a sealed box with various carburizing agents and heated to below the melting temperature of the iron, allowing carbon to migrate to the surface of the metal, creating a hardened case. Such objects were referred to as case hardened. The cutting-edged implements produced by Crowley’s shops were case hardened to allow them to be resharpened.

Plating was the process by which wrought iron was forged into flat plate suitable for hollow-ware such as pans, frying pans, shovels and spades. Forging plate, rather than moulding cast iron in a foundry, creates articles which are stronger because forging refines defects within wrought iron billets and produces a reliable object which is more resilient to heat exposure (FIA 2016). Plating was carried out at Winlaton Mill and Swalwell’s High Mill.

Many of the items produced in the manufactories required grinding which was done in water-powered grinding or blade mills. Roughly shaped tools, such as anvils, were finished off, and cutting tools which had been steeled along their work edges had the welded joint ‘ground off’, a process of grinding down the weld so that the interface between the iron and steel becomes seamless; the steeled edge can then be ground sharp. Grinding was the final process carried out on the sword blades of the Shotley Bridge area. Powered shafts either had a number of grindstones set along their length, or a number of flat-wheels which would drive individual stones set in vertical frames. The grindstones were spaced to allow workmen sufficient room to draw long items such as scythe blades perpendicularly across the rotating stone. Angerstein (2001 [1765]: 261) observed both the Winlaton Mill and the Swalwell grinding mills had six grindstones.

The largest pieces of iron ware produced in the valley during this period were the ships’ anchors and grapnels at Crowley’s Swalwell works. Flinn (1962: 190-1) provides a description of an anchor shop: Anchors were forged by teams of six to eight workmen. Anchors could not be cast as a single object because they would be brittle and snap when in use. Within an anchor shop there was a hearth, a crane, or cranes, to lift the anchor in and out of the fire, scissors for cutting bar iron, copper rollers for rolling the bar iron into hoops and a beating hammer, which would be powered in the larger anchor shops. The anchors were created by forging the hoops together. The bar iron could include broken bars which could not be used for other purposes and the ends of bars and nail rods left over from other processes. As such, anchor forging used up waste material produced throughout the ironworks. In the mid-18th century some 250 tons of bar iron was used in anchor manufacture at Swalwell, it is not clear whether this figure included the recycled material, however, in accordance with Admiralty preference, bars of Spanish iron were specifically included. In the 18th century it was believed that large anchors needed cool atmospheric conditions to be forged satisfactorily. It appears, therefore, that for much of the year, except for the depths of winter, an anchor smith's working day would begin at midnight. During the 19th century the start time was moved to 3.00am for the convenience of an Admiralty inspector. At Swalwell the anchor palms, the spade like ends to the arms of an anchor, were produced and or affixed to the anchors in their own workshop to the east of the complex.

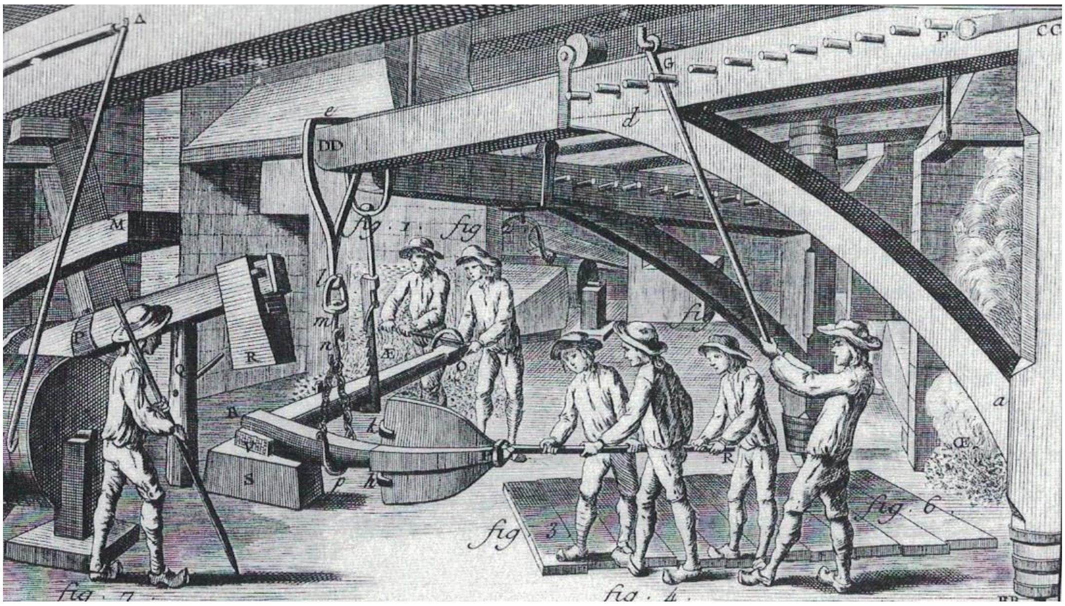


Figure 5.12 Eighteenth century anchor shop. (Lambert 2000: 22)

Along with forging and cementation, Crowley also had a foundry at Swalwell to produce cast iron items. The general process of casting iron within a foundry was to melt a mixture of pig iron, scrap iron, carbon and limestone in a charcoal-fuelled furnace. Once liquid, the metal would be tapped into a clay crucible and transferred to a mould. The mould would be made of loam; a mixture of sand, clay and horse manure which, when wet, would produce a pliable medium which would be applied over brick formers. It would then be shaped with wooden formers and the surface smoothed with a stick called a ‘strickle’. Angerstein (2001 [1765]: 261) reported that Crowley’s foundry reused scrap cast-iron imported from the Continent. During the 18th century, there were several advances made in foundry techniques: the air, or reverberatory, furnace was adopted for melting cast iron and in 1794 John Wilkinson patented the cupola furnace which resembled a small coke fuelled blast furnace. In 1785 ‘green sand’ was introduced for mould making. Green refers to sand in an undried soft state. It could be used with dry sand or loam.

Puddling was a process by which pig iron could be converted to wrought iron without going through the finery process. An early example of a puddling furnace was constructed at Derwentcote in the 18th century. The process was patented in 1784 by the ironmaster, Henry Cort (c.1741-1800), working out of an ironworks at Fontley, Hampshire, (Evans 2006). The puddling furnace was an unpowered reverberatory unit. Heat from a pit-coal fire in the furnace chamber was reverberated or reflected down onto the pig iron charge, lying on a bed of sand in the working chamber while the gasses were drawn away from the iron by venting through a chimney flue. A cycle of production would take about two hours and was known as a ‘heat’. A crew of two men tended the furnace, the puddler and his underhand. The puddled iron would be removed from the chamber once stiff and said to have ‘come to nature’.

The reverberatory, or air, furnace could be used for other processes. At Derwentcote and Swalwell they are noted as being used for balling, a process in which iron scraps were heated to welding heat and rolled up into balls within the air furnace. The balls would be lifted out of the furnace and worked into a required shape under a hammer.

5.3.3 *Iron and steel processes of the Machine Age 1840-1915*

The Derwent Iron Works opened in 1840, introducing technologies used throughout the national iron industry into the valley. Ironworks at Consett, Bradley and Crookhall built coke fired blast furnaces. Between the three works there were over 100 puddling furnaces in operation and steam-powered rolling mills produced lengths of bar, rail and plate (Fig. 5.13).

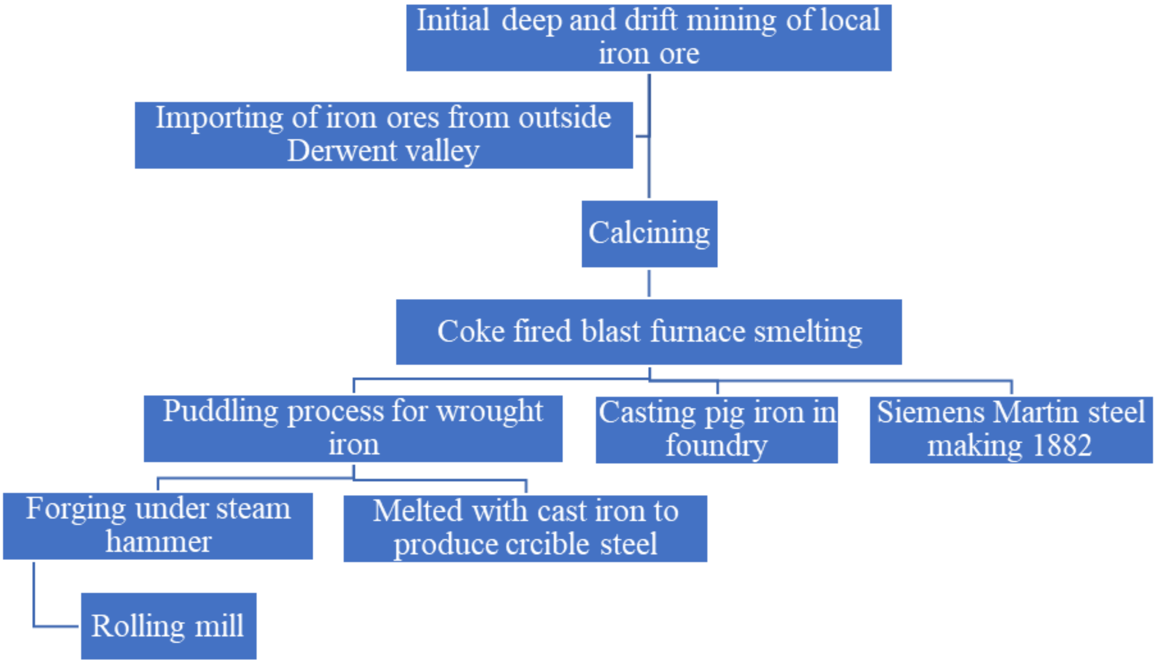


Figure 5.13 Iron processing in the Machine Age.

Abraham Darby (1678-1717), was the first iron founder to successfully smelt iron in a blast furnace using coke instead of charcoal in 1709 at Coalbrookdale, Shropshire (Cox 2008). Teething problems with the process were overcome by 1713. The coke required to fuel a furnace is produced by cooking pit-coal in ovens in a low oxygen atmosphere in order to drive off volatile impurities such as water, coal-tar and coal-gas. During the 18th century coke-fuelled blast furnaces retained the same basic design and operational practices as their charcoal-fuelled predecessors. The use of coke, however, allowed the overall size of a furnace to increase by the turn of the 19th century to 12m high because the integral structure of the coke nuggets resisted crushing beneath the weight of ore, fuel and flux within the stack.

From the second quarter of the 19th century developments were made to the form and operation of blast furnaces. The Glasgow engineer, James Beaumont Nielson (1792-1865), invented the hot blast process, taking out patents in 1828. The cold blast created by the furnace bellows was heated when passing through a red-hot vessel. At 315^{o} C the blast produced three times as much iron from the fuel in the furnace (Espinasse, rev. Donnachie 2009). In 1832 the internal design of the furnace was changed by the Staffordshire ironmaster, John Gibbons (1777-1851). The blast furnace had maintained the square plan since its inception. Gibbons noticed that once a furnace had ended a campaign the hearth had been roughly rounded by the action of the fire. He built a furnace with a round hearth and discovered that the furnace performance increased by 33% (Gale 1969: 44-6). Further experiments with hearth size, bosh steepness and stack height also proved favourable. Gibbons also discovered that puddling furnace slag made an excellent additive to the charge of iron ore in a blast furnace. Experiments in increasing the pressure of the blast into a furnace were carried out by T. Oakes of the Black Country in 1838. In a new furnace with a 2.4m diameter hearth built to 18m in height Oakes increased the blast pressure from the traditional 1lb/in^2 to 4lb/in^2 with spectacular results in output (*ibid.* 45).

The puddling furnaces (fig.5.14) in the Consett area therefore benefitted from 50 years of development since the unsuccessful attempt at Derwentcote. Joseph Hall, an iron worker from the Black Country, began experimenting with developments to Cort's process in 1816. Instead of using sand to line or 'fettle' the working chamber, Hall tried using the bosh cinder or slag on the basis that the material contained iron. The reaction was violent the pig iron was seen to boil, leading to Hall's process being referred to as 'wet' puddling or pig boiling.

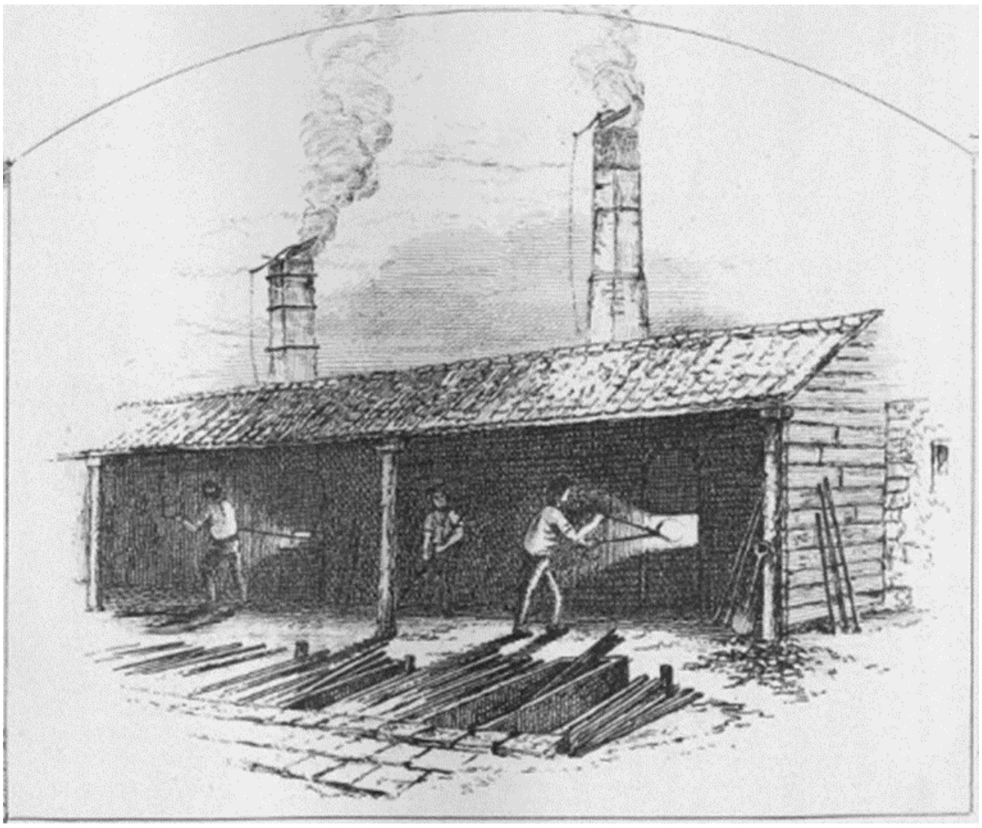


Figure 5.14 Nineteenth century puddling furnace.
(detail from Fordyce 1860: plate facing page 119)

Following some revisions, the wet puddling process began with the puddler 'fettling' the bottom of the working chamber with the oxidising layer. The fire was then lit in the furnace chamber and the whole unit brought up to welding temperature. A second layer of fettle, puddling furnace slag, mill scale and, if available, a little iron ore would be added. The working chamber could then be charged with pig iron, two hundred and fifty kilogrammes being a typical amount (Gale 1969: 57). The working chamber door was closed and the furnace brought up to temperature. The melting down of the pigs took about half an hour during which time the underhand turned the iron every few minutes with an iron paddle, called a rabble, which was inserted through a small hole in the working chamber door. When the iron melted it began to react with the fettling and decarburise. To prevent over-oxidising the iron a non-oxidising or reducing atmosphere had to be created so a damper was lowered over the exhaust flue and the working chamber filled with smoke. This part of the process was known as 'smothering' and lasted 10 minutes. Smothering also helped to remove other chemical impurities in the iron such as manganese, silicone and phosphorus. As the iron was losing its carbon the melting point rose. The skill of the puddler was to operate the damper in such a way as the heat in the furnace was increased without losing the reducing atmosphere. The iron would then 'boil' as the decarburising reaction became more violent. Carbon dioxide gas burnt off at the surface of the iron in jets of blue flame known as puddler's candles. The iron was stirred constantly, or puddled, during this process. The boil would last about half an hour, when the candles suddenly extinguished and the iron became stiff and pasty against the rabble, indicating that it had 'come to nature'.

To remove the iron, the puddler divided the pasty material into four pieces with the rabble and rolled each into a ball shape of about 50kg in weight. These were lifted out of the furnace with tongs. Any molten slag remaining in the furnace was drawn off through a tap hole beneath the working door and the furnace was ready for another heat as the fettle was already in place. The puddled balls were then hammered under a powered shingling hammer to consolidate and weld the iron content, expel cinder and form a rectangular bloom.

Steam hammers were installed at Consett soon after its inception as there was a lack of running water on the Consett plateau. A steam hammer also replaced the tilt hammer at Swalwell. The steam hammer was conceived by the engineer James Hall Nasmyth (1808-1890) in 1839 to forge a paddle shaft for Brunel's ship, the *Great Britain* (Buchanan 2004). Nasmyth's hammer, built in 1842 was based on a single action piston. An iron framework was constructed over an anvil onto which a vertical steam cylinder was mounted with a heavy hammer head fixed onto the piston shaft hanging below the cylinder. Steam was introduced into the bottom of the cylinder, lifting the piston and hammer vertically until the steam was exhausted from the top, allowing the hammer to fall to the object being forged on the anvil under gravity. Nasmyth soon made improvements to the steam hammer, he constructed valve gear which gave the piston a double action; steam was used to raise the hammer and then power the hammer down to the anvil with a force greater than gravity (Gale 1969: 130).

At Consett, Winlaton Mill, Swalwell and Derwentcote powered rolling mills were built to produce long merchantable products: rails and plate (fig. 5.15). The rolling mill was an evolution of the rolling facility of the slitting mill. Angerstein (2001 [1765]: 259) reported that the slitting mill at Swalwell was used for rolling heavy sheets and suggests that the slitting mill at Winlaton was also used as a rolling mill as much as it was used for slitting. The leap from slitting mill to rolling mill came with Henry Cort's (c.1741-1800) patent of 1783 (Evans 2006). The powered mill would produce plate similar to that produced in a slitting mill when the two rollers were plain cylinders. Cort designed rolling cylinders with half-round or half-square grooves which diminished in size from one side of the roller to the other. When red-hot blooms were squeezed between the rollers, lengths of round and square bars for various applications were produced. The rolling mill replaced the function of the chafery, producing a higher quality product in terms of finish and processing a higher volume of iron in a given time.

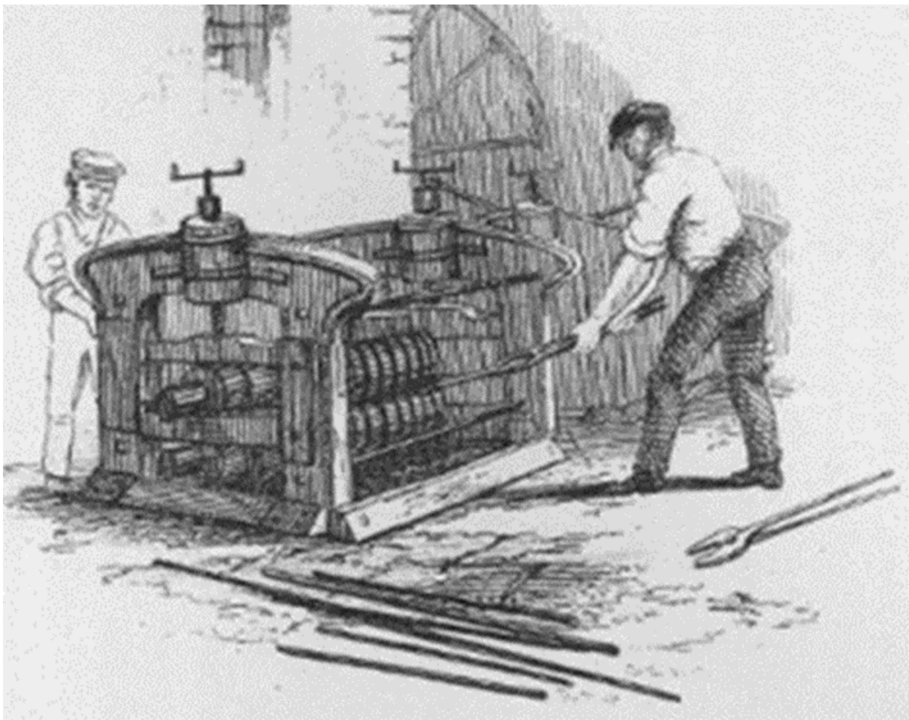


Figure 5.15 Nineteenth century rolling mill.
(detail from Fordyce 1860: plate facing page 119)

Passing the bloom between the two rollers was known as a 'live pass' as work was done to the iron. The mill workers would then return the part-worked iron back to the input end of the mill. No work was done on the iron on this return and so it was known as a ‘dead pass’. The gap between the rollers would be reduced or the iron ‘live passed’ through the next smaller set of grooves until the finished product was achieved. A rolling mill with two rollers mounted one above the other in the style of a slitting mill was known as a two-high mill. The design was improved in the early 19th century with the development of the three-high rolling mill (Gale 1969: 52). A third adjustable powered roller mounted vertically over the traditional pair provided a return live pass.

The final electric powered rolling mill constructed at Consett in 1960 covered 28.3 ha. Variations on the rolling mill built at Consett were the angle mill, 1888, to produce various profiles such as ‘L’angle, and the chequer plate mill to roll an anti-slip tread pattern onto steel plate in the 1920s.

Crucible furnaces were present at Derwentcote from the 1850s and at Swalwell in the 1820s (Parson and White 1828: 197). The process was invented by the clockmaker, Benjamin Huntsman, of Doncaster (1704-76). Huntsman was dissatisfied with the quality of shear steel even after several forgings to improve the quality. He discovered that if blister steel was melted in a clay crucible on a coke fire the carbon content distributed itself uniformly throughout the liquid and any slag remaining in the steel would rise to the top of the liquid and could be scraped off leaving a consistent, high-quality product. It is thought that his crucible experiments were carried out at Handsworth, Sheffield in the later 1740s. In 1751 he moved to Attercliffe Green, Sheffield as a steel maker (Hey 2008).

A crucible furnace about 600mm deep was set below the floor of the workshop, often in multiples; Derwentcote and Swalwell both had six. The clay crucible, 125mm in diameter and 400-450mm in height, was lowered down onto a support of firebricks upon the bars of a grate at the base of the furnace. A fire was set on the grate at the base of the furnace using coke as a fuel. Access to the bottom of the furnace to riddle the ash and allow an air supply to the fire was through a cellar below the workshop. Fuel was added to the furnace through the top to ensure that the crucible was heated from the bottom up until the crucible was white hot. At this point the charge of 15-22kg of blister steel was introduced into the crucible and sealed with a lid to prevent the oxidising of the carbon within the steel. A cast iron lid on the furnace was closed to ensure that all gasses produced in the furnace were exhausted through a chimney flue. Through control of the air-flow the furnace could be brought up to 1600^{o} for a period of one to three hours depending on the nature of the blister steel. When the charge was judged to be completely liquid by the steel master the crucible would be lifted out of the furnace, the lid removed and any slag which had come to the surface removed and then, after a stir with an iron rod, the liquid steel would be poured into cast iron ingot moulds (Overman 1854: 476-7). It is probable that the Swalwell crucible furnaces, benefitting from their urban location, may have been heated by gas by the late 19th century.

In the 1850s William and Frederick Siemens invented the Siemens open hearth process for steel making which was adopted by the Consett Iron Company in 1882. In this technique the used combustion gasses from the smelting process preheated the air for combustion within the furnace. The combustion gasses were exhausted through a chamber at one end of the furnace which contained a latticework of firebricks that became heated. The gas flow was reversed so that they exhausted through a similar chamber at the other end of the furnace, heating the bricks within that structure. The air for combustion was drawn through the heated chamber and itself became hot while cooling the firebricks until the gas flow was reversed and the bricks were heated again. The first use of the Siemens air heating system was used to produce steel by the crucible method. In 1862 Siemens began experimenting with furnace with a dished 'open' hearth at an ironworks at Tow Law just outside the Derwent valley. Here, as with crucible furnace charges, a mixture of cast and wrought iron was melted on the hearth to produce steel. An open hearth furnace resembled a large coal fired puddling furnace with an air heating chamber at each end. In 1863 in France, Emile and Pierre Martin, who had built a Siemens open hearth furnace, experimented with mixing scrap iron and steel with the cast and wrought charge with favourable results which were adopted by later furnace operators. In Britain the Siemens brothers experimented with adding iron ore to cast iron with a limestone flux; this became the Siemens Open Hearth Process. An early Siemens furnace opened at Landore, Wales, in 1869, could produce 75 tons of steel per week using a 6-ton pig iron charge (Gale 1969: 75-7, Barraclough 1990: 137-148).

5.3.4 *Twentieth century technologies*

Consett was the sole producer of iron and steel from smelting to rolled finished products in the valley by the end of the First World War. On Derwenthaugh Raine and Co. and later, Ellis, specialised processing scrap metals into new goods. Scrap melting had taken place since the early 18th century at Crowley's, Raine's and Ellis's carried out the same process on a larger scale. This section looks at some of the new technologies adopted by Consett over the last 60 years of its operation: sinter preparation, the continuous billet mill, Duplex process steel making, oxygen steel making and pressings.

The Consett Iron Company opened a sinter plant in 1942 to feed its blast furnaces. Within a sinter plant the dust or fines of iron ore, coke and limestone flux (which had formerly been discarded as useless for smelting) were combined in pre-set proportions with additives, calcined lime and water within a rotating drum to combine them into pellets. The pellets were burned within a sinter machine to produce blast furnace feed-sinter (Gale 1969: 99).

A slabbing, blooming and continuous billet mill was opened at Consett in the early 1950s. In this process molten steel was ladled into a vertical mould in a continuous casting machine. Solidification began, but the billet, slab or bloom continued through the machine in a stream of semi-molten metal which was robotically cut into predetermined lengths by acetylene torches (Kozak and Dzierzawski 2016).

The duplex process for steel making was adopted by the Consett Iron Company at the same time as the continuous billet mill. The duplex practice is carried out in two parts. First iron is converted to steel through the Bessemer process and is then finished through deoxidising with the Siemens process. The Bessemer process was invented by Henry Bessemer (1813-1898). In 1855 he designed an egg-shaped furnace called a 'converter' into which molten pig iron was poured. Air was then blown through the liquid which ignited and rapidly burned out the carbon and other impurities resulting in mild steel. Bessemer patented the tilting converter design which was the same basic design that is used today. (Tweedale 2006). The molten low carbon and high phosphorus steel created in the converter is conveyed to a Siemens open hearth furnace for refinement into the required end product. (Chest of Books 2016).

An Oxygen steel making plant began production at Consett in the early 1960s. Bulk oxygen became available following the Second World War through the discovery of the liquid air process. Pig iron was melted in a converter similar to the Bessemer model except it had no tuyeres in the bottom. Instead a lance was lowered into the molten metal and oxygen blasted into the liquid, resulting in a fast reaction and the production of a good quality steel (Gale 1969: 99-102). Once the reaction was complete the lance was withdrawn to permit the steel to be poured out. This process was later modified with additives of scrap.

Pressing is the process by which wrought iron or steel, usually in flat plate form, is shaped through the application of pressure. Pressing shops have been noted at Consett and at Raine's works on Derwenthaugh. The stamping press had two main components, the static bolster plate and the moving ram. Though early examples were hand operated through the turning of a screw, it was through the adoption of steam power that traditionally hand forged hollow-wares such as spades and shovels could be mass produced.

5.3.5 *The social organisation of production*

The numbers of workmen employed in each task can be estimated through analysis of the processes described above.

The activities of busy-ness in the pre-industrial landscape: extraction, bloomery smelting, forging and the later operation of blast furnaces could be carried out by small groups. These sites across Nookton, Muggleswick, Edmundbyres, Espershieds, and Whittonstall were, and still are, essentially rural sites although none of them are remote. The medieval settlements of these iron miners and smelters were all within an hour's walk of the sites. A single person could excavate a bell pit, though with safety issues and the additional speed afforded by a permanent surface worker to draw mined material up and out of the ground, two or three people could efficiently work a bell pit of the size exposed at Whittonstall. Smelting iron in a bloomery furnace of the bowl type would also be most efficient with two or three members in a team: one iron master with the experience to smelt the iron correctly and one or two assistants. The miners and smelters could work side by side or separately. It may be possible that the miners and smelters were the same people carrying out both processes.

When later bloomeries adopted a degree of water power they needed to be close to a suitable water supply. The 16th century forge at Gibside, and perhaps the forge at Muggleswick Park, were of this more permanent nature. Beyond the Derwent valley, records of the 15th century bloomery forge at Byrkeknott (Bedburn) in Weardale name four principal employees: a manager, John Dalton, a collier who prepared the charcoal, a *blomesmyth* to operate the bloom hearth and a *faber* to operate the string hearth. When there was insufficient water to power the bellows of the bloom hearth the *blomesmyth's* wife worked them by hand. There were four houses built for the forge suggesting four workmen were required (Sellers 1907: 279-280). The ore would still have to be extracted by a team, or teams, of miners and also led into the forge by cart or pack-horse. At Byrkeknott the production of the forge was said to be

2 tons of iron per week (*ibid*. 280); this amount of iron would require at least 7 tons of ore so one or two teams of miners may have been required to keep the forge supplied.

Blast furnace technology was present at Gibside, Derwentcote and Allensford. All three sites are a little distant from settlements suggesting that the workforce would have to journey out to them. The salient change in working practice between the bloomery and the blast furnace is that the latter produced iron 24 hours a day for weeks or months. This necessitated round-the-clock shift work (Cranstone 2001: 187) suggesting that there were at least 2 full teams to tend the furnace. Again, an experienced foreman with two or three assistants would form a team. Raw materials: ore, charcoal fuel and limestone flux would all be stockpiled prior to a blast campaign.

On the evidence of the Solingen court order of 1688, 21 German sword makers were enticed to Shotley Bridge. In 1703 the Shotley Bridge sword factory was leased to 6 Germans. In 1754 Angerstein encountered 8 Germans at Shotley Grove (2001 [1765]: 270). It appears that a sword factory could be run with under 10 men. Forging a sword blade may have been a solo occupation or the smith may have had an assistant; grinding was certainly a solo occupation. One social advancement made at Shotley Bridge was that worker's housing was provided at the sword factory.

Steel cementation was another process which required 24-hour attention for over a week per firing. As there was no need to handle the converting metal during the heating process the whole process may have been carried out by one man. At Derwentcote there is only one 'steel converter' mentioned in the national census returns (1851: H.O.107/2389; 1861: R.G.9/3735; 1871: G.G.10/4960) with several 'steel forgemen' listed who would work the blister steel up into more valuable grades. The steel converter, who was experienced in keeping the furnace fire burning at the correct rate, may have been practiced in cat-napping, with work mates or family members calling in to check on his welfare during the firing period. Worker's housing was built close to all the cementation furnaces.

The numbers of workmen required for all the manufacturing processes at Crowley's works was small. Most items would be made by teams of one to three men per hearth headed by a smith sometimes aided by hammermen and apprentices. The one exception was anchor manufacture which required six to eight workers. Crowley's works had many workshops of different sizes. Nail shops were small and contained a single hearth, others were larger;

Angerstein reported that the three file makers workshops at Winlaton Mill contained 35 hearths (2001 [1765]: 264). It may be calculated that upwards of 70 men were employed on the file making process alone.

Crowley introduced the slitting mill to the Derwent valley. Angerstein observed that the mill at Swalwell was operated by four men and would sometimes work two shifts a day (2001 [1765]: 259). As a development of the slitting mill it may be assumed that early rolling mills required similar numbers of operators; the rolling mill installed at Derwentcote in the 19th century only has one named operator (1861: R.G.9/3735) so it may be assumed that a forgeman would have to assist him in the process. As rolling mills became larger though the 19th century more men were required as the weight of iron being processed per pass increased. In the 20th century the process became increasingly automated.

Puddling was carried out by a team of two, as was balling in an air furnace. At Derwentcote in the 18th century this would mean two workmen struggled with the process. The following century at Consett at least 400 men would be required to work the 100 puddling furnaces in two shifts. The scale of all the processes at the Consett area ironworks would require more men than had been employed in the same processes than during the Industrial Revolution. One consideration to the Machine Age is to the number of men employed to work and maintain the steam engines powering the rolling mills and cranes for lifting the iron goods; each would require an engineer (or driver) and usually a fireman per shift. Jenkin's (2008 [1893]) description of the Consett works indicates how many processes were carried out with steam power. Other than those in the Consett area, the only other pieces of steam plant were at Swalwell and the Derwenthaugh businesses.

5.3.6 *A comparison between the processes available in the Derwent valley and Sheffield*

This section compares the development of the iron and steel industries with another major industrial centre, Sheffield (fig. 5.16). Sheffield has been chosen because of the place it holds in the public consciousness as the 'Steel City' (Symonds 2006). Like the Derwent valley, the Sheffield area was rich in the raw materials for iron working: ore, coal, timber for charcoal and stone for grinding wheels. The local rivers, for example the Sheaf which runs through the city were, like the Derwent fast flowing and therefore suitable for supplying power.

Figure 5.16. Location map for Sheffield.

(Google Maps 2017)

Iron working in Sheffield entered the documentary record in 1297, two years before iron was produced in Muggleswick park, with a record of Robert the Cutler in the hearth tax records (Museum of Sheffield 2017). The iron industry in Sheffield was founded upon cutlery: knives, scissors, shears, scythes and other edged tools. By 1600 Sheffield had become second only to London for cutlery production and in 1624 the Company of Cutlers was formed to regulate the quality of items produced in the town (Lambert 2017: 1-2).

Steel was required for cutlery. It was possible to produce 'natural steel' in a bloomery by using a higher fuel to ore ratio and providing a rapid air flow, or 'artificial steel' where bloomery iron was heated on a bed of charcoal so that carbon diffused into the iron. By the 17^{th} century smelting was almost universally carried out in blast furnaces and the method of producing steel changed: cast iron was melted and sufficient carbon burned out in a modification of the finery process. This steel was known as 'Styrian steel', 'German steel' or, confusingly, 'natural steel' (Barraclough 1984a: 11-12). Before 1650 much of the steel used in Sheffield had to be imported from Sweden (Museum of Sheffield 2017) until steel cementation technology reached Yorkshire. A Swedish traveller noted cementation furnaces in Sheffield in 1692 which only produced 20-30 cwt (1-1.5 tonnes) per firing (Barraclough 1984a: 58; Symonds 2006).

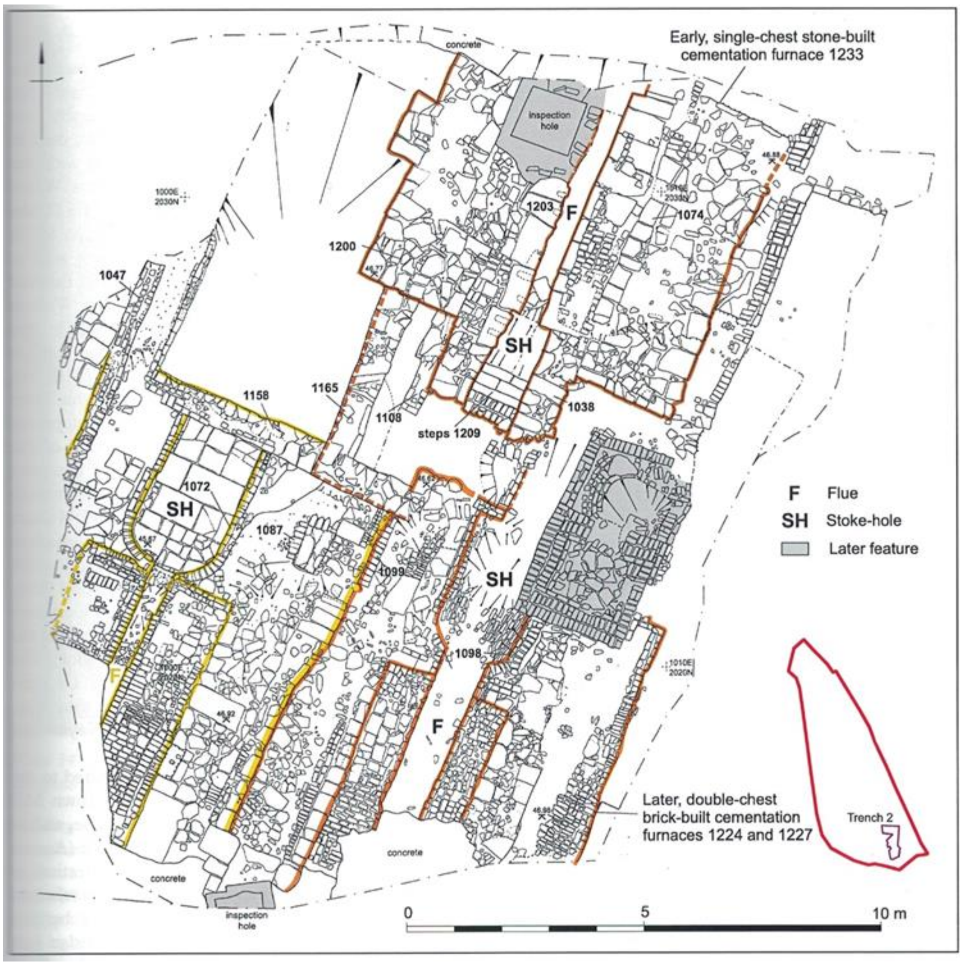


Figure 5.17 Plan of cementation furnaces off Hoyle St., Sheffield.
(Powell 2014: 43)

Excavations of the Riverside Exchange area of Sheffield uncovered the remains of three cementation furnaces (fig. 5.17). Furnace 1233 was an early 18th century stone built rectangular furnace 8.25m long x 7.0m wide with steps leading down at one end to a rectangular stoke hole, ash pit and central flue which was 0.4m wide. This was interpreted as a single chest cementation furnace with a capacity of 3 tons. Furnaces 1224 and 1227, built adjacent to each other, were dated to the later 18th century or early 19th century. They were both were constructed of brick and were at least 9.5m long x 6.0m wide. Each had a stoke hole, ash pit, a main flue, either side of which were platforms for sandstone chests. The chests were 4.0m long x 0.9m wide x 1.3m deep, each had a capacity to produce between 10-15 tons of steel per firing (Andrews 2015: 41-43). Two more 19th century cementation furnaces are under investigation by Wessex archaeology at the time of writing, located at Hollis Croft in the city centre. Both have intact footprints of their conical chimneys, one was made entirely of brick, the other had stone foundations (Rajic and Tuck 2017: 11).

In 1765 the operation of the Sheffield cementation furnaces was witnessed by the French traveller, Gabriel Jars. He noted that the Sheffield furnaces were smaller than those he had previously seen at Swalwell (Jars 1774 in Barraclough 1984a: 213). This model of furnace would have been the single chest type found at the Riverside Exchange. The blister steel produced in the Sheffield furnaces would have been used for tools such as scythes. The higher quality shear and German steel for finer cutlery was only available from one source: the Derwent valley. From 1687 to 1733 these high-grade steels were only produced at Hayford's furnace at Blackhall Mill. From 1733 to the early 1750s Derwentcote produced the materials too, from then until 1767 Crowley's works also joined the Derwent valley monopoly. A steel converter, Thomas Eltringham, left Blackhall Mill in 1767 to make shear steel for Thomas Boulsover in Sheffield (Jeans 1880: 14), taking the secrets of the Derwent valley steel to his new employers. The Derwent valley shear steel was known by various names amongst which were: Hayford steel, Newcastle steel and German steel. German steel refers to the German, Wilhelm Bertram's, specifications for reforging shear steel, rather than the European German Steel noted above.

The cutlers of Sheffield were one of the main markets for Derwent valley steel throughout the 18th century (fig.5.18). However, the adoption of Benjamin Huntsman's crucible method of steel making in Sheffield from 1751 led to an expansion of local steel manufacture (Symonds 2006).

Figure 5.18 Late 18th century Sheffield knives. Excavated from the Riverside Exchange.

(Symonds 2006)

Jars saw the production of crucible or cast steel in 1765 but observed that the cast steel was not in general use and that it was only used for items that required a fine polish (1774 in Barraclough 1984a: 214). As the century progressed more Sheffield steel works produced crucible steel, reducing the need for the Newcastle product. As the Sheffield steel makers could produce their own high-quality steel through the crucible process they needed more blister steel for refining. This necessitated the building of the larger, two-chest, type of cementation furnace found at the Riverside Exchange and at Hollis Croft. Two 19th century crucible furnace cellars (fig. 5.19) were excavated by the Archaeological Research and Consultancy at the University of Sheffield, 2006-8, on the site of the former Titanic works at 24 Malinda Street, Sheffield (Powell 2014).

Figure 5.19 Cellar of a crucible furnace, Sheffield.
(Symonds 2006)

Sheffield developed a process to fuse copper and silver to produce Old Sheffield Plate in the 1740s. This development was without a parallel in the Derwent valley. The method was invented by Thomas Boulsover prior to his venture into steel making. This process created fashionable ornaments and tableware for the middle-class market (Olive 2006: 6).

In the Derwent valley the majority of workmen were employed by the entrepreneurs who had set up the iron working businesses, however, in Sheffield the 'Little Mester' system dominated. A Little Mester was a skilled craftsman who worked with a few employees and apprentices in his own workshop, often in his home. Each mester would specialise in one process, collecting and delivering cutlery from other mesters through private arrangement until the items were complete (Museum of Sheffield 2017).

In the early 19th century while the iron industry in the Derwent valley declined, the Sheffield industries benefitted from a wide adoption of steam power and the opening of the Sheffield

Canal in 1819 (Olive 2006: 7). In both areas the 1840s was a significant decade. In the Derwent valley the Derwent Iron Works began operation. In Sheffield, the railway arrived creating new manufacturing opportunities and electroplating was introduced creating New Sheffield Plate (*ibid*. 7; Lambert 2017).

For the first half of the 19th century the combination of the cementation furnace (fig. 5.20) and the crucible furnace became the basis for steelmaking in both regions, more so in Sheffield (Barraclough 1990: 4) as within the Derwent area only Swalwell and Derwentcote built crucible furnaces. In 1856 Henry Bessemer patented his bulk steel manufacturing process which was readily employed in the Sheffield area. During the 1860s vast new steel works were constructed, expanding Sheffield to the east, employing 1000s of men and creating the Steel centre of the world (Olive 2006: 7). Consett was at this time the largest iron works in England but it would never compete with Sheffield in steel production.

Figure 5.20 Cementation furnace, Sheffield. The only remaining 19th century cementation furnace built in 1858 by Daniel Doncasters and Sons on Doncaster Street, Sheffield.
(Symonds 2006)

In the early 20th century Sheffield benefitted from the development of stainless steel. Both Consett and Sheffield continued making steel until the late 20th century. Consett ceased production in 1980 and Sheffield a little before 1990. The exact date is uncertain because the surviving Sheffield steelworks, active today, Outo Kumpu Ltd, moved into scrap reprocessing, as did Raine's and Ellis' on Derwenthaugh. Several cutlery works, family run firms, remain in production in the 21st century, these possibly employ under 1000 workmen today (Museum of Sheffield 2017).

This comparison with Sheffield shows that the Derwent valley had the preeminent national role within the steel industry during the 18th century. The Derwent's position was created by the ability to produce a high quality sheer steel for the Sheffield cutlery market. By the time Thomas Eltringham arrived at Sheffield with the knowledge of its manufacture Benjamin Huntsman had developed the crucible method of steel making. As this method gained acceptance in Sheffield, demand for Newcastle steel fell. The Derwent valley adopted crucible steel by 1828 but with only two furnaces, the quantity of steel was small and probably only supplied local markets. From the mid-19th century the Derwent became host to the largest bulk iron production centre in England, and Sheffield to the largest for bulk steel. When market conditions forced the Consett Iron Company into steel production it was never on the same scale as Sheffield. Both areas ceased steel making in the last quarter of the 20th century.

Until the 18th century Sheffield produced cutlery for a largely regional market whereas the bulk of the iron product in the Derwent area was for manorial or estate use with the surplus sold onto the local market. From 1691 The iron wares produced by Crowley's works were sold nationally and internationally including to America, a market which became important to Sheffield a century later (Museum of Sheffield 2017).

5.4 The GIS model of the Derwent valley

The GIS created from the documentary and archaeological sources presented in chapters 1 and 2, with additional data from the Manchester Methodology and process recording sections of this chapter is presented on the DVD attached below. The DVD contains 8 file folders and 1 MXD file – 'the Derwent Valley GIS mxd.' – which is the project file ready to load into ArcGIS 10.3.1. and hosts the connections to the file folders. The contents of the file folders are given in table 5.21. The GIS has been given three uses within this thesis: location maps of archaeological sites, broader location maps of documented sites whose exact location remains unknown, and a display of the total station data. Location maps created though this GIS appear in chapters 1, 3 and 5. Historic OS maps and total station data have been used in chapter 6.

DVD

File name	Contents
Database	Microsoft Access database containing a list of the archaeological sites of the Derwent valley, their georefrencing data and additional attributes.
Derwentcote TST	Leica Builder total station data from the Derwentcote Forge Cottage excavations.
Extracted Historical Sites	Historic OS maps for ironworking sites within the Derwent Valley at 1:2500
HLC	Polygon shapefiles for the parishes within the Derwent valley. Parishes have been chosen as the units for the Historic Landscape Characteristics.
Historic Landscape	Historic OS maps at 1: 10560 to give a map regression of the landscape of the Derwent valley.
Limit of Project	Polygon shapefile which gives the geographical limit of the thesis project.
Raster Base maps	OS base maps at 1:250000, 1:500000 and 1:250000 over which the contents of the other file folders can be displayed.
Rivers Clipped	Polyline shapefile for all the watercourses within the Derwent valley.

Table 5.21 File contents of the Derwent Valley GIS

The HLC element of the GIS has been used to illustrate the broader locations of documented sites whose exact location remains unknown. Below, a HLC for the valley has been created to show the spread of the iron industry by the century of its appearance within the documentary record (fig. 5.22). It shows that iron working was known within the valley in all areas of the valley by the 17th century except those at the mouth of the valley, Ryton and Whickham, on the north and south banks respectively, and the small parish of Ebchester: the three parishes which accommodated the entrepreneurs of the Industrial Revolution on their arrival. One explanation for this migration may be that the pre-industrial instances of iron smelting were close to the ore beds, so they were established to the west of the valley where the geology allowed ore extraction. During the Industrial Revolution iron smelting was largely not an issue so the new entrepreneurs chose sites to the east of the valley with abundant water power and transport links via the Tyne to the Baltic iron trade, national and international markets.

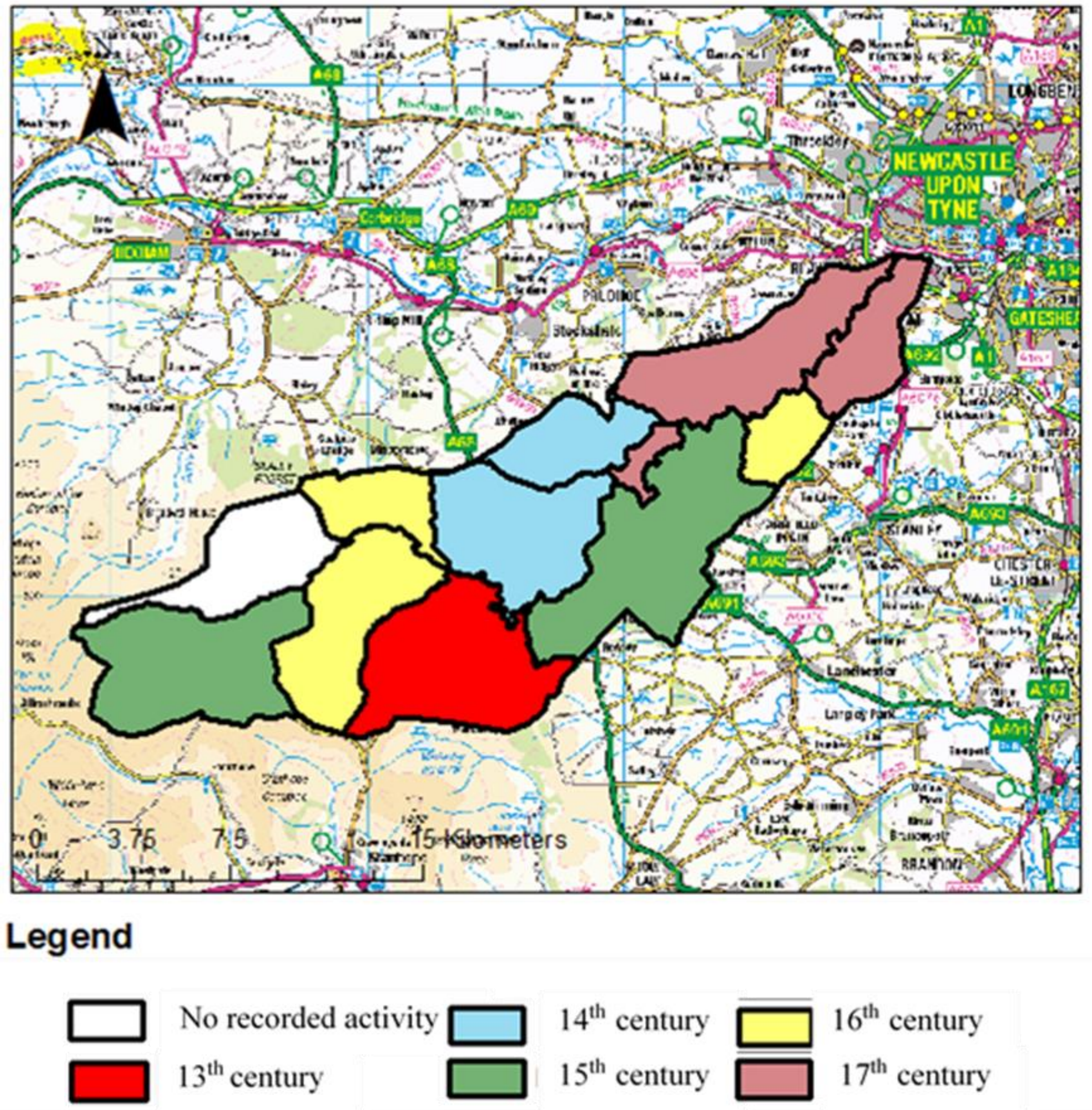


Figure 5.22 HLC for the Derwent valley

5.5 Summary

This chapter has been concerned with the application of three current industrial archaeology and landscape archaeology methodologies to the Derwent valley: the Manchester Methodology, process recording, and the construction of a GIS.

The original Manchester Methodology analysed the ownership of new monument types as they appeared in the landscape. The adaptation created for this thesis examines who benefitted from the monument. This adaption showed that as the study period (1600-1900) progressed monuments which could be enjoyed by all social classes appeared in greater numbers; these classes included people who were not of the ‘lords’, ‘freeholders’ or of the ‘tenants’ social groups as understood by the original Manchester Methodology. The original Manchester Methodology discounts the working masses because they would never own a monument.

This Manchester Methodology adaptation demonstrates a noticeable increase in the number of new monument types from the late 17th century onwards with the arrival in the Derwent valley of a new social class, the entrepreneurs. Many of the new monument types which appeared in the late 17th century and early 18th century were related to the iron industry.

The process recording carried out for this thesis produces an enhanced understanding of the operation of the varied ironworking and steel making sites within the Derwent valley. It has also facilitated the interpretation of the damaged, incomplete and demolished sites (Malaws 1998: 77).

By understanding the processes within the sites, the social structure of the workmen performing the various ironworking tasks within the valley can be explored. Most activities could be carried out by small teams of 2-3 men, until the bulk-production methods of the Machine Age, which arrived in the area in the mid-19th century. The labouring teams would usually comprise an iron master/steel master or a smith with assistants and/or apprentices. A works manager or agent liaised between the labourers and the entrepreneurial lease holders.

Comparing the processes carried out in the Derwent valley with Sheffield shows a complex relationship between the two areas. Sheffield became dependent on the Derwent valley for high-quality steel for its cutlery trade during the 18th century. From the mid-18th century the crucible steel making method reduced the need for Derwent or ‘Newcastle’ steel in Sheffield. By the 19th century Sheffield was almost self-sufficient in high-quality steel. In the mid-19th century Sheffield benefitted from the development of Bessemer steel while the Derwent area concentrated on iron production, with only a limited adoption of crucible steel making. By the time the Consett Iron Company opened its steel plant in the late 19th century Sheffield was preeminent in British steel manufacture.

Data generated through chapters 3, 4 and the methodologies applied in this chapter is uploaded into a GIS and presented on a DVD. The material within the GIS is used to illustrate the thesis with plans in different scales. A HLC has been created which can be used to visualise a range of historical criteria across the landscape; the example of ‘the spread of the iron industry by the century of its appearance' has been shown above. The database created from this material, and contained within the GIS is fully interrogatable, allowing a range of queries based on the available data to be addressed.

The adapted Manchester Methodology acknowledges the presence of workers, as they benefit from new monument types. However, even in this adapted form, this civil class is only recognised through generalisation. Process recording attributes more recognition to the working classes, but only in terms of their performance. Other than by their relationship to their trades individual iron workers remain anonymous. While both these methodologies can look at aspects of social archaeology they lack the ability to place individuals within the industrial landscape. This project seeks to rectify this through the application of artefact biography in chapter 6.

Chapter 6. Derwentcote: a case study in artefact biography

6.1 Introduction

Joakim Thomasson's study the biography of the Lembke house (2.4.3 above), described a web of human-material relations and demonstrated how different chains of social action were co-ordinated through the building (2004: 185). Consideration is not only given to the house itself, but also to the uses of the streets adjacent to the building (*ibid*. 176-7), moving beyond the physical limits of a single building to create a fuller picture of its relationship with both named individuals and more general social groups. This chapter expands on Thomasson's approach to a single building and its immediate urban surroundings to consider the whole rural industrial landscape of Derwentcote. This is the first time that the methodology of artefact biography (described in 2.4 above) has been used on this scale.

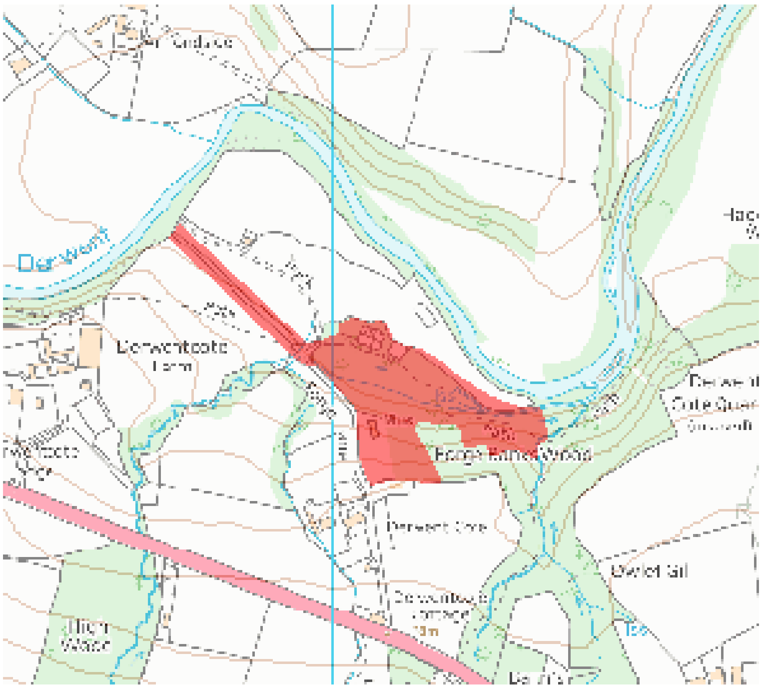


Figure 6.1 Derwentcote under Historic England stewardship.
(Historic England 2017)

Derwentcote has been selected as a case study because of the extensive documentary record for the history of the Derwentcote ironworks and its development into a steelworks (outlined in 3.3.4), and the archaeological data generated through recent fieldwork, as outlined in 4.3.4. The present chapter draws on these datasets and expands them in developing an artefact biography of the Derwentcote Historic Landscape. This historic landscape specifically comprises an area of land taken into English Heritage/Historic England stewardship in 1985 and includes Derwentcote Forge, its cementation furnace, forge cottages, mill races and the Forge Banks, including the entrance to the Derwentcote drift mine. The area is a Scheduled Monument No.1015522. (fig. 6.1).

Artefact biography highlights the human factor in a way that neither the Manchester Methodology with its broad social groupings (5.2), nor process recording with its calculation of numbers and movements of anonymous workmen (5.3) can accomplish. By employing the technique of artefact biography Derwentcote comes into focus, not simply as a collection of buildings, but as the workplace and home for generations of individuals whose own histories were enmeshed with that of the industrial complex itself. Their physical and emotional investment in Derwentcote shifted according to time and context, and in exploring these changes a fuller picture of the Derwentcote Historic Landscape over the course of its life history emerges.

An artefact biography should divide the life cycle of its subject into passages or chapters (Dannehl 2009: 126). Each passage studies the subject in terms of its relationships with, and meanings to, the people or 'curators' who are associated with and experience the object (or here, site) over time. In the case of Derwentcote these many curators comprised the freeholders, leaseholders, management, workforce, tenants and other individuals who held, lived in or around, or moved through the Derwentcote landscape between 1569 and the present day.

There are four 'chapters' to the Derwentcote biography. The first three follow the temporal divisions used throughout this thesis and as experienced at Derwentcote: pre-industrial (1569-1718), the Industrial Revolution (1718-1850s) and the Machine Age (1850s-1895). The forth discusses the 'after life' of Derwentcote following the closure of the steelworks up to the present day (1895-2017).

The pre-industrial chapter introduces and defines Derwentcote: a rural estate, created through specific circumstances, in the 16^{th} century. The evidence for activity during this period is largely document based, though archaeological evidence for occupation and a short-lived blast furnace will be discussed. The Industrial Revolution arrived at Derwentcote in 1718 with the creation of an iron forge, later followed by a steel cementation furnace. A social structure was created around these developments, anchored to the ironworks/steelworks. The conserved standing remains of the cementation furnace are the salient surviving feature of this period, while recent archaeological work on the forge cottages has recovered some of the personal material culture of the steel making community. In the 1850s the production techniques at Derwentcote were updated, which led to a change in the workforce. Whether it can be considered that Derwentcote ever entered the Machine Age is debateable; the forge never invested in a steam engine as a reliable power source, nor was it well placed to take advantage of the Derwent Valley Railway for supply and distribution. Derwentcote's Machine Age may be seen as a reaction to industrial developments occurring elsewhere in the valley. The ongoing afterlife of Derwentcote began with the closure of the steelworks in 1895. Between the abandonment of the steelworks and the Second World War the Forge Banks area had been subject to drift coal mining, necessitating the demolition of the forge. In recent years Derwentcote has become a heritage asset under the stewardship of Historic England and has undergone several programmes of archaeological investigation.

The primary and secondary textual sources concerning Derwentcote were first signposted in David Cranstone's 'History' section of his *Derwentcote Steel Furnace* (1997: 17-25) and Robert Surtees' *History and Antiquities of the County Palatine of Durham* (1820: 259-83) and are summarised in section 3.2. Figure 6.2 below shows the various additional sources employed in creating the artefact biography presented below.

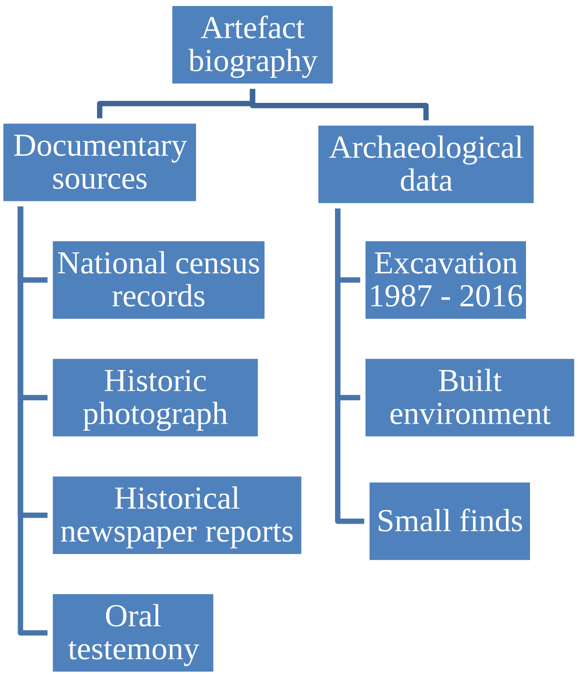


Figure 6.2 Facets of the artefact biography.

The National Census returns have been used to identify the steel working community for the majority of the 19th century. Eight records for the National Census are available for analysis, 1841-1911 (National Records Office record nos. HO 107/301/19, HO 107/2389, RG 9/3735, RG 10/4960, RG11/4950, RG 12/4091, RG 13/4667 and RG14/29879 respectively and available to view through www.ancestry.co.uk). Workmen's houses are acknowledged at the site from the mid-18th century but caution has been exercised in ascribing their location to the present forge cottages.

The National Census records all the persons present at an address on the census day. Census days are 10 years apart; they therefore provide a snapshot of the residents of Derwentcote at regular intervals. The census not only names the heads of families at Derwentcote but gives details of whole family groups, including servants. The weakness of the census data is that little more than ages, familial relationships, occupations and places of birth can be determined. Family members absent from the home on the night of the census will be missing from the record and individuals and families who lived at Derwentcote between the census dates are missed from the record altogether.

The census returns were developed over time to show more information. The 1841 record is very basic. It lists all the people between Byreside to the south and Blackhall Mill to the north-west, within the township of Medomsley, as living at Derwent Cote in fifteen separate buildings, two of which are both described as the Derwent Cote Gate which was the tollhouse on the junction of Forge Lane and the Shotley Bridge Road. The only other information in this early census is the ages of the occupants of the dwellings, their occupations and an indication as to whether the occupant was born in England or elsewhere.

The 1851 census was improved to indicate the head of each occupancy group and the relationship of each other occupant to the head and the marital status of all mature occupants. Information on the place of birth was added to show town/village and county. All dwellings were given an individual consecutive schedule number. The enumerator for 1851 differentiated the Derwent Cote Forge addresses from Derwentcote indicating that 11 properties belonged to the works. Derwent Cote Forge addresses fall to 7 in 1861. It was not until 1871 that the phrase 'Derwent Cote Forge Cottages' was first recorded for four properties but additional notes by the enumerator continue to cast doubts on these four being the present forge cottages. The Forge Lane properties lost their nominal link to the forge but remained available for the steelworks management; an arrangement which remained until the works closure.

The form of the census return remained unchanged until 1891 when the number of rooms occupied within a house (if that number was under five) was given. Larger houses are therefore suggested by a blank entry in the census report. The employment status was also given for the first time, indicating whether the individual was an employer, an employee or in neither category. From 1891 to 1911 'Derwent Cote Forge' is only applied to the 4 cottages (and their sub-divisions in 1911), which are certainly the 4 cottages whose remains are visible today.

Analysis of the census returns strongly suggests that Derwentcote was divided into five areas of occupation: Derwentcote (manor) House with its lodge house (the former barley mill) and farm (the farm was at least once leased out to the Steelworks' manager), Derwentcote Gate, which was the toll gate at the top of Forge Lane which had been divided into two units and a cottage on the south side of the Shotley Bridge road, Derwentcote (Forge Lane) House, generally occupied by the steelworks' manager with two cottages in its curtilage, East Derwentcote Cottages, or Cottage, which were built in the immediate vicinity of the Derwentcote Crane Gate on the south-east corner of the area, and the forge area. The Derwentcote Crane Gate was the toll gate for the main turnpike road, the A694, from Swalwell to Ebchester. Derwentcote Gate took the toll from carts using Forge Lane.

Other official records for the population exist, notably parish registers. Analysis of the census returns has also been used to discuss trends within the workforce of Derwentcote; its size and changes in origin and addresses the occupation of the forge cottages, suggesting a method for ascribing the location of individual family groups within the buildings.

Some aspects of the lives of the Derwentcote residents have been traced through mention in the contemporary press indicating some of the experiences of the individuals and providing more detail of their periods of tenure. There are also three known historical photographs of Derwentcote. One (see section 6.4) is a photograph of what appears to be a family group standing at the Derwentcote millpond dam head in the forge area during the steel working period. Another is a post-closure landscape of the *Damhead* (see section 6.5) which was published as a postcard by Shurey's Publications of London. Shurey's were active between

1903 and 1927 (Petrulis 2017), and the last is an indistinct aerial shot of the forge cottages taken on the 1st January 1945, available through *Google Earth* (see section 6.5).

Much of what is known of the activities taking place at Derwentcote during the early period of its afterlife has been provided through the oral testimony of Mr and Mrs Ken Haley (6.5 below), local residents who live close to the site, and through them Mr William Kerr, Mrs Haley's brother, who was instrumental in the final abandonment of the Forge Cottages.

Details of the archaeological work at Derwentcote have been presented in 4.3.4 above. Recent fieldwork by Newcastle University has been recorded in unpublished interim reports (Webster and Young 2012, 2013; Webster *et al* 2015). This fieldwork has been used to analyse the built environment at Derwentcote and provide examples of the material culture of some of the people living in the forge cottages. The cottages were numbered 1 to 4 by the University excavation (fig. 6.3) and that numbering is adopted in this chapter. During the Newcastle University excavations attention was given to the quantities of stamped colliery bricks and red common bricks found across the forge cottage site. A discussion of how the brick types can inform on the biography of the site has been integrated within the chapter.

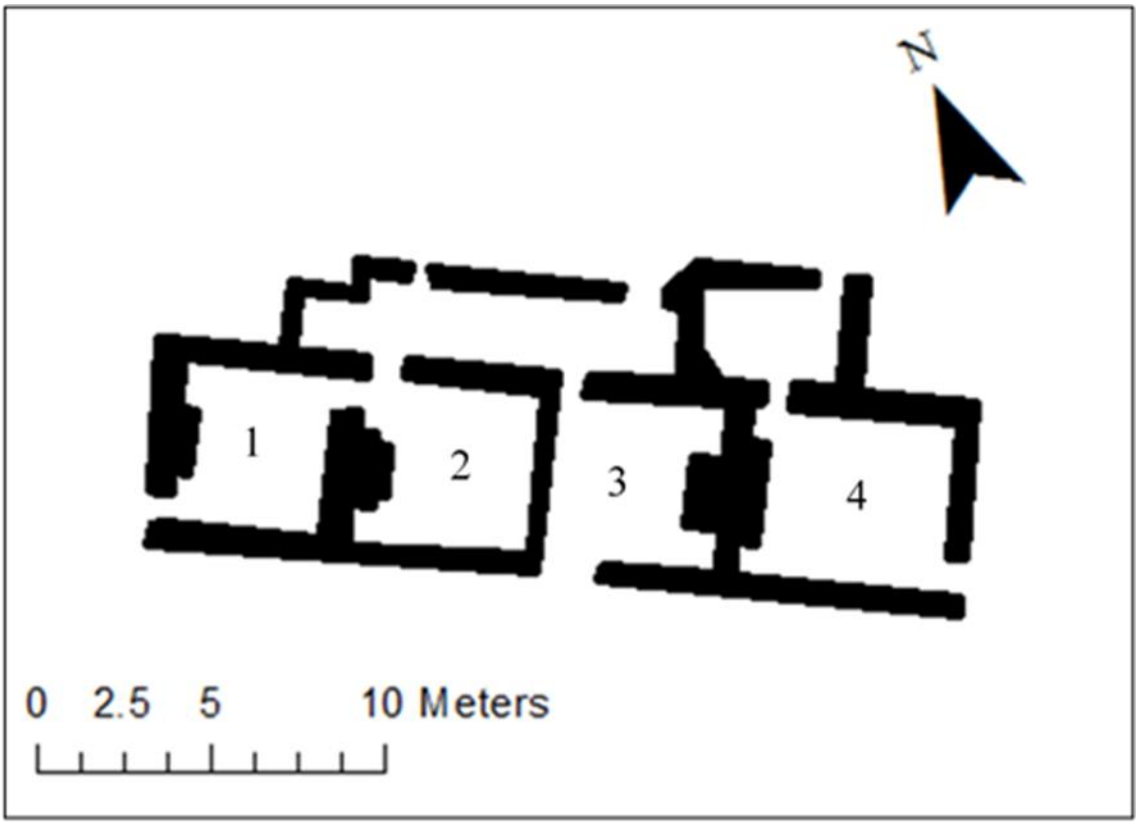


Figure 6.3 Numbered footprint of Derwentcote Forge Cottages.

6.2 Derwentcote: a pre-industrial rural estate 1569-1718

Derwentcote originated as part of the Chopwell estate of the Swinburn family who had entered the land as tenants of the Church and, it is conjectured, gained ownership through the Crown between 1553 and 1562 (Surtees 1820: 259-83). John Swinburn forfeited Chopwell to the Crown in 1569 due his part in the Northern Rebellion of Catholic noblemen against Queen Elizabeth I, the part known as Darwencote was described as:

> The tenement called Darwencote, and the water-milne, and the park, and the wood called Darwencote Hagg, the Midlefield and Ormeside (Surtees 1820: 292)

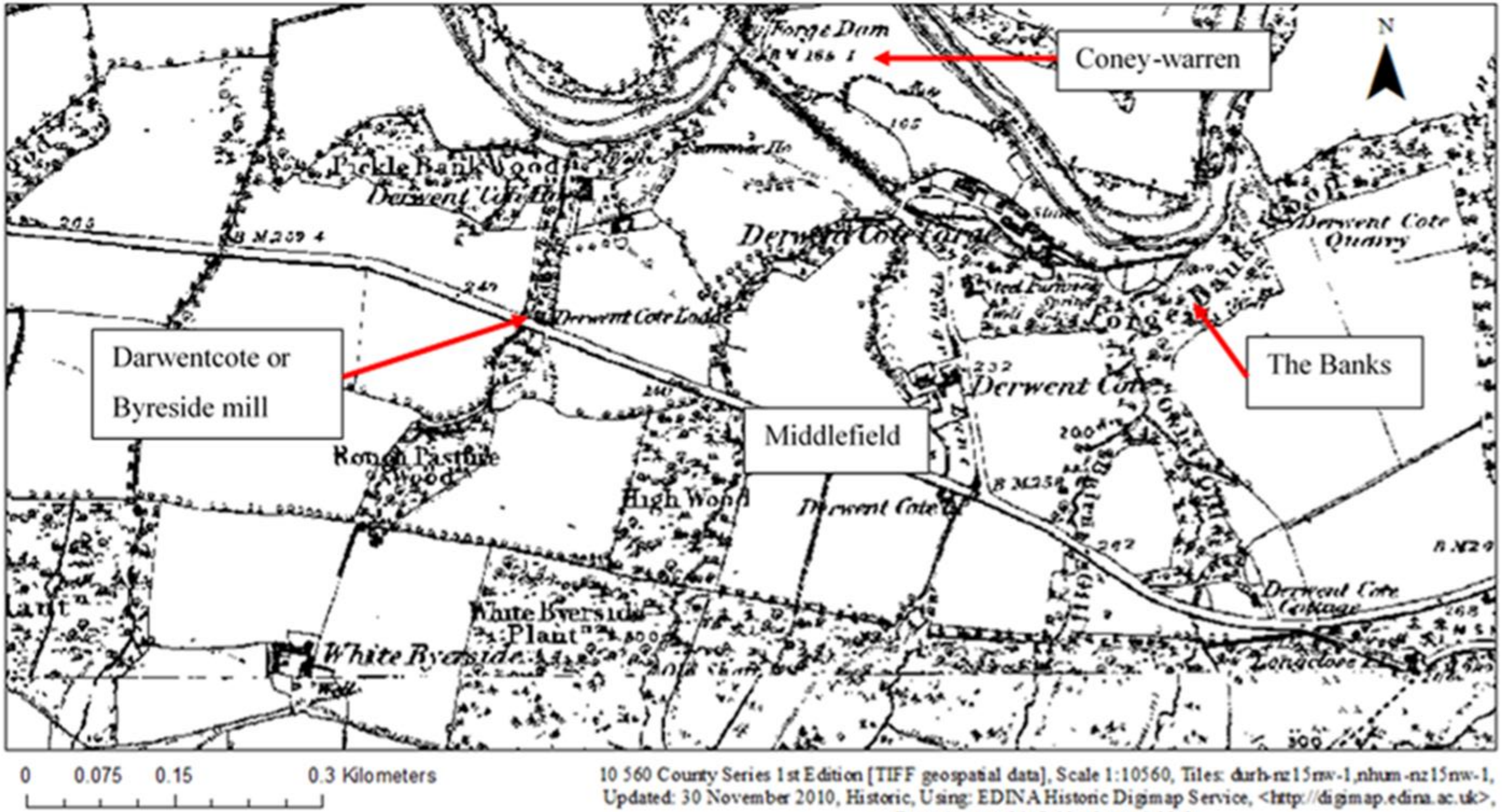
The name *Darwencote* may have an origin indicating the presence of a building near to the *Darwen* or Derwent. The suffix 'cote' is derived from the Old English for cottage or may equally refer to an animal shelter, usually for sheep (Beckensall 1992: 8). The presence of a park may confirm the existence of a house in the vicinity, or the park may have been accessed from the north side of the river by the Swinburns, There is, however, a water-mill present whose function is not specified, though the importance of this parcel of land may have been founded on the ownership of this building, and it may be that the woodland, parkland and agricultural land listed in 1569 was bound to the mill for reasons of access. Derwentcote Hagg was undoubtedly the land lying to the east of the later forge site. Modern OS map analysis shows an area of land c1.5 x c0.6 km bounded to the south by the A694 road occupied by the features Hagg Farm, Haggdene Wood and Hagg. *Ormeside* may well have been Armondside, a piece of land now occupied by a farm of the same name on the north bank of the Derwent, opposite the forge site.

King James I granted Derwentcote to Sir William Constable (bap.1590, d.1655), of Flamborough and Holme, Yorkshire c.1611. Constable was a spendthrift and sold most of his estates to cover the debts run up during his lifetime. He was forced to sell both his manors of Holme and Flamborough in the mid-1630s (Scott 2004). The disposal of Derwentcote, along with Blackhall by Philip Constable to Sir William Carr of Cocken, Co. Durham, on the 1st July 1614 may have been an early expediency. In a mid-17th century pamphlet listing all the villages of England (R.H. 1655 in Spelman 1723), the name Darwencote appears in the Bishopric of Durham. The preface explains that the places named within the list are '*confderable* Villages' and 'single houses' are omitted (*ibid.* 193). The village of *Medumfley* and two named Blackhall are also listed suggesting that Darwencote has not been confused with either of its nearest population centres. This suggests that a sizable community existed at Derwentcote at that time, though whether this was located around the mill or elsewhere is impossible to tell. Under the ownership of Constable and Carr, Derwentcote would have appeared as a fine country estate, centred on a mansion surrounded by parkland, meadowland, pastureland and woodland, with possibly the only other building of note, the water-mill, processing agricultural products.

By 1660 Derwentcote had passed to Francis Carr who, on the 13th June of that year, granted the manor to Ambrose Stevenson of Byreside, Robert Surtees of Ryton and George Surtees of Broadoak. These three, all described as 'gentlemen', split the estate between them on the 6th June 1661. The absence of Armondside and the Hagg in the 1661 sale may be indicative that the Surtees family had already bought them from the Carrs by this date as they certainly formed part of the greater Hamsterley Estate in the 19th century. The account of the division states that:

> Stevenson took Darwencote-mill, the Middlefield, the coney-warren and the Banks; described as the eastern portion. Robert Surtees took the Mansion-house, the meadow, Park-heads, the Meadow-close and the Pig-hill; and George Surtees took the Walke-Milne meadow, the Stanners and Coult Parke as the western portion. (Surtees 1820: 292-3)

The above account clearly shows the existence of a mansion-house at Derwentcote in 1661 which may also be the tenement of 1569. The mansion is shown on the first edition OS map of 1856 (fig. 6.4) as being sited within Pickle Bank Wood which may be Surtee's 'Pig-hill'. The exact limits of the agricultural land bought by Surtees is uncertain as the names Park Heads, Meadow Close and location of the meadow have been lost to the documentary record, but if his portion remained intact until the 19th century, the estate which surrounded Derwent Cote House, advertised in 1841 (*Newcastle Courant* 28 May 1841, second part:1), was of 79 acres. The lack of a mention of workers' cottages may suggest they formed part of the mansion demesne. Perhaps this was the settlement of Darwencote noted in the *Villare Anglicum*.



10 560 County Series 1st Edition [TIFF geospatial data], Scale 1:10560, Tiles: durh-nz15nw-1,nhum-nz15nw-1, Updated: 30 November 2010, Historic, Using: EDINA Historic Digimap Service, <http://digimap.edina.ac.uk>, Downloaded: 2017-09-19 11:13:22.51

Figure 6.4 Area map of Derwentcote. 1st edition OS map showing elements of Stevenson's portion of the estate. Robert Surtees portion lies to the north-west and west. The patch of woodland to the west of Pickle Bank Wood is the east end of Colt Park Wood, part of George Surtees portion. To the east of the (Forge) Banks lies the Hagg – part of the original estate.

The western portion of Derwentcote estate, bought by George Surtees, contained the Coult or Colt Park; its name lived on in the Colt Park Wood, visible on the 1856 OS map, and it has been recently redeveloped as housing. Surtees (1820: 293) indicates that the Coult Park extended to the area of Cronniwell, until recently marked by a public house of the same name on the north side of the A694 in Hamsterley. The Walke-Milne meadow was probably the land that lay on the south bank of the Derwent to the north of the Coult Park; Walke-Milne may have been a reference to a path across the meadow leading to the Blackhall Mill on the north bank. Mapwork offered no evidence for a feature which may be equated with the Stanners.

Stevenson's portion was later leased out for the Derwentcote Forge. The Banks, taken by Stevenson, are those now known as Forge Banks; these are on the steep sides of the valley to the south side of the river and contain Derwent Cote Quarry. The Forge Banks Woods connect at their eastern end with the Haggdene Wood. The Banks may therefore be the western remnants of the 'woods called Darwencote Hagg' in 1569 or planted up later to replace the lost asset. The coney-warren comprised the fields lying to the north of the later forge (Medomsley Estate Map 1842). Coney or rabbit warrens were a means of managing rabbits for commercial use (Rackham 1986: 47-49). At Derwentcote the warren is naturally bounded from east to west by a northerly meander of the river (rabbits hate to swim) (*ibid.* 47). The Middlefield may be the remainder of the land of Stevenson's portion stretching west from Owlet Gill to that of Robert Surtees's. The position of Darwencote-mill is unclear. Beneath Derwentcote Lodge, to the west end of the Middlefield are the remains of a capped millrace which is culverted off the property to the north. To the north of the Lodge the remains of the miller's oven and cottage were visible at ground level until the current owner, Mr Ken Haley, covered them during the landscaping of his property some 40 years ago.

The conjectured blast furnace at Derwentcote, suggested through the slag deposits collected through both the TimeTeam and Newcastle University excavations (see 4.1, 4.3.4 above), may have been built and abandoned under Ambrose Stevenson. Cranstone suggests that the Gibside forge may have been supplied by the Derwentcote blast furnace (2014: 30), with the ore coming from Gibside. The same ironstone seam which ran beneath Gibside may have been accessible at Stevenson's Byreside estate which stood on the south side of the valley above Derwentcote. Stevenson died in 1713 and was succeeded by his son, John. The Derwentcote blast furnace may not have continued in operation until 1713: the date when it is thought that the Allensford blast furnace was abandoned.

The lack of documentary evidence for the Derwentcote blast furnace may suggest that Stevenson operated it as an own-account venture so no leases were required. The building stone still visible in revetments of the Derwentcote dam head on the south bank of the Derwent and the northern bank of the millpond (fig 6.5). Similarly, the millpond dam face and overspill, the wheel pit to its east and the extant linings of the mill tailraces, are built of stone extracted from his Derwentcote Quarry. Cranstone further contends that the forge dam was built for this blast furnace (*ibid.* 30). The siting of a blast furnace to the south-east of the wheel pit at Derwentcote could suggest an arrangement similar to that at Allensford, with access to the top of the furnace being facilitated by Forge Banks (fig.6.6).

Figure 6.5 Derwentcote millpond. Stone revetment on the north bank. Photographed from the overspill on the south bank. (Photograph: J. Bowman 2016)

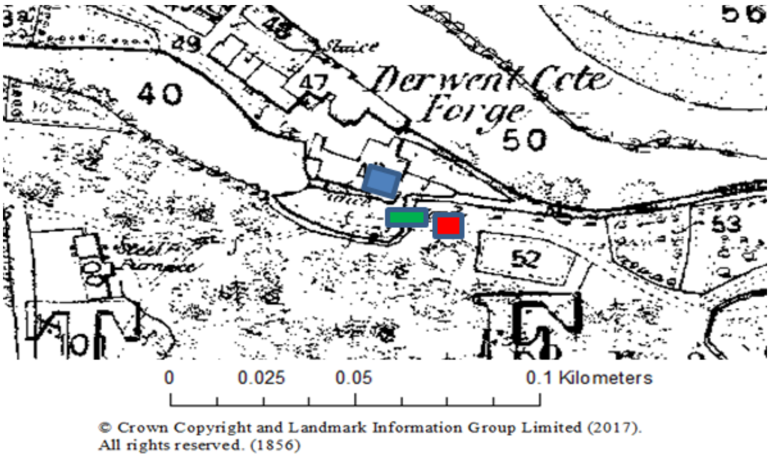


Figure 6.6 Conjectural layout of Stevenson's ironworks. Overlaid on 19th century forge - blue = finery forge, green = bellows house, red = blast furnace.

The line of Stevenson’s headrace is still clearly visible as an earthwork stretching from the dam head area of the Derwent to the west end of the millpond (fig 6.7). The water-management infrastructure left by Stevenson would certainly have been a factor for siting some later form of powered plant.

Figure 6.7 Derwentcote head race inlet. Photographed from the north-west.
(Photograph: J. Bowman 2016)

Derwentcote was essentially a rural estate until the intrusion of a blast furnace at the very end of this period. Very few finds dating to this period have been recovered; the only securely dated finds are tobacco pipe bowl dating to 1610-40 (Ayto 2002: 8) and an Elizabethan coin. The pipe (fig. 6.8) was found in the rubble to the exterior of stone wall to the south-western corner of the forge cottages. The coin was found close to the pipe, it was recovered from the top of the soakaway which runs outside the west gable end of cottage 1. The lack of finds perhaps suggests the iron working area had a small footfall during the period. The pipe would have been contemporary with the village of Derwentcote, allowing for the possibility that material from the lost village was reused at the ironworks site.

The family historian, William Gelley, produced an account of his family connections with Derwentcote beginning in the 17th century (1983: 96-7). In his account, the Gelleys arrived in England from Germany as iron workers and settled in Newburn outside Newcastle. Of the next generation, Richard and John appear in the Medomsley parish registers in 1681, and were said to work at 'the forge' at Derwentcote. This may suggest that Stevenson brought iron workers into the area to operate his blast furnace and that there was at least a finery forge present. Gelley states that his family had connections with the forge for 150-160 years and as will be seen below they were still present in the 1850s.

Figure 6.8 17th century pipe bowl.
(Photograph: Derwentcote assemblage 2012)

6.3 Contribution to the Industrial Revolution 1718-1850s

John Stevenson leased his Derwentcote estate to a business partnership of Alderman Ralph Reed of Newcastle and William and Richard Thomlinson. An order, placed with the South Yorkshire ironmasters partnership for cast-iron forge plates, dates the establishment of the forge to 1718 (Barraclough 1984a: 67). This date is agreed by the term remaining on the lease, being given as 75 years in 1742 (*Newcastle Courant* 23 October 1742: 3). The Swedish industrial 'spy' Henric Kalmeter reported the existence of a forge at Derwentcote in his diary for 1719 (Barraclough 1984a: 209). Wessex Archaeology's phasing of the area of the forge they excavated indicates that the earlier structures, built onto the natural geology, were of 'well-hewn and regularly coursed sandstone' while later stone work was 'relatively poorly constructed' (Wessex Archaeology 2012: 7-8). Cranstone contends that the initial workforce at the forge included Irish forgemen (1997: 22), suggesting that there may have been insufficient local ironworkers willing to start a new venture.

Under Reed, sustained industrial development began at Derwentcote, attracting its own community of iron workers. Reed died in 1720 and his wife, Isabel, sold his share in the business to the Thomlinsons, her brother and nephew, who continued to operate Derwentcote as Richard Thompson and Co. until 1733 (Cranstone 1997: 19). The lease for Derwentcote or 'Derwent Coat Mill, otherwise Byarside Mill, with lands adjoining, an iron forge, warehouses, workinghouses and other buildings' (Quoted in Cranstone 1997: 19) was taken by a partnership of Cuthbert Smith, Thomas Wasse, Ralph Harle and George Blenkinsopp in 1733 who held a lease on one of the former Hollow Sword Blade Company sword mills from the same time (3.2.1 above). The lease gives primacy to the mill and the lands adjoining, suggesting that the Thompsons may have considered the market for iron forging was over. The Allensford forge closed around the same time.

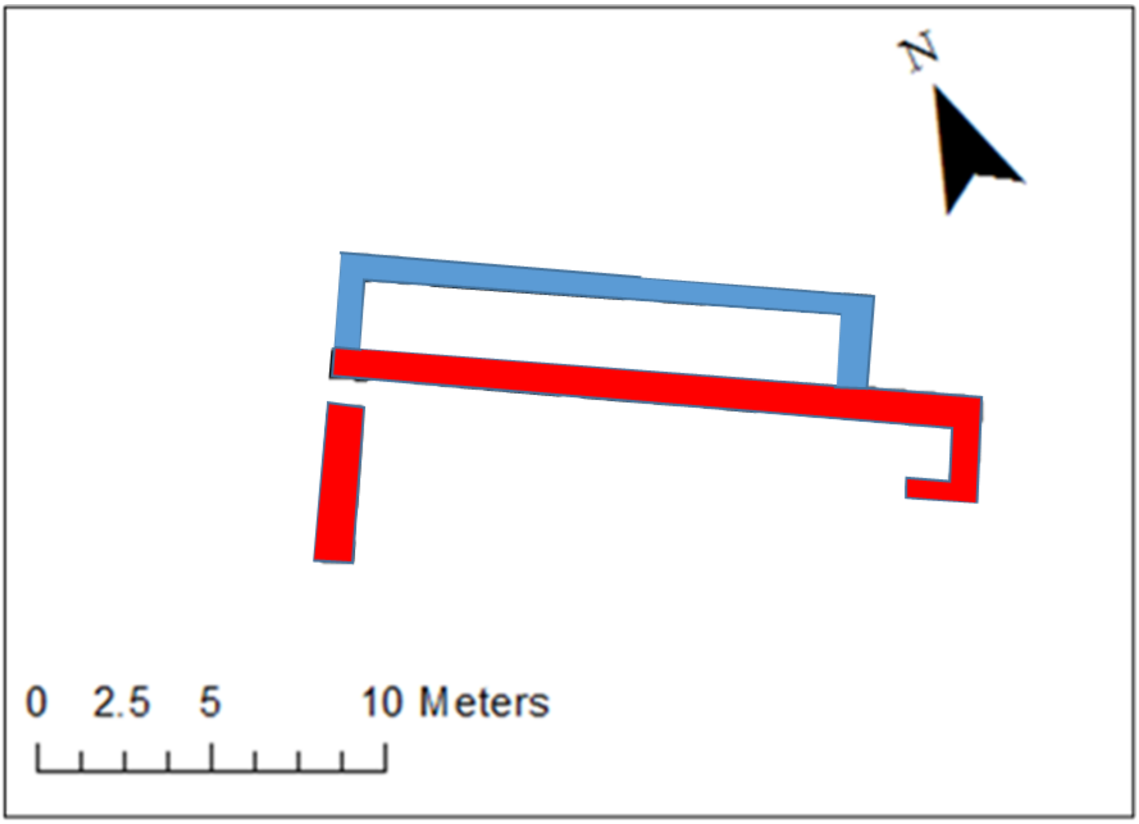


Figure 6.9 Conjectural initial industrial phase of the forge cottages: 1718-c.1780s. Red = initial structural wall as identified through excavation 2012-16. This wall is punctured by several doorways, both blocked and open along its east-west length, suggesting a permeable barrier to the rear area Blue = possible extent of original stone wall based on fieldwork observations and OS map footprint. Any remains are presently sealed beneath a later brick wall and concrete.

A range of buildings appears to have been developed at the ironworks under Reed and partners, amongst these may have been the stone-built 'charcoal store' sited between the west of the forge and the stone structure which was later developed into the forge cottages.

What became the forge cottages appears originally to have been a single three-sided, stone-built structure, open to the south, which gave access to the forge entrance track (fig. 6.9). There may have been a doorway at the north end of the west wall (Webster *et al* 2015: 30). The long east-west wall has a small plinth running along its north face at about waist height which may suggest that the stone work went up in two phases. The size and position of this building would suggest it may have been the warehouses mentioned in the lease. It may also have originally been open to the sky. Crowley's works at Winlaton Mill and Swalwell contained several 'dead walls', one of which 'is Dead Wall Against which any thing is laid' (Warner 1718: 5).

Denis Hayford's death in 1733 may have led to concern over a steel supply for Shotley Bridge and the Smith partnership built its own cementation furnace between this date and 1742.The furnace appears in a notice for the sale of the lease in the Newcastle Courant:

> Darewntcoate Forge, together with a Steel furnace, a Mill for making French Barley, Warehouses, Workmens Houses etc, all in very good Repair, except the Barley Mill. (Newcastle Courant 23 October 1742: 3)

Unlike the 1733 lease, the forge is the primary item for sale. It can be assumed that the Steel Furnace surviving today is on the same site as the one built by Smith and partners; however, the constant repair and lack of absolute dating evidence prevent certainty. There is no evidence for a cementation furnace at the Forge site and so the construction of the Steel Furnace may represent the first stage of the development of the area to the south of the Forge on the crest of the steep Forge Banks. The Forge failed to sell in 1742 and was represented in 1748 with a much fuller description of the estate:

> Darwentcoat Farm and Forge, a Steel Furnace, and Smith's Shop, Warehouses, and Workmen's Houses, and other Erections therewith enjoy'd, held by Lease for a long term of Years, and of which about 72 years are yet to come; with the necessary Materials and Utensils now used with the forge, with the Bellows and Anvil belonging to the Smith's Shop; together with a small farm, adjoining to the

said Darwentcoat Farm, held by Lease for a term of Years yet in being, taken for the Convenience of Way-leave to the said Forge. (Newcastle Courant 30th Jan. 1748: 3) .

Figure 6.10 Derwentcote House. Occupied by a succession of steelworks managers and their families. There were cottages to its rear, but these were demolished in the 1980s. Photographed from the south-east. (Photograph: J. Bowman 2016)

The major differences between the advertisements of 1742 and 1748 concern the smith's shop and the specific inclusion of Darwentcoat Farm and a small farm adjoining it. The smith's shop, unless merely omitted in 1742, indicates that Smith and partners were still developing the site. A separate smith's shop suggests that items were being produced on site. The single anvil suggests that it was a small workshop, perhaps in the style of Crowley's unpowered workshops at Winlaton (see 4.3.3) and may have only been for items for consumption at the works. The purpose of leasing the small farm was to negate the way-leave for traversing Forge Lane; a factor which had not been documented before. The lane passed to the west of the forge and furnace. It carried traffic from the south side of the valley, over Derwentcote Ford, to Chopwell on the north side. Requiring control of the lane suggests that raw materials and finished products were brought in and dispatched to the south. The house called Derwent

Cote (fig 6.10), on the west side of Forge Lane and a little to the south of the cementation furnace, and its attendant cottages, may have been built about this time performing the function of both farmhouse and manager's dwelling. One possible reason for the protracted period of sale between 1742 and 1748 may have been the tenancies of the workforce. George Blenkinsopp attempted to evict six workmen between 1746 and 1748: George Beavins, Joshua Copely, Joshua Cotton, two Thomas Elteringhams and John Ward (Cranstone 1997: 22).

It must be considered that Smith and partners would require German steel for their sword making business. It is uncertain when they attracted Bertram's secret for the process from Blackhall Mill, but by the time Angerstein visited Derwentcote in the late August or early September of 1754 he found the business in the hands of John Hodgson of the Close, Newcastle, and the works was producing German steel:

> Derwentcote forge belonged to Mr Hodgen in Newcastle and consists of a hammer with two hearths with a yearly production of 150 tons of bar iron. The pig iron and comes from London and some of it is American and some English. The charcoal used for the firing is collected from many miles away, and the wood has to be bought in advance, and is subsequently made into charcoal and carried to the works. It was said that a horse load of 10 bushels cost 4/6. Pitcoal can be bought cheaply in the neighbourhood and is, therefore, used in the chafery hearth. The firers are paid 10.1/2 shillings and the smiths at the chafery hearth 9.1/2 shillings a ton. The bar iron is consumed in the district and is used for the fire grates of steam engines, for axles of coal wagons and for other similar purposes that do not require the highest quality iron. A steel furnace and a hammer for drawing out the steel also belongs to this works. The furnace is of the same design as the one described at Blackhall Mill. The pots are charged with 10 to 11 tons of Oregrund iron at a time and the heating takes 6 to 7 days, and the cooling 12 to 18 days, 40 shillings worth of coal is used [both pitcoal and charcoal] of which some can subsequently be used again. There are two workers who are paid 8 shillings [per week] and 2d each per ton of steel. The man in charge of the steel forging was an apprentice of old Bertram's and he also makes a few tons of the so-called German Steel, but the main work carried out here is plain drawing out of blister steel to 1" and ¾" square bars that are collected together into bundles of half a hundredweight and dispatched to London for the East India Co. The production of

> steel is little more than 100 tons per year due to a limited source of Oregrund iron. (Angerstein 2001[1765]: 272)

Under Hodgson the forge appears to have shut its smith's shop and concentrated on wrought or bar iron and steel production. The forge has the hammer and two hearth arrangement which was typical for such a process. One hearth would be a finery used for decarburising pig iron and thereby converting it to wrought iron. It would require powered bellows as well as a powered hammer. The other hearth was the chafery where the decarburised wrought iron blooms would be shaped into bar iron of merchantable dimensions. A second and separate hammer is inferred for steel production. The supply of pig iron from London strongly implies Crowley was its source. Cranstone (1997: 23) found no evidence that Derwentcote supplied the East India Company with blister steel, however, Angerstein noted at Crowley's Swalwell works that such a large order had been received from the East India Company that all Crowley's forges were occupied with it. This may suggest that Hodgson sub-contracted work from Crowley (2001 [1765]: 261).

Though Angerstein was given Hodgson's name as owner of Derwentcote, Hodgson was in a partnership with Gabriel Hall and others. Hall held the lease on Blackhall Mill in a partnership with John Cookson. Another Swedish spy, J. L. Robsahm, visited Hodgson in 1761 where he noted that Hodgson was using the same maker's stamps as were used at Blackhall Mill plus his own name (translation in Barraclough 1984a: 203). Barraclough contends that this indicates that Hodgson operated Blackhall Mill as well as Derwentcote and therefore all steel production within the Derwent Valley not controlled by Crowley (*ibid*. 69). Hodgson was declared bankrupt in 1782 (Cranstone 1997: 20).

The path of the lease on Derwentcote is opaque from 1782 until 1784 when Richard Chambers and his partner, Landell, applied to Henry Cort for a licence to use his puddling process at the ironworks. Both a puddling furnace and a separate air furnace were built and were in use by 1788. Landell and Chambers continued to produce steel until 1795 (*ibid.* 20,24). Richard Gelley is known to have been a forgeman at Derwentcote in the 1780s (Cranstone 1997: 22) and had been present in the area since the 1750s.

Isaac Cookson, who also operated Blackhall Mill, may have taken over the Derwentcote ironworks by 1788 as he is named in the Medomsley Land Tax assessments from that date. The name Ruben Richley and Co. also appears alongside Cookson in the assessments, of which nothing more is known (*ibid*. 20-1). Cookson formally announced his control of Derwentcote in 1797 from the anonymous Owners of Derwent Coat Forge (*Newcastle Courant* 15 April 1797: 4). A description of the forge in 1794 listed three hearths, two fineries and a chafery, and a balling furnace (Riden 1987 in Cranstone 1997: 24). The balling furnace was undoubtedly the air furnace noted above. The absence of the puddling furnace and the addition of one finery suggests that the management of Derwentcote had abandoned Cort's process. The steel furnace and hammer reported by Angerstein are also missing. These may have been mistaken for a finery, or Derwentcote and Blackhall Mill may have become an integrated unit with all steel forging taking place at the latter site.

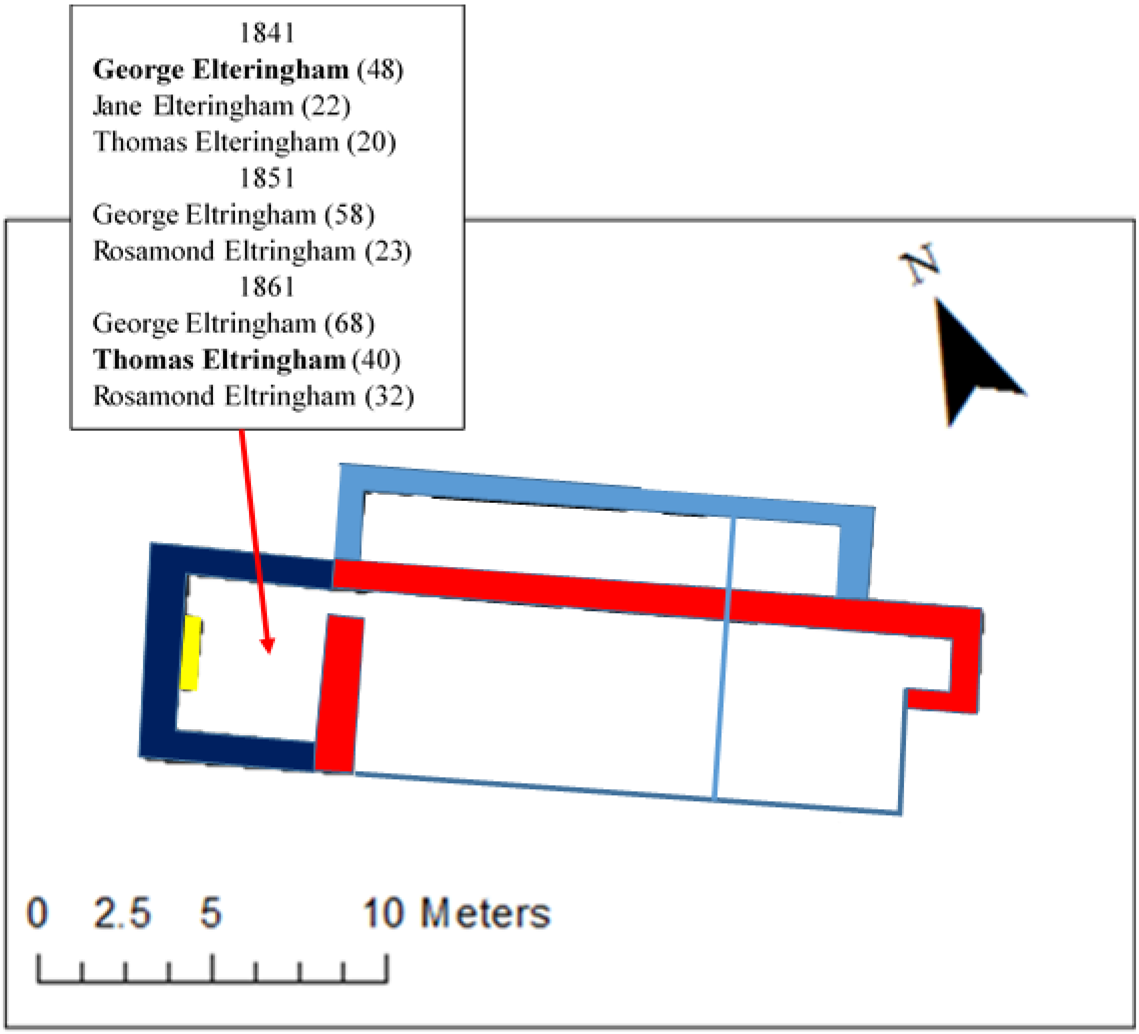


Figure 6.11 Conjectural development of the forge cottages 1780s -1850s. Based on the footprint shown on the 1st edition OS. Dark blue = a stone extension butted onto the red wall. This extension probably originally had an industrial function, possibly a secure area. Yellow = hob grate fireplace inserted against the dark blue wall converting the chamber to a domestic space. Based on national census returns this room may have been occupied by George Eltringham and his family (names in bold indicate employed at the forge). Light blue thin lines = footprint shown on the 1st edition OS, the fabric of the building edges indicated by these lines is unknown. Any remains are presently sealed beneath later brick walls and concrete.

The transition of the 'warehouse' to a domestic building may have commenced around the late 18th/early 19th century. A single celled stone extension, forming the footprint of cottage 1, was added to the west of the 'warehouse' building which comprised the earlier structure at the forge cottages site (fig. 6.11). Post and stake holes were found in the natural clay within the interior of the extension and these showed no alignment with the walls (Webster *et al* 2015: 5-6). These holes may have held timbers serving some industrial purpose within the extension, or been present and removed from the original structures exterior to facilitate the new building. A heavily degraded iron object was recovered from the bottom of one of the stake holes. The western extension may have been the first part of the forge cottages site to be converted to domestic use as a red brick fireplace containing a hob grate of the Pantheon type was imposed onto the western wall (fig. 6.12). Webster and Young (2012: 9-10) have argued for a late 18th century date for the fireplace, though the hob need not have been a new unit when it was installed. The depth of the fireplace construction bricks is c.50mm, which supports an 18th century installation. This date would suggest a slightly earlier date for the construction of the extension.

Figure 6.12 Pantheon hob grate. Cottage 1. Scale 1.0m. (Photograph: J. Bowman 2012)

In January 1803 Joseph Gelley married Elizabeth Brown at Medomsley. One witness was Christopher Oley of the Shotley Bridge sword-making family (Gelley 1983: 96). This indicates that there were bonds of friendship between the steel making and sword making communities in the Derwentcote area.

Pottery has been found scattered throughout the excavated areas of the cottages both internally, externally and within tumble layers. Quantities of ceramics which can be dated to the 18th century were recovered from sub-floor level contexts of the western stone extension. Evidence that the sub-floor contexts had been disturbed, and presumably resealed in the 1850s or later, was provided by the insertion of two drains which included crucible pot lids within their fabric. These drains may have replaced crude gullies cut into the natural which drained the building through culverts through the north and west walls of 'proto-cottage' 1. This may have ensured that the artefacts in these contexts were less likely to be redeposited from elsewhere which is the case with material recovered from other contexts across the site. Analysis of the ceramic assemblage by Jenny Vaughan of Northern Counties Archaeological Services for the Forge Cottages Project (2013) revealed that the dominant fabrics present are, in descending order of quantity, redware, creamware, stoneware, transferware and earthenware.

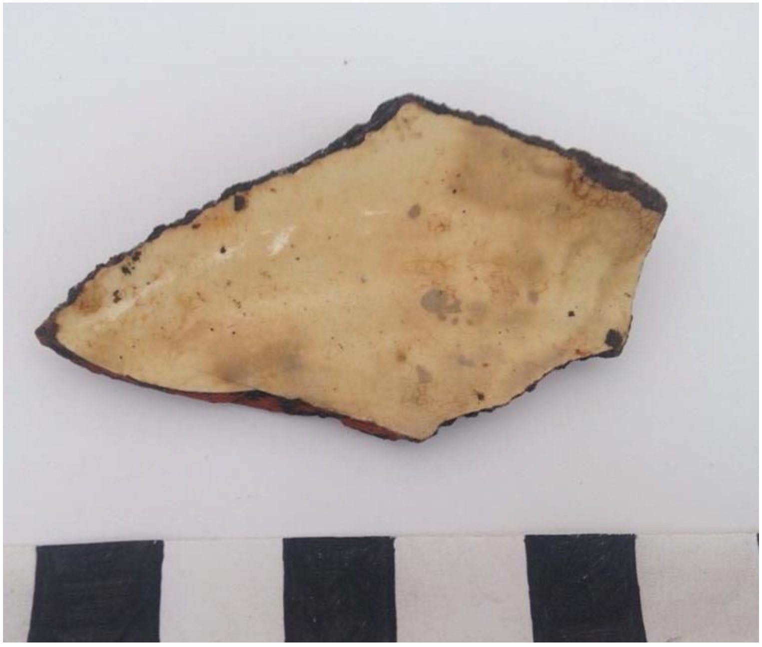


Figure 6.13 Redware with yellow interior slip glaze.
(Photograph: Derwentcote assemblage 2012)

Redware (fig. 6.13) is a form of stoneware originating in the 1790s and still produced to c.1900; the stoneware was produced from the 1730s up until the 1900s. Such material is representative of everyday low-status utilitarian items: cooking pots and storage jars. Creamware is a form of earthenware with an all-over cream glaze. It was developed in the mid-18th century for kitchen use and tableware. Sherds of transferware, notably the 'Willow Pattern' (6.14) demonstrates that the residents of Derwentcote exercised choice in their tableware and were aware of the fashion and desirability of such items. The popularity in transfer ware began in the late 18th century, spread nationally throughout the 19th, and it is still in production today. Larger items of transfer ware may have been used for display within the home, for example, on a sideboard. Such items may have been curated as heirlooms for successive generations living on the site.

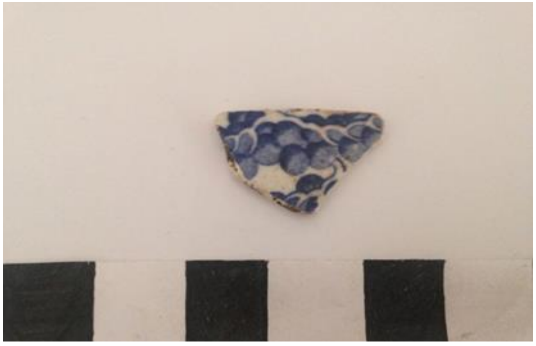


Figure 6.14 Transfer ware sherd.
(Photograph: Derwentcote assemblage 2012)

The fourth most common ceramic material recovered was earthenware. The sub-floor contexts of the western cottage contained some tin-glazed earthenware dated 1800-1900, and green glazed dated from 1750-1900.

Figure 6.15 Famile Verte style porcelain sherd.
(Photograph: Derwentcote assemblage 2012)

Several pieces of porcelain (6.15) and pearlware, both plain and decorated were also found in the sub-floor contexts. The porcelain is dated 1720-1900 and the pearlware 1799-1860. These represent high status materials whose presence suggests that the workforce could display the wealth gained through the well-paid steel making. Pearlware originated in the mid-18th century as a cheaper substitute for porcelain and may represent aspirational purchases by the tenants.

The oldest item from the sub-floor contexts was a fragmentary piece of Staffordshire ware dated to 1675-1775. Its red body is decorated with a yellow slip glaze which has been hand combed and has scalloped edges. This piece may represent one of the earliest breakages and discards on the site or a curated piece. The assemblage of ceramics discussed above could have been deposited beneath the floor of cottage 1 by the 1850s - numerous remnants of clay tobacco pipe stems recovered have been dated to 1800+ - and may represent the domestic life of the iron and steel workers for the first 130 years of documented production.

Figure 6.16 Derwentcote earthenware? (Photograph: J. Bowman 2017)

No examples of Derwentcote ware have been positively identified. A 'brown earthenware manufactory' was recorded as being established at Derwentcote around 1757 (Buckley 1927: 76-7). As there are no known examples of ceramics from this pottery, positive identification of this material is impossible. Examples of a brown gazed earthenware material were recovered from a test-pit dug into the north end of the soakaway and from which the Elizabethan coin was found (fig. 6.16). There may be a possibility that these sherds could be Derwentcote ware.

Cottage 3 had its stone flagged floor removed at some point following its abandonment. Against the north wall a small pit was discovered. Sealed within the pit were the remains of a bone comb (fig. 6.17) and a gilded or enamelled button whose coating had become loose (6.18). Gilded buttons were produced in Britain from c.1800 as an affordable garment fastening which gained an instant popularity (Buttonmonger 2011: 1). The comb may have been used for removing lice from hair and beards attesting to the hygiene conditions at the forge.

Figure 6.17 Bone comb. (Photograph: J. Bowman 2017)

Figure 6.18 Gilded button. (Photograph: J. Bowman 2017)

Surtees remarks in his History that Stevenson's holding passed to a John Wharton and then 'lately' to the Surtees family (1820: 293), then in the person of Anthony Surtees JP who had established himself at Hamsterley Hall c.1806 (Gash 2004), thus restoring the whole of Derwentcote to one estate. In 1807 the Stevenson portion of Derwentcote was offered for sale:

> Lot 17. Derwent Cote Forge and Farm in the Township of Medomsley and Parish of Lanchester, consisting of many Houses, Steel Forges and Buildings and 65A [acres] and 19P [perches] of Land, all Freehold, and held by Messrs. Cookson and Co. under an ancient lease, which will expire on 1st May 1823. There is a valuable manufactory of fine Brick on this Estate. (*York Herald* 5th Dec. 1807: 1)

Here, the acreage of Stevenson's estate is made clear and while the description of the buildings offered is general there is a farm with the sale and a brick factory. The same advertisement offers as lot 16: Byreside West Wood, a farm of over 88 acres and lot 13: a farm at Sheep-Walk, Lanchester Parish, of over 99 acres both also held by Cookson and Co and held by leases of the same expiry date of 1823, indicating a link with Derwentcote. While there is no suggestion that the 'valuable manufactory of fine Brick' was ever the property of the Forge its proximity as a supplier of bricks to the concern cannot be overlooked. Bricks, especially refractory bricks, would be required on a constant basis to make repairs to the lining of the cementation furnaces both at Derwentcote and at Blackhall Mill. No brickworks appear in the historical record for Blackhall Mill. The brick factory may have supplied the red brick used within the fireplace in the warehouse extension.

John Bailey's short account of Derwentcote and Blackhall Mill (1810: 288) does not differentiate between the two sites. He notes the production of blister steel and implies the balling furnace is still in operation. There is also an implication that sock moulds, shovels and boiler plates may have been produced on the site, equally, Bailey's wording may suggest the iron produced at Derwentcote would be used for these products elsewhere. Cranstone argues that Derwentcote closed down for a period about this time (1997: 21). A description of the County of Durham by MacKenzie and Ross, in 1834, reports on Cookson's works. Blackhall Mill is recorded as producing German steel (1834: 205) but contemporary activity is absent from the entry for Derwentcote (*ibid*. 239). William Gelley was at Derwentcote in 1809 (Cranstone 1997: 22) and it may be that he would be redeployed to Blackhall Mill. Another Gelley, Joseph, appears to have worked in the Derwentcote/Blackhall Mill area until 1802 when he left to work at a steel works at Chester-le-Street (Gelley 1983: 96-7). This may suggest that Cookson's workforce was already having to be cut at this time. McCord and Rowe (1977: 38) have noted that Cookson was a main contractor for government armaments orders in the French Revolutionary wars (1762-1802), but do not mention similar contracts for the following Napoleonic wars (1803-15).

The Forge Lane Toll Gate (fig. 6.19) was added to the southern entrance to Forge Lane in the early 19th century, possibly when Cookson's lease expired in 1823. The former importance of Forge Lane is recorded in an account in the Times newspaper in 1858 of a court case between Robert Smith Surtees, the landowner, and a carter named Ritson who broke down the toll-gate and trespassed on the Lane. Forge Lane linked the old Derwent Valley road from Gateshead to Ebchester to the Derwent Ford which led onto the public road on the north side of the river which passed through Chopwell (fig.6.20). The Lane had been used commercially in the years before the railways to transport cart-loads of lead from Weardale to Blaydon; many of the carters came from Medomsley. Following the arrival of the railway along the south side of the Valley, the Lane was used to convey timber from the Chopwell plantations south to the loading-points (*Times* 31 July 1858: 11).

Figure 6.19 Derwentcote Gate. Standing at the top of Forge Lane from the 1830s. Photographed from the east. (Photograph: J. Bowman 2016)

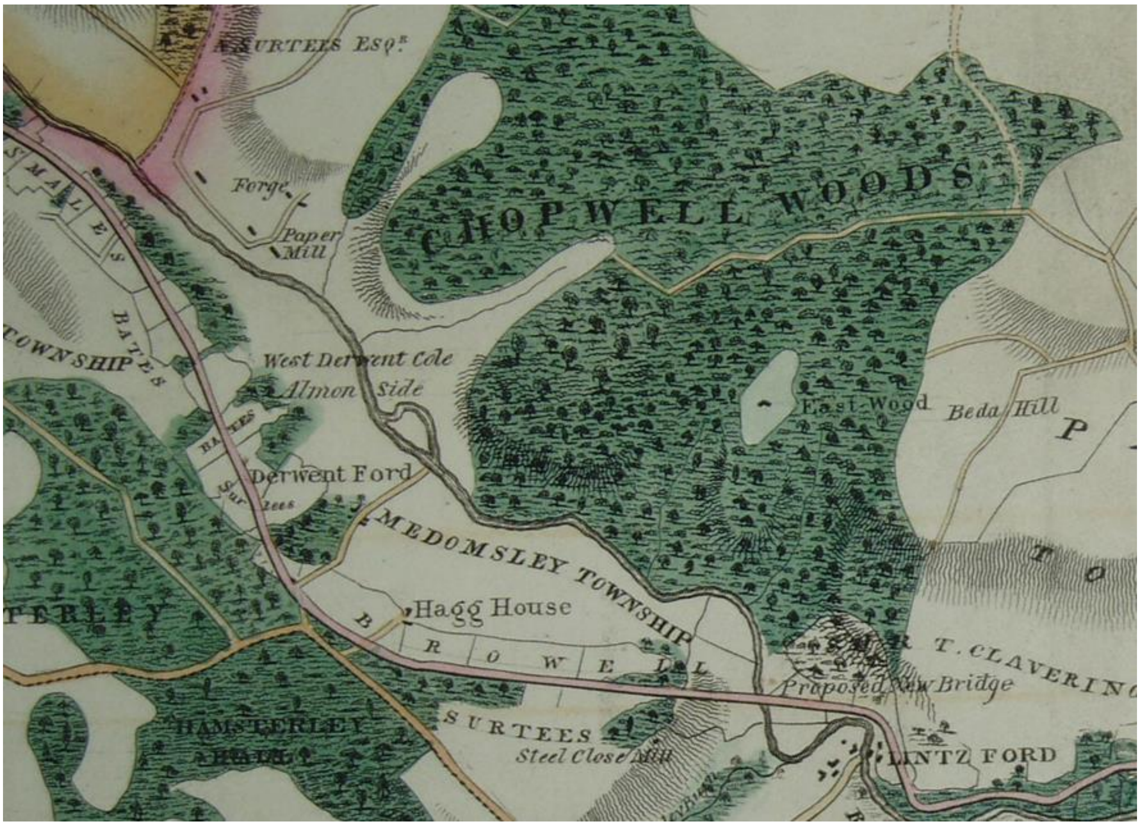


Figure 6.20 Detail of Sopwith's map: 1832. Thomas Sopwith indicated the Derwent Ford at the north-east end of Forge Lane. The island in the river may be the warren field with the meander surrounding its west, north and east sides and the straighter forge headrace cutting the core off from the south. Derwentcote forge is absent from the map though Blackhall Mill forge is represented. (Sopwith 1832)

Isaac Cookson died in 1831 and was succeeded by Thomas Cookson who reopened Derwentcote, installing Thomas Jefferson as manager. Thomas Cookson suffered financial difficulties placing the company in his son's name, C E Cookson and Co. in 1850 (Cranstone 1997: 21). Jefferson appears in both the 1841 National Census return (H.O.107/301/19) and within an advertisement for the sale of (West) Derwent Cote estate:

> Dwelling House with Stables and Coach House. A Farmhouse, cottage and 79 acres of land of which 18 acres are put to wood, principally oak. The lands, Stables, Coach House and Farm House are in the occupation of Mr. Jefferson as tenant and the Dwelling House and Cottage are also occupied by Tenants. Of above acreage includes 2 1/2 acres recently appropriated for the Derwent and Shotley Bridge Turnpike-road.
>
> (*Newcastle Courant* 28th May 1841, second part: 1)

The 1841 census lists 75 individuals living at 15 Derwentcote or Derwentcote Gate addresses. The occupations listed for Derwent Cote in 1841 include five forgemen and Henry Jefferson. There are also two carpenters, a charcoal burner, a farmer, a coal miner and two households headed by persons of independent means. The main forgeman families are listed as being headed by Stephen Elteringham aged 70, Stephen Elteringham aged 44, George Elteringham, Joshua Atkinson and Spencer Smith. The Elteringhams, Smiths and Atkinsons are known through parish records to have been present at Derwentcote since the middle of the 18th century (Cranstone 1997: 22). The Elteringhams are also known through the court case of 1746-8. Representing the Gelleys, Richard held the position of carpenter at the forge, and Jane Gelley headed another household, shared with her two young children. The three branches of the Elteringhams totalled 10 individuals, plus one Hannah Richardson. The Smiths formed a single household with 8 children under 15 years of age and Joshua Atkinson, 4 children of similar age, possibly under the care of a live-in young lady called Margaret Mitchelson, who may have been one of the 7 children of the charcoal burner, Michael Mitchelson. At the forge lane cottages lived the elderly farm labourer, Stephen Armstrong. During the period when the steelworks may have been closed the plot appears to have been held by John Armstrong (*ibid*. 21), possibly the same person, as names may change between official forms.

The 1851 census, the last before Cookson's technological improvements, shows a similar picture of occupation. George Eltringham had retired but maintained a tenancy at the forge. The elder Stephen Eltringham had died; his widow and family, none of whom worked at the steelworks, remained at the forge. They had been joined by the late Stephen's nephew, Thomas Eltringham, a steel convertor. A decade before Thomas had lived with his other uncle, George. His move to his late uncle's house may have been to ensure the family's continued tenancy. The younger Stephen Eltringham, and the widowed Spencer Smith with his growing family, were still present. Two of Smith's sons had matured and worked with their father as steel forgemen. Joshua Atkinson, who would have been into his 70s, had left and his role as forgeman had been taken by Joseph Gelley. The elderly carpenter, Richard Gelley, had also left, and his position was held by Anthony Fewster from Chopwell.

The original worker's housing may have been built closer to the forge. The Medomsley estate map of 1842 (fig. 6.21) shows four discreet blocks of buildings in the forge area. Later 19th century Ordnance Survey maps show a row of three buildings stretching north-west from the forge building. These may be the block, C, integrated into a remodelling of the forge and possibly the worker's housing. The analysis of the 1851 census, below, indicates that there were 5 worker's houses at the forge (see further argument in 6.4 below) but there were 3 other families with Derwent Cote Forge addresses: Thomas Pigg, a stone quarryman, Thomas Hetherington, a coal miner and Sarah Gilley, a widow on parish relief. These three households appear to have no link with the steelworks.

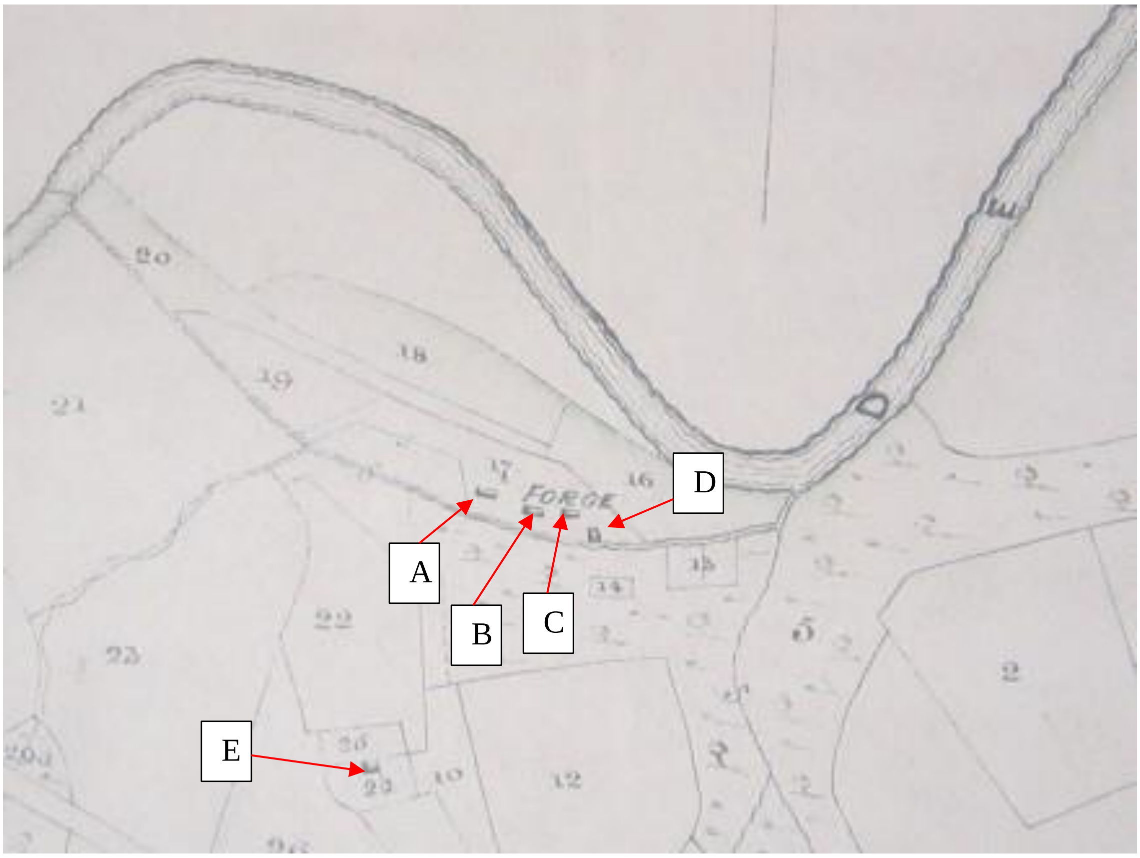


Figure 6.21 Detail from Medomsley estate map 1842. The forge area (17) is described as 'houses, forge, track, etc.' A conjectural reconstruction of the forge: A = possible domestic housing to west of current forge cottages, B = the forge cottages as possible warehousing, at the time of this map resembling figure 6.11 above, C = possible detached row of workers housing before the northern forge building was constructed, D = the forge building on the north bank of the mill race, E = manager's house and agricultural workers' cottages referred to in the commentary as 'Derwent Cote homestead'. Plots 14 and 15 are listed as 'gardens'. (Medomsley estate map 1842)

During the Industrial Revolution Derwentcote changed from an agricultural estate with a mill, and short-lived venture into iron smelting, to the site of several industries: the steelworks, the quarry, a pottery, brickworks, and a coal drift which may have provided the fuel for the cementation furnace and chafing furnace - sited to the south of the barley mill/Derwentcote Lodge and rented by the occupant (Haley 2015: pers. comm.). It remained a predominantly rural estate and maintains this character to the present day.

The workforce at the end of this period appears to have comprised well-established local family units, with some 20 children living around the forge area. The census returns show that the forgemen and the majority of their children were born either in Chopwell, across the river from Derwentcote, or Medomsley, which could indicate that they were born at Derwentcote itself. Forgemen's wives were either local or from nearby Northumberland and Durham.

There was evidently a desire to live at the forge as shown by George Eltringham remaining on the site after he retired and the Eltringham's reorganising their living arrangements to ensure that the elder Stephen's family could remain there after his death. This demonstrates that the Eltringham's and many of the other residents had an emotional attachment to Derwentcote. Three family units of Eltringham were present presumably offering each other support. There was probably a long-established friendship network between the Eltringhams, Smiths, Gelleys and the farming Armstrongs on Forge Lane.

6.4 On the periphery of the Machine Age 1850s-1895

Henry Jefferson appears to have given up Derwent Cote (manor) Farm on its sale to the new owner, the consultant surgeon William K Eddows, as he advertised for a new tenant for the farm (*Newcastle Courant etc.* 7 March 1851, second part: 2). The farm was taken for a short period by a farmer named Edward Greener and his family at the time of the National Census (6 June 1851), but the farm – reduced to 60 acres - was advertised again in November 1851 with a tenant named William Bell (*Newcastle Courant etc.* 28 November 1851: 4). Jefferson continued to farm the steelworks' land until April 1855, possibly due to his redundancy. The auction of Jefferson's domestic effects and agricultural stock was conducted by Joseph Oley, the last of the original Shotley Bridge Swordmakers (*Newcastle Courant etc.* 13 April 1855: 2). An advertisement of August that year offered a crop of standing hay on both Derwentcote Farm and the Hagg to the east; enquiries were to be made to the Hagg (*Newcastle Courant etc.* 31 August 1855: 2). It may be conjectured that Jefferson farmed all the land east of Derwentcote (manor) House including some relationship with the Hagg. Henry Jefferson Esq. was one of the 'gentlemen' who attended the first annual show of the Derwent and Shotley Bridge Agricultural Society, held in a field belonging to Shotley Hall on the 13th October 1843 (*Newcastle Courant* 20 October 1843, second part: 3).

At some point in the 1850s the Derwentcote steelworks invested in a crucible steel furnace (fig. 6.22) and a rolling mill. The 1861 census return shows that Thomas Eltringham held the position of steel converter and roller, and Joseph Brown was a steel melter; both jobs are indicative of the new venture. The workforce of the locality may have been unwilling or unable to work the crucible steel process. Brown was from Newburn, Newcastle and may have directly displaced Spencer Smith from the worker's housing as Smith had left with his two sons. The retired George Eltringham still lived at the forge, as did Stephen Eltringham and Joseph Gelley. Ralph Elliot was recruited to replace the Smith boys as a steel forgeman and lodged with Stephen Eltringham and his wife. George Harrison also joined the workforce as an iron forgeman. Although he was born at Catton, Northumberland, his sister was born in Chopwell, suggesting he had lived in the area for some time. Harrison, his wife, their 4 children and his sister all moved into Derwentcote. The census shows that by 1861 Thomas Eltringham had moved back in with his uncle George and that the late Stephen's family had moved out to a cottage on the Shotley Road – the Derwent valley turnpike road – remaining close to the rest of the family. This adjustment in the workforce accommodation strongly suggests that there were five workmen's houses available at the forge site.

Figure 6.22 Crucible pots. Residue of the steel melting process coat the interiors. These pots are trapped in tree roots to the north of the Derwentcote crucible furnace.
(Photograph: J. Bowman 2015)

The date at which the forge cottages took on their fully domestic role is uncertain. The difference between the cottages' layout between the 1st and 2nd edition OS maps (figs. 6.23, 6.24) dates their conversion between 1856 and 1895. The forge area around the crucible furnace develops between the dates of the two maps. On the earlier map, a three-celled structure is visible; the western cell is undoubtedly the footprint of cottage 1, the large central cell is connected to the eastern cell by a 'field tie' and the eastern cell is of a different form to that on the later map. The field tie suggests that the larger cell was an open space between the other two. The eastern cell must have been physically separated from the central cell, perhaps the eastern cell was roofed separately.

The continued conversion of the warehouse or industrial building to cottages may have taken place in two further stages. In the first stage, the internal east end of the building was enclosed with a brick wall creating either a small industrial unit or cottage 4 (fig.6.25). The brick wall appears to have been built around the west side of a substantial chimney block which is incorporated into cottage 4 (fig. 6.26). On examination, the block bears a resemblance to a small reverberatory furnace. The stepped-in southern end of the block surrounds what may be the base of a circular flue with no external access (fig. 6.27). The chimney block has been much altered to take a later cooking range. The stone wall at the east end was remodelled to provide a larger footprint to the new space and joined the brick wall at the south-east corner.

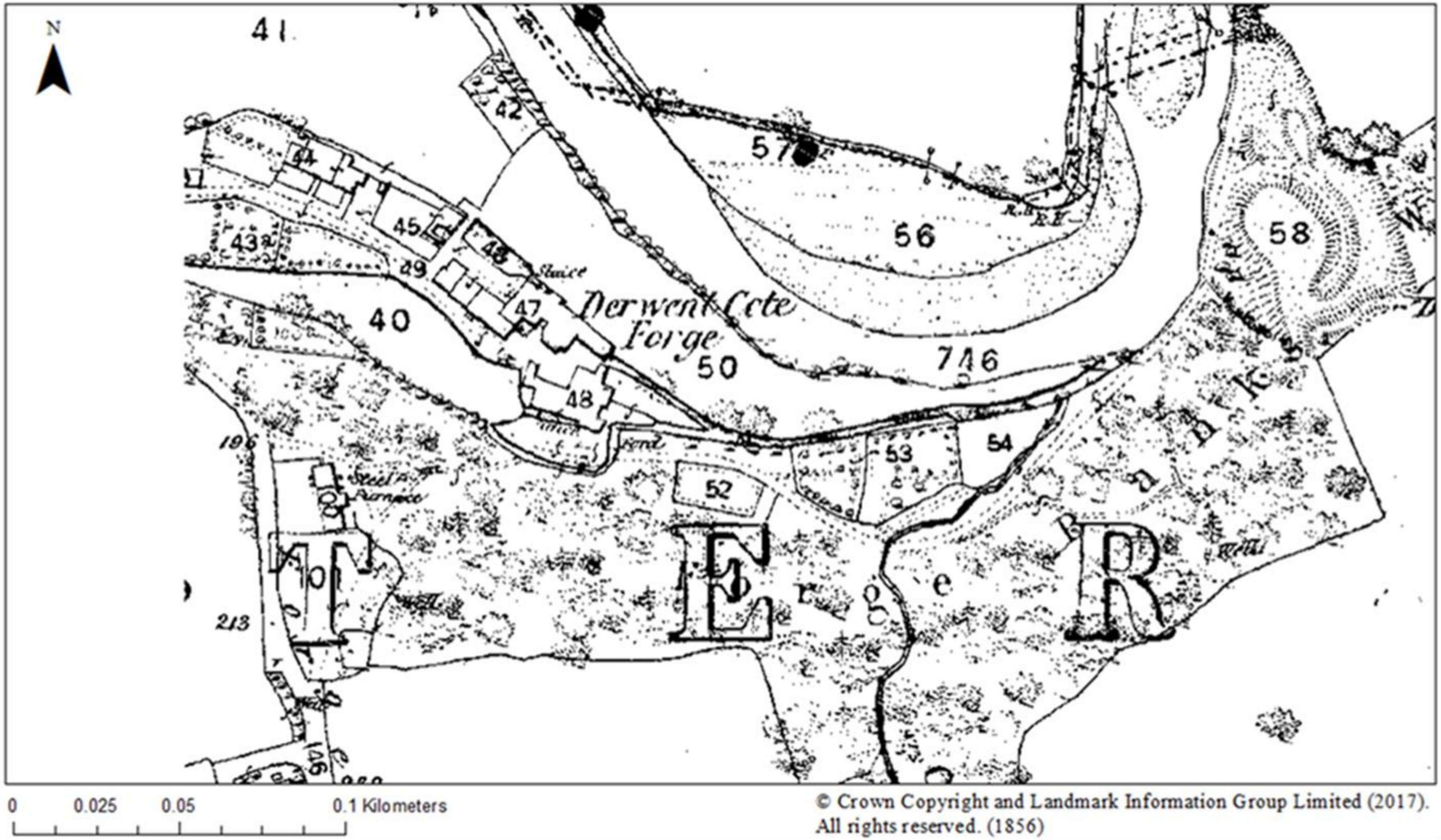
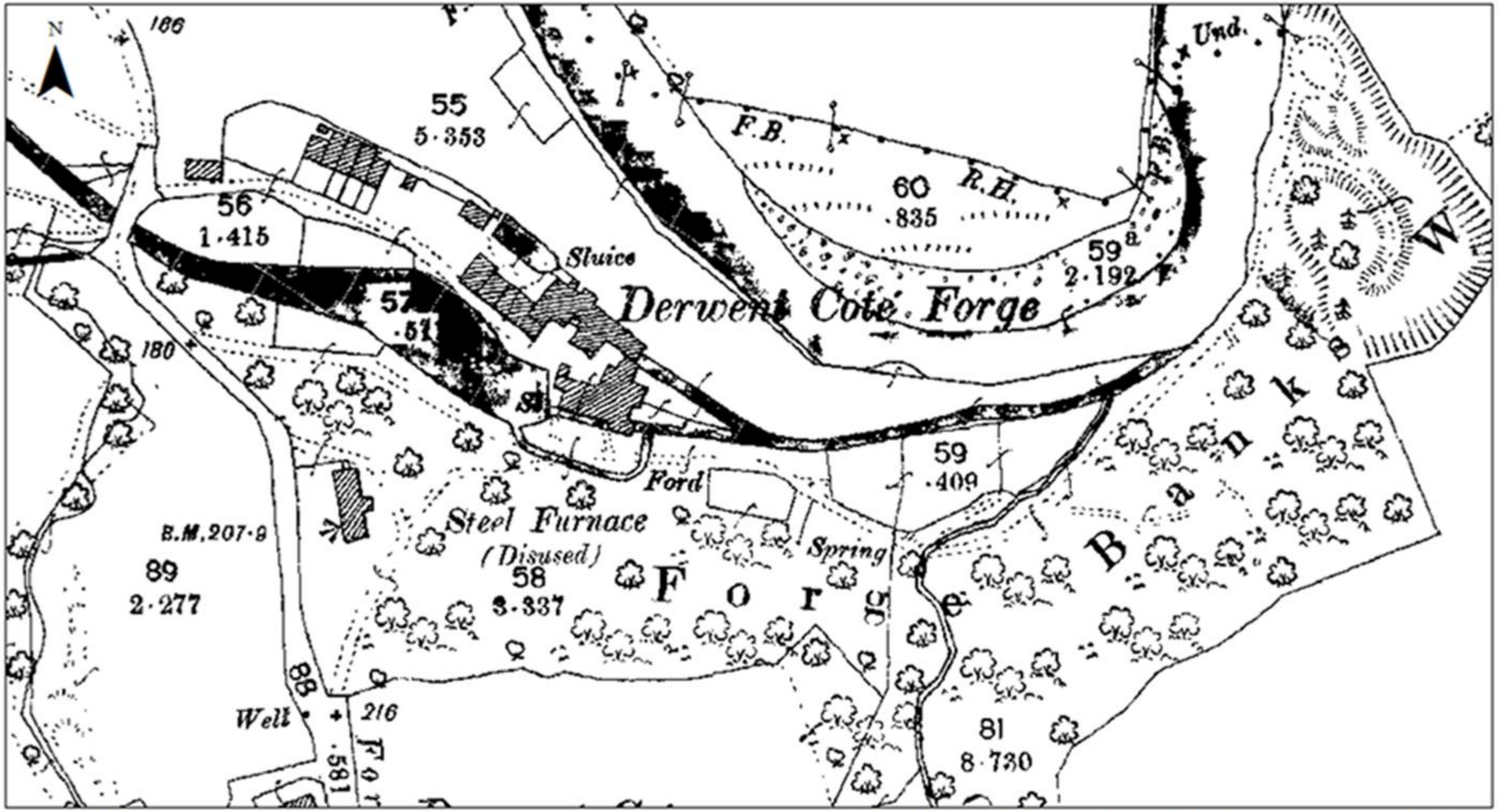


Figure 6.23 Derwentcote 1st edition OS map 1856



0 0.025 0.05 0.1 Kilometers

Figure 6.24 Derwentcote 2nd edition OS map 1895

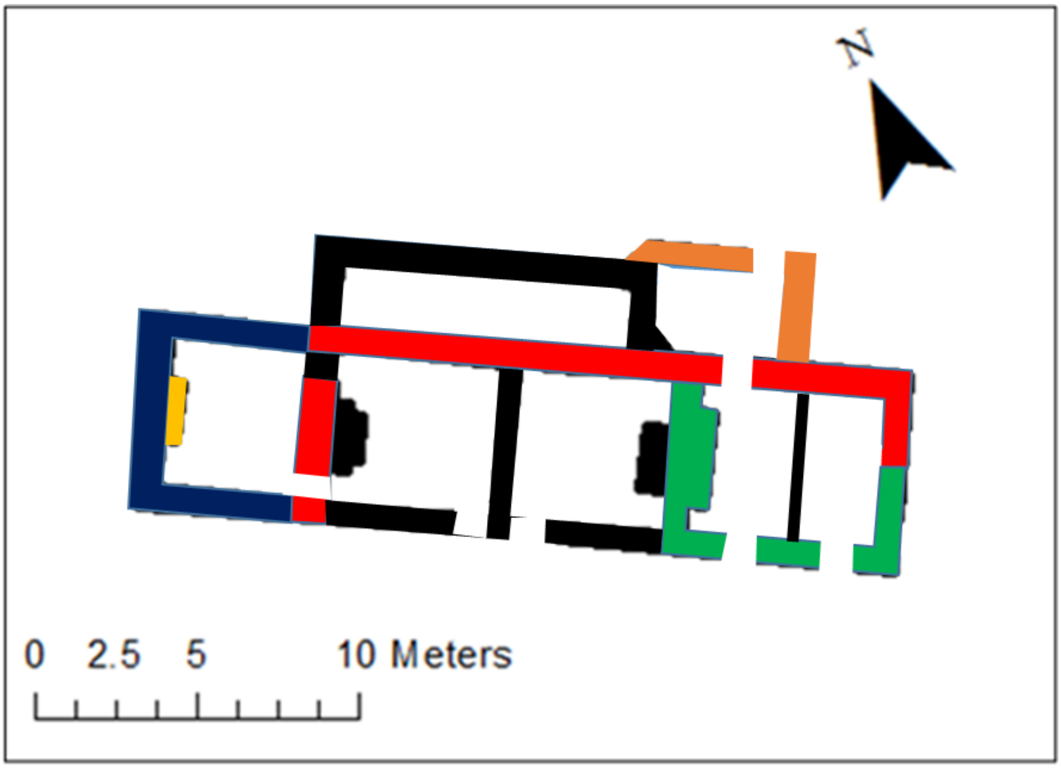


Figure 6.25 Conjectural conversion of the forge cottages 1850s-1880s. Green = red brick wall enclosing east end of the cottages and the remodelling the east gable end in stone. Black = domestic conversion phase, red brick used to fill gap between earlier red and green walls and form a central dividing wall, fireplaces inserted against red and green walls, red brick single storey 'lean-to' range built along north elevation, original western cell door possibly blocked and new entrance created on south side of new fireplace, eastern cell sub-division wall to create two small dwellings. Tan = stone extension to north, this butts against the red wall at its east end and against the black wall to its west. It may be possible that the black (brick) wall has been slipped to the inside of the tan wall – indicating the tan wall predated the black wall and may be a remaining part of the blue wall shown in fig. 1.

Figure 6.26 Fireplace in cottage 4. Photographed from the east.
(Photograph J. Bowman 2016)

Figure 6.27 Interior of the chimney block cottage 4. Photographed from east.
(Photograph J. Bowman 2016)

By the 1861 census the brick maker, John Cawthorn had moved to Derwentcote. His presence may have coincided with the construction and opening of the crucible furnace. Red brick is certainly found in the later phases of the forge building and the crucible furnace. Within the forge red brick is used for many of the culverts and for culvert cappings. In the crucible furnace area red brick was used for walls, a culvert and was mixed with old firebrick to make the floor surface in the furnace cellar (Wessex Archaeology: 7-8). Quantities of red brick were recovered from the post-closure contexts of the cementation furnace and may have been used for minor repairs and inserts of the buildings (Cranstone 1997: 85). The largest quantities of red brick at Derwentcote are within the fabric of the Forge Cottages. There would also have been a constant requirement for crucible pots for the steel melting process. Cawthorn, his wife and daughter lived in the sub-divided toll-house at the top of forge lane, but after they had another 4 children they moved out to the East Derwentcote Cottages. This move must have been by 1870 as by that date a family called Robson had moved into the toll-house.

When the Wesleyan Chapel was founded at Blackhall Mill in 1870, the *Newcastle Courant* (24 June 1870: 5) reported that two young ladies from Derwentcote 'provided' at the tables of the tea-party following the laying of the foundation stone: Miss Ann Robson from the Toll Bar and Miss Mary Davison from the farm. This article may suggest that the Derwentcote

Forge community were connected to the wider community through Wesleyanism and there were social ties between the Toll Gate and the rest of the Derwentcote concern.

In the second stage of the conversion of the Forge Cottages the central cell was subdivided, creating cottages 2 and 3 with a curtain brick wall enclosing these cottages to the south. The cottages appear as a five-celled structure on the 1895 OS map. The footprint of cottage 4 was also divided into two by a north-south partition splitting the building in line with the east end of the stone northerly extension. There is no evidence today for a brick partition in cottage 4, suggesting the division was a timber stud wall. The western portion of cottage 4 holds the fireplace noted above; the eastern part has no evidence for a fireplace, though it may have been heated by a free-standing stove. Cottages 2 and 3 had inserted fireplaces; the fireplace mantles and pillars appear to be of the same build, suggesting both were added to pre-existing walls at the same time. The fireplace in cottage 2 has been filled in to allow for the insertion of a domestic hearth (fig. 6.28); the fireplace in cottage 3 was occupied by a cast iron 'Newcastle' cooking range with a barrel oven (fig. 6.29). The map shows four garden plots in front of the 5 cottages. Cottages 1 and 2 share a plot across their southern frontage. There is evidence for a doorway, now blocked, between the two cottages on the south side of the fireplace in cottage 2. It is possible that cottages 1 and 2 were one dwelling, with the cooking range in cottage 1 and a domestic fire in cottage 2. The 1891 and 1901 censuses give the numbers of rooms in the four Forge Cottages in the order 4:4:3:2 indicative of the enumerator scheduling the cottages from west to east as they were encountered on entering the forge site.

Figure 6.28 Fireplace in cottage 2. Photographed from the east. Scale 1.0m.
(Photograph: J. Bowman 2013)

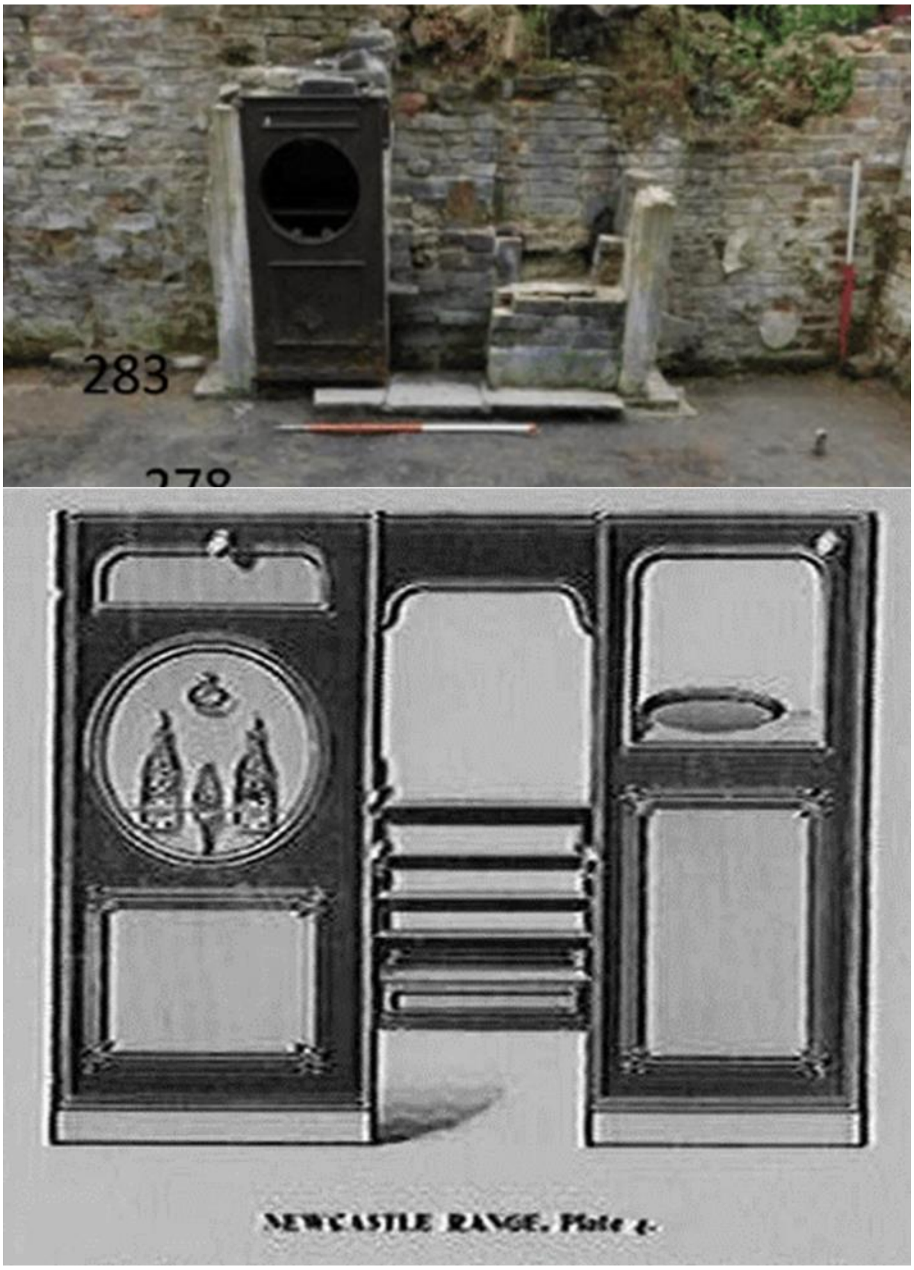


Figure 6.29 Newcastle cooking range. (above) Photographed from west. Scale 1.0m. (below) Image from a trade catalogue.
(Photograph: Webster *et al* 2015: 12; image: Beamish Museum 2017: neg. 19207)

Iron forging seems to have ceased by 1871 when the Cooksons installed Thomas Stanley Winter as manager. This would certainly have been due to the Consett Iron Company's local competition, if not the national picture of larger ironworks. Consett was, however, not producing any steel at all. Thomas Winter lived in the manager's house on Forge Lane with agricultural labourer, Henry Davidson, and husbandman, Joseph Henderson, living in the two Forge Lane cottages. Of the two iron forgemen listed in the 1861 census, Joseph Gelley had left and George Harrison gave his occupation as steel forgeman. Thomas Eltringham was listed a steel maker, perhaps he had learned the method of crucible steel making and would have been responsible for both producing cementation steel and then melting it in crucibles. Thomas was now the only Eltringham living at Derwentcote; George, who would be in his late 70s, was absent and Thomas was living with a servant. The younger Stephen—then in his 70s—his wife and Elliot had left, and the elder Stephen's family are not mentioned in the census. There are only four Derwent Cote forge cottages listed in 1871: Thomas Eltringham's and George Harrison's, with the other two occupied by steel forgeman, Matthew Wright, from Bensham, Durham, who may have arrived in 1865/6, and Matthew Broadsword, the forge carpenter, who arrived perhaps in 1868 based on the birth dates of their children born at Derwentcote or Medomsley. There are 3 houses marked as unoccupied on the census return. These are enumerated between Thomas Eltringham's residence and the other 3 listed cottages.

John Cawthorn was joined at the East Derwentcote Cottages by a relative, Thomas; both of whom were listed as brick and tile manufacturers. The appearance of his relative suggests an expansion of his business. It appears that the East Derwentcote cottages belonged to the Hagg farm because they are included in a notice of sale in the *Newcastle Courant etc.* (16 Jan 1874: 4). Cawthorn's tilery also appeared in this notice and is marked on the 1st and 2nd edition OS maps (NZ 1410 5676). It seems unlikely Cawthorn's tilery was the same as the tilery offered for sale in 1807, because it is on the neighbouring estate.

A succession of partnerships began in 1872: Scott and Winter 1872-3, Ramsay, Winter and Co. 1874-5, Charles H. Winter 1875-8 and 1891-5 (Cranstone 1997: 22). Thomas Winter partnered Joseph Scott and Thomas Ramsay and brought Charles Winter in as a manager by 1874. Charles Winter operated the steelworks until 1878 when he was declared bankrupt. In 1878 the Derwent Cote (Durham) Steel company was registered (*Sheffield and Rotherham Independent* 28 December 1878: 3), otherwise known as the Derwentcote Steel Company Limited, with George C. Barker as director.

The occupancy of the manager's house had changed from Thomas Winter in 1871 to Charles Winter by 1874. Thomas Winter was recorded as being married from Derwentcote that year (*Newcastle Courant* 13 November 1874: 2). Charles may have stayed at Derwentcote until 1878. That year he is mentioned in the *Newcastle Courant* (18 January 1878: 8) as being 'in at the kill' for the Braes of Derwent foxhounds at Birtley; and as suffering an assault in the August: Winter, 'the manager of the steelworks' was returning from Ebchester, to the west of Derwentcote, after 10.00pm at night, when he was set upon by a miner from Croniwell, a hamlet between Ebchester and Derwentcote. The assailant, Joseph Fenwick, leapt out from behind a hedge, knocked Winter down, struggled with him and stole his scarf and pin—which were found in the road the next morning—before making off into the night. Fenwick was jailed for the assault at the Lanchester Petty Sessions, but the robbery was unproven (*Newcastle Courant* 30 August 1878: 8). Charles Winter was declared bankrupt in October (*London Gazette* 1 October 1878: 5416).

Winter's partner, 1874-5, G. H. Ramsay, was a brick manufacturer at Derwenthaugh who may previously have operated a steel forge at Blaydon. His involvement with Derwentcote may have influenced the closure of Cawthorn's brick works as Ramsay supplied his steelworks. His partnership ends possibly at the same time as the cementation furnace was abandoned. Repairs to a cementation furnace were largely down to replacing firebricks. Ramsay's bricks were stamped with RAMSAY in their frog face. RAMSAY bricks have been found at the cementation furnace, the forge and the cottages. At both the forge and the cottages bricks stamped with HAMST.ERLEY, the product of a local colliery, are dominant but at the furnace RAMSAY bricks appear to be the most common (Cranstone 1997: 91; Wessex Archaeology 2012: 15).

Charles Winter may have been responsible for the last technological advance at Derwentcote which was to melt varied quantities of cast and wrought iron together within the crucible furnace to produce steel instead of remelting blister steel from the cementation furnace. The final attempt at steel manufacture at Derwentcote was under the Derwentcote Steel Company Limited. This company was headed by a director, George C. Barker, who took up residence in the manager's house. Barker brought in a manager, John Long, and a steel melter, Henry Godley, from the Sheffield area. The advent of steel production at Consett in 1882 would have made crucible steel uneconomic but Barker remained at Derwentcote until at least 1887. Barker brought Charles Winter back to Derwentcote by 1891. Winter claimed to be a steel manufacturer on the 1891 National Census and payments to Derwentcote were made in his name (Cranstone 1997: 22). The steelworks were put into liquidation in 1894. Barker, acting as liquidator, announced that the property of the company had been disposed of in the April of that year (*London Gazette* 17 April 1894: 2195). A last sale of stock appeared in 1895 and the works were vacated by Winter in 1896 (Cranstone 1997: 22).

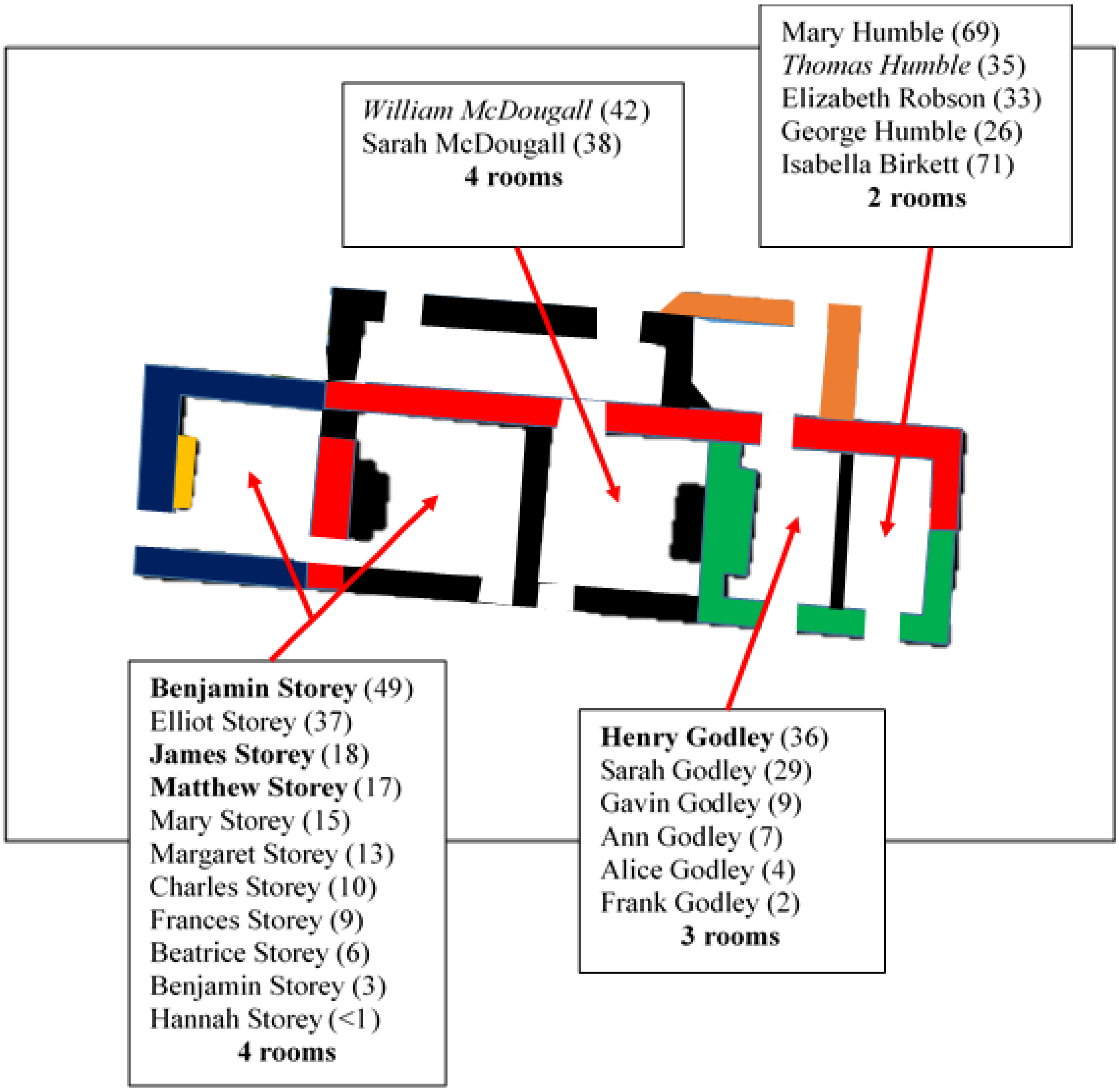


Figure 6.30 Conjectural occupancy of the forge cottage 1881. Names in bold are steel workers. Names in italics are labourers. The labourers may not have worked at the steelworks. (J. Bowman 2017)

Henry Godley replaced Thomas Eltringham as steel melter by 1881 (Fig.6.30). Eltringham may not have known how to mix quantities of wrought and cast iron for charging the crucible pots and so left Derwentcote when the technology changed. The Harrisons, Wrights and Broadswords had also gone by that date; this suggests tension between the workforce and the management, perhaps created by the absence of Eltringham. The Storey family provided the bulk of the workforce with the father, Benjamin, and two eldest sons, James and Matthew listed as forgemen. The Storeys had been present at Derwentcote since at least 1873. The *Bradford Observer* (5 September 1874: 5) reported on the case of Benjamin Storey at the Lanchester Petty Sessions, resident at the time of his offence, the 1st August 1873. Storey's brother George had visited at Derwentcote for supper where the pair subjected Benjamin's wife, Elliot, to a sustained assault which included Benjamin producing and discharging a gun during the struggle. The cause of the incident is not recorded in the press but the couple were still married in 1881and had two children in the intervening years. A lead bullet was recovered from the tumble of the northern wall of cottage 4 during the Newcastle University excavations. The bullet showed no sign of distortion or flattening, indicating it had never been fired, but its presence acts as a mnemonic for the domestic incident. This bullet and the Storey's story suggest that the Derwentcote tenants may have hunted small game to supplement their larders.

The Derwentcote community also practiced horticulture. The area around the forge contained gardens from at least the date of the 1842 Medomsley estate map, which notes gardens in its written commentary. The 1856 OS map shows four areas of shrub lined plots; to the west of the western forge cottage, between the track which ran across the south of the forge cottage buildings and the north side of the millpond, between the south side of the millpond and the base of the Forge Banks, and several plots to the east of the forge on the southern side of the tail race. Care was taken of the gardens from an early time. In the western wood plot the central path is lined by 50mm thick stone slabs placed on edge. The garden paths on the north bank of the millpond are lined with crucible pot lids indicating they were laid from the 1850s onwards. The crucible lids would be plentiful, but their use reflects a collection process which would have taken some time to complete in order to line all the paths.

Barker, and the manager, Long, occupied the Forge Lane properties. In 1885, the *Newcastle Weekly Courant* (2 January 1885: 5) reported on the presentation of the tenants of the Hamsterley Estates to Miss Eleanor Surtees, the estate owner's daughter, on the occasion of her forthcoming marriage. It was George C. Barker who represented the tenancy of the Derwentcote Steel Forge Works. By 1887 Barker was chairing meetings of the Ebchester Local Conservative Association (*Newcastle Weekly Courant* 25 February 1887: 4).

For the reason suggested above the Cawthorn brickworks had closed in 1874 and their buildings were converted to a small farm occupied by Thomas Newton, who had previously farmed the Derwentcote Farm attached to the larger Derwentcote House. The East Derwentcote Cottages, recently vacated by the brickmakers, had been converted to one cottage and an outbuilding, confirmed by the report of an alarming incident in 1875, when Thomas Newton of Derwentcote Cottage heard a commotion in his outbuilding, and on investigation discovered his donkey being eaten alive by rats (*Bradford Observer* 31 January 1875: 5).

The group photograph, taken on the millpond dam head, and noted in 6.1 above, is thought to depict a manager and his family (fig. 6.31). The image shows three, or possibly four, figures standing to the left of the lady in a light dress. Two younger figures stand on the lower rail of the fence, the one on the right, possibly obscuring a taller figure, stands behind. It is difficult to determine whether the two young figures are girls or boys; the one on the right could be wearing a knee length skirt, the one on the left, knickerbockers. The clearer tall figure standing behind the child on the left appears to be a female of adult height. To the right of the lady in the light dress stands an elderly lady who appears to share some facial characteristics with the top-hatted gentleman standing behind and between them. To the right of the group stands another, bareheaded, lady. The top hat was in style across the period of activity at Derwentcote; the light dress was fashionable during the 1870s but would be considered too wide by the 1880s. From the composition of managerial families given in the census returns it is possible that the photograph is of the agent, John Long c.1881, and his family.

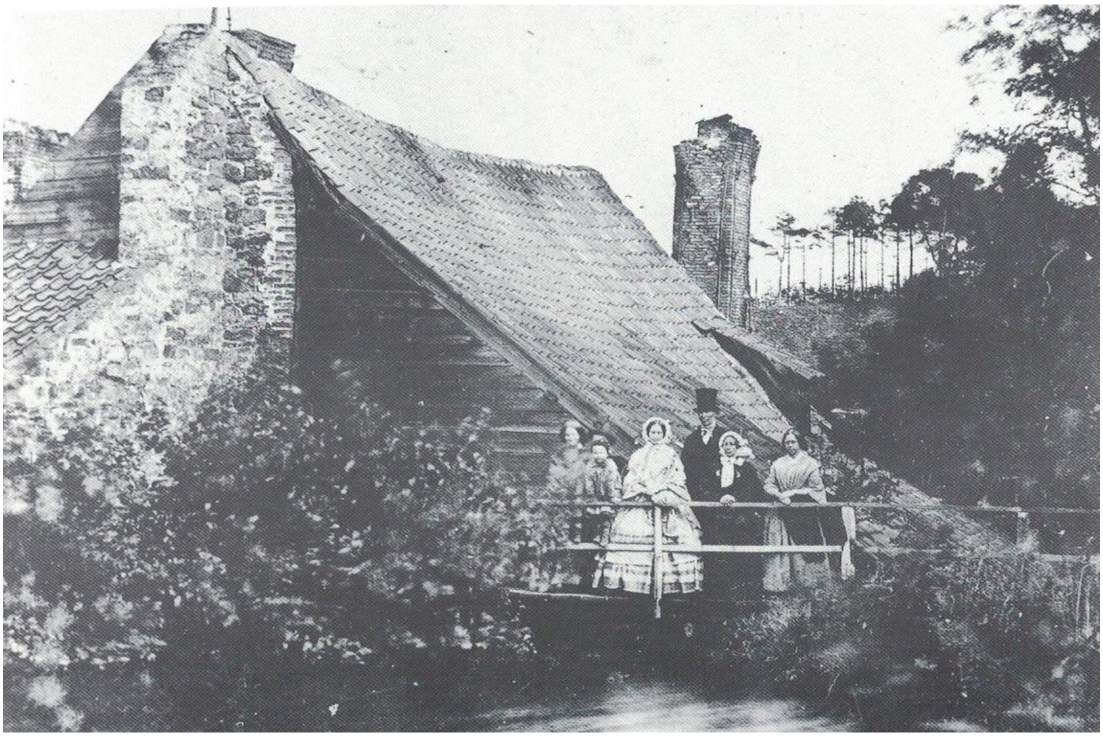


Figure 6.31 The Derwentcote photograph. (Photograph: Beamish Museum neg. 12663)

In 1881 Long was 29 years of age and had a mother of 60 and an aunt of 59 living with him, plus two daughters, 7 and 5 and one son, 4. Ruth Long, the mother, was a widow and may be the elderly figure in dark clothing standing to the right of the gentleman, John Long, in which case her sister, Margaret Corbett, is the woman wearing paler clothes. The female on the right of the photograph may have been a servant or a visiting family member not accounted for in the census return.

The steelworks were all but closed down in 1891. Winter had returned to the manager's house where he was described as a steel manufacturer and an employer. Who he employed is conjectural. There were four general labourers living in three of the Forge Cottages (fig.6.32): Edward Davidson, Edward Wilson and William Ward. Davidson and Ward were both from Winlaton, Wilson was from Northumberland. The fourth cottage was occupied by a widowed dress maker, Agnes Shaw, and her brother and border who worked as coke fillers. Agnes's brother was Robert Davidson, suggesting family ties with Edward Davidson. The labourers may have been employed clear up the site. Another possibility is that Winter was obliged to rent the farm attached to the steelworks and the farmer, John Marsh, was his single employee.

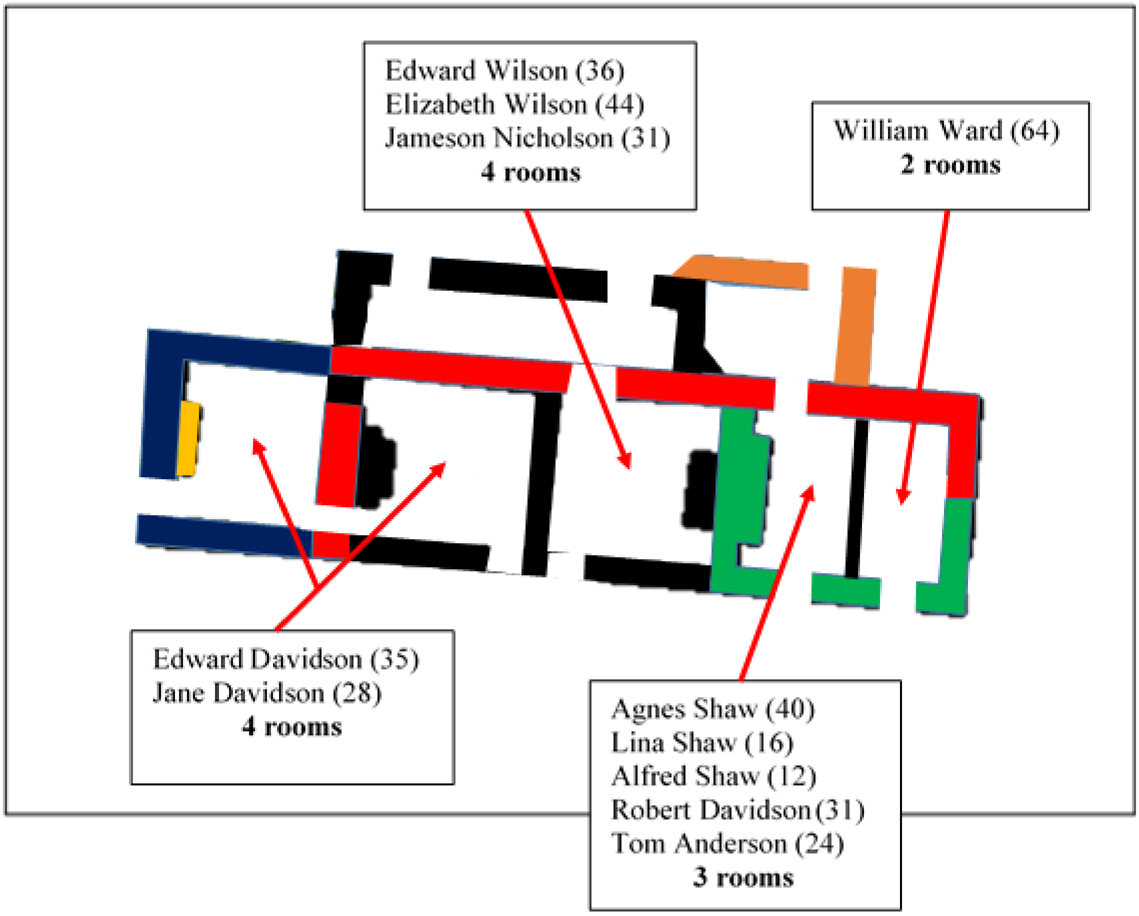


Figure 6.32 Conjectural occupancy of the forge cottages 1891.

From 1875 there is no evidence for major building projects at Derwentcote. Bricks were sourced from various suppliers for repairs and patching. In the later 19th century many local collieries produce their own bricks from readily available fireclay associated with the local coal measures. Fireclay is prepared for moulding in a different manner to that of common clay, necessitating additional plant. Refractory bricks were commonly made at brickworks associated with the coal mines which extracted the fireclay as a by-product.

Unstamped firebricks were found in the cementation furnace, crucible furnace and as inclusions within the millpond dam head. Fireclay would have been available from the nearby Chopwell and Hamsterley collieries for bricks and for the crucibles for steel melting.

Stamped firebricks or colliery bricks have been found at the cementation furnace, the forge and the forge cottages. David Cranstone's excavation of the cementation furnace produced a record of a large quantity of plain firebricks, plus stamped firebricks from BUTE, R. DICKINSON & CO CONSETT NEWCASTLE on TYNE, DODD, HAMST.ERLEY, HANNINGTON, LINTZ, RAMSAY, H. RAMSAY NEWCASTLE, RITSON, VGC, WILKINSON (which may have been more DICKINSON) These stamped bricks may have formed about one fifth of the total bricks recovered. RAMSAY and H. RAMSAY bricks constituted just under half of all the stamped bricks counted at the cementation furnace and were the only type to be found *in situ* within the furnace structure (1997: 85-91).

The analysis of the brick assembly recovered during the Wessex Archaeology TimeTeam excavations of the forge area suggests that the HAMST.ERLEY, VGC (Wessex identified VGC as VCC), BUTE, DINAS and RAMSAY were present (2012: 14-15, 40). Wessex state that 57% of the bricks in the forge area were stamped firebricks (*ibid.* 14-15). The number of firebricks sampled by Wessex was not large, but VGC and HAMST.ERLEY appear to be dominant.

At the Forge Cottages examples of firebrick were stamped: APC, BUTE, COWEN, COWEN M, COWEN 4, DELVES, DICKINSON, HAMST.ERLEY, HAMSTERLEY, LILY, LINTZ, RAMSAY, RAMSAY NEWCASTLE, RITSON and VGC. There are also three stamped brick types which were only found in the interior of the easternmost cottage; several bricks stamped AC and a pair with two small circles or dots within the frog are visible *in situ* within the fabric of the fireplace against the west wall. Two large firebricks, or more correctly firebacks, were recovered from the fireplace area: these were marked OLIVER (fig. 6.33). HAMST.ERLEY bricks were the dominant make around the cottages with some 63% of the stamped bricks recovered bearing this mark, with various RAMSAY marked bricks being the second most often encountered.

Figure 6.33 Stamped bricks of Derwentcote. Scale 300mm. (Photos: J. Bowman 2015)

The most commonly encountered brick, the HAMST.ERLEY, was produced at Hamsterley colliery 1.2km to the south-west. The majority of the other stamped bricks were produced within the Derwent valley or on Derwenthaugh. BUTE (Marquis of Bute pit), LINTZ (Lintz Colliery), VGC (Victoria Garesfield Colliery) and LILY (Lilley Colliery) all lay within 5km to the east of Derwentcote. DELVES, DODD, DICKINSON and RITSON were all from the Consett area within 6km. RAMSAY marks, APC (Axwell Park Colliery), and HANNINGTON were produced on Derwenthaugh. COWEN were based on the Blaydon Burn adjoining Derwenthaugh. One single, brick appears to have made its way to Derwentcote from outside the area, marked DINAS, from Wales (Wessex Archaeology 2012: 15).

Between cottages 2 and 3 are two north-south aligned dividing walls, the eastern one built parallel to the western one and of superior construction with the space between taken up by the plaster on the eastern side of the east wall or mortar to broach the small gap between them. The bricks of the western wall were laid on their string edges allowing their bed faces to be visible; two beds have HAMST.ERLEY stamped into them. This suggests that the earliest date for the party wall may be 1888 (Durham Mining Museum 2014). This date would agree with the difference in structure of the cottages between the two editions of OS maps, however, this date obfuscates the post-1871 tenure of the buildings unless this wall replaced a previous dividing structure of brick or timber studwork as has been suggested as present in cottage 4 above. The early 1870s date for the conversion of the cottages fits with the arrival of the new workforce coming to serve the later steel melting process. This presents the possibility that the four households who appear in the 1881 census were all living in the forge cottages and therefore for a relatively short time, compared with the total working life of the steelworks, forge employees were in residence.

During the 2013 excavation season, two coins were recovered from the collapsed material from the interior of cottage 3. One was a corroded Victorian penny, which could have been lost within the fabric of the building at any time since its production. The other was a 1797 George III 'Cartwheel penny' (fig. 6.34). The Georgian penny is in fair condition, the king's profile is a little worn but the legend is easily readable. A coin of this type would be a common currency during the early 19th century; it may have been hidden or lost within the fabric of that area of the industrial building at that time, or perhaps it was curated as an heirloom during the later domestic period and misplaced, slipping between the first-floor floorboards.

Figure 6.34 George III Cartwheel penny. (Photograph: J. Bowman 2017)

Other, ubiquitous small finds were recovered which broadly fit in with this later 19th century period. Several buttons were found within the demolition of cottage 1 (fig. 6.35), these may represent casual losses but for a while in the 1890s a dress maker, Agnes Shaw, lived in one of the cottages: these buttons may be losses from her stock. One button is a large livery button manufactured by Firmin and Sons of London from the 1850s, its presence at the steelworks is an enigma.

Figure 6.35 Selection of clothing buttons. Top (l-r): plastic, metal – stamped 'WELL MADE', mother-of-pearl. Centre: Firmin and son's livery button. Bottom: metal button – stamped 'BEST SOLID RING'. (Photographs: J. Bowman: 2017)

6.5 Afterlife 1895-2017

Several drift mines were sunk into Forge Bank Wood at Derwentcote after the closure of the steelworks. The earliest, on the west bank of the Bairns Gill (NZ 1321 5643), appeared by the 1910s. Three more were operational during the 1930s, two on the Gill banks and the main Forge Drift (NZ 1317 5649). Several concrete features remain visible for both of the drifts and also for collapsed footbridges across the Gill. The main Forge Drift has been scheduled (monument number 948810) and is also detailed on the Historic England listing for Derwentcote (1015522). The drifts formed part of the nearby Hamsterley Colliery Co. (C. Bell 2012: pers comm).

By 1901 three out of four of the Forge Cottages were occupied by coal miners (Harry Ashburn, Frank Light and James Davison) which may indicate the Bairn's Gill drift was operational by this time (fig. 6.36).

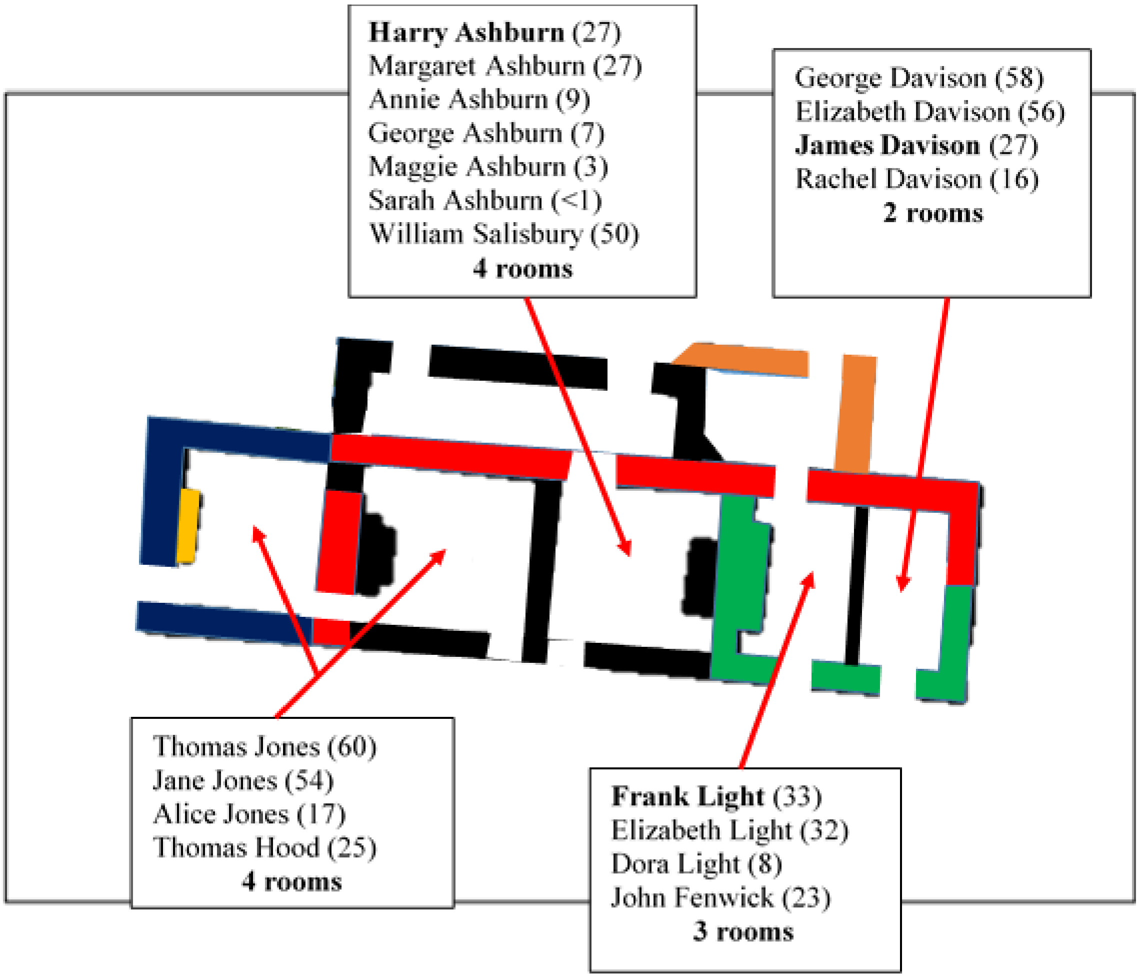


Figure 6.36 Conjectural occupancy of the forge cottages 1901. Names in bold are colliery workers.

The fourth cottage was occupied by a spade and shovel maker, Thomas Jones with his family and servant, who could have used the old forge building as a workshop as he may have needed the furnace to heat rivets to attach the tool blades to the handles. Jones may have formed a small workshop at the cottages: a rivet furnace is not a large item. These residents were from all over the country, only Ashburn may have worked locally previously at Croniwell. However, the size of the community was rising again after the low point of the 1890s. Ten years later all the cottages housed mine workers (fig 6.37).

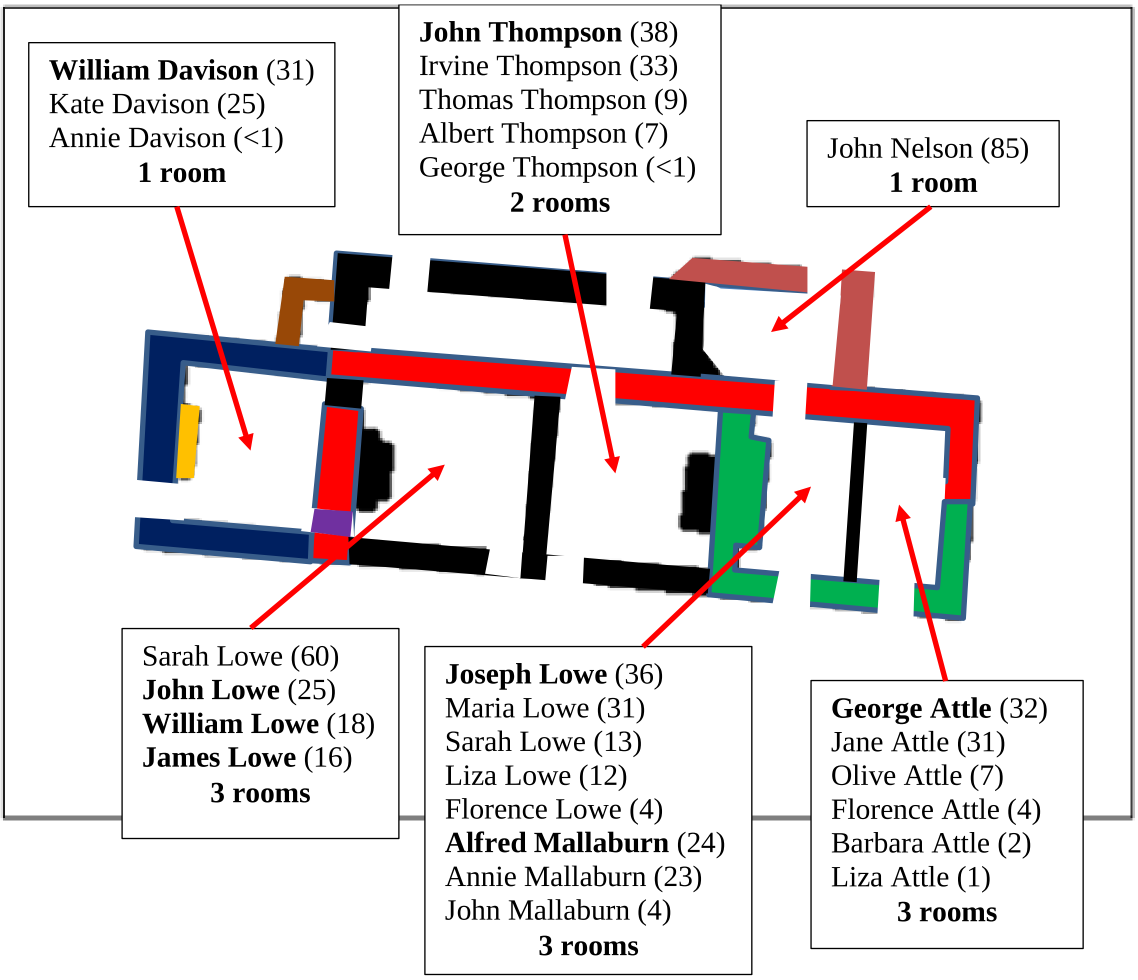


Figure 6.37 Conjectural plan of the forge cottages 1911. Colliery workers names are in bold. Western cell has been separated from its neighbour and a new entrance door broken through to the west. Footprints of cottages 1 and 2 are now in the form they appear today. Occupancy suggested by national census return.

There were two families named Lowe: one headed by Joseph and the other by a widow, Sarah Ann. Sarah's 3 sons, John, William and James were all miners. A family of 3 named Mallaburn boarded with Joseph Lowe. On the night of the 1911 census James and Alice Mallaburn were visiting Sarah Lowe: she was their mother-in-law. On Forge Lane, the former toll house and the cottage on the Shotley road were also occupied by coal workers.

As noted above, both in 1891 and 1901 the number of rooms given for the forge cottages are 4:4:3:2, a total of 13 rooms in occupation. In 1911 (fig. 6.38) the number of rooms given is 1:3 (4 scratched out): 2: 3: 3: 1. As the eastern cottage is the smallest it has been assumed that it was the two-roomed dwelling with the cottages enumerated from west to east. The first building with one occupied room must be the stone cottage 1, separated from cottage 2, with their connecting wall blocked up preserving some wall-plaster in the joint. The reason why cottage 3 has had its number of rooms reduced from 4 to 2 is unclear. Of the two parts of cottage 4, the western part remained at 3 rooms while the eastern part added a room. Sub-dividing and opening up 1st floor spaces is relatively easy by adding and removing stud partitions. The second single occupied room may be the northern extension to cottage 4. This room has a domestic fireplace built into its south-west corner. In previous returns, as the room was ancillary to the main dwelling, it would not have been counted.

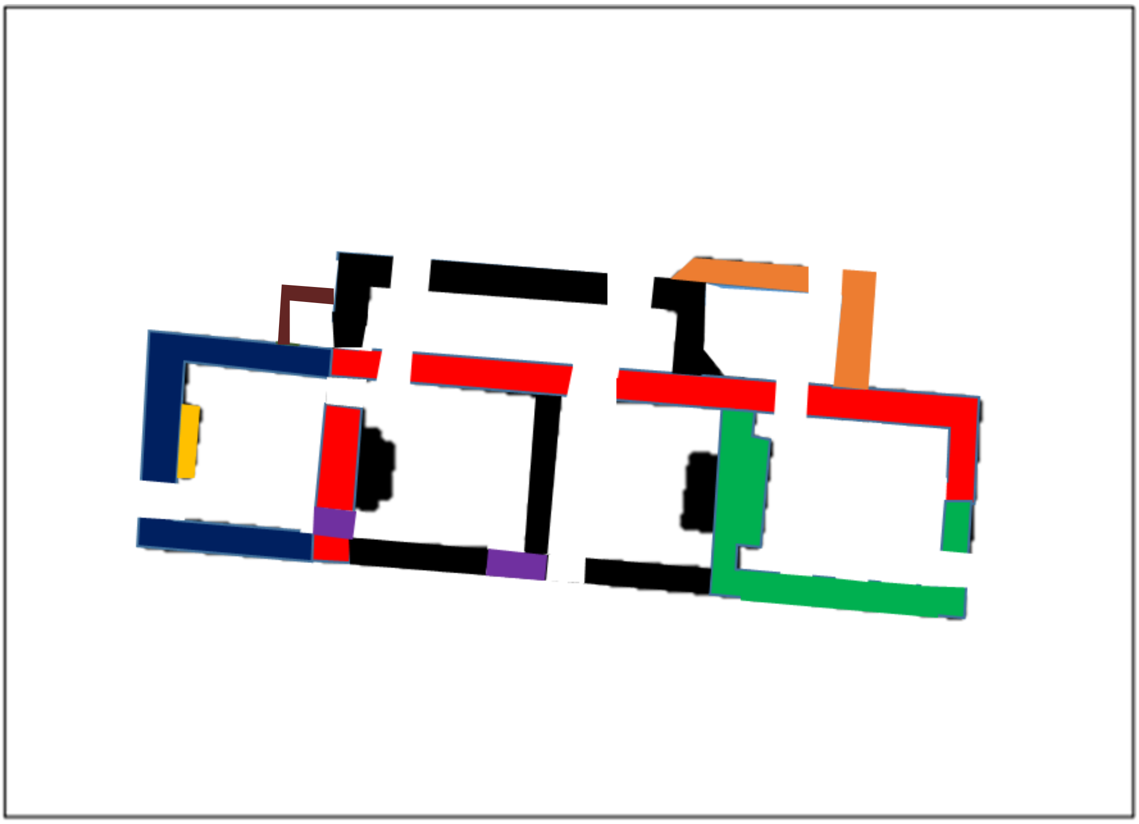


Figure 6.38 The final phase of the forge cottages. The cottages footprint appears in the present four celled form. Cell 1 was re-joined to cell 2 by the removal of the blocked doorway (or first breach of the wall) to the north of the fireplace in room 2. The external southern door of cell 2 was bricked up (dark green), forcing access through cell 1 or the north. In cell 4 the central dividing wall was removed creating 1 large chamber, within the green wall the two southern doors were converted to windows and a new door was broken through the east gable wall and given a porch. Internal divisions were made within the lean-to range in brick and concrete block in addition to a small brick extension to their west (brown).

During the 1910s OS mapping evidence suggests that the sub-division of cottage 4 was removed creating the floor plan visible at the forge cottages today (fig. 6.40). This enlargement of cottage 4 may suggest that either such a large workforce was no longer required or that the mining families were no longer prepared to live in cramped conditions. The map also shows that entry to the cottages was facilitated by a path which replaced part of the large plot across the frontage of cottages 1 and 2.

A scenic landscape photograph of the Derwentcote Damhead taken about this time shows the stone lined inlet to the head race with a timber structure on the north bank in a state of collapse (fig. 6.39). The OS map of the 1910s shows the millpond is filled in, indicating that the sluice had been shut or the channel dammed. Today the 'tumble' visible in the mid-ground of the photo has disappeared and the inlet channel is silted up, though some of the stonework of the revetment is still visible.

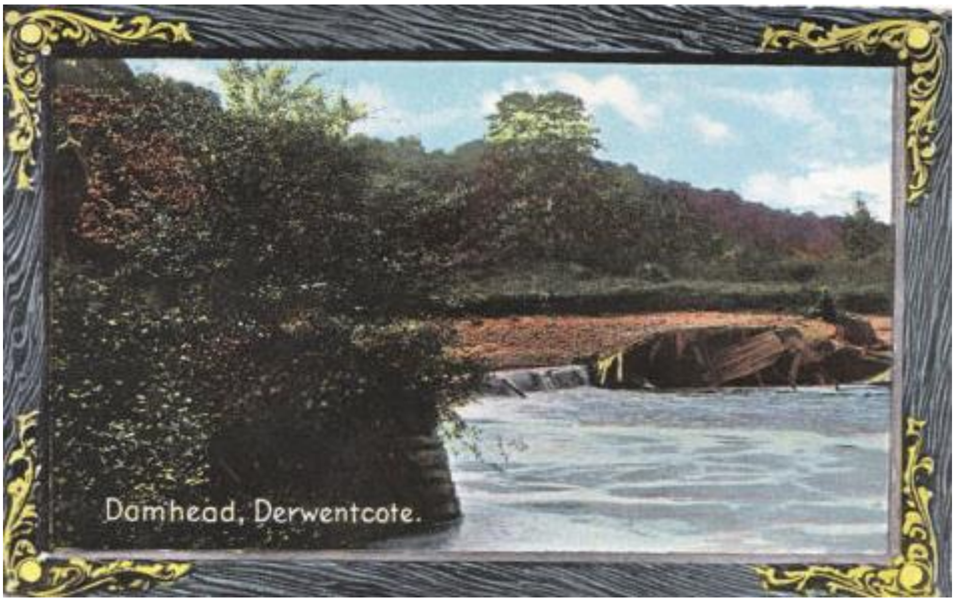
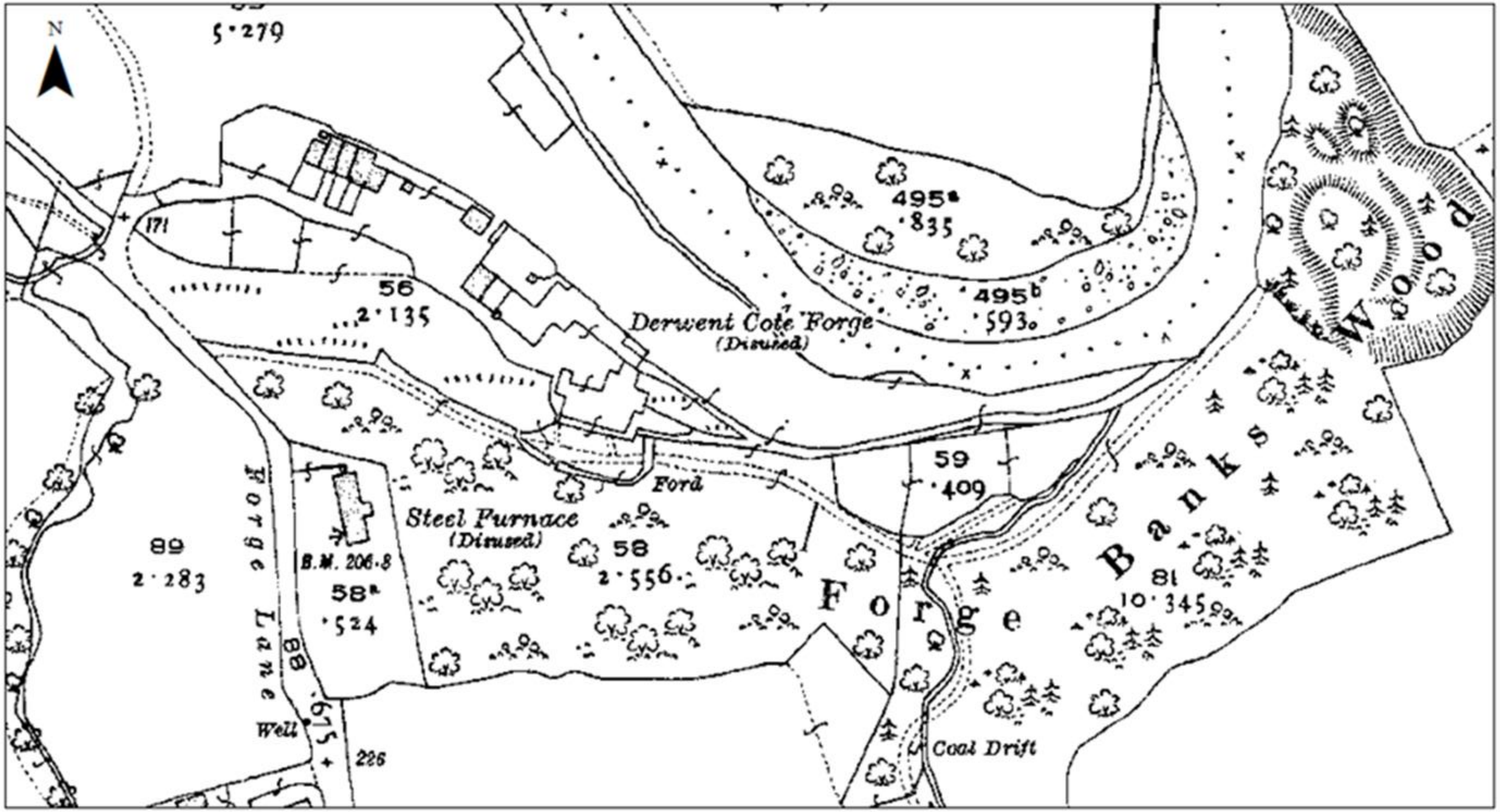


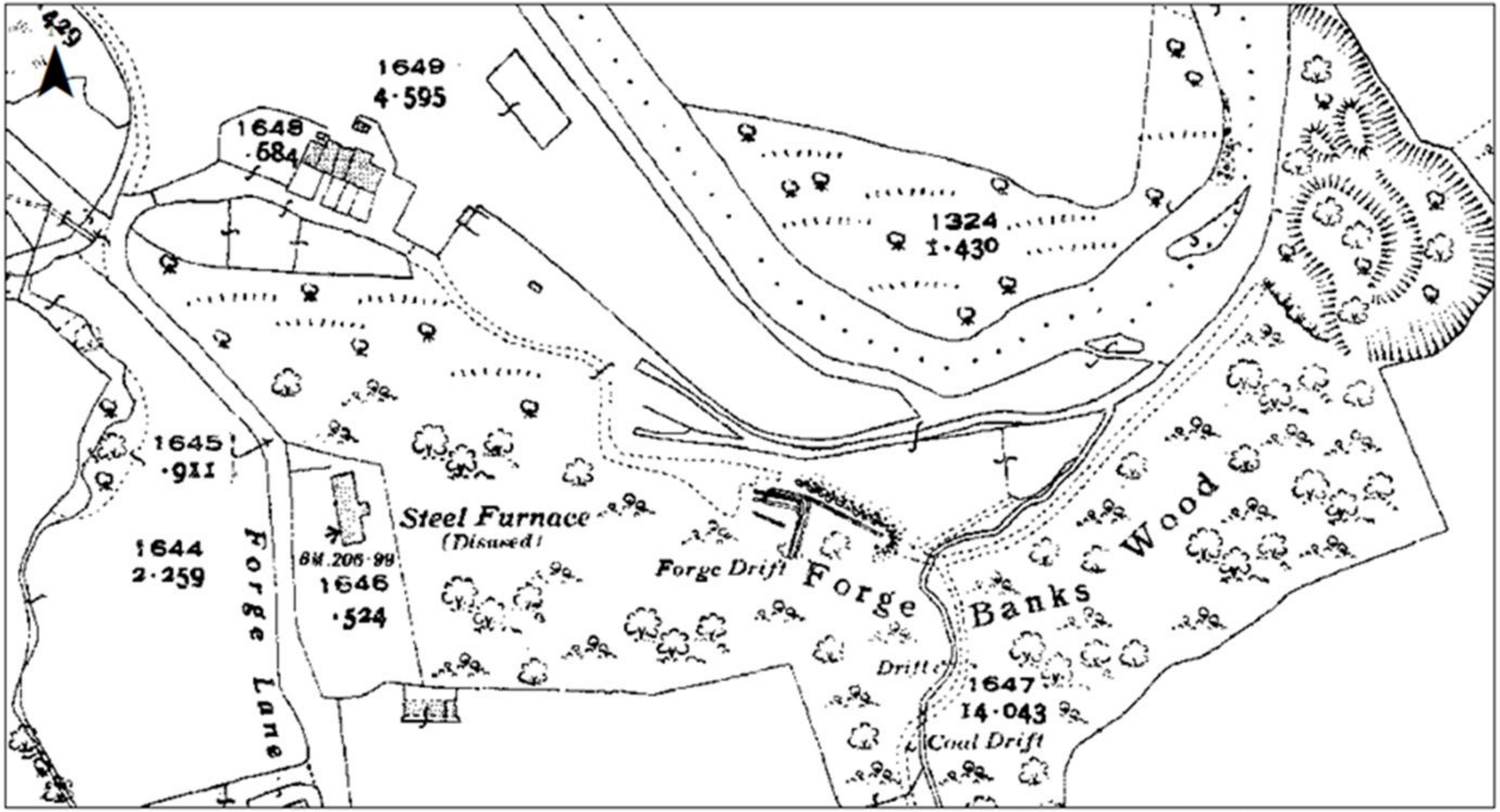
Figure 6.39 Damhead postcard. (Photograph: Shurey n.d.)

The final developments in the forge and cottage areas appear to have taken place in the 1930s. The major development was the demolition of the forge buildings, possibly to allow modern vehicular access to the drifts. OS mapping evidence (fig. 6.41) shows some 50m of rails, probably for mine tubs, running from east to west across the front of the Drift. Mr. Ken Haley, a local resident, provides further details of the mining infrastructure: Mr. Haley recollected that coal was flown from the mine head to two loading hoppers by a skyline, though he did not indicate where the hopper stood. Coal was carried away by a local haulage company, Jowett's, in steam wagons. Forge Lane is so steep that the wagons would use a boiler-full of steam to climb to the old toll house where they would have to build up pressure again before they moved off onto the main highway. There is no evidence for the drifts being worked after the second world war.



0 0.025 0.05 0.1 Kilometers

Figure 6.40 Derwentcote 2nd edition OS map 1910s revision.



0 0.025 0.05 0.1 Kilometers

Figure 6.41 Derwentcote 2nd edition OS map 1930s revision

At about this time, a row of 3 outhouses were built to the north of the third and fourth cottages. These possibly replaced a single shared outhouse to the east of the cottages. The western cottage had its own outhouse to its north; this was not the same 'netty' as was excavated in 2012 to its west. It may be assumed that these outhouses were lavatories. There was a piped water supply to the cottages. Its stop-valve may still be under the cast iron service housing cover on the bank side south of the eastern cottage. A single external stand-pipe may have served the four cottages. The only internal water features within the cottages, excluding the sub-floor drains in the western cottage, are the remains of a 'Belfast' sink stand and a copper for heating water in the northern extension to the eastern cottage (fig. 6.42).

Figure 6.42 Lean-to on north of cottage 4. (l) Photographed from the south-east showing iron sink stand to right, copper in centre and inserted fireplace to left. (r) Copper photographed from the south with brick chimney to rear. Scale 1.0m.
(Photographs: J. Bowman 2016)

Concrete may have been introduced to the cottage site as a building material during this phase. The collapsed roof of the 3 outhouses is of cast concrete and concrete paths were laid to along the south and north of the cottages. The northern concrete path has been poured over an earlier brick path which has raised its height slightly. There are gullies with cast iron drain covers set into the concrete: these may pipe water away or be soakaways (fig. 6.43).

Figure 6.43 Concrete path to north of the forge cottages. Photographed from the north-east.

(Photograph: J. Bowman 2015)

The cottages are quite near the river level and may have been prone to damp. The drains under the floor level of the western cottage and to its western exterior have been noted above. The floors of the three eastern cottages have all been raised. The western central cottage has a quarry- tiled surface on a concrete sub-floor, the eastern central cottage has an enigmatic concrete slab on its earthen floor and the eastern cottage has a concrete floor. This shows an attempt to improve the comfort level of the cottages. There were traces of a purple linoleum floor covering in the southern entrance to cottage 3. Within Lowes' cottage successive layers of patterned linoleum covered the living room surface, cut short of the eastern wall where the staircase, possibly with an under stairs cupboard, ascended to the first floor (fig. 6.44). The layering of the linoleum may be indicative of damp rising through the sub-floor. Asbestos was used for damp proofing in the past; quantities of asbestos sheeting were recovered from the south-western corner of cottage 4. A cement render was applied to the whole of the southern elevation of the cottages to a height of 0.4m, possibly another attempt to combat the problem.

Figure 6.44 Interior of cottage 4. Photographed from the south-east showing a patchwork of linoleum layers. (Photograph: J. Bowman 2016)

Some artefactual remains of the last residents of the cottages have been found in contexts above the concrete layers. Within the fill deposit above the southern concrete path the remains of a locket (fig. 6.45) and a glass marble (fig. 6.46) were found. There were very few personal feminine artefacts recovered, a locket and several pieces of lace trim, possibly for undergarments, from the interiors of the cottages constituted the only physical evidence for the presence of women. Children are even less visible in the archaeological record; the marble may be the only visible evidence for the generations of children who lived at the forge. However, within the north-eastern corner of cottage 2 a small hand-carved bone or wooden spoon was recovered (along with a worn half-penny coin); the spoon is small enough to be used for weaning babies (fig. 6.47)

Figure 6.45 Locket. (Photograph: J. Bowman 2017)

Figure 6.46 Marble. (Photograph J. Bowman 2017)

Figure 6.47 Carved spoon. (Photograph: J. Bowman 2017)

The Surtees family married into the Vereker family, entitled Viscount Gort, in the later 19th century. The latter took over the Surtees estates. Following the war, with the drifts closed down, the cottages were largely abandoned. Ken and Joyce Haley (fig. 6.48) were able to provide information about the abandonment of the cottages. By 1944 only the easternmost cottage was still occupied, by Lord Gort's head forester, Mr. Lowes or Lowe. Lowes was a very neat and particular man who had taken over all the gardens around the Cottages and kept them immaculately. The hedges were always clipped and he grew a mixture of vegetables and flowers. All the gardens were accessed through wicket gates. By the early 1950s the western cottage was derelict. The roof tiles had largely gone and the roofing timbers were clearly visible. The central cottages were still roofed though the tiles had started to slip and several holes were apparent. All the cottages were described as being of two storeys with the first-floor attic bedrooms receiving daylight through roof-lights: plates of glass inserted into the roof. The roofs were recalled as being tall and steeply pitched, possibly to maximise the headroom for the upper chambers. Lowes moved out of his cottage in 1962. Joyce Haley's brother, Billy Kirk who worked for Lord Gort under Lowes, moved Lowes' furniture to Blackhall Mill. He was then instructed to reclaim the timbers from the cottages. One piece

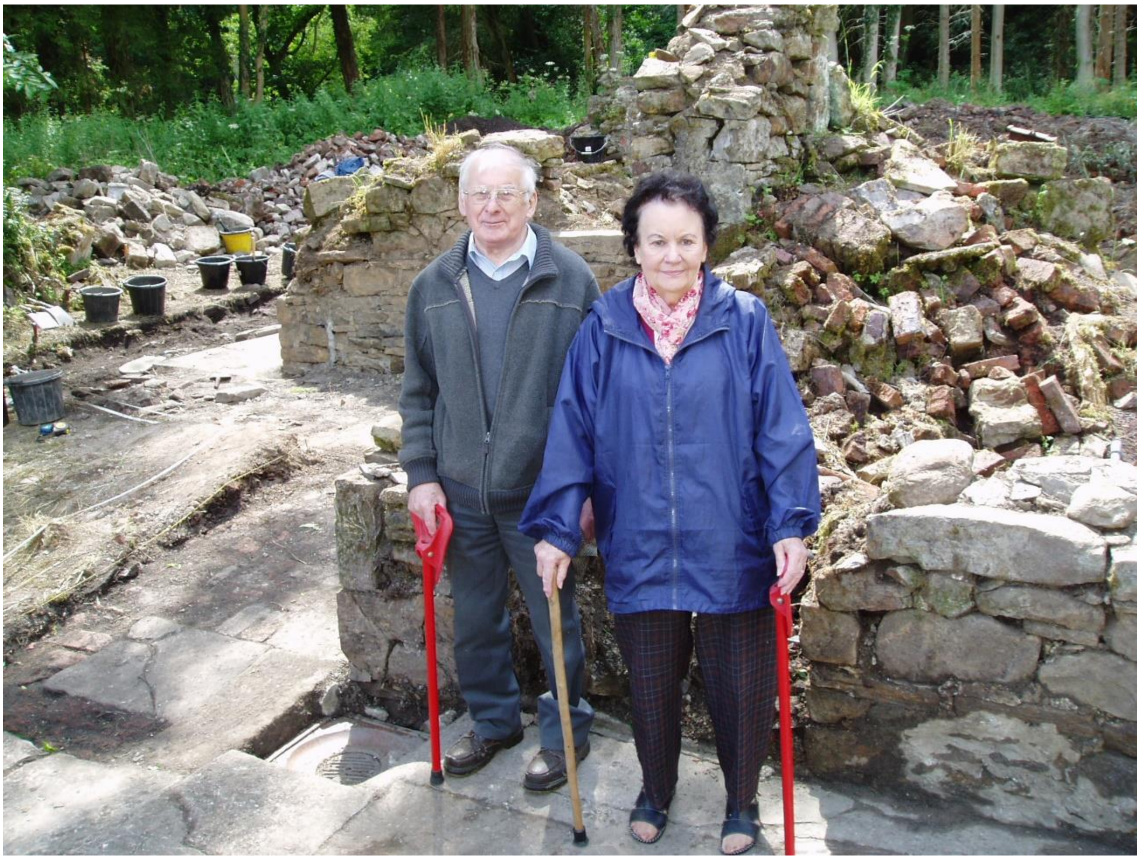


Figure 6.48 Ken and Joyce Haley. Photographed from the north outside the back door to Lowes' house. Joyce's parents had donated a green 3-piece suite to Lowes which was delivered on a milk-cart. (Photograph: J. Bowman 2015)

survives, built into a trailer belonging to Kirk in Weardale. By the same time the area containing the cementation furnace was fenced into a paddock where the local farmer kept a horse (J. Britton 2012: pers comm).

The latest datable pottery sherds were recovered from the former garden area to the south of cottage 1. These were two pieces of Ringtons of Newcastle Malingware (fig. 6.49), possibly from a blue chintz teapot and dated to 1930-1955. If they were not deposited by Lowes, following a breakage his cottage, they may still have been turned over by him as he tended the gardens.

Figure 6.49 Ringtons Malingware.
(Photograph: J. Bowman 2017)

The bowl of a clay briar style pipe was recovered to the western exterior of the cottages from the loam beneath the wall tumble (fig. 6.50). Its form dates it to 1860-1930 (Ayto 2002:8) making it one of the last commercially produced clay pipes. It was found within metres of the 17th-century clay pipe bowl (section 6.2 above) showing that tobacco smoking had taken place at Derwentcote across almost the whole history of that artefact type.

Figure 6.50 Briar pipe. (Photograph: J. Bowman 2017)

An aerial photograph of 1945 (fig. 6.51) shows the landscape of Derwentcote with less tree cover than today. The shape of the curtilage of the forge cottages is clear. The dark lines around the cottages and to their south may be hedges which bounded gardens (see below).

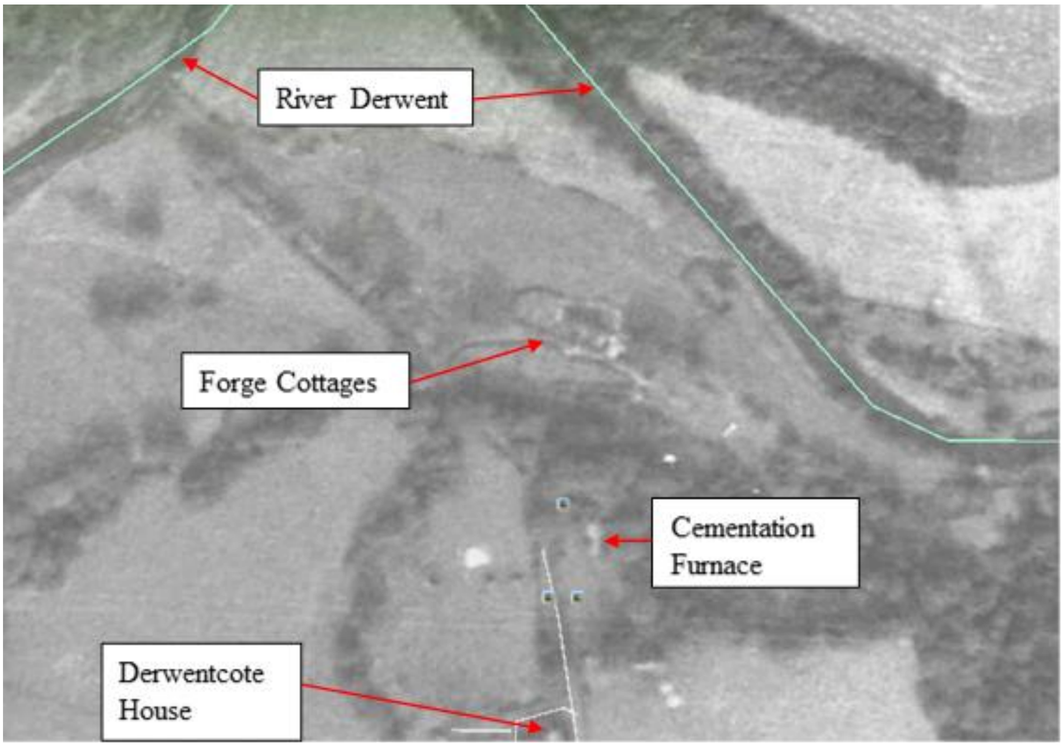


Figure 6.51 Aerial photograph 1945. (Photograph: Google Earth 2017)

The lighter track running to the east between the hedges appears to terminate at a rectangular feature; this may be a remnant of the forge, or the footings for the coal hopper, the white rectangle to the south-east could be interpreted as the footings for the skyline as it appears to be in a direct alignment with the hopper.

The immediate area of Derwentcote cementation furnace, forge and cottages was taken into the stewardship of English Heritage in 1985. The cementation furnace became a scheduled ancient monument in May 1997, and the forge and cottages were also scheduled at the same date.

The work of David Cranstone prior to 1991, and the opening of the cementation furnace to the public, is discussed in 4.3.4 above. English Heritage initially staffed a custodian's hut on the site but the low footfall made manning the site unviable. Currently access to the exterior of the furnace is free with internal access available through arrangement with Historic England. The forge and cottage area has never been open to the public and remains padlocked. In the last 7 years the forge and cottage area have received attention as an archaeological site (see 4.3.4 above). The public were allowed on this site while excavations by Newcastle University were taking place. The University have made use of the custodian's hut as a site office.

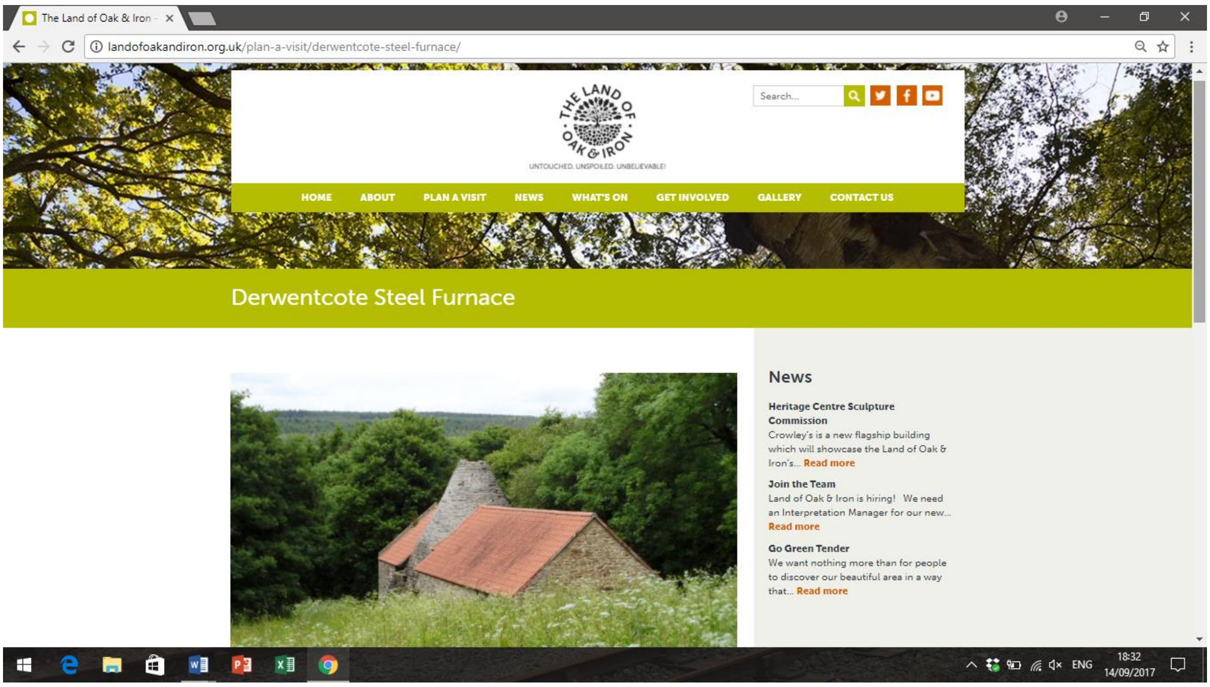


Figure 6.52 Screenshot of Land of Oak and Iron's listing for Derwentcote.
(Land of Oak and Iron 2017)

Derwentcote has been included among heritage sites to be promoted through the North of England Civic Trust's (NECT) 'Land of Oak and Iron' project (NECT 2014: 6, 49, 51). The NECT's vision is to 'celebrate, conserve and enhance our natural, industrial and cultural heritage' (NECT 2014: 3). The Forge Woods are seen as equally important an asset as the steelworks within the site. The condition of the hardwoods across the site will have to be assessed for safety reasons before public access can be granted. It is the intention of the NECT to create a circular walk at the site. Visitors will leave the car parking area on the southside of the A694 and travel down Forge Lane, passing the cementation furnace, crossing the millrace culvert, and entering the forge area. Here, the public will pass the forge cottages and the forge site and enter the Forge Woods. Return to the carpark will be facilitated by the old miner's track winding up the Bairn's Gill accessed at its northern end by passing the Derwentcote Drift mine (NECT 2013: pers. comm. on site meeting). It is hoped that the attention, publicity and funding generated through the project will attract public support for Derwentcote, continuing its afterlife as an important natural, industrial and cultural asset (fig. 6.52).

6.6 Discussion

The community of Derwentcote living around the forge area fluctuated between 44 and 11 individuals between the dates of the 1841 and 1891 censuses (fig. 6.53). The two largest populations, those of 1841 and 1851 are recorded for the two periods when there are nine households listed on the census returns. However, the presence of the large Smith family in both censuses and the Mitchelson family in 1841 inflates these early figures. Following the closure of the steelworks the population grew again, up to 30 individuals (based on the limitation of the data) as the replacement community, based on the coal industry, moved in.

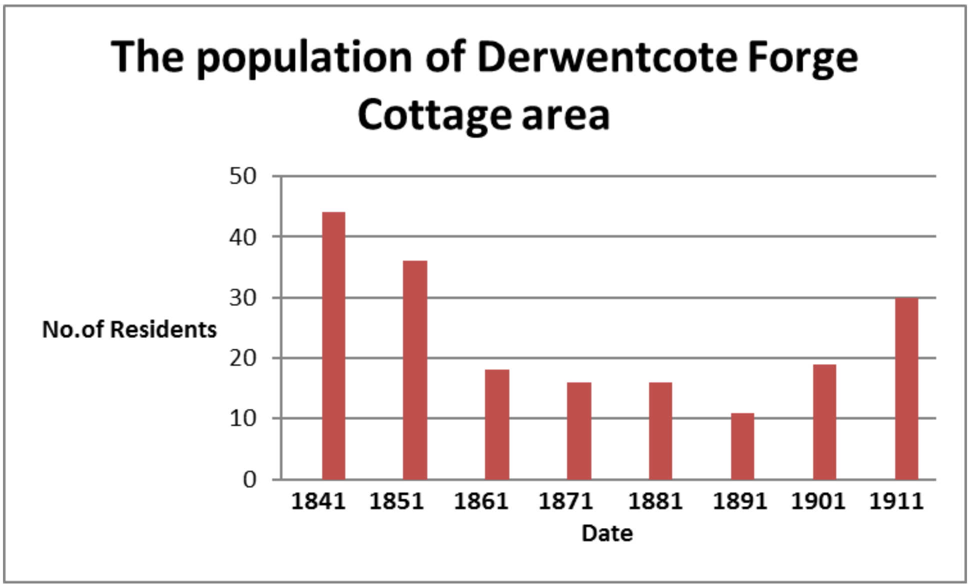


Figure 6.53 The population of Derwentcote Forge Cottage area.

The pie-charts (fig. 6.54 below) show the percentages of households at the forge area which held residents who: were employed at the ironworks, had been employed by the ironworks but were now retired, were possibly employed by the ironworks, or had no relationship with the ironworks. From 1861 to 1881 the Forge Cottages are tenanted entirely by the families of employees, former employees or persons who may have worked at the works as labourers. In 1891 75% of the households contained general labourers who may have, as discussed above, have had an association with the works. The proportion of households in 1841 and 1851 which have no relationship with the ironwork inclines the argument towards the presence of cottages with a Derwentcote address, but separate from the forge, on the Medomsley Estate.

The steelworks seems to have required a workforce of between 4 and 7 employees to operate throughout the period 1841-1881, a number comparable to the 6 workmen involved with the court action of 1746-8. One forgeman lived in Chopwell in 1871, and another, Stephen Hanson, lived at Blackhall Mill in 1891 (Cranstone 1997: 22), so it is possible that there were other employees living away from Derwentcote. In addition to these employees there are labourers and other tradesmen who possibly had a relationship with the works, their numbers always augment the 'permanent staff' until 1891, a period of doubtful steel production and, indeed, may have only been present for a period of dismantling and clear up of the works. The presence of George Eltringham, the retired steel converter, has not been included above. It may be that he played no part at the forge, but conversely, he may have lent a hand or given the benefit of his experience on an ad-hoc basis. It must also be remembered that there was at times an agent or manager or owner resident at Derwentcote House on Forge Lane who may be added to the number of employees at the forge.

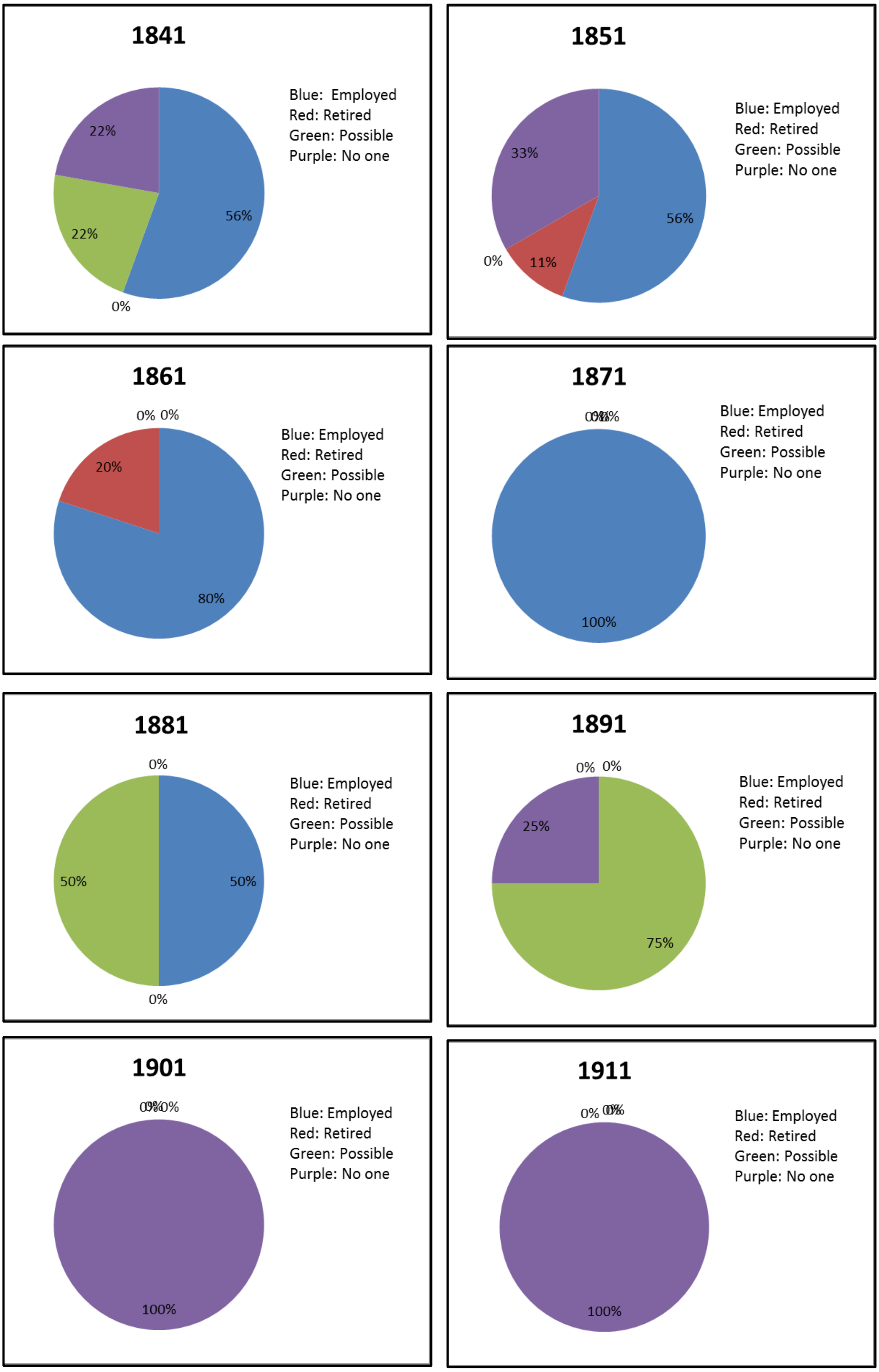


Figure 6.54 Proportion of households involved with the steelworks.

The following graph (fig. 6.55) shows the number of people living at the forge who were employed or possibly employed at the steelworks.

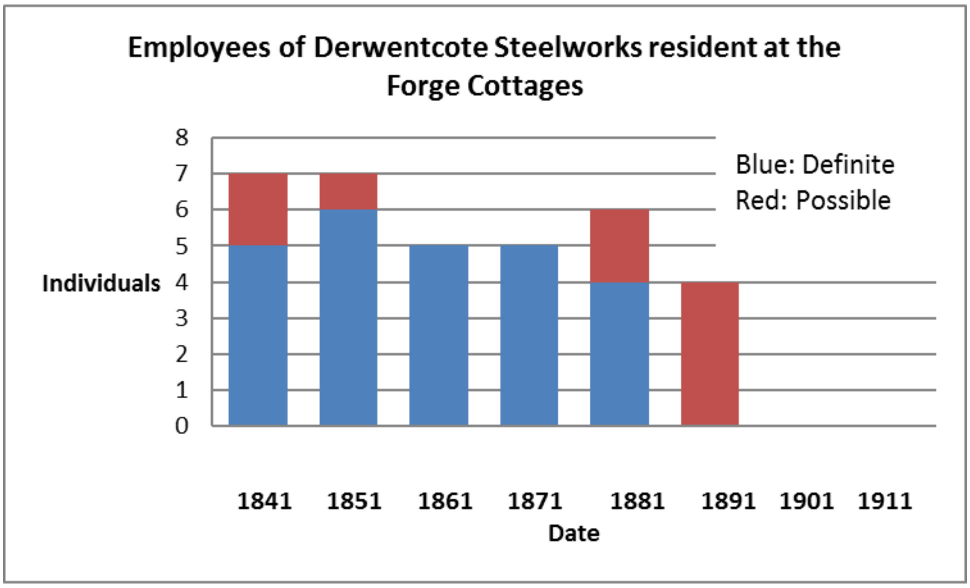


Figure 6.55 Number of steelworks' employees resident in Forge Cottages area.

The locations for most of the processes which took place at Derwentcote remain unclear. The position of the standing cementation furnace is known, as is the position of the crucible furnace and one forge located to its north by Wessex Archaeology (2012). A puddling furnace, balling furnace, warehouses, rolling mill, and three hearths with two hammers have yet to be placed around the site. The forge is built in two major parts: a southern building, (photographed fig. 6.23 above), taking its power from the millpond dam head, and a northern building appears on the OS maps standing between a sluice at its west end and with a visible tailrace exiting from its east end which joins the tailrace from the southern building. The sluice appears to be at the east end of a small bottle-shaped millpond which must have been fed through a culvert running north-east from the main reservoir.

The position of the crucible furnace is known. It lay at the north-eastern of the southern building. Its partially back-filled cellar from the Wessex excavation remains visible. To the north of the crucible furnace was a forging area which would have butted up against the northern building. There is a possibility that there was a forge (Gelley 1983: 96) alongside the blast furnace. It would be logical if it was positioned on the north side of the wheel pit, on the site of the southern forge building. It would also make sense for Reed to build his forge (or refurbish the earlier one) on that site.

As an ironworks built only for the conversion of pig iron to wrought iron bars, Reed would require a finery hearth and a chafery hearth, both with powered bellows and a powered hammer; these would all fit into the southern building and could be worked off a single waterwheel (fig. 6.56). When Smith and partners began producing steel a third hearth and a second hammer were installed. To the south of the crucible furnace is a bricked over culvert with a visible tailrace leading away from the forge. Perhaps this culvert provided the water for the steel plant. Once the crucible furnace was installed, the hammering of steel on a bellows served hearth was unnecessary and that equipment could be removed to make room for the steel melting process.

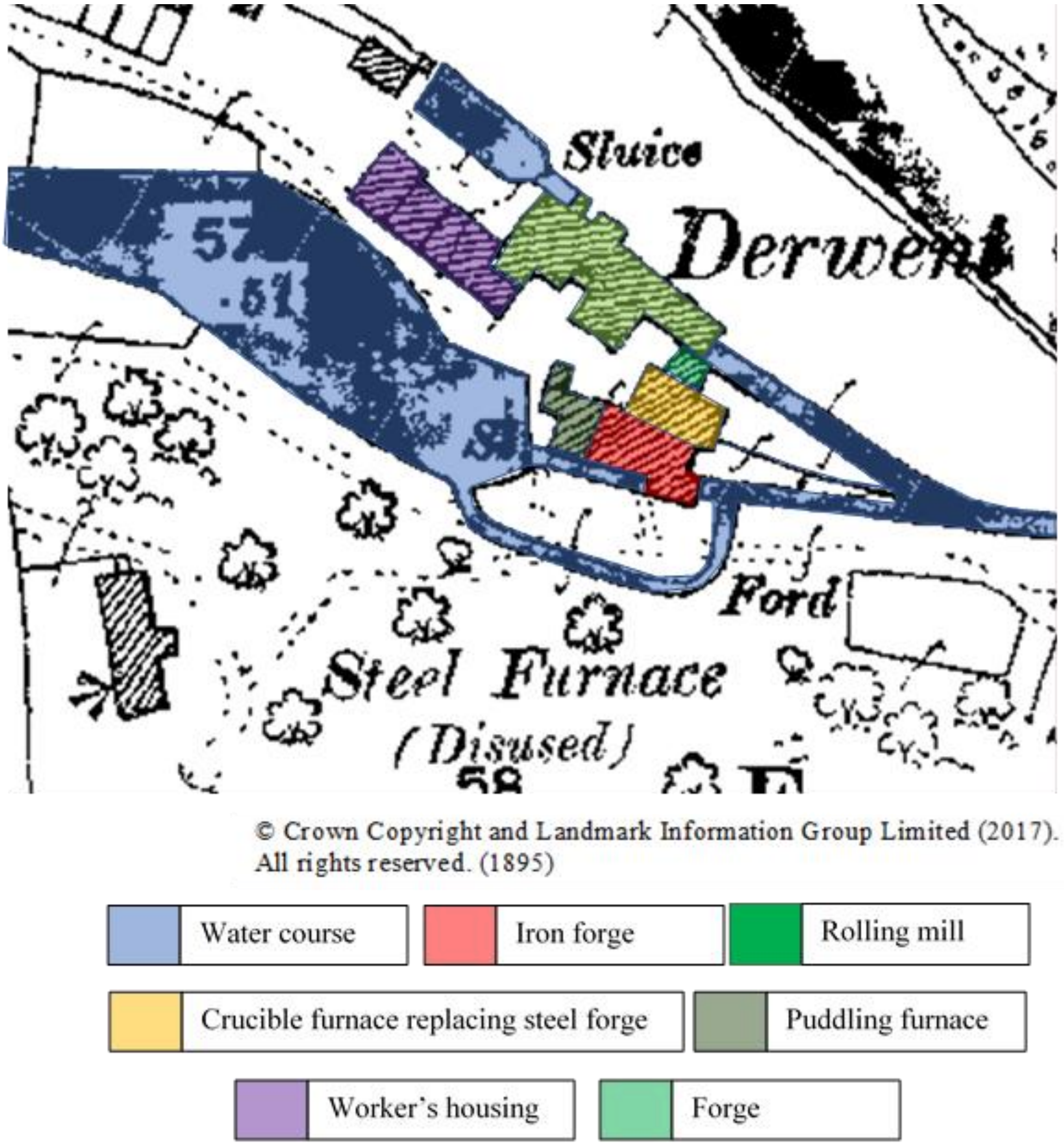


Figure 6.56 Conjectural positioning of forge elements.

The northern building, constructed over a major culvert, must have housed some powered plant. It is indicated in the 1861 census that the iron forge was still in operation and it may be assumed remained in the southern building. The other piece of plant mentioned, for the first and only time that year, was the rolling mill, this would require a sizable building—based on the footprints of the rolling mills at Winlaton Mill and Swalwell—such as the northern building. If the northern building was a late build it may have been constructed to respect the row of three buildings to its western end which may have been workers housing.

The unpowered puddling furnace and air furnace would have been most usefully sited at the southern building as the wrought iron would require working on the chafing hearth. The possibility of the air furnace for the balling process being at the cottage site has been discussed above; it would be remote from the powered hammer but small-scale forging could be done with hand-hammers. As much of the forge buildings still lie beneath the topsoil a full excavation may clarify the layout of the processes.

6.7 Summary

Through the creation of an artefact biography a complete 'life cycle' for the Derwentcote Historic Landscape has been created. The biography shows that Derwentcote was created in the 16th century as a rural estate. In the 17th century the estate was divided, and the portion which would hold the iron works was bought by a neighbouring land owner, possibly in order to secure a corn-mill on the land. The land owner may have developed the riverside area of his Derwentcote estate with a blast furnace and its associated infrastructure.

Derwentcote was the last site developed during the local Industrial Revolution. Initially an iron finery forge was built along with warehousing and accommodation for its workers. The arrangement of industrial and domestic buildings on the same site was seen at ironworking sites throughout the valley established during the industrial period. Alongside the ironworks in the 18th and early 19th centuries a farmstead, brickworks and a pottery had been developed. By the end of the Industrial Revolution, Derwentcote had joined with the nearby Blackhall Mill site to form an economic unit of production.

At the end of a long economic decline Derwentcote survived Blackhall Mill because the latter site suffered flood damage. The management of Derwentcote invested in new technologies, but due to the restrictive nature of the site, could not be competed with the economies of scale afforded to the new steam driven ironworks in the Consett area. Derwentcote therefore moved out of wrought-iron production to concentrate on steel. Once the Consett Iron Company began bulk-steel production, the Derwentcote steelworks closed c.1895.

The ‘afterlife’ of Derwentcote has two phases (so far), after the closure of the steelworks the forge area was demolished to facilitate the Derwentcote drift mine; a fate shared by the Winlaton Mill ironworks for the Clockburn drift. Coal working at Derwentcote ended by the Second World War and the site was largely abandoned. The last resident of the forge cottages left in 1962 and Derwentcote reverted to an agricultural estate. Following decades of neglect, from 1985—and continuing at the present time—the forge and steelworks, have been recognised as a heritage asset with several programmes of archaeological investigation and conservation taking place.

The community of Derwentcote has been shown to have been drawn from the locality the iron and steel works from an early stage its establishment. The same families have been shown to have been present at Derwentcote from the middle of the 18th century to the middle of the 19th. One family, the Eltringhams are known to have been working at Blackhall Mill during the same period. The break with local families at Derwentcote began with the adoption of new technologies in the 1850s. Analysis of the small finds recovered from Derwentcote indicates that there were some high-status ceramic sherds which have been interpreted as evidence of a good standard of living or aspirational objects to differentiate the forge workers from common labourers.

Through analysis of the historical processes carried out at Derwentcote it has been shown that the iron and steel works could have been operated by 6-8 men for most of its history. The main product of the forge for most of its working life was wrought-iron under two hearths and a hammer: manageable by 6 men. A steel hearth and hammer were added c.1733; this would only be required at the end of a firing of the cementation furnace and would employ 2-3 men. The attempt to work a puddling furnace in the later 18th century, and operate a balling furnace over a longer period, would replace the finery forge and use the same workmen. When the only process carried out on the site was crucible steel melting in the final 15 years of operation the number of forgemen recorded fell to 4. Steel forgemen differentiated themselves from iron forgemen in the National Census returns indicating the difference of their status. Above the steel forgemen was the ‘steel converter’ and later the ‘steel melter’, their singular titles conferring greater status than the more numerous forgemen.

The artefact biography not only deals with the gentry who owned Derwentcote and the entrepreneurs who leased the site from them, whose decisions shaped the industrial landscape over time them; but also the forgemen and other individuals who lived in and around the iron and steel works. Artefact biography looks at the relationship of these individuals with the site, through decisions made over the built environment (the acceptance of cramped conditions, the need for new housing, and damp proofing methods) and their own depositions of material culture around the forge cottages. Artefact biography adds the human factor to a traditionally top-down subject and when combined with the other methodologies employed in this thesis contributes to the understanding of the research question.

Chapter 7. Conclusion

The purpose of this thesis has been to understand how the Derwentcote Historic Landscape operated within the economic and social networks of the iron and steel industry of the Derwent valley during the 18thand 19th centuries. Its aims and objectives (as listed in section 1.3 of chapter 1) were to produce an overall history of the iron and steel industries in the valley in order to determine the economic, technical and social networks which linked them and shaped their development. A case study centred on the Derwentcote Historic Landscape facilitated a deeper understanding of a single site, and its workforce. Employing the methodologies described in chapter 2 the objectives of the thesis have all been achieved. The findings of this thesis are summarised below.

Drawing on a range of primary and secondary historical sources in chapter 3, this thesis has established that small-scale iron production took place in the Derwent valley for centuries before the Derwentcote forge came into being. The earliest recorded iron working was in 1299 in the manor of Muggleswick. Iron smelting and extraction processes were controlled by the land-owing gentry during this period. Iron ores were smelted close to the extraction sites and generally worked into ironware for home-consumption. Muggleswick and its surrounding parishes at the head of the valley were important in supplying the Durham priory during the later 15th and 16th centuries. The Blakiston family of Gibside began smelting their own iron on the estate in the 16thcentury. Though the two recorded furnaces were established through lease-holders, the Blakistons took over their operation. The iron produced at Gibside was mainly used on the estate for their coalmining interests, any surplus iron was sold in the Newcastle area. The only hint of iron working activity at Derwentcote at this time comes from a family history of the Gelley family which suggests that an ancestor of the writer worked at a forge there in the 17th century. The nature of iron working during this period could be described as the 'busy-ness' Barrie Trinder noted in the pre-industrial landscape (1982: 4, 12-51, 202-244).

In the late 17th century the iron industry of the Derwent valley underwent a revolution in terms of operators, supply chains and markets. Geographical and economic conditions attracted entrepreneurs from outside the valley to lease land and establish businesses on a larger scale than previously experienced in the locality. This Industrial Revolution began with a sword factory at Shotley Bridge, established by a partnership of Newcastle and London businessmen. The swords produced at Shotley Bridge were sold in London. The sword factory was immediately followed by the Yorkshire iron master, Denis Hayford, who leased a forge and land to build steel and blast furnaces. Hayford 's Blackhall Mill steelworks produced the highest quality and most expensive steel in Britain for a period of over 30 years. Ambrose Crowley III established ironware manufactories at Winlaton and Winlaton Mill and, with the addition of the existing ironworks at Swalwell, he created the largest iron manufactory in Europe. Crowley imported raw materials by ship to the Derwent, removing the need for producing local iron. His finished goods were largely sent by sea to his warehouse in Greenwich, London, from where Crowley controlled the business. Derwentcote was the last of the businesses to be established during this period. Official documentation suggests a foundation date of 1718 for a forge on land leased by Newcastle businessmen. By this date most, if not all, the iron worked in the valley was imported.

The iron industry of the Derwent was revitalised by the discovery of ore at Consett in the mid-19th century. Local businessmen leased land to build new ironworks high above the river on the valley side next to the ore mines. The new ironworks employed steam power for the forging, rolling and transportation of materials; a dependable infrastructure which, together with the economies of scale enjoyed by the new businesses, largely bypassed the survivors of the previous era as they could not compete with bar iron production. These smaller sites, including Derwentcote, concentrated therefore on steel production. Once the Consett Iron Company began to produce bulk steel its competitors all but ceased production.

Throughout this thesis archaeological data has been used to augment the historical narrative, in order to better understand the development of the iron and steel industries of the Derwent valley. Traditionally archaeology has acted as the 'handmaiden to history' (Hume 1964: 214), with archaeological sites being located through references in the documentary record and archaeology serving to confirm that historical record. The archaeology in this project is not used simply to corroborate the historical evidence, in some instances it is the only evidence for industrial activity. The integrative methodology set out in chapter 5 (combining an adapted version of the Manchester Methodology with process recording) and chapter 6 (artefact biography) has enabled a new understanding of the intricate web of dependencies and entrepreneurism within the industrial landscape of the Derwent valley, in turn providing a deeper and more comprehensive understanding of patterns of industrial activity within the valley.

Using archaeological databases and reports (as set out in chapter 4) it has been possible to locate remains, and possible remains, of iron working sites which are not recorded in any historical sources, such as the bloomery slag heaps in the Nookton area (4.2.1) and the possible blast furnace at Derwentcote (4.3.4). The HER indicates that iron was mined from bell pits and open quarrying along the northern valley side, from Greymare Hill in the west to the Milkwell Burn, Chopwell, in the east. While medieval sources suggested that iron mining took place in that area its scale becomes apparent only through the archaeological record, along with evidence from Boundary Lane (4.2.2), Ravenside and the Milkwell Burn (4.2.3) that smelting took place close to the extraction sites.

Research for this project shows that the existing archaeological databases were incomplete. The massive bloomery slag heaps at Ravenside, Chopwell, were tracked down through descriptions in local history accounts, as were the millrace bridge said to belong to Allensford forge outside Shotley Bridge and the Hammer mill thought to be used by the Shotley Bridge sword makers. Surprisingly, the largest remaining artefact of the industry in the valley is not recorded in any way the HER: this is the 18th century Dam Head which blocks the Derwent below Winlaton Mill which, for all its significance and antiquity, has recently had a concrete fishpass cut through it.

The fieldwalking undertaken in the course of this research (set out in 2.2.4) has made possible a detailed assessment of the quality and condition of the standing archaeology of the Derwent valley iron industry, and some calculation of the proportion which has been lost from through redevelopment and other factors. One previously unrecorded site was found through fieldwalking: the scatter of bloomery slag on the north bank of the Milkwell Burn near Chopwell (4.2.3).

Kate Clark has contended that ‘it is not the size or scale that determines whether a structure survives, but whether it has been reused’ (2005: 101). The evidence of the Derwent valley appears to run contrary to this statement. The prime examples of surviving industrial structures in this area are the Allensford blast furnace (4.3.2), the Derwentcote steel furnace (4.3.4), the single remaining workshop in Winlaton and the Dam Head (both in 4.3.3). Except for the workshop, it is the remoteness of these structures from urban settlement which has ensured their survival.

Developer-led excavation at Swalwell and Winlaton Mill and research-led work at Derwentcote and Allensford (discussed at 4.3.3, 4.3.4 and 4.3.2) have shown that a substantial amount of these sites survive beneath the surface level. Where physical evidence has not survived, conservation by record has played an important part in suggesting the building materials within both the industrial buildings and also the housing stock available to the workers at the sites. The Derwent vernacular for industrial buildings, shown through photographic evidence, was for stone pillared structures with red tile roofs. The gaps between the pillars and roof gables, when not left open to the elements, appear to be filled with horizontal timber boarding. Warehouses, like those at Winlaton Mill, were more impressive and secure, built from stone and tile. Worker's housing, again in stone and tile, could be one, two or three stories high; arranged in terraces, blocks or squares. The data collated in chapters 3 and 4 of this thesis informed the detailed interpretive analysis set out in chapters 5 and 6. An adapted version of the Manchester Methodology (2.3.1, 5.2) informed the development of a social model of the Derwent valley landscape during the Industrial Revolution.

The Manchester Methodology is a valuable tool for industrial archaeologists but takes a purely 'top-down' approach focussed on the ownership of monuments. In chapter 2 the Manchester Methodology was modified in such a way as to make possible an analysis of the landscape from a different perspective. The question asked was: who benefitted from these monuments? This focus provided a new understanding of the quotidian experience of people who lived and worked in the valley. The results, shown in graph form in 5.2, indicated that industrial growth began in the late 17th century and was spurred by the burgeoning iron industry created for the benefit of the entrepreneur class. Though there is a lack of new industrial monument types created through the establishment of the Consett ironworks, the graph maintains a slight upwards direction at its termination date of 1900 indicating that social development was still taking place. From the 1840s, the number of new monument types which benefit the civic class, or general public, is shown to increase.

In chapter 5.3 the technique of process recording was employed in an effort to better understand the nature of and changes to manufacturing processes over time. The Consett Iron Company was the only business which adopted any new technologies following the First World War, so detailed process recording has been limited to technologies present at 1915; the year Raines withdrew from their Winlaton Mill works, and 3 years after Ridley and Company of Swalwell closed down. A briefer account of the technological advances at Consett in the rest of the 20th century was carried out because descriptions of these processes would be uninstructive in explaining the competitive edge of the near monopoly of the iron and steel industries held by Consett (5.3.4). Where possible an estimate of the numbers of men required to operate the processes was also provided in order to illustrate social organisation of production. A comparison with the steel manufacturing centre of Sheffield (5.3.5) showed how the Derwent valley held a preeminent position for the production of high-quality steel during the 18th century. This position was lost in the 19th century as new steelmaking technologies were developed at Sheffield.

The additional information created in chapter 5 combined with the data from chapters 3 and 4 facilitated the creation of a *Derwent Valley Archaeology* database. The database (contained on the DVD attached at 5.4) has been imported into the Geographical Information System, ArcGIS 10.3.1, so that the site data may be viewed against Ordnance Survey maps of various scales and the information within the database more easily interrogated. A Historic Landscape Characteristic map illustrates areas of the valley where no certain site coordinates are known. Total station survey results for the forge cottages at Derwentcote are also processed through ArcGIS to produce the most up-to-date and accurate plan of the site. Excerpts from the GIS have been used to illustrate the thesis throughout.

Chapter 6 studies the Derwentcote site through the methodology of artefact biography. Artefact biography looks at a site through the experience of all classes who interacted with it. Through recent programmes of archaeological research Derwentcote has become the most comprehensively excavated and recorded site in the valley. The small finds recovered during these excavations shed light on the lives of the employees of the iron and steel works. From 1841 the employees, their families and other denizens of the community of Derwentcote can be named and analysed through the national census returns revealing social trends. Some details of these individuals can also be traced in the contemporary press. In the artefact biography, careful attention is also paid to the built environment, which has been used to inform on phasing, especially in the forge cottages. The artefact biography combines data from all the other methodologies employed in this thesis. The outcome is a deeper, more holistic understanding of the Derwentcote works within its landscape.

In addressing the research question, it is clear that Derwentcote was one of the longest lived businesses within the valley. The Derwentcote iron forge and steelworks operated for some 177 years within the documentary record and possibly around 230 years overall. The supposition for the longer time frame is supported through archaeological evidence that there was a 17th century blast furnace present at the site. Within the valley only the unpowered Winlaton site worked iron longer (1690-1966), but that was achieved by small private businesses within Crowley's former works rather than the site remaining as a single manufacturing entity. Derwentcote was established during the local Industrial Revolution, positioned between the two major economic units of the valley: the sword makers with Hayford to the west and Crowley to the east. Its history, as uncovered in the research set out above, can be summarised in the following way:

For the first 15 years of operation, c.1718-c.1733, Derwentcote forge operated independently from both Hayford and Crowley. The smelting of local ores within the valley appears to have ceased prior to the establishment of the forge. The pig iron converted at the forge must have come from elsewhere. Records show that by the mid-18th century this pig iron was sourced from London, suggesting that Crowley was the supplier. Crowley's nearby iron manufactories may have been the primary market for the converted bar iron. If this is so, then Ralph Reed and his partners may have set up their forge at Derwentcote to supply Crowley. Additionally, the site may have benefitted from a pre-existing infrastructure from Ambrose Stevenson's blast furnace.

In 1733 Derwentcote became linked to the Shotley Bridge sword factories. The partnership which took on the lease of the Shotley Grove sword mill from the Hollow Sword Blade Company constructed the steel cementation furnace above the forge on the valley side. Derwentcote steel furnace was the seventh and last cementation plant built in the valley. There may not have been more than four in operation at any one time. Derwentcote and Blackhall Mill were converting Oregrund bar iron to steel, which may have been obtained from Crowley. By the late 1750s John Hodgeson of Newcastle had bought the leases on both Derwentcote and Blackhall Mill and was running them as one economic unit. There followed a short period of independent ownership by the partnership of Landell and Chambers. Derwentcote was reunited with the Blackhall Mill steelworks c.1788 under Isaac Cookson and the two sites worked together, with perhaps a short closure of Derwentcote in the early 19th century. The closure may be indicative of the post-war downturn in the national iron industry following 1815, which also affected Crowley Millington's locally, and eventually saw the closure of the sword factories. Derwentcote may have only survived this period due to the closure of Blackhall Mill because of flood damaged between 1834 and 1851.

The wider economic base of the Derwent valley was essentially rural, an economy based on agriculture and forestry until the mid-19th century. Documentary evidence shows that the lease for the land upon which the Derwentcote forge was built included agricultural land and a corn mill. An agricultural homestead was built on Forge Lane in the 18th century and the forge manager was managing the farmland in the mid-19th century. The iron and steel works may be seen as part of a larger range of economic interests at Derwentcote which also included a brickworks and perhaps a pottery.

Looking at the social structure of the operators of the ironworks in the Derwent valley at this time, Derwentcote fitted in with the local trend of external entrepreneurs leasing sites to establish their businesses. The history of the Derwentcote iron and steel works is followed through the passage and reassigning of the lease initially taken out by Newcastle businessmen, Ralph Reed and his partners, from the land owner John Stevenson.

At the other end of the social spectrum, the employees for the iron and steel industries were initially brought in from outside the area. The Shotley Bridge sword factory was founded using German immigrants. Hayford employed the German steel master, Wilhelm Bertram, to run his forge and steelworks and Crowley often advertised for iron workers from the south of England. Although Reed and his partners may have brought in iron workers from Cumbria to set up the forge, it appears from parish records that Derwentcote employed local men from Chopwell and Medomsley from an early date. This may be because locals had 30 years of experience of iron forging at Hayford's or Crowley's before Reed's forge was set up. Derwentcote continued to employ local men until the introduction of the crucible furnace in the 1850s when men from further afield were brought in to operate the new process; a trend which continued until 1881 at which time no local men are recorded at the forge. One of the longest serving families at the steelworks, the Eltringhams, was the last local family to leave. Eltringhams are still to be found at Chopwell and Blackhall Mill suggesting that the last Eltringhams at the steelworks were either unable or unwilling to adapt to new technological processes introduced in the 1870s or were unwilling to work for the new management.

Derwentcote's place in the national Industrial Revolution is highlighted through its adoption of two processes. In 1754 Angerstein noted that Derwentcote produced 'a few tons of the so-called German Steel' (2001 [1765]: 272). It may be that Derwentcote had produced this precious material since its involvement with Shotley Bridge in 1733. Angerstein also discovered that Crowley's had recently learned the secret of German steel. Before this, Derwentcote may have been only other steelworks, besides Blackhall Mill, to produce German steel for a period of 20 years. The second process at Derwentcote was puddling, attempted under Landell and Chambers. This enterprise failed because of insufficient expertise and deviation from the process patent. Though unsuccessful, Derwentcote was the only place in the valley where puddling was attempted, until the establishment of the Derwent Iron Company at Consett in 1840 heralded the advent of the Machine Age.

Derwentcote survived into the Machine Age, receiving some technological investment in the form of a crucible furnace for steel making and a rolling mill, bringing the site up to the technological level of Swalwell. Derwentcote stopped producing bar iron in the 1850s. At this time Derwentcote could probably only convert the same amount of pig iron as it was producing in the 1750s, around 150 tons annually. The Derwent Iron Company could easily convert this amount in a week. Derwentcote concentrated on producing crucible steel until the end of its working life in the 1890s when the Consett Iron Company commenced mass production of acid grade steel.

During the Industrial Revolution Derwentcote operated successfully within the economic and social networks present in the Derwent valley. However, it failed to keep up with the new economic model created in the Consett area during the Machine Age. It had twice been at the forefront of national technological innovation. The site was operated on a day-to-day basis by a largely stable community of local iron and steel workers, which only began to fracture as later technologies were introduced.

This analysis of Derwentcote provides the most complete and up-to-date history of any iron and steel industrial site in the North East of England. The investigation of the Derwent valley through ‘third generation’ industrial archaeological techniques is original research and has allowed a comprehensive exploration of the industry within the landscape in its physical, temporal and social presence. This research is presented as a GIS which allows direct access to the data generated and facilitates further interrogation beyond the remit of the project. Both the GIS and the adaptations to the Manchester Methodology are original contributions to knowledge.

The natural resources of the Derwent valley, iron ore, timber, coal and water for power nurtured industrialisation, but much of its history is now hidden. This research project stemmed from the belief that the industrial heritage of this key player in the Industrial

Revolution should be more widely recognised and celebrated. This thesis is itself a contribution to that cause.

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