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Blackbeck Gunpowder Works, Cumbria: an archaeological and architectural survey

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Frontispiece. View of the former gunpowder works site from the hillside to the west, looking north east.

Roof of saltpetre house together with that of store and stable beyond visible at foot of slope near centre of photograph.(NMR: DP003430)

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1. INTRODUCTION, SITE LOCATION AND SUMMARY

Between November 2003 and February 2004, English Heritage (EH) carried out an archaeological and architectural survey and investigation of the former gunpowder works at Blackbeck in Cumbria. The survey was undertaken as part of a wider thematic project investigating gunpowder manufactories across the whole of Cumbria, initiated in June 1999 (Dunn 2000; Jecock 2003) as the logical progression to the EH Monuments Protection Programme (MPP) Step 3 and Step 4 reports for the gunpowder industry nationally (Gould 1993; Chitty 1996). Although there has been considerable interest and research into the Cumbrian works in recent years, directed both at the group as a whole and at individual sites (*e.g.* Wilson 1964; Marshall & Davies-Shiel 1969, 75-88; Crocker, G 1988, 36-41; Crocker and Crocker 1992; Patterson 1995; Palmer 1998; Tyler 2002), this has mostly concentrated on the documentary evidence with little formal examination or detailed recording of the physical remains. EH's Cumbrian Gunpowder Industry Project is intended to rectify this omission, and will aid the conservation management of those gunpowder works which have been designated in whole or in part as protected monuments; the inclusion of all sites

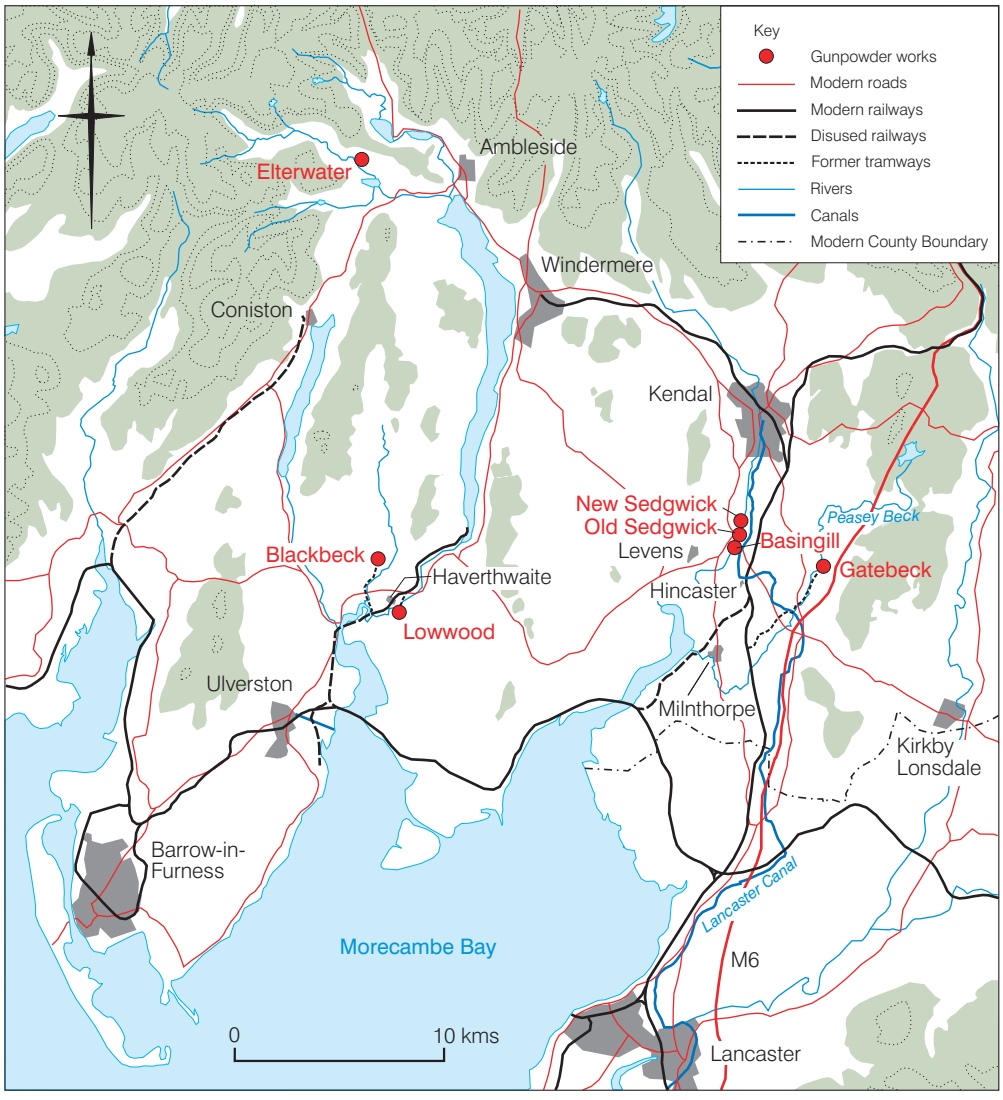


Figure 1. *General location diagram.*

irrespective of their current level of designation will also enhance our overall understanding of what was once an important regional industry.

The works at Blackbeck is one of seven gunpowder manufactories (eight if Gatebeck is treated as two sites) which operated in the historic counties of Westmorland and the Furness area of Lancashire (present-day south Cumbria) at various times between *c*1764 and 1936 (Fig 1). All produced gunpowder chiefly for the civilian, as opposed to the military, markets. Geographically, the factories are concentrated at four locations across the region: Old Sedgwick, New Sedgwick, and Basingill lie in close proximity along the banks of the River Kent, 5-6kms south of Kendal; Gatebeck High and Low Works stand adjacent to each other on the banks of the Peasey Beck about 4km to the south east of the first group; Blackbeck and Lowwood occupy neighbouring valleys close to Haverthwaite; and Elterwater forms an outlier at the foot of Great Langdale. The industry became established in Cumbria mainly in response to the increased national demand for blasting powder from mines and quarries during the second half of the 18th century, but the Lake District also provided a highly suitable environment for gunpowder manufacture: its numerous rivers could supply the waterpower needed by the different processes, and the rural and wooded situations of many locations were sufficiently remote from populous areas to minimise the effects of any explosions. Later, as more regard was paid to the safety of the workforce, several mills - including Blackbeck - incorporated trees, natural rock outcrops and low hills into their layouts as barriers to dampen and help contain the inevitable, accidental explosive blasts. In addition, timber was locally available both for charcoal manufacture and for the making of barrels and packing crates, whilst proximity to the coast meant that other raw materials (sulphur and saltpetre) could be readily imported and the end products easily exported. As a result of overseas contacts - mostly routed through Liverpool - the Cumbrian gunpowder industry was able to build up a healthy market for its products abroad, both in parts of the British Empire, and at home. After *c*1860, alternative forms of explosive based on the nitration of a variety of organic compounds appeared. Other English gunpowder works diversified into producing new explosives, but the Cumbrian mills stuck with their traditional stock-in-trade, now re-christened blackpowder to distinguish it from the newer forms. Despite the failure to diversify, the Cumbrian blackpowder industry continued to prosper until the end of World War I, when demand for the product collapsed catastrophically. The response of the Cumbrian mill owners was to merge with their competitors as part of Explosives Trades Ltd., the forerunner of Nobel Industries (from 1926, itself incorporated into Imperial Chemical Industries Ltd. (ICI)) (Crocker, G 1988, 2). However, by 1928, ICI had started the inevitable process of rationalisation in order to concentrate blackpowder production at a single site, namely Ardeer in Scotland. Production in Cumbria finally ceased in 1936, with Gatebeck the last site to close (Crocker, G 1988, 1-2; Patterson 1995, 3).

Blackbeck is the fifth of these sites to be recorded by EH (the other sites completed to date are Old Sedgwick (Jecock and Dunn 2002), Basingill (Hunt and Goodall 2002) Elterwater (Jecock *et al* 2003) and New Sedgwick (Dunn *et al* (2003)). The survey and investigation of the Lowwood works was also completed during summer 2004 and preparation of the report is underway (Jecock *et al*, 2004). The main phase of fieldwork at Blackbeck took place

between November 2003 and February 2004 with the final elements being undertaken during spring and October 2004. The work has involved an analytical field survey of the archaeological remains at 1:1000 scale (to Level 3 standard as defined in RCHME 1999, 3-5) and an architectural survey of the standing buildings. The fieldwork was backed up by documentary research confined to readily available published sources, including some of the local newspapers, in the Cumbria Record Office at Barrow and the Local Studies Library in Kendal, and a limited search of historical archive material. The research has also benefited from access to photographs, notes and plans held in a number of private/ public archives and collections.

The former works is located close to and east of the village of Bouth (Fig 2) at the southern edge of the Furness Fells which separate Coniston Water on the west from Lake Windermere on the east. It is centred at National Grid Reference (NGR) SD 3344 8560. The site is nearly 4km from and almost due west of Newby Bridge and 2km north west of Haverthwaite village. The remains of another gunpowder manufactory - the Lowwood Works - are located near Haverthwaite on the banks of the River Leven, which emanates from the southern end of Lake Windermere. Below and to the west of Haverthwaite the River Leven starts to become a tidal estuary as it approaches Morecambe Bay and is joined by a tributary from the north, Rusland Pool. Blackbeck Gunpowder Works is located on the western side of

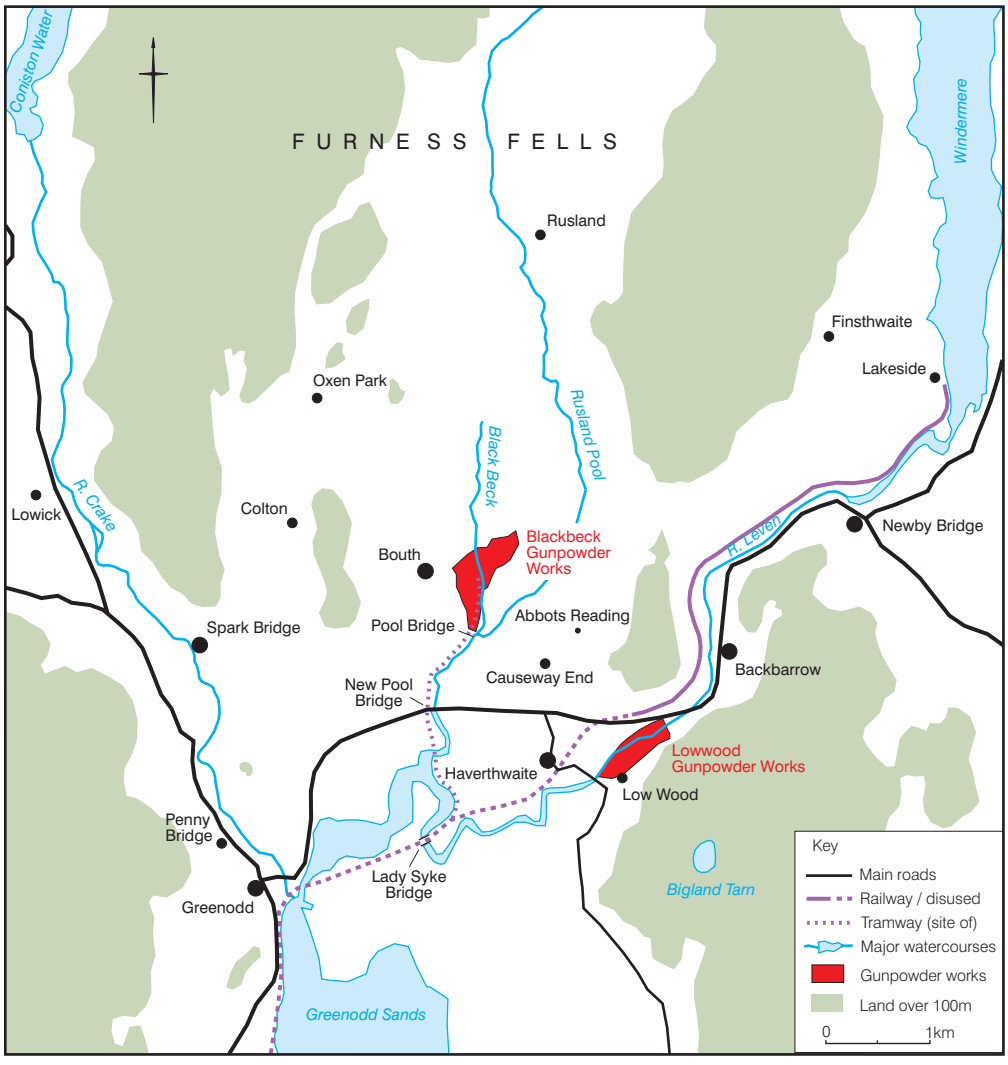


Figure 2.
Local setting diagram.

the Rusland valley and extends over both sides of a small stream, the Black Beck, which flows into Rusland Pool just above Pool Bridge at the southern end of the site of the former gunpowder manufactory.

The remains of the works occupy an area, triangular in plan, of about 16 hectares with its component elements being dispersed over a distance of about 900m in length; they are chiefly located on the valley floor of the stream and around the periphery of a low hill which separates the Black Beck and Rusland Pool valleys. The gunpowder works was established in the early 1860s by Arthur Benson Dickson, owner of Abbots Reading and its estate, with production starting in 1862. The works, by then in ICI ownership, had closed by the autumn of 1929 (if not before); actual powder production had probably ceased during late September of the previous year when an explosion caused much damage at the works. At closure the processing buildings were demolished in order to prevent any residual gunpowder adhering to their fabric being accidentally ignited. Without more detailed research it is unclear what happened to the site during the years immediately after closure, although local tradition has it that there was activity here during World War II - one of its uses may have involved food storage. Air photographic evidence (NMR: F21.58/RAF/2151 26-APRIL-1957/0058-9) indicates that by the late 1950s at least the wooded area of the former works had become the caravan park that is still its use today. The selective demolition of some of the buildings at closure and the subsequent creation of caravan pitches has meant that much has been destroyed, but in spite of this a number of significant elements still survive. Some of the archaeological features are related to the principal power source at Blackbeck which gives them increased importance because Blackbeck was the only gunpowder works in Cumbria to be steam-powered from the begining. Others are particularly valuable because they throw light on periods, especially the early and last years of the works, when there is either a lack of or insufficient cartographic evidence to pin-point the exact location of a number of buildings whose existence is known from contemporary documentary sources. The standing buildings which survive have either been converted into dwellings or are now used as workshops and stores by the caravan park; one building has been converted into a toilet block and shop.

The principal surviving features are two building ranges close to the site of the former incorporating mills, as wall as the saltpetre house, an oil store, an electric motor house, a former stable and store, the watch house, the women's changing house, the cooperage, and a small office at the southern end of the works. The brick-lined flue from the works boiler house still survives on the hillside above it as does much of the drive-shaft tunnel which linked the principal steam engine with the machinery in the second mixing house; the site of the latter survives as a deep, stone-revetted cutting near the saltpetre house. Part of a line of stone-built pillars which supported pipes supplying steam from the boiler house to an isolated steam engine also survives. The sites of two of four former cartridge houses form prominent earthworks in a pasture field while platforms, partly cut into bedrock, are the sites of the second charge house, a cart shed (and probably the first charge house), the first corning house location, and the dust and packing house. The cutting which contained the main store magazine also survives. Above the works, on the west, a concrete-lined

reservoir associated with the works is still partially water-filled. The works had its own internal narrow gauge tramway system which was linked to the former railway branch line which extended from near Ulverston to Lakeside, by a standard gauge tramway whose route immediately south of the works is still visible. Inside the former works the main sections of these tramways have been utilised as the caravan park's road system.

2. GEOLOGY, TOPOGRAPHY AND LAND USE

Blackbeck Gunpowder Works is situated at about 8m above Ordnance Datum immediately to the north of the confluence of the Black Beck and Rusland Pool at Pool Bridge (Fig 3).

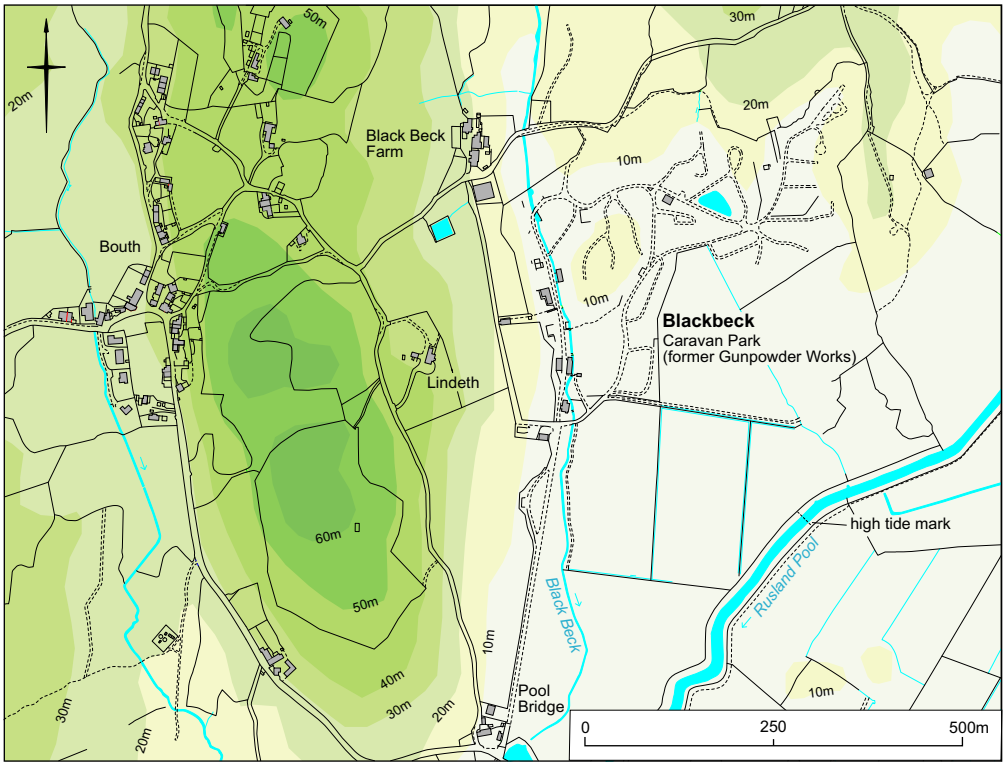


Figure 3.
The local topography.

The underlying geology belongs to the Bannisdale Formation (consisting of mudstone, siltstone and sandstone) of Silurian Age. On the floor of the Black Beck, in the area occupied by the central part of the gunpowder works, Till overlies these rocks and to the east are raised marine deposits of Flandrian Age. The latter deposits, together with peat, occupy the lower (southern) part of the valley of Rusland Pool (British Geological Survey 1997). This area is flat, low-lying and prone to flooding as was witnessed first hand by the EH survey team in November 2003 when, after the first real rain of autumn, flood water extended across the Rusland valley right up to the southern boundary of Blackbeck Caravan Park which currently occupies the site of the former gunpowder works (Fig 4). The principal access road to the caravan park leaves a minor road (which links Bouth to Newby Bridge and Haverthwaite) at Pool Bridge and follows the route of the former works tramway in an almost south to north direction virtually as far as the northern boundary of the works. For its first 450m the access road is situated east of and just in front of the foot of the hillside which rises steeply to the west to form the valley side of both the Black Beck and Rusland Pool. Three of the cartridge houses and the works store magazine were located in this area at the foot of the natural slope. To the east of the access road lies the flat and boggy floor of the Rusland Pool valley; the annotation on the OS 25" maps indicates that the river is tidal in this area (Ordnance Survey 1890b; 1913b). Proceeding northwards, as the divergence of the Rusland Pool and Black Beck watercourses becomes more marked so the separate

Figure 4.
The Rusland Pool valley in flood, looking west from near Causeway End. Southern part of gunpowder works visible in distance with the manager's house just below skyline on right and buildings near Pool Bridge to left. (Christopher Dunn, November 2003)

little valley of the Black Beck commences, the western side of it is formed by the continuation of the hillside described above while to the east an undulating low rocky hill separates the two valleys. The hill is about 250m long (north east to south west) by 100m wide, and at its north end there is a narrow dry gap before the land starts to rise steeply again to form a prominent south-facing rocky scarp; the gap provides a short natural corridor between the two valleys. The bottom of the Black Beck valley, the north end of the low hill, the dry gap and the eastern foot of the low hill (which is here the western side of the valley of Rusland Pool) together formed the area in which the main part of the works was situated. The low hill also provided good natural blast protection for the processing buildings grouped around it. Advantage was taken of the hillside on the west side of the Black Beck because it provided an elevated location above and away from the processing buildings for the location of the boiler house chimney. Unfortunately this was not initially a total success (especially as the prevailing winds tend to be from the south west and west) because sparks from the original chimney (it was subsequently re-sited further up the hillside) caused an explosion at the incorporating mills and mixing house in 1891 (Explosives Inspectorate 1898, 4).

The first edition of the OS County Series 6" map was prepared well before the gunpowder works was built and it shows that its site then comprised a number of small irregular fields on the west while towards the north there was a substantial area of woodland (chiefly on the east side of the beck) called Rough Moss (Ordnance Survey 1851). A number of these field boundaries still survive as stony scarps in the current pasture fields while the presence of the woodland (which still survives although much altered by the caravan park) was one of the reasons why this site was such an attractive location for a gunpowder works. Trees helped to provide blast protection and caught flying debris in the event of an explosion. The fields and woodland are also marked and named on an 1860 plan of the proposed area of the works which accompanied Arthur Benson Dickson's notice of intention to the Justices of the Peace that he was going to apply for a licence to build the works (LRO QSP 3619/3). On the east side of the beck as well as Rough Moss woodland parts of several fields situated on the valley floor towards the south (Broad Meadow, West Rough Moss and Moss), together with Sour Earth field, formed part of the land parcel (the field names accurately

reflect the waterlogged nature and quality of this low-lying land). On the opposite side of the beck the eastern parts of three hillside fields (Lindeth, Middle Lindeth and Harry Close), together with the whole of Little Field and a narrow strip of Rough Moss, were included within the proposed boundary of the works.

Most of the workforce at Blackbeck Gunpowder Works lived in Bouth village, just over the hill to the west of the site (*Westmorland Gazette*, 5 May 1906), but references in contemporary newspapers indicate that some of the men came from other small villages and hamlets in the locality, mostly within a 3.5km radius of the works, including Causeway End, Colton, Penny Bridge, Backbarrow and Oxen Park (Fig 2). Not all the workers, however, originated from the local communities and an examination of the 1871 Census (LRO RG10/4239) indicates that some of the employees at Blackbeck were born in Scotland; there are also references to workers from Middlesex, but as their children's birthplace is given as Scotland they too had probably moved to Blackbeck from north of the border. Presumably many of them were involved in the gunpowder industry in Scotland, but it is not clear if they came to Blackbeck because they were seeking work or because they were encouraged to by the Company which may have required their skills and experience. One of the men killed in an explosion at Blackbeck in 1881 had previously been employed by the Kames (Tighnabruaich, Scotland) and New Sedgwick gunpowder manufactories (Explosives Inspectorate, 1881, 7), while another killed in August 1900 had only recently come to Blackbeck from Fernilee near Buxton (*Westmorland Gazette*, 1 September 1900); Fernilee was the location of Derbyshire's sole gunpowder works (Crocker, G 1988, 35-6). George Shackley was yet another gunpowder worker with previous experience of the industry - he had been employed at the Lowwood Gunpowder Works but transferred to Blackbeck in 1927 (Tyler 2002, 256). The nearest road bridges to Blackbeck are at Pool Bridge, where the Rusland Pool is crossed just beyond the southern end of the works, and to the east of Black Beck Farm (just beyond the northern end of the works) where a minor road crosses the Black Beck. The Pool Bridge crossing was particularly important because vehicular access to the site was from the south. In spite of its rural setting Blackbeck was well sited to take advantage of good transport links including the shipping routes around Morecambe Bay and, later, the railway network of southern Furness.

The central and northern part of the former gunpowder works lies within the caravan park which is within woodland (largely deciduous) although there are many grassy open areas, especially around the caravan pitches which tend to be hard standings (supplied with electricity and water); some of the caravan owners have even created small gardens and patio areas. Much of the site, especially the low hill which separates the Black Beck and Rusland Pool valleys, has been heavily landscaped to create flat pitches for caravans and to allow for service roads. A number of new buildings have also been erected, including the large toilet block to the east of the north-east end of the low hill. Beyond this building a pond, complete with exotic ducks, has also been created. The fields that contain the southern part of the works (the sites of two of the cartridge houses), together with the most of the boiler house flue and upper pond, are currently under pasture which appears to be infrequently ploughed. Of the surviving factory buildings the cooperage, the office at Pool

Bridge, the women's changing house and the watch house are used as dwellings while others are workshops and stores for the caravan park.

3. HISTORY OF RESEARCH

In October 1929 the recent closure of the Blackbeck Gunpowder Works was referred to in a short historical account published in ICI's house magazine describing the companies which formed the North of England Gunpowder Group (Imperial Chemical Industries 1929, 339). Paul Wilson's seminal paper on the Cumbrian gunpowder industry, published in 1964, includes a paragraph on the history of the Blackbeck Works (Wilson 1964, 61). Mike Davies-Shiel (*pers comm*) also undertook fieldwork at Blackbeck from the 1960s onwards as part of the research into the Cumbrian gunpowder manufactories which enabled him to produce an overview of the industry published in 1969 (Marshall and Davies-Shiel 1969, 75-88). Blackbeck and its tramway system was one of the sites included by Andrew Lowe in his undergraduate dissertation presented at the University of Liverpool in 1968 (Lowe 1968, 36). Brief accounts of the tramway system at Blackbeck also appeared in 1968 and the 1970s (Joy 1968, 48; Quayle 1974, 476; Quayle and Jenkins 1977, 69-70). Glenys Crocker produced a short description of Blackbeck (based on a field visit in 1985) and its history for her gazetteer of gunpowder mills (Crocker, G 1988, 37). In 1988 Alan Crocker, in a note in the Gunpowder Mills Study Group Newsletter, drew attention to records held by ICI concerning the sale of the Blackbeck Works to the Chilworth Gunpowder Company in 1916 (Crocker, A 1988, 12). Ted Patterson's Blackbeck chapter in *Blackpowder Manufacture in Cumbria*, comprises a brief summary of the site and its principal accidents together with a discussion of the manufacturing methods employed at the works (Patterson 1995, 38-40). The latter are largely derived from information gleaned from the accident reports of the Explosives Inspectorate for Blackbeck and from notes written by the late Mr. A P Cattle which Patterson had access to. Patterson also includes a plan of the works in his book that is a composite of the depictions of the factory layout, which appear on the OS 25" maps published in 1990 and 1913. Caution needs to be exercised when using both Patterson's plan and those produced by other recent researchers - contemporary 19th and early 20th-century annotated site plans indicate that the functions which they ascribe to the buildings are not always correct. An illustrated account of Blackbeck, its tramway and the explosions which took place at the works was recently published by Ian Tyler in *The Gunpowder Mills of Cumbria* (Tyler 2002, 223-58). Some of the photographs he includes are of historical interest because they show the incorporating mills and corning house after destructive incidents in 1928 and 1929 respectively. He also includes an interpretative site plan based on his research and, on pages 282-86, provides a list of men and women who worked at Blackbeck from 1867 to 1928. Ron Mein from Bouth village has also undertaken research on Blackbeck and has produced an interpretative plan of the site and reconstruction diagrams of the incorporating mills and the boiler house flue with the second chimney at its west end. Mike Thwaites, the former manager of the caravan park, has a deep interest in Blackbeck which led him while manager to amass a small collection of artefacts relating to the gunpowder works that are now kept at the caravan park offices. They include brass and copper caulkers from footwear worn at the works together with a barrel stencil bearing the words 'F. C. Dickson & Co Gunpowder Ulverston'; Tyler (2002, 233 and 237) included photographs of these in his book.

4. THE DOCUMENTARY SOURCES AND HISTORY OF THE WORKS

A brief history of the gunpowder works and a summary of the principal documentary sources are presented below. Detailed discussion of historical sources in relation to individual archaeological features is reserved for section 6.

4.1 Documentary sources.

(see also Postscript, page 153)

The two editions of the OS County Series 25" maps published in 1890 and 1913 show how the site evolved during the middle years of its existence (Figs 5 and 6). The works fall between two map sheets (Lancashire Sheet VIII.13 (northern part of site) and Lancashire Sheet XII.1 (southern part of site)). For the first edition both sheets were surveyed in 1888 and published in 1890 (Ordnance Survey 1890a; 1890b). However, for the edition of 1913 the northern sheet was revised in 1912 (Ordnance Survey 1913a) while the southern sheet was revised during the previous year (1911) (Ordnance Survey 1913b). Unfortunately there are no large-scale OS maps showing the layout of the works during its early years or towards the end of the late 1920s when it closed. The OS 1:2500 map revised in 1974 is also useful because it shows what still remained of the former works in the early 1970s (Ordnance Survey 1976).

In addition to the OS maps a number of other plans of the gunpowder site have been located while undertaken the research for this report. Two plans pre-date the construction of the works. One is held at the Lancashire Record Office, Preston and is a depiction of the area chosen for the works with individual fields and woodland shown and annotated (LRO QSP 3619/3). It accompanied Arthur Benson Dickson's notice of December 1860 to the Justices of the Peace that he was going to apply for a license to erect the works. The other plan is in the Cumbria Record Office & Local Studies Library, Barrow and is undated but was probably drawn up either in late 1860 or early 1861 (CRO(B) BDKF Plan 7). It again shows the proposed site of the works but the intended locations of the buildings are now shown and labelled although few of these locations were adopted when the actual construction of the gunpowder manufactory took place. From now on in this report it will be referred to as the 1860/1861 site plan (Fig 60). The earliest plan located by EH of the established works is also in the Cumbria Record Office & Local Studies Library, Barrow and is attached to the front of an indenture dated November 1881 relating to the works (CRO(B) BDX 294). The plan (Fig 7) was produced by Settle and Farmer, Architects and Surveyors, Ulverston with most of the gunpowder buildings depicted on it named, which helps to identify their functions. However, some caution needs to be exercised when using this plan because, when a comparison is made with the OS 25" maps and other site plans, it appears that a few of the structures were not drawn in quite their correct positions; hereafter in this report it will be referred to as the 1881 site plan. The text of the indenture contains much valuable information, especially about the roads serving the site and the water supply (upper pond) while a number of the buildings at the works are also referred to. A reasonably detailed and annotated

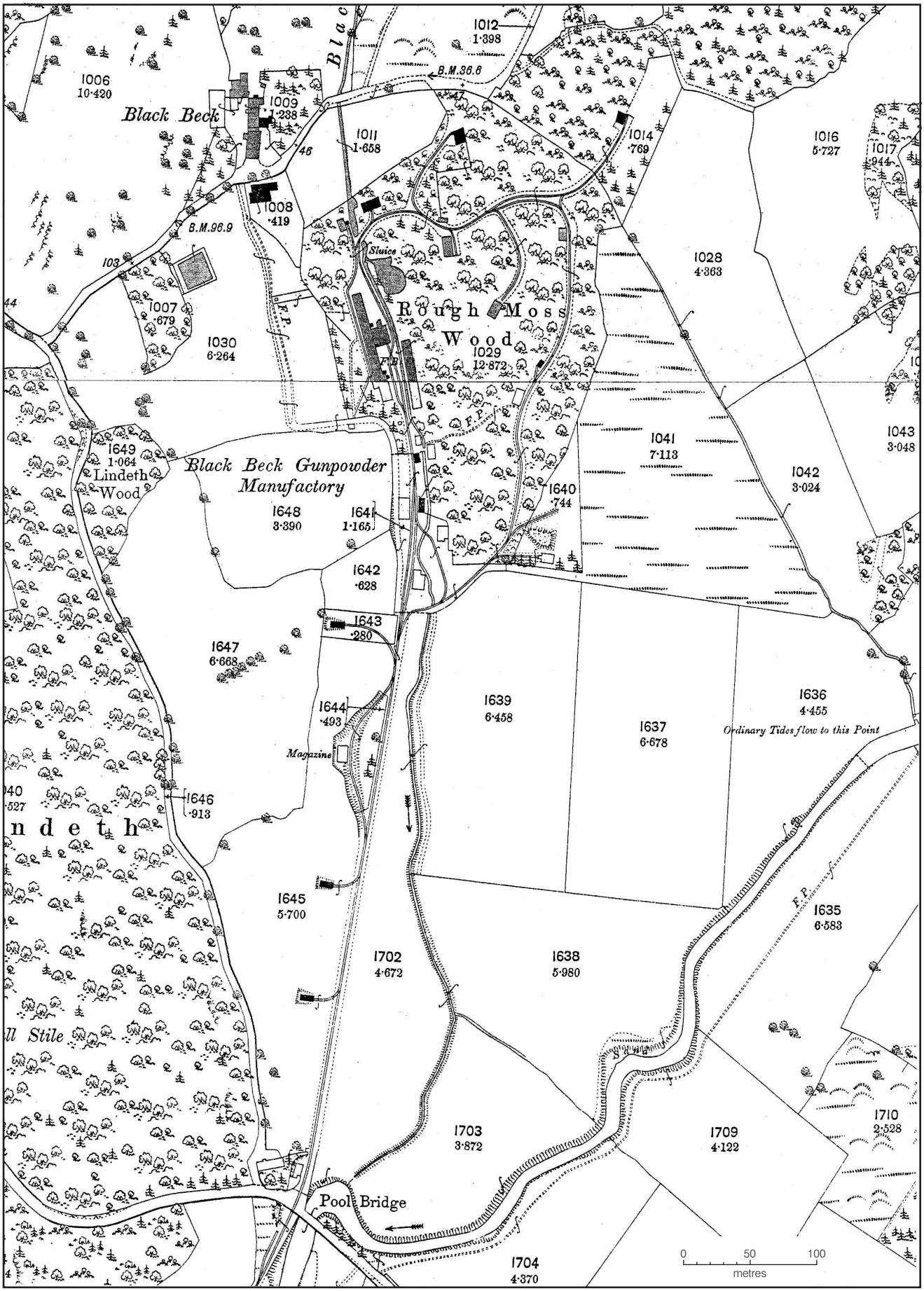


Figure 5. *The BlackbeckGunpowder Works as surveyed in 1888. (Reduced extract of the Ordnance Survey 25" maps published in 1890)*

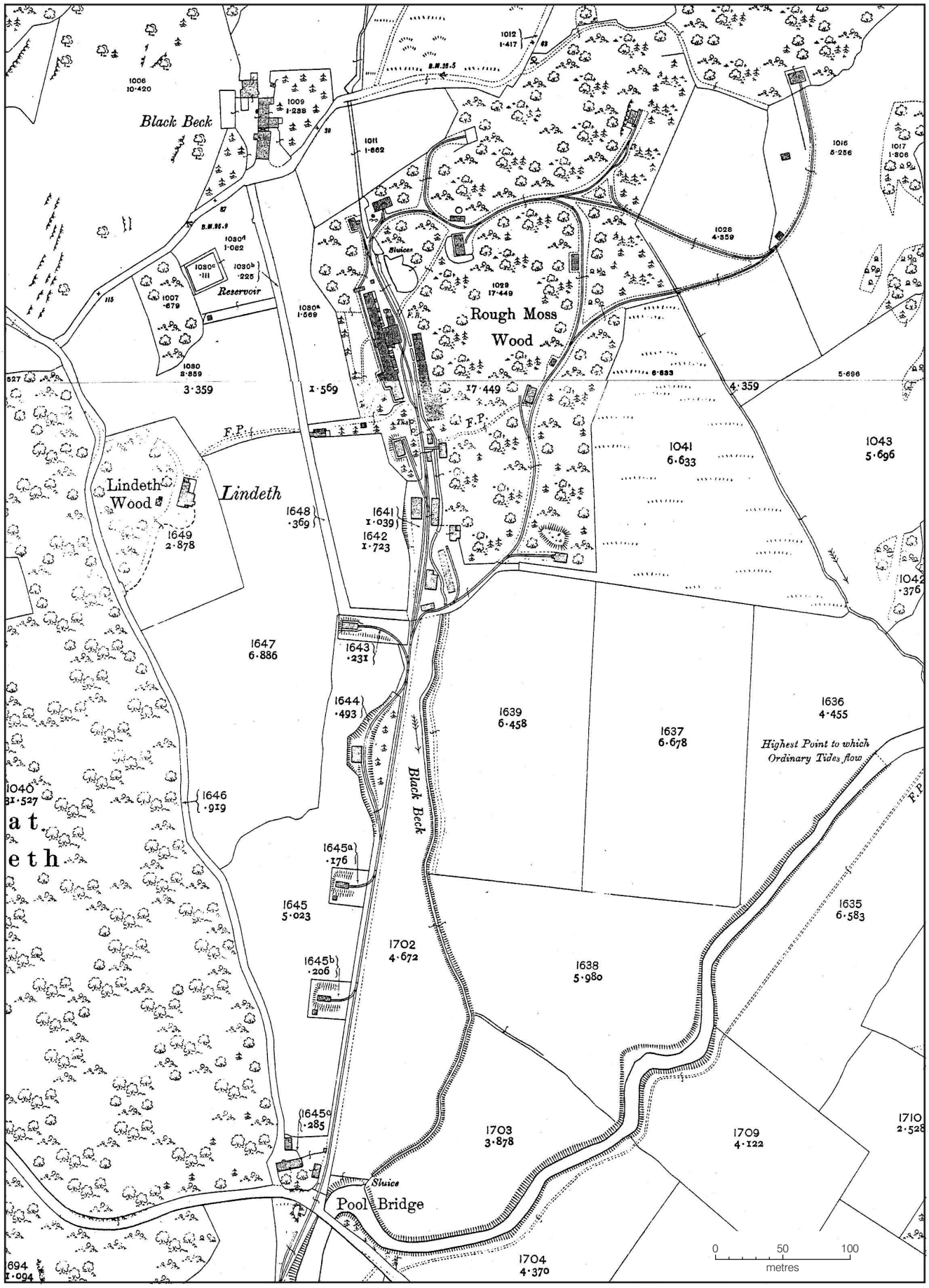


Figure 6. *The Blackbeck Gunpowder Works as surveyed in 1911 and 1912 (north end). (Reduced extract of the Ordnance Survey 25" maps published in 1913)*

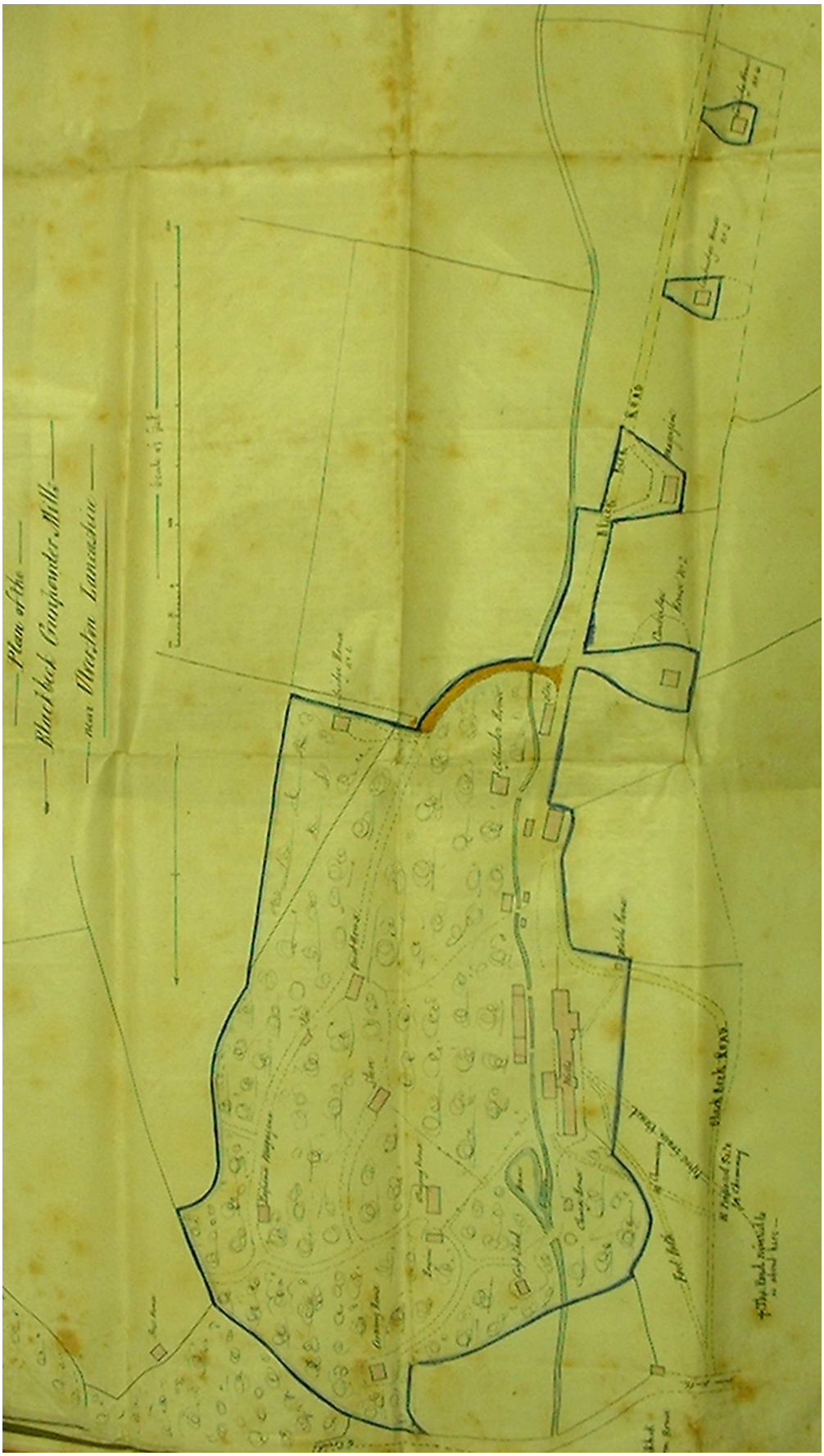


Figure 7. *Plan of the works attached to the indenture of November 1881 ('the 1881 site plan'). Taken from CRO(B) BDX 294, reproduced with acknowledgments to Cumbria Record Office & Local Studies Library, Barrow. (Abby Hunt, November 2003)*

plan of the works that accompanied Amending Licence No. 789 (issued in 1898) is held by Nobel Enterprises at Ardeer and was once again prepared by Settle and Farmer. It was signed (approved) by Captain J H Thomson (HM Inspector of Explosives) on 12th April 1898 and will be referred to in this report as the 1898 site plan (Fig 8). It is a particularly useful source of information because, in addition to naming individual buildings, it falls almost at the midpoint between the two editions of the OS County Series 25" maps and therefore permits some of the changes to the layout of the works which took place between these map editions to be more closely dated. Two copies of an engineering drawing, one dated 12 September 1923, of the hydraulic press in the powder press house survive in the Patterson Collection; the original was drawn to a scale of one and a half inches to one foot (38mm to 305mm) and was prepared by the Technical Department of Nobel Industries. The Patterson Collection also contains material relating to the gunpowder industry nationally which was gathered together by Ted Patterson for his own private research and is now held by the NMR at Swindon.

Blackbeck suffered from a considerable number of explosions that resulted in a large number of fatalities. The thirty six deaths recorded represent more than one third of the total number of fatalities at the Cumbrian gunpowder works in the years between *c*1764 and 1936; one hundred and two deaths has been given as the overall total (Tyler 2002, 258). The major incidents at the site were reported in a number of contemporary local newspapers, some of which have been consulted for this report at the Local Studies Library, Kendal and at the Cumbria Record Office & Local Studies Library, Barrow (however, an exhaustive study of these sources lay outside the remit of this report), and after 1875 (as a consequence of the Explosives Act of that year) also resulted in detailed official accident reports by HM Inspectors of Explosives (Explosives Inspectorate 1881; 1884; 1898; 1900a; 1900b; 1906; 1909; 1912). Both of these sources, especially the reports by the HM Inspectors, contain detailed and sometimes incidental information about the buildings and the processes undertaken in them. The 1898 HM Inspectors report, for example, even contains a measured plan of the stove house, the subject of the report, showing the internal arrangements of pipes and drying drawers before the explosion. The report into the incident at the powder press house in May 1900 (Explosives Inspectorate 1900a) similarly has a plan of the press house prior to the explosion; the plan is referred to on page 3 of the report but is missing from the photocopy in the Patterson Collection (the one used by EH). However Tyler had access to the photocopy of the plan which is in the caravan park files (see below) and has reproduced it in his book, although the caption incorrectly gives May 1903, not 1900, as the date of the explosion (Tyler 2002, 238). ICI also produced a detailed report for the explosion which occurred at the incorporating mills in 1928 (Imperial Chemical Industries 1928). Appended to the report is an annotated plan - from now on this will be referred to as the 1928 site plan - showing the central part of the gunpowder works (Fig 9). Smaller explosions or flashes occurred regularly in the incorporating mills and were such a fact of life that they were not normally reported in detail. However, HM Inspectors also published annual reports listing all explosions on a nation-wide basis and these sometimes provide brief details of incidents which may not have been reported elsewhere. Following the 1875 Explosives Act, all changes to plant had to have the approval of the Explosives Inspectorate and be

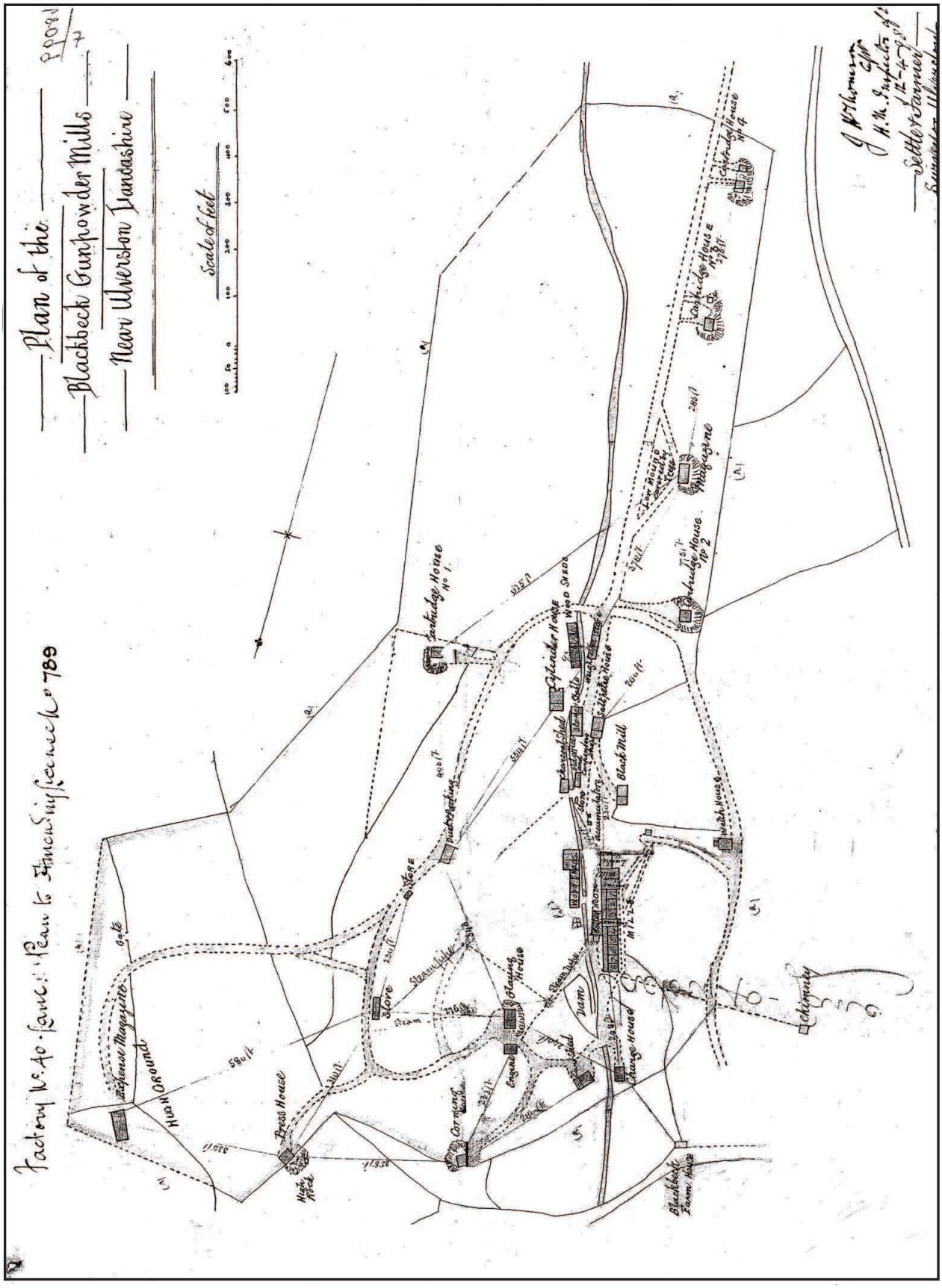


Figure 8. *Plan of the works accompanying Amending License No. 789, signed by H. M. Inspector of Explosives on 12th April 1898 ('the 1898 site plan'). (ICI plc, copyright reserved)*

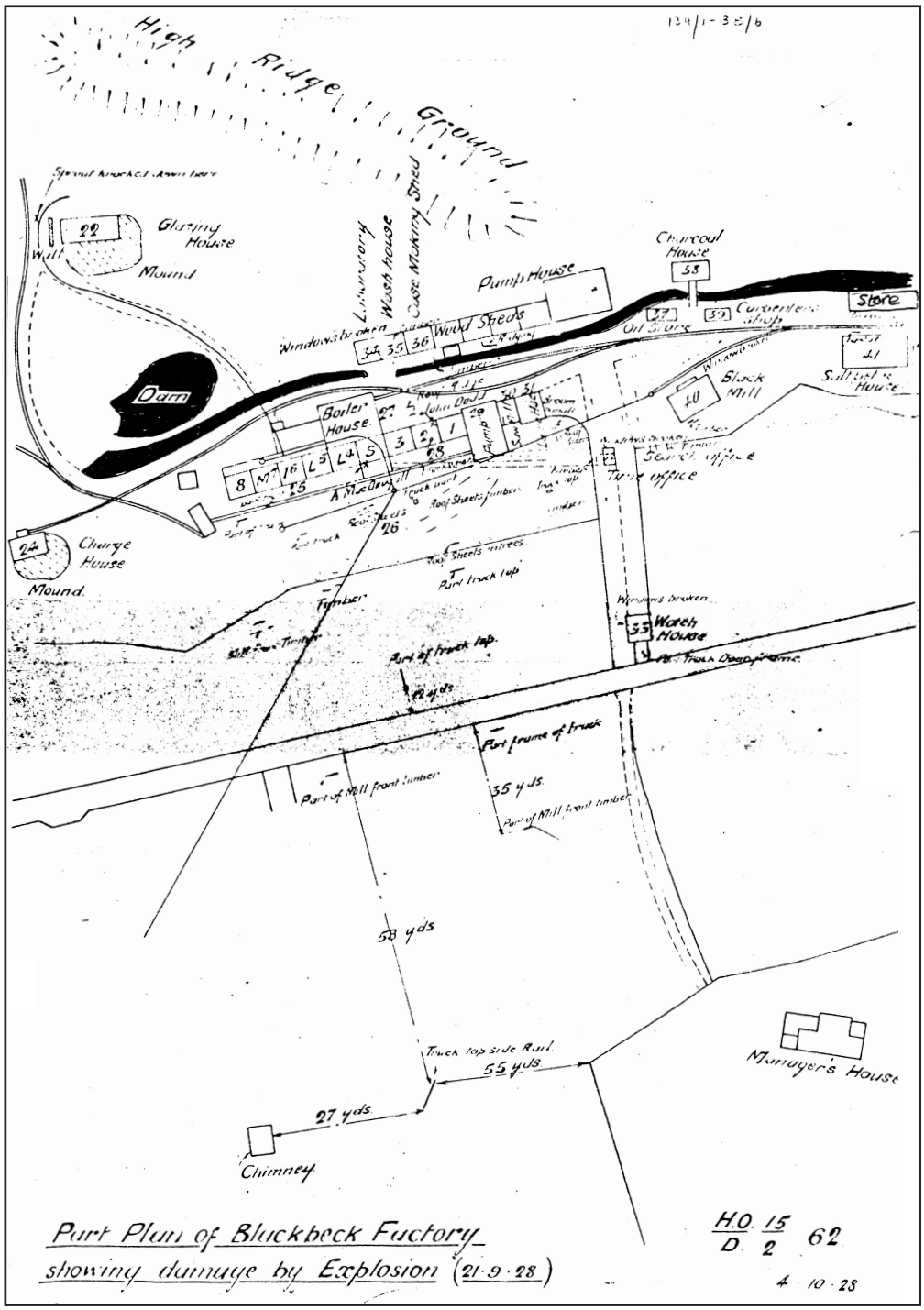


Figure 9.
Plan of the central part of the works attached to the ICI report into the 1928 explosion ('the 1928 site plan'). (NMR: Patterson Collection)

authorised through the issuing of an amending licence. It is known from the official reports into explosions at Blackbeck that two amending licences were issued in 1877, and single ones in 1880, 1881, 1882, 1886, 1891, 1892 and 1898 (Explosives Inspectorate 1898; 1900a); EH has found no information for any amending licences issued after 1898.

ICI produced detailed manuals called Manufacturing Method Books (MMBs) which gave details of the processing methods and plant at each of its manufactories. Unfortunately the one for Blackbeck does not appear to have survived although, according to Ted Patterson, there was once an MMB for this works in the Research Department Library at Ardeer 'but it

was discarded some years after Blackbeck closed' (manuscript draft of his 1995 book, Patterson Collection). Patterson also had access to notes by the late Alfred Cattle on some of the machinery at Blackbeck. The latter joined Nobel in 1924 and rapidly became involved in blackpowder manufacture at several of the Cumbrian works (Lowwood, Gatebeck and New Sedgwick); he died in 1986 aged 90 (*Nobel Times*, May 1986).

A number of official black and white photographs were taken immediately after the explosion at the incorporating mills in 1928 and also after the fire at the second corning house location in 1929. Ted Patterson managed to obtain copies of these which are in the Patterson Collection. He had spare prints of some of them which he gave to Mike Thwaites (*pers comm*) for the caravan park files (see below), hence their reproduction in Tyler's book (Tyler 2002, 239-40). The photographs are very important because they throw light on both the construction of the buildings and also on the machinery which they contained. A number of much more recent colour photographs of Blackbeck taken in April 1979 and July 1993 also form part of the Patterson Collection; two of the 1979 photographs have proved particularly helpful in identifying the site of the second corning house. Several of the 1979 images show a man (annotated Mr Tyson (senior) on the reverse) at Black Beck Farm holding a mounted brass/copper horseshoe from the former gunpowder works. Ron Mein also has a black and white photograph of the watch house taken in 1958 which shows the building prior to it being heightened and modified in order to convert it into a holiday letting.

The caravan park also has a number of files relating to the gunpowder works containing material which appears to have been largely brought together by Mike Thwaites during his tenure as site manager of the caravan park. These contain photocopies of contemporary newspaper articles (although it is not always clear from which newspapers they have come from) together with photocopies of the special reports produced by the Explosives Inspectorate. There are also copies of material produced by Ron Mein, including an interpretative site plan, a reconstruction drawing of two of the incorporating mills, and recollections by a former gunpowder employee of the workforce and where they worked. This private collection will be referred to below as the 'caravan park files'. Mike Davies-Shiel (*pers comm*) also has material relating to Blackbeck in his gunpowder archive including photographic slides and information from George Shackley.

4.2 Company history

(see also Postscript, page 153)

In the first half of December 1860 a notice of intention to apply for a licence to erect the gunpowder works was issued as follows:

'To Thomas Crewdson overseer of the parish of Colton in the County of Lancaster. I the undersigned, Arthur Benson Dickson Esquire of Number 19 Old Square, Lincolns Inn London and of Abbots Reading in the parish of Colton in the said County of Lancaster Barrister at Law, do hereby give you notice in writing as follows, Whereas it is necessary to have some place appointed in the County of Lancaster, in which it may be lawful to erect new mills and other engines for making gunpowder with proper magazines and offices adjoining thereto.

And whereas I am possessor of the lands hereinafter particularly described and am absolute Owner of the same, now therefore I do hereby give you notice that I do intend at the next General Quarter Sessions of the peace for the said County to be holden at Lancaster in the said county on the thirty first day of December in the year of our Lord one thousand eight hundred and sixty, to make an application to the Justices of the Peace assembled at the said Sessions and to the said Court of General Quarter Sessions, to appoint that part of the Abbots Reading Estate situate in the parish of Colton in the said County described by and included within the Blue Line upon the plan attached to this notice, and including part of Lindeth, part of Middle Lindeth, Little Field, part of Harry Close, part of Broad Meadow, part of West Rough Moss, part of Moss, Rough Moss, and Sour Earth, all being in the said parish and being more particularly described upon the said plan comprising an area of about twenty seven acres, as a place in which it may be lawful to erect new mills and other engines for making Gunpowder with proper magazines and offices adjoining thereto. And to license the erecting and having such mills and magazines and offices as aforesaid within the said part of the said Estate so described as aforesaid - Given under my hand this twelfth day of December 1860' (LRO QSP 3619/3).

Dickson was granted his license, and at least the whole of 1861 must have been spent erecting the works because according to Tyler (2002, 224) the commercial production of gunpowder did not start at Blackbeck until 1862. Support for this claim comes from the Explosives Inspectorate special report into the explosion at the first stove house which occurred in January 1898. The report says that the building had been used as a stove house 'ever since the factory was first established 36 years ago' (Explosives Inspectorate 1898, 12) - this gives a date of 1862. The Explosives Act of 1875 created a national licensing system for gunpowder works and, as an existing factory, Blackbeck was permitted to carry on under Continuing Certificate No. 40 (dated 2 June 1876) (Explosives Inspectorate 1881, 1). The terms of this certificate were subsequently varied or enlarged by a series of amending licences.

As a result of the Explosives Act of 1875 the Explosives Inspectorate visited Blackbeck during the following year. They were concerned to find that 'in one or two instances the distances intervening between the buildings appeared to us insufficient to afford a reasonably sufficient guarantee against possible communicated explosion; and we deemed it our duty, immediately after the first inspection which we made under the Act, to give notice [in a letter to the Company dated 26th July 1876] under section 64 of undue proximity of certain buildings, viz., glazing-house and stove, glazing-house and press-house, charge-house and press-house, mixing-house and adjoining buildings' (Explosives Inspectorate 1881,1). The response of the Company appears to have been that when one of the buildings listed by the Inspectorate was destroyed during an incident, the opportunity was taken to re-site it in a more suitable location (Explosives Inspectorate 1898, 4).

On 31 December 1881 an indenture was made between Arthur Benson Dickson of Abbots Reading (the lessor) and Frederick Cartwright Dickson, from Chapel House, Cartmel parish together with the latter's only son, Frederick Maurice Dickson of Leven Side, Colton parish

(the lessees). In the text of the indenture the lessees are described as 'now carrying on in the premises intended to be hereby demised the business of Manufacturers of Gunpowder in copartnership with Charles Singleton Haines under the form and style of F. C. Dickson and Company'. The lease was for fifty years and the rent was £150 per annum for the first ten years and then £200 for each subsequent year (CRO(B) BDX 294). By 1881 the site covered an area of about 33 acres and employed a workforce of about fifty people 'of whom about 20 are 'on powder'' (Explosives Inspectorate 1881, 1-2).

The later history of the works is unclear and requires further research to unravel. It has been stated that the Dickson Company was acquired by Explosives Trades Ltd. during 1920 (Imperial Chemical Industries 1929, 339; Tyler 2002, 256). This company became part of the Nobel Industries Ltd which was itself incorporated into ICI during 1926 (Crocker, G 1988, 2). Alan Crocker, however, has had access to records held at ICI's Head Office in London which indicate that Frederick Maurice Dickson sold the works in March 1916 to the Chilworth Gunpowder Company who operated the business until May 1921 when they assigned it to W.H. Wakefield and Company Ltd., who also ran the Lowwood and Gatebeck gunpowder manufactories (Crocker, A 1988, 12). Wayne Cocroft (*pers comm*) thinks that by about 1910 the majority of shares in the Chilworth Gunpowder Company were held by the Alliance Explosives Company, most of whose shares were held by Nobel's. The sale of Blackbeck to Chilworth may thus have been a standard commercial transaction (or a cover) for its acquisition (or control) by the Nobel Company. Cocroft also wonders if what actually happened in May 1921 was more of a transfer of title between companies already substantially owned by Nobel's.

On 21 September 1928 an explosion at the incorporating mills caused a lot of damage and it is questionable whether this was ever put right given that the closure of the works was imminent. This explosion may thus have marked the end of gunpowder production at Blackbeck and may be why Wilson (1964, 61) considered 1928 to be the closure date of the works. Gunpowder production had certainly ceased by the late spring of 1929 because the corning house burnt down on June 8 of that year and a newspaper account of this incident reports that 'the corning house has not been in use for some time, and no gunpowder was stored there' but that the manager still lived on site (*Westmorland Gazette*, 15 June 1929); it has even been suggested that when this fire took place the manufactory was in the process of being demolished (Tyler 2002, 257). Whatever the actual date of closure, the works had definitely been officially shut by the autumn of 1929 since it is stated in ICI's house magazine for October that 'in order to concentrate manufacture this [Blackbeck] factory was recently closed down' (Imperial Chemical Industries 1929, 339).

An examination of the reports by the Explosive Inspectorate and the local newspapers consulted by EH provides limited information about the managers at the works and their dates. There are also references to the managers in Tyler's book; apparently Mr Hayes was manager in May 1871 (Tyler 2002, 228). In 1881 Mr. William Kitchen was the sub-manager (*Westmorland Gazette*, 26 March 1881) but by 1884 he had become manager (*Ulverston Mirror and Furness Reflector*, 2 August 1884); a photograph of Mr Kitchen appears

on page 234 of Tyler's book. Kitchen occupied this post until Mr. G.W. Wraighte took over as manager on 6 October 1900 (*North Lonsdale Herald and Dalton Advertiser*, 5 May 1906) and still occupied the post in 1911 (Explosives Inspectorate 1912, 4). Mr Charles Robert Cowtan was the last manager of the Blackbeck works (*Westmorland Gazette*, 15 June 1929) and a photograph of him was published in ICI's house magazine (Imperial Chemical Industries 1929, 357).

The gunpowder produced was chiefly for blasting purposes and was sold either in loose form or as blasting cartridges (the latter were produced at the works soon after the passing of the 1875 Explosives Act). According to Wilson (1964, 61) the output of the works was about 20 tons of blackpowder per week which went principally to the limestone quarries in the Peak District and to the slate quarries of North Wales. The latter probably accounts for the occurrence of a barrel lid bearing the F.C. Dickson and Company name which was found a number of years ago on a farm rubbish heap at Bettws Garmon, between Caernarfon and Beddgelert (photocopy of extracts from the Furness Railway Journal in the caravan park files). Local markets were also served such as the quarries at Stainton and Plumpton together with those of Thomas Mandall at Coniston which produced slate (note in caravan park files; Tyler 2002, 244). Some of the gunpowder produced at Blackbeck also went overseas (Crocker, G 1988, 37).

4.3 Blackbeck after 1929

The use of the site after the gunpowder works closed has not been researched in detail. However, it appears that those buildings which were not demolished were maintained hence their survival to the present day. Jean Tyson (*pers comm*) reports that there is a local tradition for the site having been used in World War II, possibly for food storage, and Mike Thwaites (*pers comm*) has heard stories that there was even an abattoir here. By the late 1950s if not before the former works site had become a caravan park. Mike Davies-Shiel visited Blackbeck in the early 1960s, soon after the caravan park had been established, to find that as a result of its creation a number of the gunpowder remains had been dynamited and flattened (letter in Patterson Collection).

5. THE PROCESS OF GUNPOWDER MANUFACTURE

The method of gunpowder manufacture has been described in detail elsewhere (Cocroft 2000; Crocker 1999; Patterson 1986; 1995) and only a brief outline will be given here in order to provide the reader with a general background to the terminology used in section 6, below. The chief output of the Blackbeck mills was blasting powder for mines and quarries produced both as a loose powder and as compressed cartridges.

The three ingredients of gunpowder are saltpetre, charcoal and sulphur mixed in proportions which varied but were often 75:15:10 (for firearms) and 70:15:15 (for blasting) (Crocker, G 1988, 3). These constituents do not react together chemically but are simply blended together. The manufacturing process is, therefore, concerned with creating a thoroughly combined mixture of the correct density, in an evenly granulated form. Saltpetre has two chemical forms: potassium nitrate (nitrate of potash) and sodium nitrate (nitrate of soda). The former is stable under ordinary climatic conditions and was always the saltpetre of choice. Sodium nitrate on the other hand absorbs water from the air, but was less expensive; it was often used to make blasting explosives, but had to be kept dry or it lost its efficacy. Gunpowder made from the two forms was distinguished as N/P or N/S powders (Patterson 1995, 10-11).

The first stage of manufacture was the preparation of the three ingredients. **Saltpetre**, imported from abroad (Sodium nitrate occurs naturally in Chile while India used to be the source of much potassium nitrate) and in its 'grough' or raw state, needed to be refined. This was normally achieved by gentle boiling and re-crystallisation, which enabled the impurities to be skimmed off, in the **saltpetre house** (refinery). **Sulphur** occurs naturally near volcanoes and was often imported from the Italian mainland and Sicily. It also contained impurities that were removed through distillation, but this was often done before the sulphur reached the gunpowder manufactories. **Charcoal** was often made on site in sealed retorts in order to keep out grit and stones, but could also be bought in from outside suppliers provided it was of sufficient quality. At Blackbeck the ingredients were housed in separate buildings.

In the **mixing house** (preparing house or black mill) the charcoal and sulphur were ground separately to a fine powder in an **edge-runner mill**. Power was brought to the later mixing house at Blackbeck from the north by means of a drive shaft housed in a brick-lined tunnel. All the ingredients were then sieved to remove lumps or grit before being weighed out in the correct proportions and mixed in a rotating circular drum. The mixed ingredients, called the green charge, were transferred to the **charge house** to await incorporation.

At the **incorporating mills** the green charge was fed into a series of edge-runner mills that mixed and compacted the gunpowder into a denser mass known as **mill cake** or **wrought charge** (ripe charge). While operating the mills were supervised from the comparative safety of the **watch house**, with the charge being periodically dampened to help it meld together. At Blackbeck all the mills were under-driven (powered by belts from a line shaft

situated along the outer face of the east wall of the mills). Power was provided by a **steam engine**, situated in an engine house between mills 3 and 4, which also provided power for the mixing house(s) and hydraulic pumps at the works. Steam for the engine was produced in a **boiler house** located against the eastern side of the engine house. Once incorporated the ripe charge was removed and at Blackbeck it was taken not to a ripe charge house (as at the New Sedgwick Works) but went straight to an **expense magazine** where it was stored until the powder press house was able to receive it.

At the **powder press house** (press house) the mill cake was first broken down by hand which at Blackbeck was achieved by using long-handled wooden mallets (Explosives Inspectorate 1881, 4). The powder then went to the press where it was spread thinly on to a series of copper plates - one on top of the other - to form a large 'sandwich' and then pressed using hydraulic pressure which came from the **press pumps** located in a building behind the incorporating mills.

By this stage the powder had reached a satisfactory mix and density but needed to be granulated into rounded and evenly sized grains. This was carried out in the **corning house** where the press cake was passed through a series of rollers that granulated it. The powder grains then landed on the sieves of the scry or separator which separated dust and over-size grains from the powder. The dust would have been returned to the powder press house while the over-size grains went back through the rollers.

In the **glaze house** the powder was placed in wooden drums with graphite (blacklead) and rotated. At Blackbeck a nearby steam engine (in the **little engine house**) provided power for both the glaze house and first corning house site via drive shafts. In the **reel house** the dust was removed from fine powders which were often used for sporting or military purposes**.**

The glazed powder destined to be sold loose went straight to the **stove house** (drying house) to remove any residual moisture. The stove house was heated by steam-filled pipes which were supplied with steam from the boiler house adjacent to the incorporating mills. Once dry the loose powder then went to the **dust and packing house** for final sizing and packing into barrels. In the dust house part of the building the powder was put into a separator and agitated through sieves of different sized meshes and anything that was too large or too small would have been sent to the mixing house where it was returned to the manufacturing cycle. The loose powder was then packed into barrels and taken to the **store magazine** to await despatch.

The cartridge powder followed a slightly different route through the works after leaving the glaze house. At the **cartridge compressing houses** (cartridge press houses) the powder was poured into moulds and then compressed into pellets or cartridges using hydraulic pressure. The cartridges were then taken to the **stove house** where they were dried before being despatched to the **cartridge packing houses** where women packed them into boxes but the lids were hammered on by men. Boxes awaiting despatch would, like the loose powders, have been kept in the store magazine. The women packers changed into their

work clothes on arrival at the gunpowder manufactory in a **changing house** situated near the southern end of the works.

Powder was checked for quality and reliability in the **laboratory** (the northern most compartment of a building range to the east of the incorporating mills) and on the **proofing range**; at Blackbeck the site of the latter is not known for certain. Wood was cut up in the **saw mill** which was situated in the building range immediately south of the incorporating mills. Barrels were made at the **cooperage** (situated at the southern extremity of the works) while boxes for packing the blasting cartridges were probably manufactured in the **case making** compartment situated within the building range to the east of the incorporating mills.

6. DESCRIPTION OF THE REMAINS

The following section describes the gunpowder works in detail and concludes with a brief account of some of the miscellaneous features not directly connected with gunpowder manufacture but which were recorded by EH. The hachured site plan of the earthworks and other features surveyed in the field by EH at a scale of 1:1000 is shown in figure 66 (inside back cover); the plan contains both archaeological and modern detail. In order to present a coherent narrative the remains relating to the gunpowder works are ordered by process rather than by date, however, there is a chronological account of the site in section 7 (Discussion) below. The latter contains phase diagrams (Figs 59, 61-62) and the numbers given on these to individual buildings also appear (in brackets) in this section, below. Numbers occur both in the text and also on the building location diagrams. A short account of the different processes involved in powder manufacture has already been presented in section 5, above.

6.1 The gunpowder works

6.1.1 Power systems and water supply (Fig 10)

(see also Postscript, pages 153 and 154)

Unlike the other Cumbrian gunpowder manufactories, the Blackbeck works was not situated close to a major watercourse. The Black Beck, which flows from north to south through the

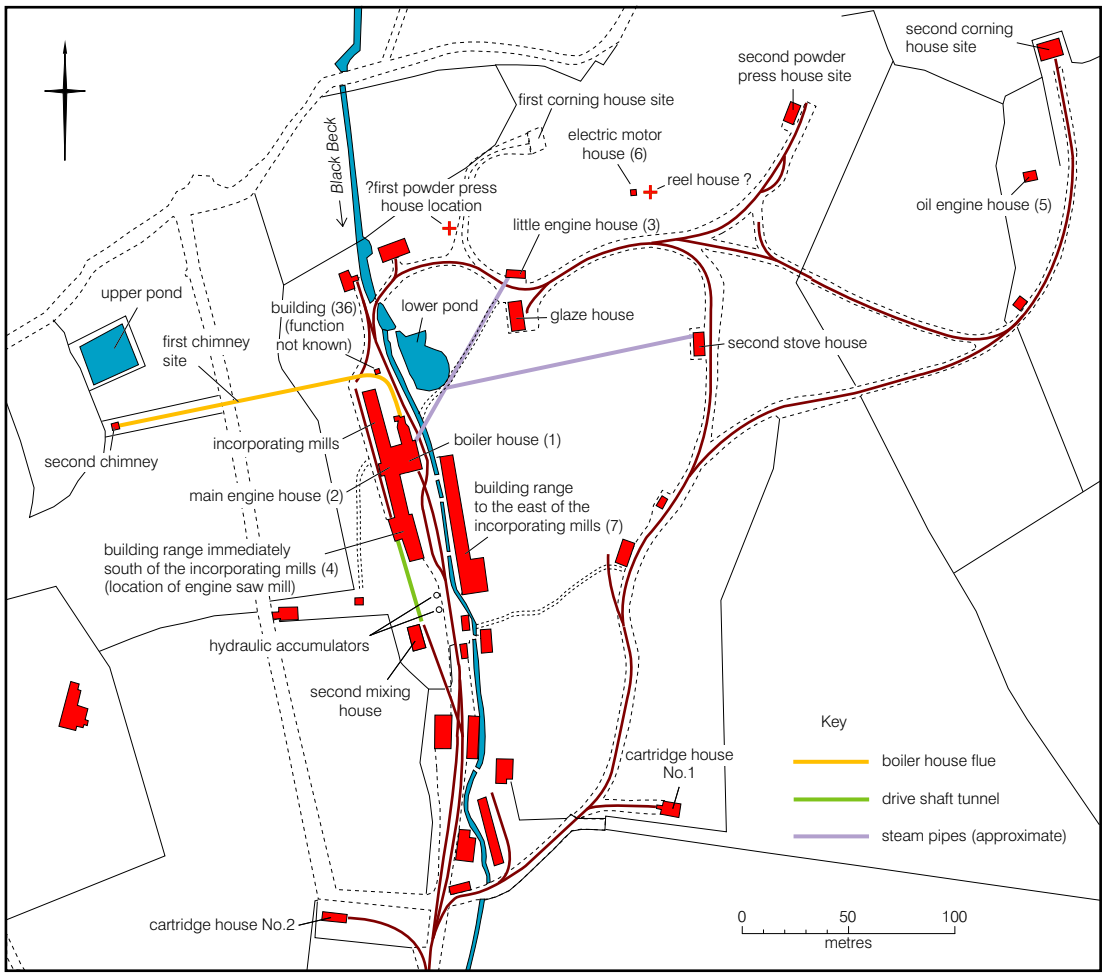


Figure 10. *Reduced and amended extract from the 1913 edition of the Ordnance Survey 25" map showing the location of the power sources and water supply. (The electric motor house and probable reel house site have been inserted from the English Heritage earthwork plan)*

site, is a small stream possessing both an insufficient gradient and also an inadequate quantity of water to power waterwheels and water turbines. To overcome this deficiency steam was used for power from the beginning and in this respect Blackbeck is unique among Cumbrian gunpowder works (Patterson 1995, 38). At Gatebeck steam was also used to provide some of the power but this was in addition to that provided by waterwheels and turbines (Patterson 1995, 25). The steam at Blackbeck was produced in a boiler house, situated in the main part of the works towards the north, which was equipped with a long inclined flue that took the waste gases from combustion to a chimney situated on the hillside above and west of the manufactory. Steam was taken from the boiler house to at least two stationary steam engines within the works which produced power to drive the machinery in processing buildings such as the mixing house, incorporating mills, corning house and glaze house. Some of the processing buildings were sited well away from their respective steam engine with the result that the drive from the engine to their machinery was transmitted by shafting and bevel gears (HF LW/959/365; *Westmorland Gazette*, 1 September 1900). As the site expanded, either due to processing buildings being moved further away from each other to reduce the risk of explosion or because new processes were being undertaken at the works, so oil and electric engines were installed to provide the power for those isolated buildings that were erected a considerable distance from the boiler house and steam engines. The boiler house also provided steam for the drying pipes in the stove houses. A dynamo house is mentioned in the report of the explosion at the incorporating mills in 1928 (Imperial Chemical Industries 1928, attached list of buildings damaged) which presumably produced the electricity for the works.

Pumps at the works produced hydraulic power to work the presses in both the powder press and cartridge compressing houses; in the case of the latter (and possibly also the powder press house rebuilt after an explosion in May 1900) this was via hydraulic accumulators. Although water was not used for powering machinery, a reliable supply would still have been required for the boiler, hydraulic pumps and for some of the tasks which were undertaken elsewhere in the works (a small amount of water, for example, was also used in the incorporating process at the mills). Two ponds or small reservoirs supplied this necessity - one (the lower pond) was located on the east side of the beck and the other (the upper pond) still forms a prominent feature in a pasture field close to the buildings of Black Beck Farm on the hillside above the works.

The boiler house (including the flue and chimney) (1)

This building was erected against the rear east wall of the incorporating mills, adjacent to the engine house (which powered the mills) and mill 4. It is depicted on both the 1881 and 1898 site plans but is annotated ‘Boiler House’ only on the latter; it is similarly labelled on the 1928 site plan. It is shown as a rectangular structure on the OS 25" map surveyed in 1888, on which it measures almost 14m (north-north-west to south-south-east) by 11m. This map shows a short projection, 6m long by 3m across, and narrowing at its north end, extending from the northern side of the main boiler house (Ordnance Survey 1890a). The latter is similarly depicted on the 1913 edition (revised 1912) of the OS 25" map but by this time the projection on its northern side had been extended thereby doubling the length of

this structure which is also drawn with a tapered north end. A small, square structure is also shown by the OS at the north-west corner of this projection whereas the 1928 site plan has a similar structure at the opposite corner. It is possible that at least one of these structures was a header tank for the boiler or even the site of the dynamo house (see this section, below). The long projection is probably the shelter over the economiser whose roof, sides, doors and windows were damaged in the 1928 explosion (Imperial Chemical Industries 1928, attached list of buildings damaged). Economisers were developed in the 1840s to utilise the exhaust gases from a boiler fire on their way to the chimney in order to reduce the amount of energy required to produce steam. They heated boiler feed water which was pumped into stacks of metal pipes placed in the flue immediately behind the boiler (Giles and Goodall 1992, 149-50 and Fig 247). Fuel for the boiler house was presumably brought in via the tramway spur which is shown on the OS 25" maps and 1928 site plan coming up to the building close to its south-east corner. It is possible that alterations to the firing arrangements of the boiler were made as early as the 1880s in order to reduce the amount of smoke and sparks being produced. The evidence for this comes from the indenture of 1881 in which it is stated that the lessees have 'within five years from the date hereof so alter or reconstruct and use any furnace now standing or being in or upon the said demised lands as that it shall at all times thereafter during the said term so far as is practicable consume its own smoke' (CRO(B) BDX 294). An automatic stoker had certainly been installed by 1900 (Explosives Inspectorate 1900a, 9) which was so effective that 'the small coal - the only fuel now used - appears to be thoroughly consumed' (Explosives Inspectorate 1912, 5) and 'there is never even the least appearance of smoke, much less of sparks, from the shaft [chimney]' (Explosives Inspectorate 1900a, 9). It is also possible that the boiler was renewed at about this time (see the main engine house (this section, below) - comment from John Phillp). The boiler house may also have contained a second boiler so when boiler maintenance was required the works could continue to operate. The slated roof of the boiler house was badly damaged during the 1928 explosion together with the corrugated iron sheeting which formed the front of the building and all its windows were broken (Imperial Chemical Industries 1928, attached list of buildings damaged). This was not the first time that it was damaged because slates were 'stripped off its east side' during the explosion at the first stove house in 1898 while a few panes of glass were broken when the corning house blew up in 1909 (Explosives Inspectorate 1898, 14; 1909, 4). The boiler house, like the economiser building, no longer survives - its site is currently occupied by caravan pitches and by part of the main access road through the caravan park.

The flue must have left the economiser house as a large pipe, probably of cast-iron, on a rising gradient which near the north-east end of the incorporating mills turned through 90 degrees to head west towards the side of the valley. Near the latter it must have crossed the tramway spur that served the incorporating mills by following the top of the blast wall which separated the second charge house from the mills (this is described in more detail with the incorporating mills in section 6.3, below). At the end of the blast wall the flue continued up the hillside as a brick-built tunnel for about 50m and then discharged into a tall chimney, 45ft (13.7m) high (Explosives Inspectorate 1898, 8) situated close to the eastern edge of the track which ran between the southern part of the works and Black Beck Farm.

This chimney, together with the field boundaries flanking the route of the flue above the works, is depicted on the first edition of the OS 25" map (surveyed 1888). The chimney is also sketched on the 1881 site plan but appears to be incorrectly placed in relation to the track and the eastern boundary of the field in which it was situated - on the plan it is very close to this boundary and some distance away from the track. This discrepancy may be no more than the result of imprecise drawing (the positioning of other features in this area is not very accurate either) unless of course the chimney was moved closer to the track and the flue extended by about 15m to 18m sometime between 1881 and 1888. It is interesting that in this respect the text of the indenture to which the site plan relates contains provision for demolishing the chimney and rebuilding it on a new site should this be required during the life of the lease (CRO(B) BDX 294); the proposed site for a new chimney is also depicted on the 1881 plan but it is on the west side of the track and not on the east side where the chimney depicted by the OS is situated. No other evidence has been found by EH to support this possible early chimney site which, given its even closer proximity to the works, seems an unlikely proposition. In April 1891 a fire started in the chimney shown by the OS (referred to from now on as the first chimney) - soot had probably built up because at this time the flue was only swept once a month - and sparks were carried by the wind to the incorporating mills causing an explosion (Explosives Inspectorate 1898, 4; 1904, 15). As a result of this incident the first chimney was demolished and the flue was lengthened by a further 60m to take the exhaust gases even further up the hillside and away from the processing buildings. In order to increase the draught the new chimney (referred to from now on as the second chimney), which was erected at the end of the lengthened flue, was built much taller (108ft (32.9m) high) than its predecessor (Explosives Inspectorate 1898, 8).

The earth-covered flue survives as a prominent bank rising up the valley side. It extends first through woodland and then enters and crosses a pasture field which terminates against the track to Black Beck Farm. It is immediately visible again in the adjacent pasture field on

Figure 11.
Upper part of flue (west of the farm track) from the boiler house. Looking west. (NMR: DP003389)

the west side of the track where it continues along its straight course to the site of the second chimney which has been demolished although its site is still marked by a slight expansion at the end of the bank together with a spread of bricks at its centre. In both fields the bank is grass-covered, and in the eastern field it is 0.8m high whereas the later section in the western field (Fig 11) is 1.2m high with a narrower and less rounded top - a marked 4m wide lowering of the bank about mid-way along has been caused by the passage of farm vehicles and animals. There is a shallow circular hollow in the top of the bank near the site of the first chimney with what appears to be a largely grassed-over concrete slab in its bottom. It is probably the site of an inspection hatch inserted when the chimney was demolished and the flue extended. Ron Mein (*pers comm*) has entered the flue at this point and recorded the internal dimensions of the tunnel as 1.6m high by 1.2m wide; the lining here apparently consists of a double skin of overlapping common red bricks. He also believes that there was once another inspection hatch a short distance to the east of the second chimney. The start of the brick-lined flue is still visible in section at the east end of the bank on the lower slope of the valley side immediately above the caravan pitches which occupy the site of the northernmost incorporating mills (Fig 12). Here the tunnel, lined with orange red brick, is 1.53m wide internally - only the outer brick skin survives and if the inner lining was still in place then it would measure about 1.2m wide internally - but its base is obscured by a build-up of leaf mould and collapsed bricks; the height of the arched roof above this deposit is 1.1m. An iron frame - the seating for an iron grating (inspection hatch) - is visible in the roof of the tunnel (and on the surface) immediately to the west of this exposure; the void for the hatch measures just over 0.5m by 0.45m.

Figure 12.
Internal view of east end of boiler house flue, looking west. (NMR: DP003402)

The steam, oil and electric engine houses

The main engine house (2)

(see also Postscript, page 153)

Power for the incorporating mills was supplied by a steam engine housed in an engine house between mill chambers 3 and 4; it is labelled ‘Engine’ on the 1898 site plan. Steam

was supplied from the boiler house against its east wall. This steam engine is presumably the one which Tyler refers to as the main power source for the works which he says, although he does not give his source, was a triple expansion engine produced in Birmingham by Belliss and Morcom (Tyler 2002, 223). However, according to John Phillp (*pers comm*), triple expansion engines had not been invented in the 1860s and Belliss and Morcom was not established as a partnership until 1884, and was not a limited company until 1899. If Tyler is correct then it is likely that the steam engine installed *c*1861 was replaced by a more efficient Belliss and Morcom engine in either the 1890s or the early 20th century. John Phillp has also suggested that the original boiler in the adjacent boiler house would have been due for renewal after a life of thirty to forty years, and may have been replaced at the same time. In addition to driving the mills, the main steam engine probably also provided power for the hydraulic pumps and mixing houses. The drive for the second mixing house was apparently taken through the west end of the building range immediately south of the incorporating mills. Between this range and the mixing house site part of the drive shaft tunnel still survives and is described with the building range in section 6.1.7, below.

The engine house is clearly visible on air photographs taken in 1945 by the Royal Air Force (NMR: RAF 106G/UK.653/13-AUG-1945/4140-1) which show a roofless rectangular compartment (although the purlins may still have been in place), slightly narrower than the adjacent mill chambers, whose east end wall protected beyond the rear wall line of the mills (Fig 26). Its south and north walls were party walls with mill chambers 3 and 4 respectively. The 1928 explosion at the incorporating mills resulted in its west front being blown in, the floor lifted in places and serious damage to the roof (Imperial Chemical Industries 1928, attached list of buildings damaged). Two of the photographs in the Patterson Collection taken after this event also show parts of the engine house indicating that it had a pitched slate roof with angled coping tiles along the ridge. The roof was set slightly below the rubble side walls which rose up above the roof line to act as blast walls between the engine house and adjacent mill chambers. The west front appears to have been timber framed and to have supported light cladding either of wood or corrugated iron sheets. A probable door in this side is also visible on one of the photographs. At either end the timber framing was attached to a short stub wall (the returns to the stone side walls). The outer face of both stub walls each had a single notice board fixed to them which may have contained health and safety regulations or details of working practices.

The little engine house (3)
(see also Postscript, page 154)
A stationary steam engine located within a narrow rectangular building (little engine house), orientated almost east to west, provided power via drive shafts to both the first corning house site and the glaze house (HF LW/959/365); these buildings are described in section 6.1.3, below. Steam for the engine was brought from the works boiler house, situated 86m to the south west, by pipes (with an internal diameter of 4in (102mm)) supported on stone pillars (Explosives Inspectorate 1898, 5). This pipeline is depicted on the both the 1881 and 1898 site plans - it is annotated ‘Steam Pipe’ on the latter. Just over halfway between the boiler house and the engine house the site plans show a steam pipe leaving the pipeline to

take steam to the site of the first boiler house. Beside this junction a tiny rectangular structure shown on the plans may have been either a steam tank for distributing/controlling the steam or a shed. EH has found no information about the actual engine, but an examination of documentary and cartographic sources has thrown some light on the engine house itself while also identifying a number of important but unresolved issues. The little engine house (called this by the Explosives Inspectorate (1898, 14)) was situated between the first corning house site and the glaze house; it was closest to this last building being only 10m to its north. It is shown on the site plans of 1881 and 1898 where it is labelled 'Engine'. On Patterson's plan the building is numbered 17 but incorrectly described as an expense magazine (Patterson 1995).

On the OS 25" map surveyed in 1888 the little engine house measures about 7m long by just over 3m wide; a line, with two right-angled bends it its course, is also shown extending from near the north-west corner of this building to the south-east corner of the first corning house site (Ordnance Survey 1890a). It is probably related to the drive shaft which provided the corning machinery with power from the steam engine. The map depiction suggests that this line may have been largely a low wall built to support the drive shaft. However at its north end, where naturally outcropping rock had to be cut through to reach the corning house, a rock-cut trench for the drive shaft survives on the ground; it has been described below (section 6.1.3) with the first corning house site. On the south the main tramway passed between the small engine house and the glaze house with the result that here the drive shaft to this last building was probably below ground and covered, hence its omission by the OS. A comparison of the depiction on this map and on the 1912 revision indicates that some time between 1888 and 1912, the little engine house had been extended east, giving it an overall length of 11m. Perhaps the building had been enlarged to house a larger steam engine, or additional functions were now taking place inside the building. In this respect it may be significant that by the time of the 1912 revision the first corning house site had been abandoned, and a drive shaft to the latter would no longer have been required. A small circular structure, approximately 4m in diameter, is also depicted on this map and is situated about 2m outside the north wall of the little engine house, slightly east of centre (Ordnance Survey 1913a). EH has found no direct evidence for its function but its depiction is reminiscent of either a small reservoir or a hydraulic accumulator - the map shows a pair of accumulators (both are smaller in diameter than the structure under discussion and their function is known from the 1898 site plan) near the second mixing house (see this section, below). If this last identification is correct then the little engine house may have been extended to provide space for the pumps which would have been required to supply the accumulator with water under pressure.

The only processing site in this part of the works which required hydraulic pressure at the time was the second powder press house location, situated about 140m to the north east of the little engine house. The press house here was completely destroyed by an explosion in May 1900 (see section 6.1.3, below) and Captain M B Lloyd who investigated the incident also looked at the provision of hydraulic power to the press - the pumps which provided this power were located a long way from the powder pump press house, behind the incorporating

mills. He was concerned to find that the press was 'worked directly off the pump' and recommended that this should instead be 'through an accumulator' (Explosives Inspectorate 1900, 10). It may be, therefore, that when the powder press house was rebuilt after this explosion the hydraulic power source was also relocated with the little engine house being extended to accommodate the extra machinery and provided with a hydraulic accumulator outside. Another possibility is that the changes at the little engine house had nothing to do with pumps but that by 1912 the steam engine had been replaced by an oil engine (hence the 'Oil Engine' annotation on Tyler's site plan (Tyler 2002, 227)); but this seems most unlikely because the steam engine was still there in December 1911(Explosives Inspectorate 1912, 3).

The little engine house was wrecked in December 1867 by an explosion which started in the nearby corning house and also destroyed the glaze house (*Soulby's Ulverston Advertiser*, 12 December 1867; *Westmorland Gazette and Kendal Advertiser*, 14 December 1867). The former was rebuilt, presumably on the same spot, and suffered minor damage (a single window facing the corning house was blown to pieces) during the explosion at the first powder press house location in March 1881 (Explosives Inspectorate 1881, 2; *Westmorland Gazette*, 26 March 1881). It was more extensively damaged during the 1898 stove house explosion when the southern side of its slate roof was stripped (Explosives Inspectorate 1898, 14) and again in July 1909 when the corning house blew up; in this explosion the window frames in the north wall of the little engine house were blown in (Explosives Inspectorate 1909, 4). A window was again broken in December 1911 when the last corning house to be erected at the first corning house site blew up (Explosives Inspectorate 1912, 3).

The little engine house has been demolished and no trace of it now survives on the surface. The eastern part of its site may be occupied by a refuse collection point for the caravan park. Six of the stone-built pillars which supported the steam pipes that supplied the little engine house with steam from the boiler house are still extant. They are located to the south-east of the site of the lower pond in a narrow triangular area of sloping land sandwiched between caravan park service roads. They are arranged in a line and are heavily encrusted with ivy which makes it difficult to ascertain their true shape and method of construction. The most prominent pillar, at the northern end of the line, is 1.7m high and is built of coursed rubble (Fig 13). It is circular in section. The other pillars are rectangular in plan and much less well-preserved; they range in height from 0.2m to 0.7m (this last one is also built of coursed rubble) and three are set quite close to one another. It is possible that the shape and height variations are partly a reflection of functional differences - some of the rectangular pillars may have supported the possible tank shown on the site plans while the others, including the circular pillar, carried the steam pipes. Mike Thwaites (*pers comm*) recalls that there used to be a lot of iron pipes lying around the former works site and from his description some may well have been former steam pipes.

Figure 13. *Northernmost surviving pillar which supported the steam pipes to the little engine house, looking south. (NMR: DP003406)*

The possible steam engine which powered the saw mill (within building 4)

The only evidence found by EH for this possible engine is the 1898 site plan. On this, the large compartment at the northern end of the building range (see section 6.1.7, below), situated immediately south of the incorporating mills, is annotated 'Engine Saw Mill'. This could mean that the saw mill was powered by a dedicated steam engine adjacent to it which had gone by the time the 1928 site plan was produced. Alternatively the annotation may simply mean that the saw mill was an engine powered one which was driven by a line shaft from the main steam engine situated between incorporating mills 3 and 4. The surviving archaeological evidence certainly suggests that this was the case in later years.

Figure 14.
The oil engine house near the corning house in process of demolition, looking north west. (Abby Hunt, November 2003)

The oil engine house near the second corning house site (5) (Fig 14)

According to Patterson (1995, 39) an oil engine supplied the second corning house site (see section 6.1.3, below) with power (a handwritten note by him in the Patterson Collection indicates that this information came from Alfred Cattle's notes of *c*1930). The corning machine would certainly have needed a power source and because it was so far removed from the works boiler, which supplied the steam engines in the main part of the gunpowder manufactory, then a more conveniently located and independent power source, such as an oil engine, would make perfect sense. In order to reduce the danger from exhaust sparks it must be presumed that the engine was housed in a building which was not part of the corning house. Unfortunately the exact location of the oil engine house (presumably erected in 1912) is not known; it was built long after the annotated site plans of 1881 and 1898, and the 1928 site plan does not include this part of the works. However, the most likely candidate seems to be the small rectangular building, orientated west-south-west by east-north-east (as was the nearby corning house), depicted on the 1913 edition of the OS 25" map (revised 1912) 50m to the south of the corning house. It lay a short distance beyond and to the west of the southern end of the long blast wall that protected the corning house from the rest of the works (see section 6.1.3, below). If this is where the oil engine was housed then power must have been taken to the corning machine via a drive shaft which had at least one right-angled bend in its course so that the blast wall protecting the corning house could be negotiated and the latter reached at ninety degrees. The structure on the OS map is unlikely to have been a processing building or an expense magazine because it was not particularly close (and lacked a direct connection) to the tramway spur which the OS show serving the corning house. Patterson (1995) numbers it 25 on his plan and in the key calls it a toilet. Until the latter part of 2003 it was certainly used as a washroom and toilet block for the caravan park but this is almost certainly a later reuse of the building; it seems both

too big and substantially built for this to have been its original function in the gunpowder works. It is clear from his plan that Tyler (2002, 227) also believes that this was an engine house.

This building no longer survives, but at the start of the EH survey in November 2003 it was in the process of being demolished, apparently because its slated roof had become unsafe (Mike Thwaites *pers comm*). Rectangular in plan, and one storey high with gabled end walls, it stood on a platform cut into land which rose in a westerly direction above the tramway spur. It was built of coursed rubble with dressed sandstone quoins and measured 7.2m by 5.25m. Two doorways pierced the long southern wall while the north wall contained another doorway off-centre towards the east. Since the openings were plaster lined, it was unclear which were original. Just below the apex, each gable end had two brown circular ceramic pipes which ventilated the building, a feature found in other gunpowder buildings on the site (saltpetre house plus store and stable). The east gable wall had a small window which was blocked by a rectangular outshot built of coursed rubble with slate block quoins which had been erected sometime after 1974 (Ordnance Survey 1976). Externally this outshot measured 3.35m by 1.5m and was set 0.7m and 0.9m in from the south-east and north-east corners respectively of the engine house. It was entered through a low doorway in its east wall. Inside the probable engine house all that was visible were the remains of modern sinks and toilet pans. Following demolition of the building the platform has been extensively graded and altered to make way for caravan pitches. The site of this building lay outside the area surveyed at large-scale by EH so does not appear on figure 66.

The electric motor house beside the reel house (6) (Fig 15)
This building stands a short distance west of two machine beds sited within the probable reel house (see section 6.1.3, below). The brickwork of the motor house looks to be of early 20th-century date, which does not conflict with its likely date of erection after 1912 since, like the probable reel house, it is not depicted on the 1913 edition of the OS 25" map. Tyler (2000, 242) has published a photograph of the west end of the building, but the caption wrongly identifies it as the oil engine house for the glaze house which was powered - certainly for most if not all of its life - by a steam engine in the little engine house (see this section, above) which was situated about 60m south west of the motor house under discussion.

The electric motor house, which stands on a concrete base, is a single-storey red brick building, 2.6m square, gabled to east and west. The brickwork is in English garden wall bond, and it has a roof of corrugated-iron sheets. The doorway, off-centre in its west wall, has a timber lintel; the door, of timber plank construction, has a small, formerly glazed frame which probably held a key for emergency use. Left of the doorway four metal pipes, each about 30mm in diameter and arranged in a rectangle (0.68m by 0.49m), may have provided ventilation or have held the fixings for a notice or distribution board. Two holes above these are lined, possibly with ceramic material, and may be connected with the supply of electricity to the building. The south wall has a small window with a fixed four-light frame and a concrete sill, the wall plate acting as its lintel. In the east wall, close to the

Figure 15.
Electric motor house for the probable reel house, from the west (a) and south (b). (NMR: DP003373; DP003374)

north corner and facing the machine beds of the reel house, there is a slot (now blocked) through which the belt which supplied the drive from the electric motor to the reels originally ran (Fig 32). The slot, 1.05m high by 0.36m wide, has a 0.64m length of cast-iron tramway rail reused as a lintel. At the time of survey the interior was being used as a store for the caravan park, but just visible under its contents was the concrete machine bed which held the motor. The 1.3m long block (0.24m high) appeared to be more or less centrally placed against the north wall from which it projected 1.1m into the interior.

There is no evidence for a vent or exhaust pipe leaving the building, which suggests that the engine or motor was powered by electricity rather than oil. Further support for this suggestion is provided by the lack of a blast wall separating this building from the reel house; one would probably have been desirable if the engine had been oil-fired in order to lessen the danger of an explosion from exhaust sparks.

The dynamo house
(see also Postscript, page 153)
The ICI report of the explosion at the incorporating mills in 1928 refers to a dynamo house at Blackbeck whose windows and door were damaged during the incident; inside the building the lamps on the accumulator charging apparatus were also broken (Imperial Chemical Industries 1928, attached list of buildings damaged). The exact location of this structure is uncertain, but since it follows the entry for the economiser in the ICI list, it is possible that it was part of the boiler house complex. It may have been one of the two small structures at the north end of the economiser building (see this section, above), one of which is depicted on the 1913 OS 25" map (revised in 1912) while the other is on the 1928 site plan. Another - and perhaps more likely - possibility is that this was the function of the small building (36) near the north end of the incorporating mills (see section 6.1.7, below) shown by the OS in 1912 and also on the 1928 site plan.

The pump houses and hydraulic accumulators (see buildings 4 and 7)
(see also Postscript, page 153)
At the end of the life of the gunpowder works there were two pump houses at Blackbeck whose locations are known from annotations on the 1928 site plan. Both were elements within larger building ranges (described in detail in section 6.1.7, below): one formed the northern part of a range situated immediately to the south of the incorporating mills while the other was at the southern end of a long range to the east of the mills on the opposite bank of the beck. Not one of the buildings shown on the 1881 and 1898 site plans is labelled a pump house, so the location of the pumps before 1928 is a matter of conjecture. According to the Explosives Inspectorate the pumps for both the first and second powder press house locations were situated behind the incorporating mills (Explosives Inspectorate 1881, 5; 1900a, 4). Strictly speaking the pump house on the east side of the beck is behind the mills, but this probably did not exist in the late 19th century. On the 1898 site plan its site was occupied by wood sheds, a function which probably continued to at least 1911 judging by the depiction on the 1913 edition of the OS 25" map (see section 6.1.7, below). The other pump house location (to the south of the mills) certainly contained machinery at

the end of the 19th century because it is labelled ‘Engine Saw Mill’ on the 1898 site plan and is considered by EH to be the most likely location for the pumps. Other possible locations include either the boiler house or the adjacent engine house, but these were very ‘busy’ and full buildings and thus seem unlikely candidates. The pumps were probably powered by the main steam engine situated between incorporating mills 3 and 4, rather than by the possible one which could have powered the saw mill in the early years. According to the Explosives Inspectorate (1881, 5), power for the pumps ‘was derived from an engine-house at the back of the mills, and distant about 100 yards (91.5m) from the press-house’. This description loosely fits the engine at the incorporating mills - it abutts the boiler house at the back of the mills, and the probable site of the first powder press house location is about 100m from this steam engine. The report into the powder press house explosion of May 1900 helps to confirm that this was indeed the steam engine because it says that the pressure water for the powder press house was provided by a ‘force pump, driven by positive gearing from an engine, which was also employed for the supply of power to other parts of the factory’. It has been suggested above (this section) that after the powder press house explosion in 1900 the powder press pumps may have been moved to the little engine house. If this suggestion is incorrect, and the pumps remained in the central part of the works, then it is possible that by 1928 the powder press pumps and cartridge compressing pumps each had their own dedicated pump house - hence the two pump houses on the 1928 site plan. An alternative interpretation is that one of the buildings contained a spare set of pumps which were used when the others were being maintained.

Although in the early part of 1900 the pressure water was fed directly from the pump to the ram in the powder press house (Explosives Inspectorate 1900a, 10), the supply of hydraulic power from the pumps to the cartridge compressing houses was via accumulators which, like the cartridge houses they served, must have been erected after the Explosives Act of 1875 that required blasting cartridges to be filled at licensed premises. A pair of accumulators, which no longer survive, were situated about 12m to the north east of the second mixing house and are marked on the OS 25" maps published in 1890 (surveyed 1888) and 1913 (revised 1911) where they appear as small circular features annotated ‘Tks’ (tanks) on the 1913 map; on the 1898 site plan they are labelled ‘Accumulators’. Iron pipes would have transported the water under pressure from the accumulators to the cartridge compressing houses.

The water supply for the boiler and works

(see also Postscript, page 153)

Despite its insignificant size, a good proportion of the water used in the works may have come from the Black Beck, although it is now uncertain exactly how the water was utilised and what the relationship was between the lower and upper ponds. Colum Giles (*pers comm*) suggests that the lower pond (which received water from the beck via a sluice) may be earlier than the upper pond. Perhaps the latter was installed because the works was initially furnished with just the lower pond, a provision which soon proved to be inadequate. A supply of water above the works would certainly have been needed to provide water to the various buildings and machinery requiring a gravity feed; it was also imperative that the

boiler house had a reliable supply. Ron Mein (*pers comm*) believes that the boiler feed water was indeed supplied by the upper pond but that the spring water which was piped into the latter was insufficient to fill it with the result that water also had to be pumped up to it from the Black Beck. If this is correct then perhaps a more likely scenario is that the water was pumped up from the lower pond rather than directly from the beck.

The beck

The Black Beck has been confined to a narrow channel for much of its course through the main part of the works; roughly coursed rubble walling still revets its sides in many places. EH measured the depth of the channel at two locations: firstly opposite the site of the lower pond, where it is 1.2m deep; secondly near the oil store where it has a depth of 1m. The OS 25" maps and site plans indicate that the beck was bridged in a number of places to permit access to buildings and to allow the main works tramway (on the site of earlier factory roads) to cross it at both the northern and southern ends of the main part of the works. These last two crossing points are still used by the principal caravan park roads. Immediately south of the northern crossing the beck has been widened, no doubt to provide a good head of water to feed the lower pond. The OS maps indicate that originally this widening extended further up the beck and terminated against the northern boundary of the works (Ordnance Survey 1890a; 1913a). The northern crossing now consists of a skewed stone bridge with a small opening for water to pass through it at its base. However, the beck itself flows out into the widened area from under a stone arch situated just beyond and to one side of the south-east end of the bridge. The floor of the widened channel has a concrete bottom while at the south end the beck channel is crossed by the remains of a sluice. The gate has gone but some timbers, together with a handle to raise and lower the gate, still survive; beyond the sluice the channel assumes its normal width again (Fig 16). The present sluice timbers and handle are clearly much later than the gunpowder works but the presence of a much earlier sluice here is confirmed by the OS 25" maps (Ordnance Survey 1890a; 1913a). On the east, adjacent to this last sluice, the site of a second sluice is also visible. This one

Figure 16.
Widened beck channel and sluice to the north west of the former lower pond. (NMR: DP003418)

controlled the supply of water into the lower pond and now comprises a large piece of concrete containing a recess for the sluice components; it is uncertain if the surviving remains relate to the gunpowder works or to the conversion of the lower pond into a swimming pool for the caravan park (see this section, below). At the southern end of the works the beck flows through pasture fields and here it is much wider, lacks revetment walls and is clearly cleaned out from time to time - hence the low banks of up-cast along its edges.

The lower pond

The lower pond was located towards the northern end of the works and was supplied by water, via a sluice, from the beck to its west (see this section, above). The pond is shown on three of the site plans (1881, 1898 and 1928) and annotated 'Dam'. On the OS 25" maps it has an irregular, rather bulbous outline and measures a maximum of about 27m long by 18m wide (Ordnance Survey 1890a; 1913a). It appears to have survived the closure of the works and to have been re-shaped and converted into a swimming pool for the caravan park (Ordnance Survey 1976).

The pond has been filled in and at the time of survey its site was occupied by caravans. However, a curving scarp, at best 1.5m high, to the east and behind the caravans, now helps to define the area of the former pond while a second scarp to the south may be the remnants of the pond's south-east corner. This scarp is situated on the south side of a caravan park access road and to the north of the pillars that supported the pipes which supplied the little engine house with steam (see this section, above).

The upper pond

The upper pond is situated in a pasture field on the hillside above the gunpowder works, about 80m to the south west of the buildings at Black Beck Farm. Although omitted from the 1898 site plan, the pond is roughly sketched on the earlier 1881 site plan – on which it is annotated 'The Pond' - and also on the OS 25" maps (Ordnance Survey1890a: 1913a). It is referred to in the 1881 indenture where it stated that the lessees have to keep the pond adequately fenced off from the rest of the field and must also supply a water trough on the side of the farm track (referred to as 'the Blackbeck Road') lower down the hillside (CRO(B) BDX 294). A line of pipes is depicted on the 1881 plan extending from the pond to a point close to the incorporating mills (mill 3); this was probably the principal water supply for the works. Provision was also made in the indenture for the lessee 'to examine repair take up and relay the same and to do all other acts necessary for the purpose of keeping them [the pipes] in proper condition' (CRO(B) BDX 294).

On the ground the upper pond, which still holds water, is slightly trapezoidal in plan and measures 24m in length by a minimum of 20m in width. The depth above its silted bottom is currently about 1.1m, and its sides are lined with concrete; there has been some dumping into it, especially at its west end. On the OS 25"maps it is shown as having four sides, but where the north-east corner should be there is now a short fifth side cutting across this end of the pond - it is uncertain if this is an original feature not recorded by the OS or the result of later modification. An iron pipe is visible here, high up in the side of the pond, and may

have supplied the water trough referred to in the 1881 indenture; the trough still survives some 38m to the north east on the west side of the farm track, opposite the south-west corner of a modern cow shed. Another iron pipe is also positioned near the top of the south-east corner of the pond and is either an overflow or possibly where water pumped up from the valley bottom entered the pond. A third iron pipe survives high up at the pond's south-west corner, and it appears to be where water collected from springs in the vicinity was fed into the pond; to the south, beyond the latter, the ground is very wet and is clearly where springs issue from the hillside - a number of partially buried cast-iron pipes there may once have connected with this pipe. The south and east sides of the pond have each a single outward-facing scarp, 1.6m high, situated a short distance away from them.

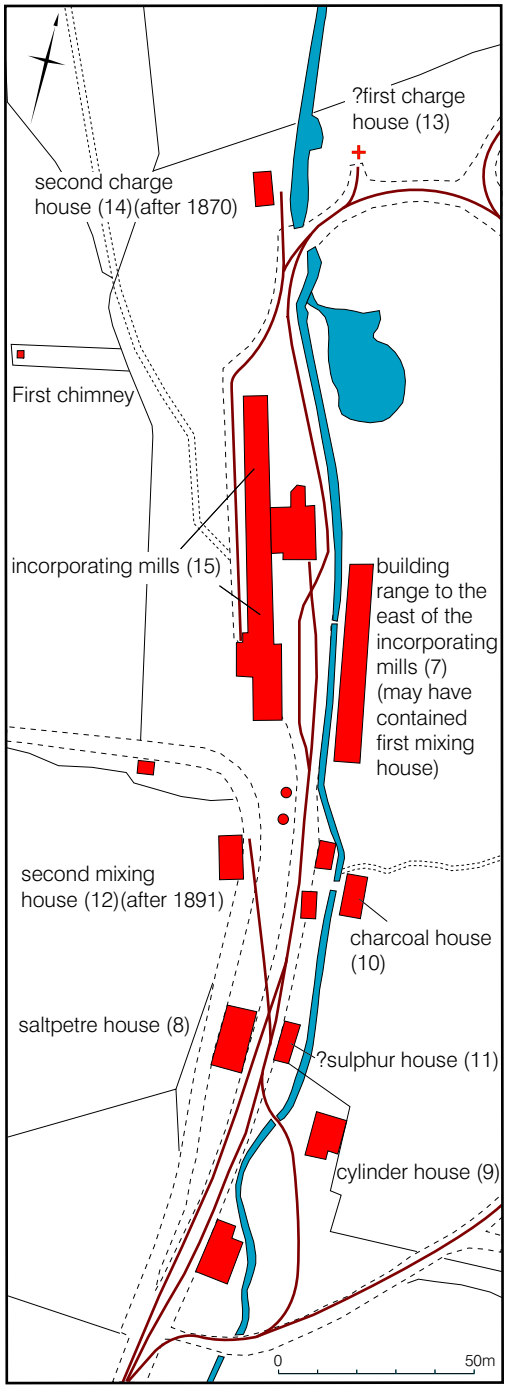


Figure 17.
Diagram showing the raw ingredient stores and processing buildings in the main part of the works. (Based on the Ordnance Survey 25" maps published in 1890 with second mixing house taken from 1913 edition)

6.1.2 The preparation and storage of raw materials (Fig 17)

The buildings which contained the raw ingredients were grouped together at the southern end of the main part of the works. Originally they were sited just outside the gunpowder manufacturing part of the factory complex, but this changed when provision was made for the production of blasting cartridges at Blackbeck, and the consequent development of the works further to the south. The saltpetre house is described in this section together with the evidence for charcoal production at Blackbeck and the provision of a dedicated charcoal store. In addition, the storage of sulphur and blacklead at the works also receives consideration.

The saltpetre house (8) (Figs 18-20)

The saltpetre house, rectangular in plan and orientated north to south, still survives and at the time of survey was used as a workshop for the caravan park; it is located at the foot of a natural slope on the western side of the beck. It is depicted but not labelled on both the 1881 site plan and the first edition OS 25" map (surveyed 1888). It is shown on the 1898 site plan on which it is annotated 'Saltpetre House' and is depicted with an internal east-west subdivision. It is similarly labelled on the 1928 site plan on which it is numbered 41.

Figure 18. Saltpetre house (left) and store and stable (right) from the south. (Christopher Dunn, November 2003)

One of the windows of the saltpetre house was broken in September 1928 when an explosion occurred at the incorporating mills (Imperial Chemical Industries 1928, attached list of buildings damaged). The first and 1913 editions of the OS 25" map indicate that it was served on the east by a loop from the tramway. The track from Black Beck Farm to Pool Bridge originally went past the western side of the saltpetre house (Ordnance Survey 1890b) but had been moved further up the hillside by the time of the 1898 site plan. A grassy terrace still marks the course of the former track beside the saltpetre house; to the south of the latter the back scarp defining it on the west has a maximum height of 3m while just beyond the north-west corner of the building the front edge of the terrace consists of an east-facing scarp, about 1.5m high.

The saltpetre house occupies a site which is cut back into the slope. It is a rectangular building, gabled to north and south, and is built of stone rubble without noticeable quoins. It has a slate roof. All openings have timber lintels, some protected from weathering by nailed slates. The south gable end is partly obscured by ivy but just below the apex of the east gable wall are two brown circular ceramic ventilation pipes. For its larger part it is a tall single-storey building, but at its north end two floors have been created within the same height, the ground floor sunk slightly into the ground, the first floor open to the roof. The main part of the building, open to the roof, is entered from a wide doorway with a slate drip course above it set centrally in the south wall. A similar wide opening in the east wall, perhaps used as a taking-in door, was altered to create a door flanked by a window before these were blocked. This part of the building, which is open full-height inside, has two blocked openings low down in its east wall, and two more higher up in its west wall, where there is also a modern fan. The interior is roofed by two king-post trusses with struts and two sets of purlins on each side. The northern end of the building, which has two floors, does not communicate with the main part. Its ground floor is entered through the gable wall

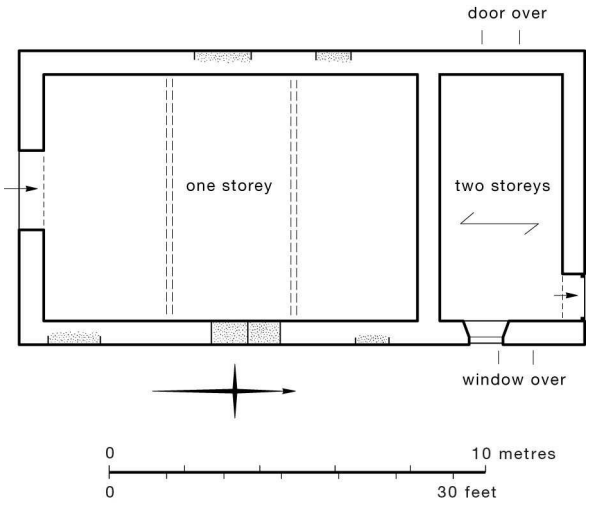


Figure 19. *Saltpetre house from the north east (Christopher Dunn, November 2003) and plan of ground floor by English Heritage.*

and is lit from the front (east), while its first floor is entered from the rear, from a terrace (former track) cut into the slope, and is lit from the front. The first floor is now a flat, a recent alteration from an original industrial use.

The cylinder house (9)

It would appear that at Blackbeck, certainly during the early and middle years of the works, charcoal was made on site in sealed cylindrical retorts. The evidence is provided by the site plans of 1881 and 1898 on which a rectangular building on the eastern side of the beck is annotated 'Cylinder House'. The depiction on the 1898 plan suggests that internally it was sub-divided into two unequal parts and that by this date it had also acquired two small projections at its south-east (also shown on the 1881 plan) and south-west corners. At the Elterwater Gunpowder Works charcoal was similarly made in retorts, but on a detached part of the site which acquired the name 'Cylinder Hill' (Jecock *et al* 2003, 41). The Blackbeck

Figure 20.
North end and west wall of saltpetre house from the north west. (NMR: DP004102)

cylinder house was situated about 21m to the south-south-east of the saltpetre house and 50m from the charcoal house where the finished product was stored (see this section, below). In later days charcoal appears to have been produced off-site because Patterson (1995, 38) refers to charcoal (both stick and Wilson's flake) being brought to Blackbeck; a handwritten note in the Patterson Collection indicates that Alfred Cattle was the source of this information. Presumably this made the cylinder house redundant and a candidate for reuse. Tyler (2002, 227) suggests that it was used as a stable but given its close proximity to both wood sheds and the dust and packing house it could even have been where barrels and casks were either made or stored. A building possessing a south end that is slightly narrower than that to the north is shown at this location on the first edition of the OS 25" map (surveyed 1888). On this map it measures a maximum of 11m by 8m and it is also depicted on the 1913 edition of the map. Unfortunately the 1928 site plan does not extend as far south as this building which no longer survives. A loop from the tramway is shown lying close to the south-west corner of the cylinder house on the first edition OS map, but by the time of the 1911 revision this had been cut back to form a spur serving a block of wood sheds. All the evidence suggests, therefore, that charcoal production at Blackbeck ceased some time between the preparation of the 1898 site plan and 1911. Some time after the cylinder house had been demolished a small building was erected on its site (see section 6.1.7, below); it is uncertain if this structure had anything to do with the gunpowder works.

The charcoal house (10)

The charcoal house was situated on the east side of the beck, opposite the mixing house and about 30m north east of the saltpetre house. It is shown but not labelled on the 1881 site plan, and again on the OS maps of 1888 and 1911 (Ordnance Survey 1890b; 1913b), as a rectangular building which on these last two sources measures approximately 11m (north to south) by 6m. It is also depicted on the site plans of 1898 and 1928 on which it is labelled

'Charcoal Shed' and 'Charcoal House' respectively. The beck in front of the building was bridged in order to facilitate access to the mixing house

The sulphur house (11)

The sulphur store is not labelled on any of the site plans used by EH, and nor is it mentioned in any of the reports by the Explosives Inspectorate. As a result its exact site is uncertain and Tyler (2002, 241 (caption)) has even suggested that sulphur was kept in the saltpetre house. At New Sedgwick the sulphur was housed, certainly in later years, not in a purpose-built store but in a compartment of the mixing house (Dunn *et al* 2003, 38). However, it appears that in the early years at least there was a dedicated sulphur store at Blackbeck because the indenture of 1881 states that the Company would pay the lessor one quarter of the cost of cleaning out that part 'of the watercourse known as Blackbeck New Cut as lies between the Sulphur House and Rusland Pool' (CRO(B) BDX 294). The course of the Black Beck has clearly been straightened and re-cut to the south of the central part of the works which indicates that the sulphur store, like the saltpetre house, was located, south of the early processing buildings. The indenture reference also suggests that it was near the beck and the mostly likely candidate is the rectangular building, orientated north to south, situated near the beck and immediately to the east of the saltpetre house on the 1881 site plan and first edition of the OS 25" map (surveyed 1888); on the latter it measures 10m by 4m. The advantage of this location for the sulphur house is that it would have kept all the ingredient stores close together with regard to easy access to the mixing house(s); the works tramway was also just beyond its west side. This building had been demolished by 1898 and replaced by a much larger building - apparently a store and stable (1898 site plan) - which is described in detail in section 6.1.7, below; it is quite possible that at least part of this new store was also used for housing the sulphur.

The blacklead store

Blacklead (graphite) was used in the glazing process in order to smooth the powder grains and make them less hygroscopic. The Explosives Inspectorate (1900a, 10) refers to its presence at Blackbeck but EH has found no evidence to indicate which building was used for its storage.

6.1.3 The manufacture of gunpowder (for building locations see Figs 17, 27-28 and 33)

Buildings examined in this section include the mixing houses, charge houses, incorporating mills, powder press houses, corning houses, glaze house, reel house, stove houses, and the dust and packing house.

The mixing houses (preparing houses or black mills)

Documentary and cartographic evidence indicates that there were two mixing houses at Blackbeck, one succeeding the other. Each occupied a different site but only that of the second mixing house is known with certainty. In order to provide a suitable site for this second mixing house, the north-east corner of the field west of the saltpetre house was encroached on.

The first mixing house (may be part of building 7)

The first mixing house was deemed by the Explosives Inspectorate, who inspected Blackbeck in 1876, to be too close to adjoining buildings (Explosives Inspectorate 1881, 1). Remedial action, involving the rebuilding of the mixing house in a more suitable location (hence the site of the second mixing house), probably took place after an incident in April 1891 when a spark from the boiler chimney ignited incorporating mill 2. A few minutes later the adjoining mills, 1 and 3, also exploded with the violent fire thus created spreading to the mixing house (Explosives Inspectorate 1898, 4; 1904, 5). If the sequence of events is correct then the first mixing house should be one of the factory buildings depicted on both the 1881 site plan and OS first edition 25" map (surveyed in 1888), but it cannot be identified from the cartographic evidence alone. It seems very likely, however, that it occupied one of the compartments in the long building range (see section 6.1.7, below) that lay to the north of the charcoal house and opposite the incorporating mills. The close proximity of this location to the main steam engine (the probable power source) - situated between mills 3 and 4 - would have facilitated the transfer of power via a drive shaft between this engine and the edge runner mill in the mixing house. This location would also explain why the fire in 1891 was able to spread so easily from the incorporating mills to the mixing house. The other possibility is that the first mixing house was in the building range immediately to the south of the incorporating mills, but this seems a less likely location because this building contained a lathe house, saw mill etc. which would not have provided a very safe environment for mixing the raw ingredients.

The second mixing house (12)

The 1898 site plan shows a rectangular building (divided internally into two parts), labelled 'Black Mill', 30m to the north-north-west of the saltpetre house. This mixing house is also shown on the OS 25" map published in 1913 on which it measures about 11m by 6m. On the 1928 site plan the building is numbered 40 and is also labelled 'Black Mill' (in the ICI report which this plan accompanies the building is referred to as the mixing house); a centrally placed narrow porch or canopy along its eastern side is also depicted. No building is marked at this location on either the 1881 site plan or on the first edition of the OS 25" map (surveyed 1888), although, a track is shown running north past the west side of the saltpetre house, up the side of the valley to the early watch house (see the time office and search house, section 6.1.7 below) and then to Black Beck Farm. This track must have been re-routed when the mixing house was built since the tramway spur which served the latter occupies part of its route: hence the revised track layout at this end of the site on the 1913 edition of the OS 25" map (see section 6.1.9, below). The second mixing house was slightly damaged by explosions in other buildings on at least two occasions. The first was in January 1898 when the stove house blew up, causing several panes of glass to break at the mixing house, the doors of which were also slightly sprung (Explosives Inspectorate 1898, 14). The second occasion was in September 1928 when one small window was broken following an explosion that started at incorporating mill 1 (Imperial Chemical Industries 1928, attached list of buildings damaged).

A limited amount of information survives about the machinery in the mixing house. According to Alfred Cattle's notes (Patterson 1995, 38 and 40 (fn 1)) the charcoal was ground before

Figure 21.
Site of the second mixing house looking west. (NMR: DP003394)

being mixed in an iron-edge runner mill with two runners, each weighing half a ton. This machine would have been situated in the mixing house and was overdriven and, like the reel-sieve which supplemented it, was steam powered (via a drive shaft - see below). However, a different weight for the edge runners is given in a letter dated 9 October 1891 (HF LW/959/365) where it is stated that the two small edge runners in the mixing house each weighed about three and a half tons. A possible explanation for this discrepancy is that the weight given in the letter was based on old information which related not to the second mixing house but to the edge runners of its predecessor which was destroyed six months before the letter was written.

The actual mixing house no longer survives but the rectangular cutting in which it was situated is still remarkably well preserved (Fig 21). It is excavated into the foot of the valley side and the lower parts of its south, west and north sides were revetted by coursed rubble walling which survives intact and stands up to 3.75m in high. At some time a concrete post and wire safety fence (not surveyed by EH) was erected on top of the revetment. A narrow berm separates the revetment from the upper part of the cut into the natural slope; this part of the excavation survives as an earthen scarp up to 2.25m high. The southernmost revetment wall may have been repaired or modified at some stage because there is a straight joint in the stonework near the west corner. At its eastern end this south wall turns through ninety degrees and continues south for a short distance as a 1.1m high revetment to the natural slope. A spur from the works tramway served the mixing house and was situated just in front (east) of this revetment - the spur is depicted on the OS 25" map revised in 1911. This map also shows that the northern revetment wall of the mixing house cutting once continued as a blast wall beyond the north end of the tramway spur and along its eastern side, thus

providing a protective barrier between the mixing house and the rest of the gunpowder works. Neither the spur nor the blast wall survives. The floor of the mixing house cutting has been surfaced with concrete and is currently used as a hard standing for propane gas cylinders. Power for the mixing house machinery was provided by a drive shaft which was probably driven by the steam engine situated between incorporating mills 3 and 4. To the north of the mixing house the drive shaft was housed in a purpose-built brick-lined tunnel, a section of which still survives and is described below with the building range immediately south of the incorporating mills (see section 6.1.7, below).

The charge houses

At Blackbeck the green charges produced in the mixing house were probably stored in the charge house until the incorporating mills were ready to receive them. Ripe (wrought) charges were taken from the mills and stored not in a charge house but in the works expense magazine - this was certainly the practise by 1928 (Imperial Chemical Industries 1928, 2-3). The location of the two successive charge houses appears to have been in the north-western part of the works, despite the fact that on the 1860/1861 site plan (Fig 60) the proposed site for the charge house is to the south of the incorporating mills; on this plan it is numbered 2. Documentary evidence indicates that the charge house which is shown in this north-western area on both the OS 25" maps and the site plans of 1898 and 1928 replaced an earlier charge house (itself rebuilt following an explosion in 1868) which had a slightly different site (Explosives Inspectorate 1881, 2). For the purposes of this report the two charge house sites will be referred to respectively as the first charge house and the second charge house.

The first charge house (13)

The exact position of this building is not known for certain because it had gone by the time the annotated 1881 site plan and first edition of the OS 25" map were prepared, although its site has been located with some confidence. The charge house was reduced to its foundations in July 1868 by an explosion that also destroyed the powder press house and corning house (*Westmorland Gazette and Kendal Advertiser*, 1 August 1868). Its replacement was probably erected on the same site because when Blackbeck was officially inspected in 1876, under the Explosives Act of 1875, it was found that the distances between several of the processing buildings, including the charge house and first powder press house, were insufficient to prevent possible explosions communicating (Explosives Inspectorate 1881, 1). This charge house apparently had no form of screening to protect it against explosions so it is perhaps not surprising that it blew up again in October 1879 when an explosion at the powder press house also extended to it (Explosives Inspectorate 1881, 2). This incident probably provided the opportunity to implement the 1876 findings of the Explosives Inspectorate with the result that the charge house was rebuilt (see second charge house below) on a new site further removed from the powder press house.

On the east side of the beck, close to the north boundary of the caravan park and former gunpowder works, a flat-bottomed rectangular cutting for a building was recorded by EH. The cutting has been excavated into the western edge of a natural rocky hillock and at the

time of the survey was occupied by a caravan (13 Beckside), but the origins of the site are clearly much earlier than the caravan park. On the north and also around its easternmost corner an earthen bank about 0.9m high surrounds the cutting; at its eastern end the base of the cutting is about 2.5m deep below the top of the bank. As the bank proceeds westwards around the easternmost corner of the cutting to define part of the latter's southern side, its top is shaped and its sides are revetted with rubble. After about 9m from the corner the revetted bank ends in a squared-off terminal, an original feature defining the eastern side of the access into the cutting from the south. A caravan park road now lies to the south in a shallow cutting but originally this was the site of the works tramway; the southern face of the revetted bank formed the northern side of the tramway cutting and is shown as walling on the OS 25" map revised in 1912. Overall this section of bank measures 3.4m across stands a maximum of 1.6m high while the revetment walling is 1.3m high. A building is shown in this area on the first and 1913 editions of the OS 25" maps and also on the 1881 and 1898 site plans where it is labelled 'Cart Shed' (see section 6.1.7, below). However, the archaeological remains seem to be too elaborate for just a cart shed site, which with the rocky hillock, the depth of the cutting and the bank all suggest a desire to provide at least limited blast protection, especially on the east side (it seems unlikely that this would have been needed for an ancillary building). Elsewhere in this report it is suggested that the first powder press house was located on the other (eastern) side of this same rocky hillock, less than 20m away from the features described above. The very close proximity of two processing buildings would certainly account for the setting and nature of these surviving archaeological remains and it is thus very likely that this is the site of the first charge house which, when its successor was erected on the opposite bank of the beck, was reused as the site for a cart shed.

The second charge house (14)

The second charge house was probably built soon after the 1879 explosion and was certainly in existence by the beginning of 1881; it is mentioned in the special report of the Explosives Inspectorate into an explosion at the powder press house that occurred on the 19th March of that year. In this report it is said that 'the last explosion at the Factory occurred on 19th October 1879 in a press house standing on the site of the house now exploded, and extended to a charge-house (then rather nearer the press-house than the present one)'. The report continues by saying that this repositioned charge house is '128 feet [39m] from the press-house (and protected by two intervening mounds and by trees) [and in the March 1881 explosion] was wholly uninjured' (Explosives Inspectorate 1881, 2). The building was damaged during the explosion at the first stove house in January 1898 when an 18inch (0.457m) square stone passed through the north end of the roof and landed on the floor, a window at the south end was also blown in (Explosives Inspectorate 1898, 6 and 14). A rectangular building measuring about 9m (north-north-west to south-south-east) by 5m, situated 47m north-north-west of incorporating mill 8, is depicted on the OS first (surveyed 1888) and 1913 editions of the OS 25" maps. A small porch is also shown mid-way along its eastern site at which a spur from the tramway terminates. This building also appears on the 1898 and 1928 site plans where it is annotated 'Charge House', and numbered 24 on the 1928 plan. The 1881 site plan does not show a building at this location but places the

charge house a little further to south, but this is almost certainly an error and not another charge house site (it cannot represent the first charge house because this had already gone by the beginning of 1881 - see above). A probable blast wall is depicted just beyond the southern end wall of the charge house on the 1913 (revised 1912) OS map whereas a large mound is shown on the 1928 plan surrounding both the southern end and western side of the building.

Although this charge house no longer survives, the cutting which was created for it at the foot of the valley side - on the western bank of the beck - is still extant and is now occupied by a caravan. The scarp that defines the western and northern sides of the cutting may have been cut back slightly when the pitch for the caravan was created and the scarp currently has an overall height of 4m; its lower part has been excavated into bedrock which is exposed to a maximum height of 2.2m. There is a narrow tree-covered bank, 'L'-shaped in plan and broken by a gap above the north-east corner of the cutting, just beyond this scarp. It measures about 1.3m high on its up-slope side and is probably an original gunpowder feature.

The incorporating mills (15)
(see also Postscript, pages 153 and 154)
The incorporating mills have been demolished with the result that we are entirely dependent on documentary, cartographic and photographic sources for information about their development and structure (Fig 22). On the OS 25" maps (Ordnance Survey 1890a; 1913a) and site plans of 1881, 1898 and 1928 the mills form a single building range which is both long and narrow, measuring about 60m by 7m. It is aligned approximately north-north-west to south-south-east and stands in the space between the beck (east) and the foot of the valley side (west), and equidistant from both the second mixing house (south) and the second charge house (north). A building range, probably containing pumps, abutted the southern end of the mills and is described in section 6.1.7, below. The fronts of the mill chambers faced west (the eastern wall of the mill range thus formed their rear wall) and on this (western) side they were served by a spur from the tramway. This spur is shown on the OS 25" maps; it lay just outside (about 2m from) and parallel to the incorporating mills. In total there were eight incorporating mills numbered consecutively from mill 1 at the south end to mill 8 at the north end. The mills were divided into two unequal sets by a steam engine house which provided them with power: mills 1-3 stood to its south, mills 4-8 to its north. The 1898 and 1928 site plans indicate that the individual mill chambers were rectangular or almost square in plan. This asymmetrical arrangement is likely to have been the result of mills being added to the end of the northern set, rather than to it being an original arrangement. Tyler (2002, 223) claims that initially six mills were constructed (he also refers to an explosion in 1871 which destroyed all six mills (Tyler 2002, 228)); this would certainly give a balanced arrangement of two sets of mills, 1-3 and 4-6, either side of the central engine house. At the New Sedgwick Works, founded only a few years before Blackbeck, the earliest range of incorporating mills had similarly contained six mills divided into two sets each of three mills, in this case separated by a central waterwheel house (Dunn *et al* 2003, 44). Mill 7 at Blackbeck was certainly in existence by 1878 because an

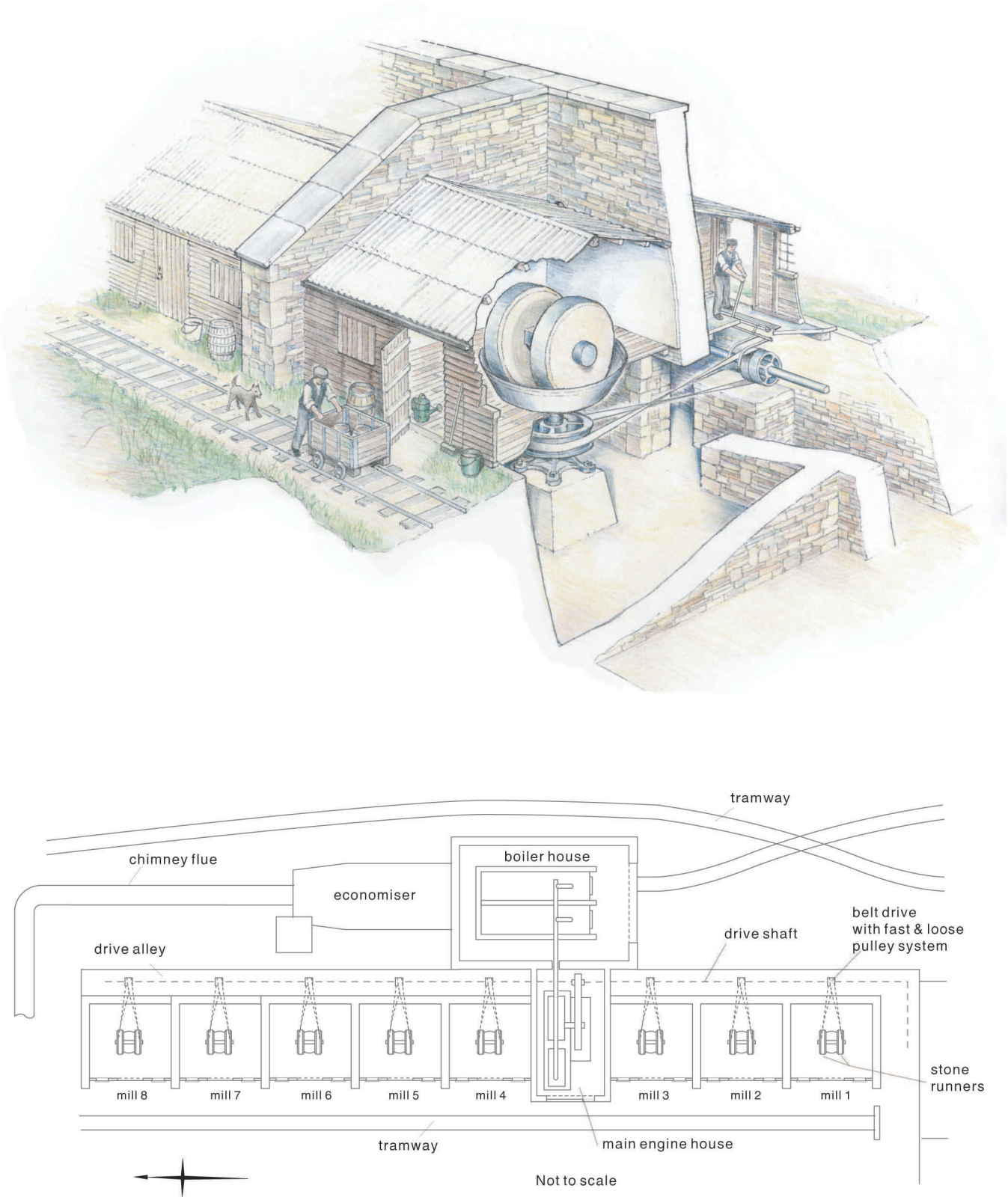


Figure 22. *Reconstructed plan by English Heritage of the incorporating mills.*

explosion at the mills on the 15 October that year damaged it (Explosives Inspectorate 1879, 67). Tyler's claim that mill 8 had been erected by the beginning of 1881 (Tyler 2002, 229) is not supported by the Explosives Inspectorate; in their special report (dated 5 April 1881) of the explosion at the powder press house in March 1881, there is a statement that 'the productive power of the factory is limited to that of seven incorporating mills' (Explosives Inspectorate 1881, 2). Mill 8 was definitely in existence by 1898 because it is drawn and numbered on the site plan produced in that year and must therefore have formed part of the depiction of the incorporating mill range on the 1913 edition of the OS 25" map. It is interesting that the length of the mill range on this map is identical to that shown much earlier by the OS on their first edition 25" map (Ordnance Survey 1890a) which strongly suggests that mill 8 was already in existence by 1888 when the map was surveyed. Mill 8 was also shown and numbered on the 1928 site plan.

The steam engine was supplied with steam from the factory boiler house (see section 6.1.1, below), situated immediately east of the incorporating mills and butting up against the rear walls of the engine house and mill 4; the engine house is also described in section 6.1.1. To the north of the mills the 1913 edition of the OS 25" map shows a narrow rectangular structure bridging the tramway spur. This feature is about 3m beyond the north-west corner of mill 8, and although incorrectly depicted on the 1928 site plan as a building, it was almost certainly a large revetted blast bank or wall designed to give protection to both the second charge house and also the northern part of the tramway spur in the event of an explosion at the incorporating mills. In addition, it must have carried the boiler house flue (probably a large diameter iron pipe) across the tramway spur, thus providing the necessary connection between the boiler house and the surviving brick-lined flue on the hillside to the west. It must also be the 'mound at the end of No. 8 Mill' referred to by the ICI (Imperial Chemical Industries 1928, 2). On the map it measures about 9m by just over 2m and is set at right angles to the principal axis of the incorporating mills. It no longer survives but a buttress-like structure of coursed rubble, situated immediately below the present east end of the brick-lined flue, may be that part of the blast wall which flanked the tramway spur immediately to the west (i.e. it formed one side of the tramway passage through the blast wall) (Fig. 27). The buttress is largely ivy-covered and measures about 2m in high by 2.3m across; it protrudes 1m out (east) from the rock face against which it has been built (in this part of the works the foot of the valley side has been cut back into bedrock which between this structure and the second charge house site forms a prominent rocky scarp up to 2m high while to the south of the buttress it is about 3m high). A cast-iron pipe, about 0.2m in diameter, protrudes from the north part of the east face of the buttress. It is situated about 1.2m up the face of the buttress and, at the time of the survey, water was trickling out of it. The pipe may come from the upper pond which is built on the hillside above and to the south of the buildings of Black Beck Farm (see section 6.1.1, above).

The reports concerning the explosion at the incorporating mills in September 1928, which caused two fatalities, give details about both their fabric and how they were powered (Imperial Chemical Industries 1928; Explosives Inspectorate 1929, 17-18). They are described as being constructed of stone with wooden fronts and doors. The latter were centrally placed

and flanked by shuttered windows (presumably there was a single window on either side of each doorway) while galvanised iron sheeting was used for the roofs; there was also an inner lining to the roof under the corrugated iron (see entry in ICI report for mill 4 under list of damage to buildings). The relatively flimsily construction of the fronts and roofs would have helped to both protect the machinery and also to dissipate any blast westwards and away from the rest of the works in the event of an explosion. The ICI report indicates that the main drive shaft which brought power from the engine house was located outside the incorporating mills. The ICI report also states that 'all mills are worked by belts and fast and loose pulleys, the gear for this being outside and actuated from behind the screen dividing the mills by a wooden lever, this to enable the mill men to have cover in the event of ignition' (Imperial Chemical Industries 1928, 1). The depiction of the mills on the 1913 edition of the OS 25" map suggests that there was a drive alley (perhaps with an awning above to protect the drive shaft from inclement weather) built against the outer face of the rear (east) wall of the mill range; this feature is also shown schematically on the 1881 site plan. A number of small and generally square structures are shown by the OS spaced at intervals along this feature - they may have been supports for the drive shaft. The 1860s incorporating mills at the Chilworth Gunpowder Works, Surrey were similarly powered by steam engine-driven external drive shafts supported on brick piers attached to the rear wall of the mills (marks on this wall also indicate that an awning or overhanging roof protected the drive shafts from rain) (Cocroft 2003, 62-3 and Fig. 26).

Incorporating mills were particularly prone to explosions, and to help reduce the risk of damage the mill chambers at Blackbeck were provided with drenchers or flashboards (Imperial Chemical Industries 1928, 1). In the event of an explosion at a mill, the flashboard was thrown up on its hinges and automatically overturned tanks of water both over its own bed and also those of the neighbouring mills (Fitzgerald 1895). The Blackbeck drenchers were not completely effective in the 1928 explosion since, although they were released in all the mills, that in mill 7 'had been held up through displacement by concussion' (Imperial Chemical Industries 1928, 3). The floors of the mill chambers, at least in mill 1, were of timber supported on joists (Imperial Chemical Industries 1928, attached list of buildings damaged) - the middle incorporating mill group at Basingill similarly had timber floors (Hunt and Goodall 2002, 26).

The eight incorporating mills each contained an edge runner mill, which was powered from below. According to a letter written in October 1881 the mill runners were of 'stone, hooped with iron, weigh from 7 to 7½ tons. The spindles & shafts are of steel, 4½in (114mm) diameter. The iron hoops are about 2½in (63mm) thick' (HF LW/959/365). This description is confirmed by one of the photographs of mill 1, reproduced in Tyler's book on page 240, taken after the 1928 incident which shows the edge runner mill very clearly. Despite the explosion the edge runners are still sitting on top of the iron bed plate and are indeed of stone with iron tyres. However, Patterson (1995, 38) claimed that 'all the mills had iron edge runners on iron mill beds'. Perhaps Patterson was referring to earlier edge runners installed at Blackbeck because Tyler says, but does not give his source, that initially the

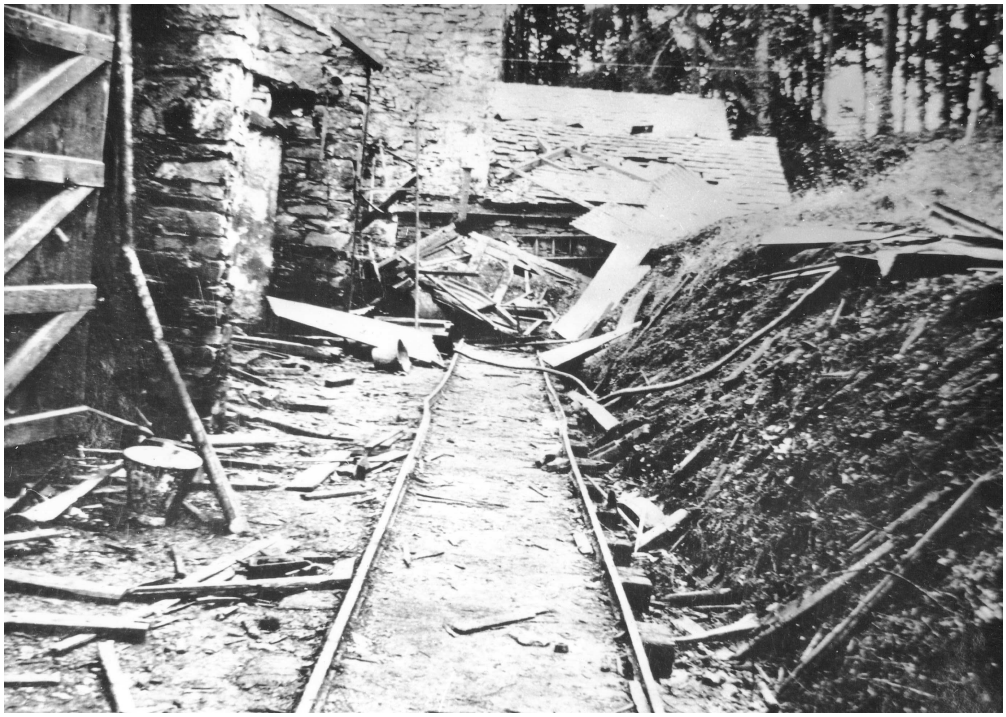


Figure 23.
Incorporating mills 3-1 (left) and the north (blast) wall and roofs of the building range immediately to the south. Taken from the north after the explosion at the mills in September 1928. (NMR: Patterson Collection)

mills had iron edge runners which had been replaced with a more modern suspended runner system (which created less friction) by 1866 (Tyler 2002, 224).

The photographs taken of the damaged incorporating mills after the 1928 explosion help to confirm some of the information derived from the documents while also providing additional details (Figs 23-25). Clearly visible are the displaced corrugated iron roof sheets that had been attached to a grid-like framework of purlins and rafters to form a sloping roof. The rubble side walls of the chambers extended both beyond the fronts of the mills and also upwards above the mill roofs in order to act as blast walls between individual mill chambers. The tops of the walls were gabled and capped by flagstone copings. The photographs also

Figure 24.
Incorporating mills 4-6 (left) and the main engine house (right) after the explosion in September 1928, looking north. (NMR: Patterson Collection)

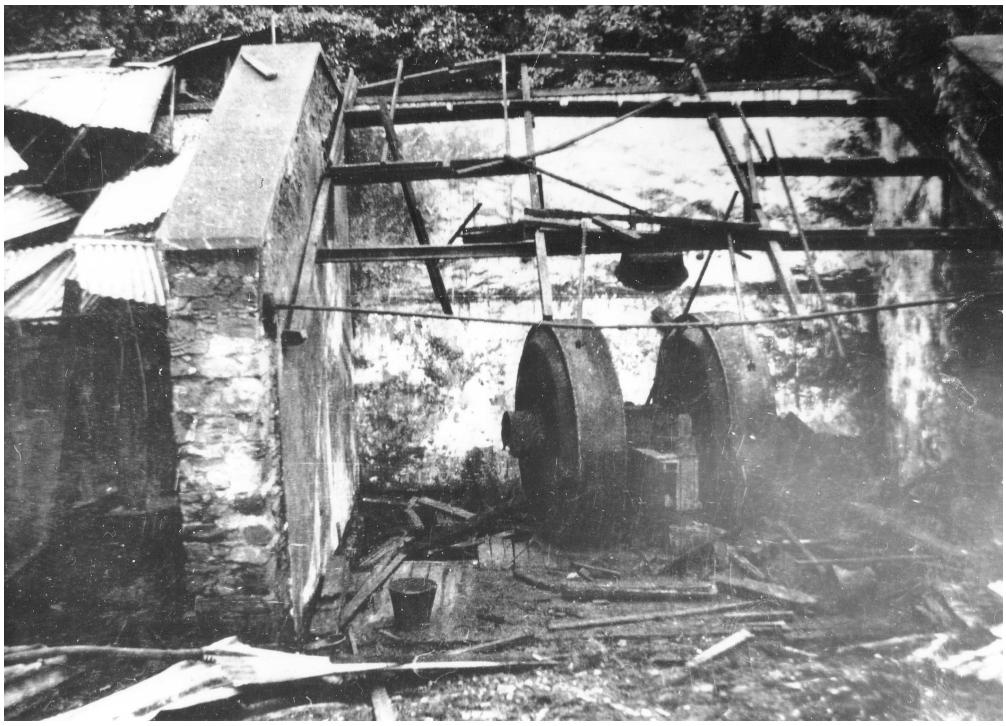


Figure 25.
Mill chamber 2 and its edge runner mill after the explosion in September 1928, looking east. (NMR: Patterson Collection)

indicate that the masonry within each chamber was rendered in order to provide a smooth surface to reduce the chance of gunpowder settling on irregularities and thus posing a threat to safety. Some of the wooden doors and shutter windows are also visible on the photographs indicating that they were fashioned from cross-braced vertical boards. Electrical conduit piping is also apparent - at New Sedgwick there were electric lights outside the incorporating mill windows (Dunn *et al* 2003, 137).

The reports into the 1928 explosion also give a valuable insight into how the mills were charged and operated (Imperial Chemical Industries 1928, 2-3: Explosives Inspectorate 1929, 17). At the start of the charging operation 'The charge truck or bogie containing four green charges is brought [along the tramway spur] and left some distance outside the mound at the end of the No. 8 Mill. The two millmen proceed to lift the charges, which are placed in barrels and left in the Mill. When numbers 8, 7, 6 and 5 Mills have been discharged, one of the millmen brings forward the truck to No. 8, places the green charge on the track of the Mill, and this procedure is followed until No. 5 has been cleared of the wrought charge and the green charge spread. During this period, the other millman has been discharging Nos. 4, 3, 2 and 1 Mills. Meanwhile, the millman who has been discharging and charging Nos. 8, 7, 6 and 5 takes the truck containing four wrought charges back to the Expense Magazine, and brings back [from the charge house] four green charges for Mills Nos. 4, 3, 2 and 1. These mills have by this time been discharged by the other millman. The green charges are put on the Mills by the Millman who has laid the charges upon the other mills. The charge bogie or truck containing the four [wrought] charges from Nos. 4, 3, 2 and 1 is then pushed forward to No 2 Mill when the charge truck is immediately taken by one Millman beyond No. 8 Mill towards the Charge House. The other millman then starts up Nos 1, 2 and 3 in the order stated, one at a time, and then leaves the Mills, passing beyond No. 8. His mate by this time is ready to start Nos. 8, 7, 6, 5, 4 [from the rear of the mills?], one at a time, in that order, and leaves the Mills, passing through the engine house [on his

way to the watch house?]. The bogie has by this time been removed to the Expense Magazine by the man who started up Nos. 1, 2 and 3' (Imperial Chemical industries 1928, 2-3; explanatory notes in parenthesis by EH). When the 1928 explosion took place the bogie (loaded with four 80-lb wrought charges) had as usual been moved to mill 2 but for some reason had not been taken on beyond the mills before mill 1 was started. Mill 1 immediately exploded, probably due to an incorrectly laid charge, and promptly spread to the bogie which in turn ignited mills 2 and 3 (Imperial Chemical Industries 1928, 4). Had the correct procedure been followed the explosion would probably have been confined to mill 1 (Explosives Inspectorate, 1929, 18).

Explosions took place on a fairly regular basis at incorporating mills on gunpowder sites with the result that the more minor incidents (which did not cause fatalities) were rarely recorded in detail - this certainly holds true for Blackbeck with the most detailed report, that for the serious explosion of 1928 (see above). This explosion took place while starting up the mills, and this activity was clearly a dangerous stage in the incorporating process. Two explosions in 1878 provide further evidence of this. The first explosion occurred in September while 'the millman was engaged in shutting the door of No. 4, after starting it from the outside, and the door of No. 5 was open at the time' (Explosives Inspectorate 1879, 67). The second explosion took place during the following month and 'occurred when the man was in the act of starting the mill upon a green charge, and was supposed to have been due to the charge not having been spread under the runners with sufficient care' (Explosives Inspectorate 1879, 67). The mills were damaged by explosions at other buildings or structures at the works on at least three occasions: the first was in October 1879 when the powder press house exploded (Explosives Inspectorate 1881, 2); the second was in April 1891 when the boiler house chimney caught fire 'and owing to the wind, sparks were carried to

Figure 26.
Enlarged extract from RAF air photograph showing the incorporating mills in 1945. (NMR Air Photo Library: RAF106G/ UK.653/13-AUG-1945/ 4141)

the mills, distant some 80 yards (73m) and on a considerably lower level' (Explosives Inspectorate Explosives 1904, 15); the third was in January 1898 when the stove house exploded (Explosives Inspectorate 1898, 14). Although the mills faced away from the stove house, all their fronts were blown slightly out and the roof of mill 8 was found resting on the edge runners. Documented incidents which affected the incorporating mills at Blackbeck are listed in Appendix 1, below.

The site of the incorporating mill range has been levelled to form caravan pitches. However, air photographs indicate that the mill chambers survived long after closure. The side walls and long end wall of the latter, together with the engine house between mills 3 and 4 (see section 6.1.1, above), were still upstanding and apparently in relatively good condition when the Royal Air Force photographed the area in 1945 (NMR: RAF 106G/UK.653/13-AUG-1945/4140-1) (Fig 26). Later photographs confirm that, although dilapidated, they were still extant in 1957 (NMR: RAF/2151/26-APRIL-1957/0005 and 0058) but must have been demolished sometime between then and May 1966 when Ordnance Survey photographs show caravans on their former site (NMR: OS/66/109/30-MAY-1966/ 478-9).

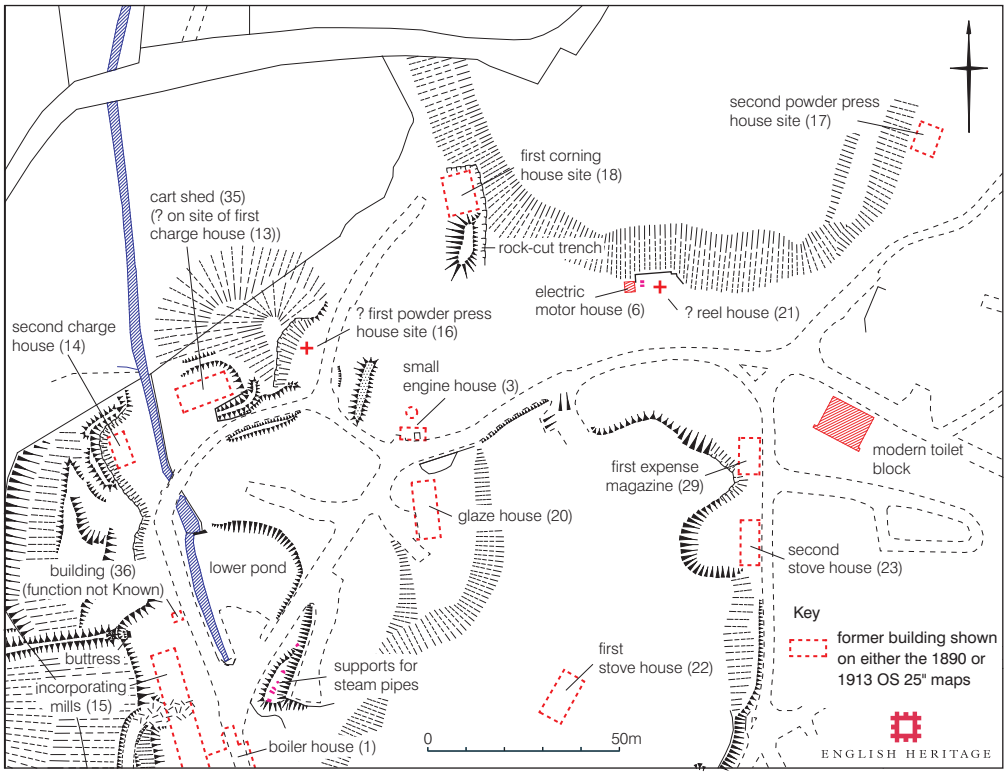


Figure 27. *Reduced extract from the English Heritage 1:1000 scale earthwork plan showing the location of the gunpowder buildings in the northern area of the works.*

The powder press houses

Documentary evidence indicates that there were two locations at Blackbeck where powder press houses were built at different times. The earliest was in the northern part of the works, situated between the first charge house and first corning house (*Westmorland Gazette and Kendal Advertiser*, 1 August 1868). After an explosion in March 1881 which destroyed the powder press house and spread to the corning house, the Company decided to rebuild the former on a new site. Extra land with good natural blast protection was acquired to the north east of the works for the new powder press house, a site which was well removed from both the corning and glaze houses (Explosives Inspectorate 1881, 13). These two locations

will be referred to below as the first powder press house and second powder press house respectively.

The first powder press house (16)

The site of this building is not known because the maps and site plans of the works, showing it as an operating concern, were prepared after the powder press house had been moved to the second location. However, quite a lot of information about it, including its likely position, can be gleaned from newspaper and Explosive Inspectorate accounts. The Explosives Inspectorate (1881, 1) informed the Company in July 1876, as a result of an official site inspection, that the powder press house was too close to both the glazing house and the first charge house, but this does not appear to have led to any instant remedial action. It, like the nearby charge house and corning house (at the first corning house site), was reduced to its foundations by an explosion on July 25th 1868 which resulted in nine fatalities (*Westmorland Gazette and Kendal Advertiser*, 1 August 1868). Its successor was built on the same site but it too was destroyed in October 1879 by another explosion which started in the powder press house and extended to the incorporating mills and first charge house killing three workers (Explosives Inspectorate 1881, 2). According to the Inspectorate this explosion was particularly violent because the powder was under pressure at the time. Its replacement was also erected on the same site but had an even shorter life being wrecked by an explosion in March 1881 (this incident also extended to the corning house and killed the three men who were in the powder press house) (Explosives Inspectorate 1881; *Westmorland Gazette*, 26 March 1881; *Ulverston Mirror and Furness Reflector*, 26 March 1881).

The detailed report of this explosion by Lieutenant-Colonel Majendie (HM Chief Inspector of Explosives) is particularly informative (Explosives Inspectorate 1881). The powder press house is described as being a wooden single-storeyed building with a galvanised iron [sheet] roof. The explosion had been so violent that even its stone foundations had been destroyed but 'a portion of the floor of the porch was still standing'. Within the interior the wooden 'binn', in which the mill cake from the incorporating mills was broken up using wooden mallets, was situated along the upper or south-east side of the building. The press itself was located between the 'binn' and the north-west or lower part of the building, a little to the south west of the latter's centre. According to the report 'the press had been manufactured by Messrs. Umpherston Brothers, of Loanhead (now Umpherston & Co. Limited, of Leith), and was of a simple and well-known construction'. The ram was 13in (330mm) in diameter and the iron standards of the press box were sheathed in canvass so that the iron was not exposed and the head of the press was thickly painted. The press box (which contained the layers of powder to be pressed) was stoutly made from 4in (102mm) thick beechwood and measured about 3ft 1in (940mm) by 2ft 7in (787mm) by 2ft 6in (762mm) deep (internal measurement). The top and front of the box were removable and the wooden slab that formed the front was secured by means of four cylindrical copper bolts. The front of the press-box had been blown some 129m from the powder press house by the explosion but the press standards and press head were left standing. Powder press pumps, probably situated in a building immediately south of the incorporating mills (see section 6.1.1, above),

provided the hydraulic power for the press but there is no above ground evidence now for the associated iron pipes which must have crossed the northern part of the site to the powder press house.

The documentary material associated with this explosion also provides clues to the setting and likely location of this powder press house. It is said in a newspaper report that the latter 'was situate in a slight hollow of the wood'. There was also 'a hill to the west' [valley side], near to Black Beck Farm, up which the remains of one of the workers (James Robertson) were blown. The corning house is referred to as being some 60 (54.8m) or 70 yards (64m) east of the powder press house 'with a high bank of earth intervening' (*Westmorland Gazette*, 26 March 1881); the latter is also referred to in another newspaper account which describes it as 'a high bank surrounded by trees' (*Ulverston Mirror and Furness Reflector*, 26 March 1881). The report by the Explosives Inspectorate also contains the distances from the powder press house of some of the other buildings in the vicinity (and how they were protected (screened) from the powder press house): [second] charge house 128ft (39m) distant 'and protected by two intervening mounds and by trees'; glazing house 160ft (48.7m) away 'and screened by mound and trees'; incorporating mills 235ft (71.6m) distant and protected by a 'mound and trees'; little engine house 135ft (41.1m) away and protected 'by mound and trees' (Explosives Inspectorate 1881, 2).

When combined, all these details and distances indicate that the powder press house was probably located at approximately NGR SD 3342 8576, near the northern boundary of the gunpowder site - this is also close to the proposed press house site marked on the 1860/ 1861 site plan (CRO(B) BDKF Plan 7) (Fig 60). In this part of the works there is a natural rocky hillock, part of whose south-east side has been cut away to form a platform open to the east but with a steep, rock-cut scarp (at least 3m high) forming its north-west side. The excavated area is currently used as a caravan pitch (unoccupied at the time of the EH survey) but it is unlikely to have been made for this purpose and is most probably the site of the first powder press house. After the 1881 explosion the intention was to leave its site unoccupied (Explosives Inspectorate 1881, 13) which may be why this spot is devoid of buildings on the OS 25" maps and later site plans relating to the works.

The second powder press house (17)

The second powder press house must have been erected fairly soon after the explosion in March 1881 because its construction was regulated by Amending License No. 146, granted to the Company on 20 May 1881 (Explosives Inspectorate 1900a, 4). It was certainly in existence by the latter part of that year because it is depicted on the 1881 site plan and is labelled 'Press house'. It is also shown on the OS 25" map surveyed in 1888 and again on the 1898 site plan on which it is annotated 'Press House'. The OS map indicates that its south-east side was served by a spur from the main tramway. A window facing south west was blown in by the explosion at the first stove house in January 1898 when the powder press house was also hit by one or two flying stones (Explosives Inspectorate 1898, 14). In May 1900 the powder press house was completely destroyed by an explosion and the press smashed; two men who were in the building at the time were killed. A blast wall was

also damaged which is described in a newspaper account of the explosion as being 'the gable end of a former press house' (*North Lonsdale Herald and Dalton Advertiser*, 2 June 1900); this seems most unlikely as there is no evidence for an earlier press house in this part of the works. The official report into this incident contains a lot of information about both press house and press (Explosives Inspectorate 1900a). The report also refers to an accompanying plan of the powder press house made some time before the explosion and supplied by the Company, but this is missing from the copy of the report in the Patterson collection which was used by EH; fortunately a photocopy exists in the caravan park files and is reproduced by Tyler (although his caption erroneously gives 1903 as the year of the explosion) (Tyler 2002, 238).

The building, orientated south-south-west to north-north-east, was rectangular in plan and measured 31ft (9.4m) by 17ft 4in (5.3m). A platform, 3ft 8in (1.1m) wide, lay immediately outside its long, south-east wall and extended the full length of the wall. A flight of steps at the south-west end of the platform led to a door with a 'Shoe House' behind it. Special footwear without nails was worn in the works and extra boots were provided for the press house 'which were never brought out of it, to prevent grit being carried in' (*North Lonsdale Herald and Dalton Advertiser*, 2 June 1900). This door gave access on to the top of the platform from where the powder press house could be entered via a pair of doors each 4ft (1.2m) wide in the south-east wall of the latter. The doors were positioned towards either end of the south-east wall and there was a centrally placed window between them, 3ft 8in (1.11m) wide; the north-east and south-west end walls of the powder press house also each had a central window, 3ft 9in (1.14m) wide. Blinds were apparently put up when the sun was shining (*North Lonsdale Herald and Dalton Advertiser*, 2 June 1900). The building was constructed of timber lined throughout with wood on top of concrete foundations - these had been 'completely broken up' by the explosion. Heavy timbers had been used for the roof which was clad with corrugated iron sheeting. Within the building was a pair of powder bins placed one at either end of the north-west wall while the press itself occupied the centre of the building with a pair of rails following the main axis of the building extending from it on either side. A small circular feature, probably the pipe which brought water under pressure to power the press, is shown on the plan in the floor-space between the press and the south-east wall. According to the Explosives Inspectorate (1900a, 4-5) this pipe extended from the powder press house to the press pumps, which may have been housed in the building immediately south of the incorporating mills, a distance of at least 260m. The pipe 'was provided with two safety valves, one at the pumps, and the other just outside the press house' - apparently the press was worked directly off the pump and not through an accumulator, a practise which was criticised by the inspector (page 10). The latter also considered that the 'positive' connection between the steam engine and the pumps was not ideal and that a 'frictional' one would be better.

Unlike the press in the first powder press house, this press was more modern and lacked a press box. It consisted of a vertical cast-iron cylinder with a flange at its upper extremity by which it was carried in a heavy cast-iron base plate. Four vertical columns of 'malleable iron' were attached to this base plate and their upper parts supported the head of the press.

The ram worked in the cylinder and was also of cast-iron. On top of the ram was a cast-iron table and over this was a thick brass plate upon which the trolley bearing the charge was supported. There were two trolleys constructed of stout wood with small brass trucks that ran on the rails mentioned in the previous paragraph. This provision meant that while one charge was under pressure the next one was being prepared with the powder being placed between a series of copper plates on top of one of the trolleys. According to the Explosives Inspectorate report (page 4) the trolleys were run out to either side of the press alternatively - hence the provision of rails on both sides of the press.

The powder press house was rebuilt on the same site and is the one depicted by the OS in 1912 (Ordnance Survey 1913a). This map shows a rectangular building, about 9m by 5.5m, with a platform against its long, south-east side fronting a spur from the tramway; unlike its predecessor this platform extended beyond the northern end of the powder press house. The Patterson Collection also contains two copies (one dated September 1923) of an engineering drawing of a hydraulic press at Blackbeck which must be the one in this building. It is possible that when the powder press house was rebuilt the opportunity was also taken to address the problems with the hydraulic power identified by the Explosives Inspectorate. It is suggested above (see section 6.1.1) that pumps may have been installed at this time in the little engine house (and a hydraulic accumulator erected outside it) to serve the rebuilt powder press house.

The powder press house has gone and caravan pitches now occupy its site. However, it was clearly built against a natural rocky scarp that formed part of the northern hillside in this area of the works. The scarp was cut back to accommodate the powder press house and the bare, steep rock face thus created now stands at least 5.5m high and forms a prominent feature in this part of the caravan park. A short iron rod protrudes from its upper edge at the south-west end. Originally there were a pair of screen walls built of earth and stone flanking the powder press house but these have also gone; one lay about 10ft (3m) from the south-west end of the building (and may be the one drawn about 3.8m beyond the rebuilt press house on the OS 25" map, revised 1912 (Ordnance Survey 1913a)) and the other was 4ft (1.2m) beyond the north-east end (Explosives Inspectorate 1900a, 4). Captain Lloyd, who investigated the May 1900 explosion, commented very favourably on the choice of site for this danger building because it provided such a good combination of natural and artificial screening - apparently the whole hillside was even planted with trees with this consideration in mind (Explosives Inspectorate 1900a. 4).

The corning houses

Although there was only ever a single corning house at Blackbeck in use at any one time, a total of ten corning houses were erected due to explosions; they occupied two separate locations, one a replacement for the other. The first location, where nine corning houses were destroyed by explosions, was near the northern boundary of the works and about 70m to the north of the glaze house. After an incident on 14 December 1911 it was decided to build the tenth corning house at a new (second) location which was well away from both the factory chimney and the buildings at Black Beck Farm (Explosives Inspectorate 1912, 5).

The first site was completely unscreened from the farm, which is situated above it on the hillside to the west; it was considered just possible that a spark from the farmhouse chimney had caused the explosion in 1911. The site chosen for what was to be the last corning house was located in the far eastern part of the works on the site of the second expense magazine. The latter was demolished and a replacement magazine (the third expense magazine) was erected to the south (see section 6.1.5, below). In this report the two corning house locations will be referred to as the first corning house site and the second corning house site.

The first corning house site (18)

Corning house 1, erected when the works was established, was wrecked by an explosion in December 1867 which also destroyed the glaze house and the nearby little engine house, killing three people (*Soulby's Ulverston Advertiser*, 12 December 1867; *Westmorland Gazette and Kendal Advertiser*, 14 December 1867). A new corning house (corning house 2) was erected on the site but it had an extremely short life since it was reduced to its foundations by an explosion in July 1868 (incorrectly dated to 1863 in a much later newspaper reference (*Westmorland Gazette*, 16 December 1911)) which also flattened the powder press house and first charge house with the loss of nine lives. The floor of corning house 2 'was of wood, fastened with wooden pins, and no metal bolts at all. The sieves are copper with wooden rims' (*Ulverston Mirror and Furness Reflector*, 1 August 1868). Corning house 3 which replaced it was also destroyed, this time in July 1873 by a lightning strike (Explosives Inspectorate 1881, 2; 1884, 5). Disaster struck once more in March 1881 when an explosion at the powder press house spread to corning house 4, erected after the 1873 explosion, and destroyed most of the building which was a single-storeyed timber structure on stone foundations with a galvanised-iron roof; it contained two corning machines (Explosives Inspectorate 1881, 2).

Once again a new corning house (corning house 5 - depicted on the 1881 site plan where it is annotated 'Corning House') was erected at this location but it too was destroyed, this time by lightning in July 1884 with the loss of four lives (*Westmorland Gazette*, 2 August 1884). This was despite the fact that the building had been equipped with two lightning conductors in 1882 installed by Messrs Norman and Son of Barrow-in-Furness (*Ulverston Mirror and Furness Reflector*, 2 August 1884). The Explosives Inspectorate report into this explosion gives a lot of information about the actual building. It was constructed of wooden planks fixed to strong uprights and externally it measured about 36ft (10.9m) by 30ft (9.1m) and was roofed with corrugated galvanised-iron sheets; a wooden platform extended around the southern and western sides of the building. The two corning machines were situated towards the rear of the building while a separating frame occupied the middle. Power to drive the machinery came from the steam engine in the little engine house (described in section 6.1.1, above); the engine could be stopped and started by a lever handle outside the corning house, with a thick wire providing the necessary link between the two buildings (Explosives Inspectorate 1884).

Corning house 6 was erected on this site after the explosion and is presumably the one shown at this location on the 1898 site plan and labelled 'Corning House'. It received minor damage (windows to the south, west and east broken as were door hinges) in 1898 when the stove house blew up (Explosives Inspectorate 1898, 14) and the machinery inside it was thoroughly overhauled and portions renewed in 1900 during the late spring or early summer (Explosives Inspectorate 1900b, 4). Very shortly afterwards, on 27 August of that year 'a comparatively mild' explosion at the corning house killed four men and left only the roof and framework of the walls standing; the metal parts of the machinery within the building were undamaged (Explosives Inspectorate 1900b; *North Lonsdale Herald and Dalton Advertiser*, 1 September 1900). The Explosives Inspectorate report (page 4) gives a brief description of the damaged building which was the same size as its predecessor and similarly constructed of wood with a galvanised-iron roof; it was lined throughout with wood. The report also contains a fairly detailed account of the corning process and machinery inside the corning house. First of all the press-cake from the powder press house was broken down by passing it between two slowly revolving metal rollers (crackers) covered with pyramidal-shaped teeth. These were powered from an external shaft by bevel-gearing and the rollers could be put out of gear by means of a clutch. The rollers were situated in the far side of the corning house in its northern corner. The powder then went through another pair of rollers located in the opposite corner of the building; these rollers had smooth surfaces. A raised wooden platform lay between the two machines. The powder was then put through a screening process in order to separate it from the dust produced by the action of the rollers. This machinery was almost centrally placed in the building and at right angles to the raised platform (Explosives Inspectorate 1900b, 4).

It is not clear whether corning house 6 was simply repaired or completely rebuilt after this explosion, but for the purposes of this report the refurbished or replacement building will be referred to as corning house 7. The machinery inside was purchased from Stevensons Limited, Canal Foundry, Preston who installed it during the latter part of 1900 (*Westmorland Gazette*, 5 May 1906; Explosives Inspectorate 1906). This building also had a short life because it and its machinery were wrecked by an explosion on the 30 April 1906 which also killed two workmen (*North Lonsdale Herald and Dalton Advertiser*, 5 May 1906). Damage to other factory buildings was slight, and according to the Explosives Inspectorate (1906, 4) this was due to the protection afforded by a dry-stone blast wall, 30ft (9.1m) high and 4ft (1.2m) thick at its top; this must be the 11m long wall shown on the OS map of 1913 (revised 1912) extending in a south-westerly direction from the south-west corner of the corning house site.

Corning house 8 was built on the same site as its predecessor but had an even shorter life since it exploded in July 1909 with a loss of two lives (*North Lonsdale Herald and Dalton Advertiser*, 17 July 1909; *Westmorland Gazette*, 17 July 1909). The building, lightly constructed of timber with a corrugated-iron roof, was completely demolished with some of the roofing sheets blown a considerable distance; the machinery inside was almost entirely destroyed. Once again the blast wall 'on the south side of the Corning House' helped to protect the other buildings from serious damage (Explosives Inspectorate 1909, 4). According

to the official report into this incident, the press cake was brought by ‘a covered bogie’ from the powder press house direct to this corning house where it was passed to the ‘crackers’ via a wooden hopper. These two rollers were kept almost in contact with one another by a suspended weight, an arrangement which allowed the rollers to move apart in the event of an over-large article passing through, thus reducing friction. Thus broken up the cake was then sifted on a ‘skry-frame’ (sieve) and was ‘then raised by endless bands and passed through other toothed and smooth rollers until by a final sifting on the ‘‘skry’’ it is sorted into grains of various sizes and is ready for removal from the house’ (Explosives Inspectorate 1909, 4).

Corning house 9 was erected by Messrs. Foster Bros. of Preston to replace the destroyed building and was the last corning house erected at this location. It consisted of a lightly-constructed wooden building with a corrugated iron wood-lined roof and stood on top of concrete sets which raised the floor 2ft (0.6m) above the ground (Explosives Inspectorate 1912, 2). In December 1911 two workmen were killed when the building was extensively damaged by an explosion which completely destroyed the roof and blew away the lighter parts of the machinery although at the south-east corner the floor and side-walls of the building remained largely intact (*Westmorland Gazette*, 16 December 1911; Explosives Inspectorate 1912, 3); once again nearby buildings were only slightly damaged. The official report into this incident contains brief details about the corning process and machinery but gives more information about how the machinery was powered by the drive shaft from the little engine house. Apparently the machinery could be thrown out of gear by two clutches, one situated in the little engine house and the other on the drive shaft outside the corning house. This clutch could be operated by a lever inside the building and also by an emergency rope near the ‘crackers’ (Explosives Inspectorate, 1912, 3). The replacement for corning house 9 was erected at a new site (see the second corning house below) distant some 230m to the east-south-east.

The first corning house site is still clearly visible as a rectangular level area (stance) cut into the lower, western part of a natural rocky hillside which, together with a rock outcrop which forms the southern side of the stance, must have provided good natural blast protection. On the east, the cut bedrock rises up to 3m above the floor of the stance although elsewhere it is about 2m high; in places the bedrock may have been cut back more recently when the stance was converted into a caravan pitch (17 Beckside). A rock-cut trench, now partially in-filled with old timber, leaves and plastic rubbish bags, extends southwards for 35m from the south-east corner of the stance. It measures about 2.5m across and despite the rubbish in its bottom has depths of about 1m (west side) and 0.5m (east side). Its orientation and position indicates that it probably housed the drive shaft which brought power from the little engine house to the corning machinery (for further information about the drive shaft see the description of the little engine house in section 6.1.1, above). There is now no trace above ground of the tall blast wall mentioned by the Explosives Inspectorate and shown by the OS on the 1913 edition of their 25" map; perhaps it was demolished for safety reasons when the caravan park was established. The depiction on the OS 25" maps (Ordnance Survey 1890a: 1913a) indicates that the first corning house site was served from the south

west by a spur from the works tramway. However, the 1913 map indicates that some time between the 1890 map (revised 1888) and the cessation of corning at this location, the spur had been realigned slightly so that it could run up to the centre of the building rather than the north-west corner (as on the 1890 map). In order to achieve this change part of the tramway had to be laid out along what previously had been the edge of the field to the north. The boundary wall of the field thus had to be moved slightly to the north in this area so that the tramway spur could be accommodated; this resulted in a kink in the line of the field wall which, although the spur has gone, still survives.

The second corning house site (19)

The corning house (the tenth to be constructed at Blackbeck) was rebuilt at a new location following the destruction of its predecessor in December 1911 (see above) and its erection was presumably completed during the early part of 1912. Unfortunately the site plans which label individual buildings are either too early or do not extend far enough to confirm the position of this second corning house site. However, three official black and white photographs in the Patterson Collection show the remains of this corning house building

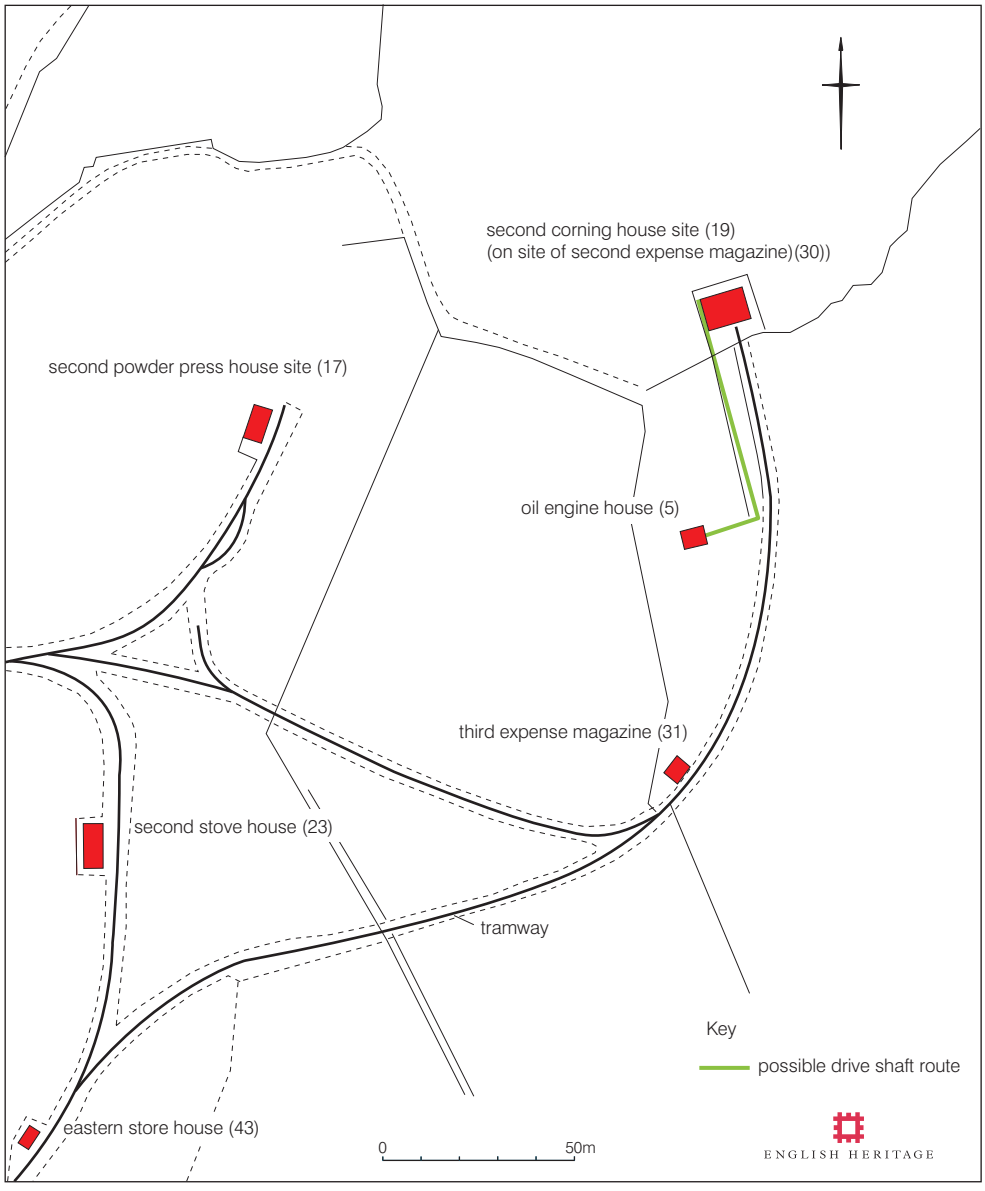


Figure 28. *Diagram showing the gunpowder buildings in the north-eastern part of the works. (Based on the Ordnance Survey 25" map published in 1913)*

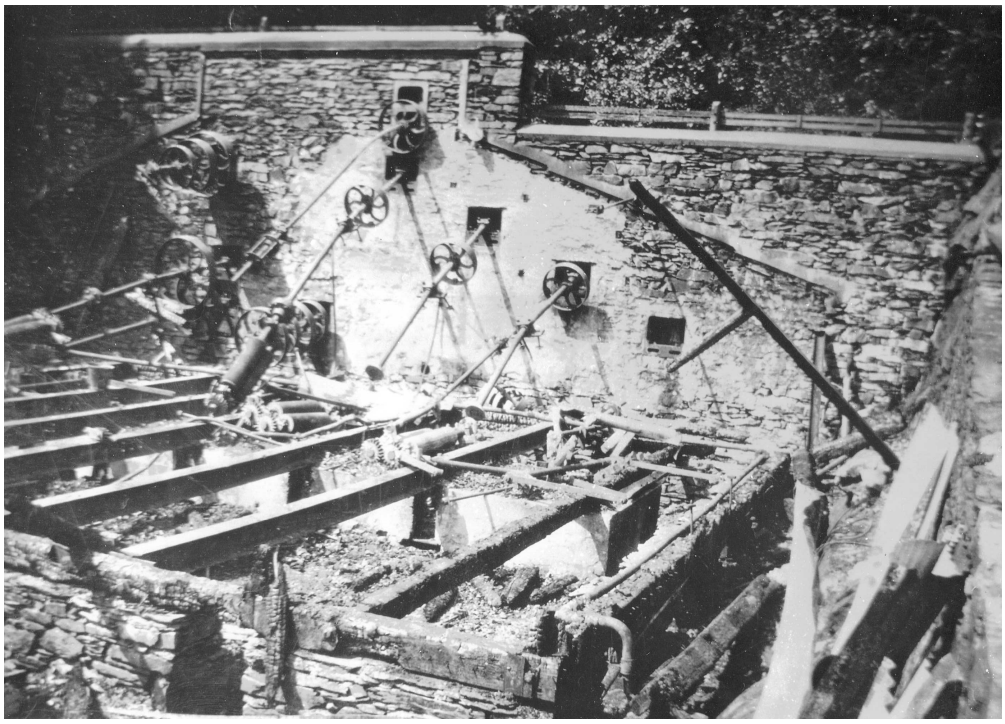


Figure 29.
The charred ruins of the corning house after the fire in June 1929. (NMR: Patterson Collection)

and its machinery after it burnt down in 1929 (two are reproduced by Tyler (2002, 239) but incorrectly captioned 1928) together with two much later colour photographs annotated April 1979 on their reverse (they were probably taken by Ted Patterson himself because he visited Blackbeck at this time (letter in Patterson Collection)) showing the same structural remains but in a much more dilapidated state (Figs 29-30). On his plan Patterson (1995)

Figure 30.
The remains of the corning house (destroyed by the June 1929 fire) in April 1979. (NMR: Patterson Collection)

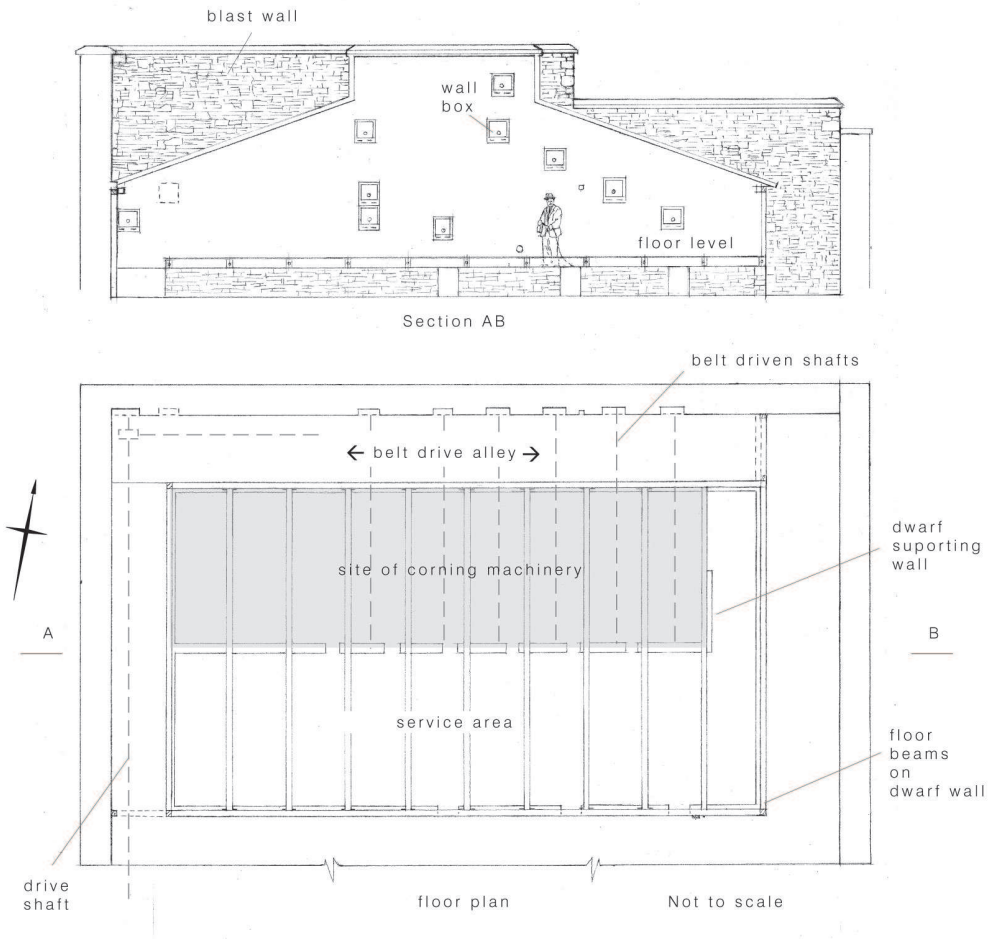
places the corning house at the far north-eastern end of the works on the site where, according to the 1898 site plan, the expense magazine was moved to after the stove house explosion in that year. Confirmation that the second expense magazine was indeed built somewhere in this area comes from a reference by the Explosives Inspectorate (1900a, 6)

to the magazine lying about 355ft (77.5m) east of the second powder press house location. When Mike Thwaites was shown copies of the colour photographs by EH investigators he immediately recognised some of the features on them and took the investigators to the place where Patterson also independently places the corning house. The area has been much altered to accommodate caravans but Mike Thwaites remembers seeing the wall boxes visible in the photographs before they were buried under material used to build up the caravan pitch. In addition, when Christopher Dunn and Amy Lax first visited Blackbeck in November 2000 during an initial reconnaissance visit for the EH Cumbrian Gunpowder Industry Project, this area of the caravan park had not been cut back into the natural slope as much as it is now and at the north-east corner of the caravan pitch a small area of old rendered walling and a recess were still just visible. All this evidence helps to confirm that this is indeed the second corning house site which means that the second expense magazine must also have been demolished and rebuilt elsewhere (see section 6.1.5, below).

The tenth corning house is almost certainly the building shown here by the OS on the 1913 edition of their 25" map (revised 1912). It seems a little big for an expense magazine and its orientation does not agree with that of the magazine on the 1898 site plan. Measured off the map it is about 11m (west-south-west to east-north-east) by 8m. The OS map also shows a blast and retaining wall on the east, north and west, with this last side continuing southwards for about 50m, presumably here as a free-standing blast wall. The latter must have been designed to protect the rest of the works in the event of an explosion at the corning house and its presence also helps to confirm that this is the corning house site - the first corning house location also possessed such a wall (see above). An examination of the photographs taken after the fire indicates that the OS depiction of the corning house does not include the main drive shaft alley or the one which contained the shafts and pulleys which drove the corning machine. But the photographic evidence suggests that the corning house roof extended across at least this last alley which should therefore be seen as an integral part of the corning house and will be treated as such elsewhere in this report. The map does, however, show that the building was served on its south side by a long spur from the tramway. It is suggested below (section 6.1.5) that the spur may originally have been installed in 1898 to serve the second expense magazine. Immediately to the west of the spur and parallel to it, the OS drew a 39m long line in front of the corning house which looks like a low wall retaining the natural slope and thus protecting the tramway from soil slippage; the wall no longer survives above ground. Mike Thwaites (*pers comm*), however, remembers this feature and says that it was platform-like in appearance, an observation which is supported by Patterson who added the annotation ‘Stone Platform’ to this part of the site on photocopies of extracts of the 1913 OS 25" map which form part of the Patterson Collection. Given its very close proximity to the tramway it is unlikely to have been the support for the drive shaft from the oil engine to the corning house and in any case its curved southern end would appear to rule this out. Perhaps it was a platform for the loading and unloading of gunpowder barrels, but it is now not clear if this was connected with the corning house or with the second expense magazine which preceded it. But one would expect such a platform to be much shorter and if the wall visible in the foreground (on the left) of figure 30 is part of this feature, then a retaining wall seems a much more likely explanation.

In June 1929 the corning house burnt down, probably as a result of lightning, and was not rebuilt. By this time it appears that gunpowder production had already ceased at Blackbeck because, according to the newspaper report of this incident, 'the corning house has not been in use for some time, and no gunpowder was stored there' (*Westmorland Gazette*, 15 June 1929). In this report the destroyed corning house is described as having been 'a stone building with pitch-pine wood-work, and a corrugated iron roof'. The three photographs taken after the fire help to confirm and expand this description. They show the inner face of one of the end walls of the corning house which was indeed stone-built and also rendered. At either end this wall rose above the roof line (marked by weathering, possibly of concrete) to form a blast wall with a capping, probably of concrete; the wall also retains the natural slope. The weathering in the central part of the roof rises vertically above the roof slopes both to accommodate some of the machinery and also because louvered vents were probably present before the fire. At least two corrugated iron sheets, presumably from the roof, are visible on the ground. A number of recessed wall boxes on the inner face of the wall are particularly prominent in the photographs. Although bent, the shafts with their attendant pulley wheels are still in place. Their presence indicates that this was the site of the drive alley. Four of the wall boxes are arranged *en echelon* (with what may be a double wall box visible above the uppermost) and occupy the right hand part of the wall. At least three other wall boxes are present on the central and left hand parts of the wall. The other side of the drive alley is also just visible at floor level and it supported one end of the floor joists (of steel and timber) which crossed the main part of the corning house interior (this floored part is what the OS show as the actual corning house). There was almost certainly a partition wall here in order to separate the drive alley from the corning machine and thus reduce the possibility of an adverse incident occurring. The other ends of the floor joists rested on a dwarf wall visible in the foreground on two of the photographs. This wall has a charred timber beam laid along its top which must have supported the other end wall of the corning house. One of the photographs also shows a tall vertical timber to the left and at least two others lying in the foreground that may be framing from this wall. In another photograph the lower stone part of one of the other side walls, complete with a long pipe, is also visible (Fig 29). These two walls appear, therefore, to have been of wood supported on dwarf stone walls (foundations). A concrete or rendered structure within the corning house, below the floor, must have supported the frame which held the ends of the shafts of the corning machine in place. EH has produced an elevation, plan and reconstruction drawing, based on the above information, to show what this corning house may have looked like (Fig 31).

Patterson had access to the late Alfred Cattle's notes which were particularly informative for the corning house machinery. Apparently there was a single corning machine that had five pairs of rollers which measured 30in (0.457m) by 8in (0.203m) and 'a hopper feed supplied the first pair of crackers, working at 21 r.p.m. These dropped powder to a second pair of crackers working at 28 r.p.m. then to a third pair of crackers working at 35 r.p.m. These were fed by an elevator from the fourth set of rolls. The fourth and fifth set of rolls (35 r.p.m.) were unusual in that they had helical grooves. There were no smooth rolls in the machine. Sieves were positioned under the third and fifth pair of rolls' (Patterson 1995, 39). He goes



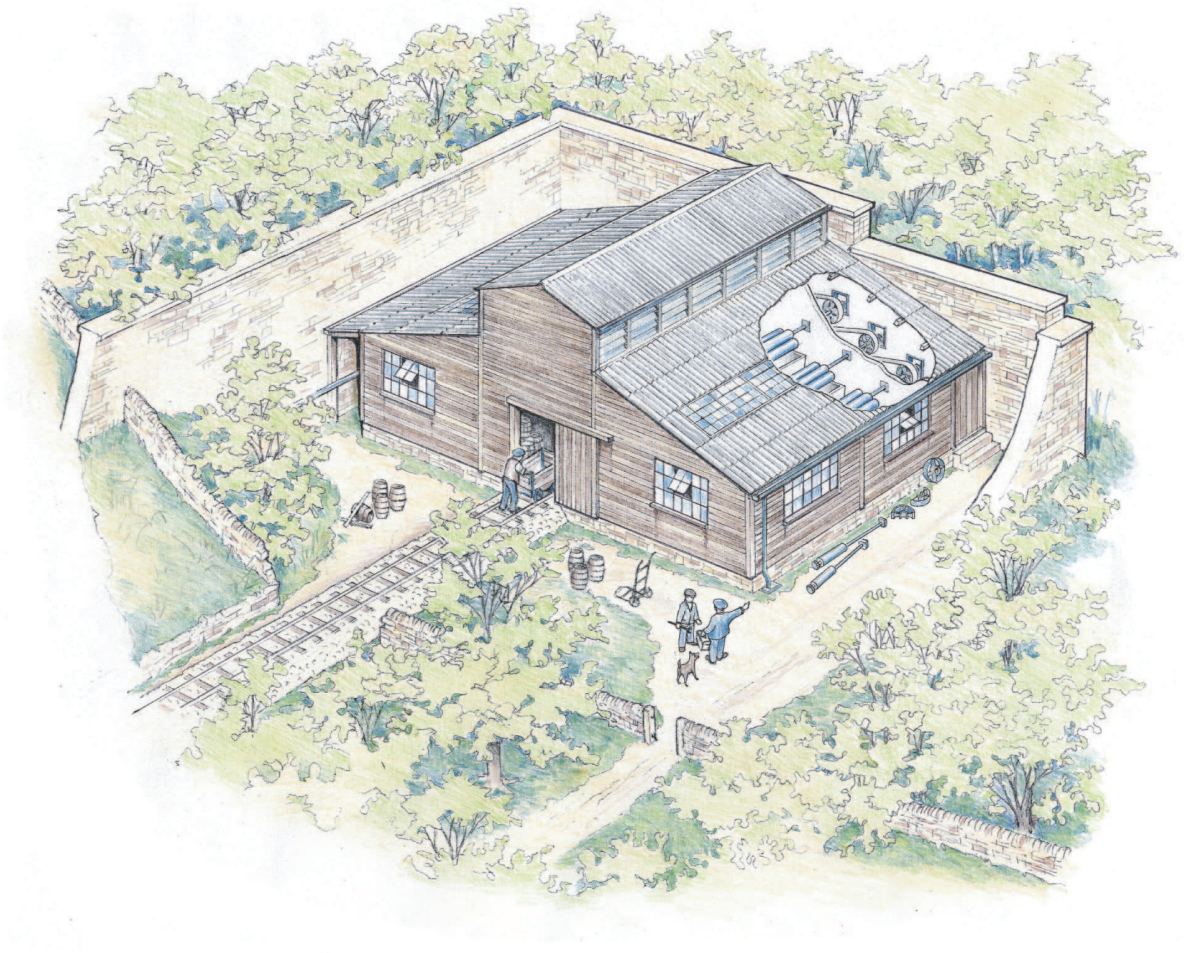


Figure 31. *Elevation, plan and reconstruction drawing by English Heritage of the corning house destroyed in June 1929. Based on photographs in the Patterson Collection taken after the fire.*

on to say that an oil engine (see section 6.1.1, above) provided power for the corning machine.

The site is now occupied by a pair of caravans (9 and 10 Crooked Oak). They sit in a sub-rectangular excavation, about 25m (east to west) by 20m, cut into the foot of a natural slope which rises quite steeply especially to the north east. The higher ground to the north rises to form a horse shoe-like natural feature which partly encloses the corning house site. Generally the excavation is about 3m deep but its east side has been very recently cut back and here the exposed bedrock rises 6m or 8m above the floor of the excavation. The bottom of the excavated area has been raised to make the pitch for the caravans and now stands about 1.5m above the track which borders the site in a southerly direction. To the south of the corning house excavation and on the west side of the access track to the caravans there is a 1.5m deep linear hollow which may mark the route of the former tramway spur which served the corning house. According to Mike Thwaites (*pers comm*) part of the platform-like feature (see above) lies buried under the west side of this hollow. The second corning house site lies beyond the eastern limit of the area surveyed at large-scale by EH so does not appear on the earthwork plan (Fig 66).

The glaze house (20)

The glaze house was situated some 70 m to the north east of the incorporating mills and about the same distance south of the first corning house site. It was built at the north-west end of the low rocky hill which separates the processing buildings in the Black Beck valley from those on the edge of the Rusland Pool valley. On both the 1881 and 1898 site plans it is depicted and named ‘Glazing House’ and on the 1928 site plan it is similarly described and, in addition, numbered 22. The OS 25" map published in 1890 (surveyed 1888) shows it to have been a rectangular building measuring almost 15m (north to south) by about 6.5m across. The map also depicts a very short spur from the main tramway serving the eastern side of the glaze house - the spur was entered from the north west, thus allowing for the easy movement to the glaze house of powder from the first corning house site, and appears to have ended at a wall which continued in an easterly direction the line of the south end wall of the glaze house. On the 1913 edition of the OS 25" map (revised 1912) a large blast mound is now shown surrounding the glaze house on its south and west sides; it is also depicted on the 1928 site plan on which it is labelled ‘Mound’. The OS map indicates that where the mound came up to the building it ended against a revetment wall with a narrow space between it and the glaze house for access around the outside of the latter. This revetment is also shown continuing as a blast wall around the north end of the glaze house; a free-standing structure annotated ‘Wall’ is marked here on the 1928 site plan. During the early part of 1912 the corning house was moved to a new site in the far eastern part of the site which meant that the corned powder now had to be brought to the glaze house from the east. This may account for (and date) the revised layout of the tramway spur on the 1913 map which shows it realigned to permit direct access from the east.

The glaze house shown at this location on the OS maps and site plans appears not to have been the first glaze house to be erected at Blackbeck although there is no evidence to

suggest that this earlier glaze house had a different site. This first glaze house was destroyed in an explosion in December 1867 which started at the first corning house site. It is stated in the newspaper report of this incident that 'the fire from the corning mill reached the glazing mill and that also exploded. Between those two mills the [little] engine house stood, and all three buildings were laid in ruins'. Apparently the 'huge timbers', together with 'the slates and stones' from these three buildings, were 'cast about in all directions'. One of the three men killed had been working in the glaze house and his body was blown a considerable distance into a nearby field (*Soulby's Ulverston Advertiser*, 12 December 1867; *Westmorland Gazette and Kendal Advertiser*, 14 December 1867). The glaze house was rebuilt but the opportunity provided by the explosion to reposition it further away from the other processing buildings in the vicinity was not taken, and when the Explosives Inspectorate visited the works in 1876 they found the glaze house to be too close to both the powder press house and the stove house (Explosives Inspectorate 1881, 1); these two buildings were later rebuilt on new and safer sites, leaving the glaze house more isolated but still on its original site. Apart from the 1867 incident there is no record of any further explosions at the glaze house, although it was damaged subsequently in some of the incidents at other processing buildings. In July 1868 the glaze house was left 'in a very dilapidated state, and the roof gradually settling down' by an explosion which destroyed the powder press, charge and corning houses (*Ulverston Mirror and Furness Reflector*, 1 August 1868) while in January 1898 the first stove house, situated about 45m to the south east, exploded damaging the windows, doors and roof of the glaze house. The official report into this explosion describes the latter as 'a wooden house, with stone ends' (Explosives Inspectorate 1898, 14). A 'recently fitted panel of matchboarding' was blown off the glaze house in April 1906 when the corning house exploded (Explosives Inspectorate 1906, 4), whilst two other corning house explosions, the first in July 1909 and the second in December 1911, also caused minor damage (a window and skylight were broken in 1909 as was a single window in 1911) (Explosives Inspectorate 1909, 4; 1912, 3). The skylight was made of special glass which incorporated wire netting in its structure - during the 1909 incident the netting held the pieces of broken glass and prevented them from falling into the building. Although the reports cited above contain limited information about the building itself there are no references to the number of glazing drums, or their arrangement within the building. However, according to a note in the caravan park files, the large glazing drums measured 10ft (3.04m) by 4ft 6in (1.37m). Power was provided by a drive shaft from the steam engine housed in the nearby little engine house (see section 6.1.1, above).

The glaze house no longer survives, and caravans (26-28 Beckside) now occupy its area, but the present topography suggests that this end of the low rocky hill may have been deliberately cut back to form a large level area for the gunpowder building. Some of the stonework in the scarp which borders the southern side of the caravan park road (which here is on the site of the main tramway), immediately to the north east of this levelled area, may have also once edged the tramway's trackbed.

The reel house (21)

(see also Postscript, pages 153 and 154)

There is only a single official reference to a reel house at Blackbeck, and this is contained in the report by ICI of the explosion at the incorporating mills in 1928 (Imperial Chemical Industries 1928, attached list of buildings damaged) during which five small window panes at the reel house were broken. It is numbered 14 by the ICI but unfortunately the site plan accompanying their report does not extend far enough to include the site of this building. The reel house is neither shown nor labelled on the 1881 or 1898 site plans, an indication that it must have been a late addition to the works. ICI's numbering sequence, however, suggests that it was located in the north-eastern part of the works because the second stove house is numbered 12 and was definitely in this area of the manufactory (it too lay beyond the limits of the 1928 site plan). According to a note in the caravan park files the reel house was staffed by two men. It is interesting that reeling (the removal of dust from fine powders) was taking place at Blackbeck because this process was often used for powder destined for sporting or military purposes. It is possible, therefore, that powder for civilian guns was being produced here during later years, but Blackbeck is generally regarded as having produced powders solely for blasting either in the form of loose powders or compressed cartridges (Explosives Inspectorate 1881, 1-2). Perhaps with the drop in demand for blasting powder as a result of World War I, the owners may have tried to extend the life of the works through diversification into sporting powder production.

The EH survey has located in the north-east part of the works what may be the site of the reel house and its associated power house. Mike Davies-Shiel, however, places the reel house on his site plan (copy in caravan park files) on the site of the eastern store house (see section 6.1.7, below). Although this last site appears to have been enlarged at some time EH feels that this location is too peripheral from the other main processing buildings for the reel house. The remains located by EH lie beyond the north-east limit of the 1928 site plan some 65m to the north-north-west of the second stove house and about 70m north east of the glaze house. They are situated at the foot of the natural slope which forms the north side of the narrow gap which links the valleys of the Black Beck and Rusland Pool; the other side of the gap is defined by the low rocky hill which dominates the central part of the works (see section 2, above). The remains clearly belong to the gunpowder industry and consist of a small brick building (6) (probably an electric motor house which is described in section 6.1.1, above) with two machine beds outside it together with a length of revetment walling. The brickwork of the electric motor house looks to be of early 20th century origin and as no building(s) is shown at this location on any of the site plans or OS 25" maps, then the remains are likely to date to after 1912 (revision date for 1913 edition of the OS map).

Behind a caravan (15 Hazel Avenue) the lower part of the side of the natural gap has been revetted by a wall, up to 1.7m in height and over 10m long, of coursed rubble with a small, ivy-covered triangular buttress-like feature protruding 0.5m out from the wall near the latter's eastern end. The actual reel house was probably built a metre or so in front of this revetment on the level area which is now the site of a patio. Near the west end of the patio two earth-fast machine beds (currently used as the supports for a low wooden table) survive (Fig 32).

Figure 32. *Machine beds on site of the probable reel house, from the east. Modern table top removed for photograph and blocked slot in end wall of electric motor house visible. (NMR: DP003375)*

They are both opposite and parallel to one another with the space between them measuring 0.23m in width. They are both 1.1m long (east to west) and 0.4m high; the one to the north is 1.1m wide while its companion is only 0.5m in width. Bolts (some still with nuts) for fixing machinery still protrude from their upper surfaces. The four on top of the southern block form two pairs - one at each end - and are set closer to the north edge of the block than to its southern side; there is also a notch in the southern face of the block near the south-west corner. The eight bolts on top of the northern block form four pairs, one towards each corner an arrangement which may mean that the block supported two machines. Power for the machines on both blocks was delivered by a belt which left the nearby electric motor house through a slot in its east wall and extended into the space between the two machine beds where it presumably went round a pulley wheel which transferred the drive to the machinery. The power would have been used to rotate the reels but EH has found no information about either their number or how they were organised within the reel house.

The stove houses

At Blackbeck two stove houses were built at different times for drying the gunpowder; steam-filled pipes provided the heat. The first house was destroyed by a massive explosion in January 1898 and its replacement (the second stove house) was erected at a new location to the north east.

The first stove house (22)

The first stove house was situated in a cup-shaped depression on top and towards the north end of the low rocky hill which dominates the central part of the works (Explosives Inspectorate 1898, 6) - a location regarded by the Explosives Inspectorate (page 12) as being an admirable site for a potentially dangerous building when a deep isolated valley was not available. According to the Inspectorate (page 4) it was the original stove house for the works and it retained this function for the whole its life, despite being too close to the glaze house (Explosives Inspectorate 1881, 1). Previous researchers have had problems in identifying

this building with both Patterson (1995) and Tyler (2002, 227) labelling it the dust house on their plans. It is shown on the 1881 site plan where the annotation seems to read store rather than stove (this is not an uncommon slip of the pen; the second stove house at New Sedgwick was similarly labelled on a site plan of 1900 (Dunn *et al* 2003, 71)). However, this is without doubt the stove house and the site plan even shows the steam pipe (bringing steam from the factory boiler to the drying pipes inside the building) coming up to its western side from the valley below. The steam pipe is also marked on the 1898 site plan, although by this time the first stove house had gone. The latter is depicted on the OS map of 1890 (surveyed 1888) as a rectangular building (measuring approximately 12m by 6m overall) at the end of a curving spur from the tramway; the spur was entered from the west, an arrangement which would have facilitated easy access to the stove house from the glaze house (situated about 45m to the north west). No building is shown in this area on the OS 25" map of 1913, which suggests that the site remained vacant after the 1898 incident.

The stove house was used for drying both loose (grain) powder and compressed cartridges (Explosives Inspectorate 1898, 5) and, although no one was injured, the Explosives Inspectorate (1898) produced a very detailed report into the explosion which destroyed it on January 19 1898. This report contains information about the construction of the stove house (supported by a plan which is reproduced in Tyler 2002, 25) and also the drying process which took place inside. It was a single-storeyed stone building, orientated almost north to south, measuring 33ft (10.05m) by 16ft (4.57m) (a check against the plan accompanying the report suggests that the Inspectorate are giving internal dimensions) with walls 2ft (0.61m) thick containing large blocks. Internally the building was lined with matchboard (this was a later addition to the building) and was divided into two compartments with the 'heating chamber' (the stove proper) at the south end and the 'cooling house' or lobby at the other end. The thin roof (part of which may have fallen into the heating chamber during a gale, thus causing the explosion) was of slates and plaster with the roof spars over the heating chamber being only 2in (51mm) square. Below the roof was a ceiling of sheet iron which, like the woodwork which supported it, was in a poor state of repair by 1898; indeed it was probably illegal as it does not appear to have been painted or lined above the heating chamber.

The heating chamber was the larger of the two compartments and had a wooden floor. The east wall was pierced by three internally-splayed shuttered openings and there was also another shuttered opening (rounded instead of splayed) in the centre of the south gable wall. The west wall faced the main part of the works and the factory chimney with the result that, in order to reduce risks from sparks, etc., this wall was blind apart from a small opening for the steam inlet pipe, low down and close to the north-west corner of the compartment. A central inner doorway in the north party wall gave access to the cooling compartment beyond; an opening also pierced this wall to the east of the doorway. The interior of the chamber contained three drying racks which supported the wooden trays (drawers) with canvas bottoms on which the powder was placed for drying; these measured 2ft 6in (762mm) by 2ft (610mm) and 5.5in (139mm) in depth. Both the east and west walls had a rack along them which both held 72 trays, while a third rack stood parallel to them in

the centre of the compartment - it was shorter than the others and held only 48 trays. The heat was provided by steam pipes which formed a continuous loop under each rack. The loops were inter-linked so that steam from the inlet pipe could circulate through them and then discharge freely via an exit pipe into a steam tank (trap) outside the south-east corner of the stove house. In order to control pressure the inlet pipe was 1.5in (37mm) in diameter whereas the pipes under the racks had an internal diameter of 4in (102mm). The cooling compartment was where the powder was allowed to cool after having been dried in the heating chamber. In addition, the powder from the glaze house was also taken through this lobby to the heating chamber. This compartment was entered through a door in the north gable wall (near to the north-east corner); there was also an internally splayed window opening in this wall between the doorway and the north-west corner. The matchboard wall lining had been painted in this compartment which, presumably, helped to reduce the danger of powder adhering.

The top of the low hill in this part of the works has been heavily landscaped and cut into to provide caravan pitches and access roads with the result that there is now no trace above ground of the depression in which the stove house was built. However, Mike Thwaites (*pers comm*) has a clear recollection of it, and also remembers it being filled in.

The second stove house (23)

The second stove house was erected in 1898 after the explosion which destroyed the first stove house. It was sited 45m to the north east of its predecessor at the foot of the low rocky hill which dominates the central part of the works. This location placed it far too close to the first expense magazine for safety with the result that the latter was demolished and its replacement (the second expense magazine) was built in 1898 some distance away at the north-eastern extremity of the works (see section 6.1.5, below). The new stove house is first depicted on the 1898 site plan where it is labelled ‘Stove’. The OS 25" map of 1913 (revised 1912) shows it to have been rectangular in plan, orientated north to south, and built against the west side of the works tramway. On the map it measures about 11.5m by 5m and a wall, presumably revetting the lower part of the natural slope to the west is also depicted a short distance away from and parallel to its western side; it is possible that this wall also continued upwards to form a blast wall.

Scarcely any details about this building’s construction (and nothing about its internal arrangements) have been found by EH but from comments in the Explosives Inspectorate’s report into the explosion at its predecessor, the intention was clearly that it was to be built of materials which, if an explosion took place, would not project masses of heavy and dangerous materials into the air as had happened at the first stove house which had been stoutly built of stone (Explosives Inspectorate 1898, 13). The pipe which supplied the steam for drying the gunpowder is shown on the 1898 site plan extending from the eastern end of the steam pipe, which originally supplied the first stove house, to the north-west corner of the new stove house. It is just possible, however, that although this linking line is labelled ‘Steam Pipe’ that this is an error and that the line should have had instead the distance between the new and former stove houses written against it (similar solid lines

elsewhere on the plan relate to distances). If this is the case then the supply pipe may be represented on the plan by a broken and intermittent line further to the north west which is also labelled 'Steam Pipe'. This pipe is depicted leaving the steam supply to the small engine house at exactly the same point as the one which took steam to the first stove house; it is then shown skirting the southern end of the glaze house to terminate a short distance north of the new stove house. However its depiction is quite faint and it may have been a proposed route which was later abandoned. The fact that it does not join the stove house may also be significant in this respect; apart from the second stove house it is unlikely that any of the other buildings in the north-eastern part of the works would have required steam unless it was used to provide warmth for the workers at the second powder press house location. The second stove house received minor damage during two explosions which occurred elsewhere at the gunpowder works - a single window was broken when the second powder press house blew up in May 1900 (Explosives Inspectorate 1900a, 6) and a number of timber ventilation windows were affected by the explosion at the incorporating mills in September 1928 (Imperial Chemical Industries 1928, attached list of buildings damaged (the second stove house is numbered 12)).

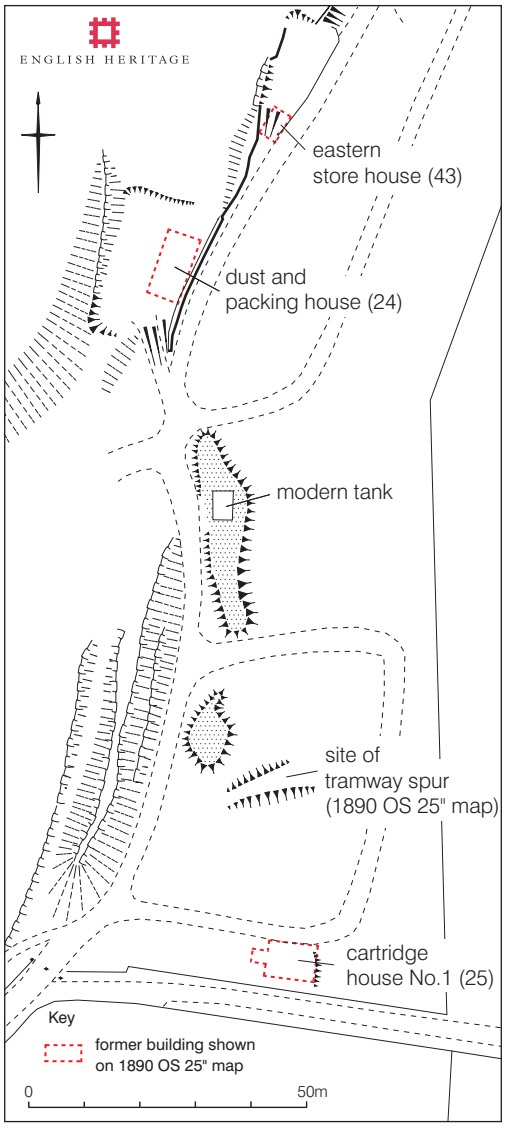


Figure 33.
Reduced extract from the English Heritage 1:1000 scale earthwork plan showing the gunpowder buildings in the south-east part of the works.

The stove house no longer survives but in this part of the works there is a large flat-bottomed rectilinear hollow, measuring about 20m (north to south) by 15m, which has been dug into the eastern side of the low rocky hill. It lies on the west side of the caravan park road, which here follows the route of the former tramway, and, although widened in recent times, may have been originally excavated for the stove house. A cutting like this would certainly have given good blast protection from those parts of the works which lay to the west and north. Exposed bedrock now forms the north side of the hollow which has a maximum depth of 3.5m; a pair of caravans occupies its bottom.

The dust house and packing house (24)

It appears that the dusting and packing processes at Blackbeck were undertaken in the same building situated on the eastern side of the low rocky hill that dominates the main part of the works, towards its southern end. It is depicted as a rectangular structure on both the 1881 and 1898 site plans on which it is annotated respectively 'Dust

House' and 'Dust & Packing'. It measures 12m (south west to north east) by 6m on the OS 25" maps published in 1890 (surveyed 1888) and 1913 (revised 1911). It was situated on the west side of the works tramway and by the revision date of the 1913 map a dedicated spur (entered from the south) had been installed from the tramway to a point near the south-west corner of the building; this map also shows a revetment wall fronting the natural slope just outside the north-west wall of the building and partly extending around the south-west and north-east ends of the latter. No power source is shown on any of the maps or site plans which may mean that the machinery used for dusting and sizing was hand operated, certainly during the early and middle years. It is, however, just possible that towards the end of the life of the works that either mechanically operated separators were installed in the dust and packing house (perhaps powered from an engine house built on the site of the eastern store house situated to the north-east) or that the dust and packing processes were separated and that a new dust house containing mechanical separators was erected on the site of the eastern store house (see section 6.1.7, below). The cartographic sources all agree in showing a footpath extending westwards from the south-west end of the dust and packing house to enter the central area of the works near the charcoal store. The first stove house was situated only about 55m towards the north so it is not surprising that when the former exploded in 1898 the dust and packing house was also damaged; windows were broken, roof slates were lifted and a few boards were sprung at the back of the building (Explosives Inspectorate 1898,14). On Patterson's plan this building is unlabelled while Tyler (2002. 227) thought that it was the reel house; the first stove house is incorrectly labelled the dust house by both sources although Patterson's brief textual account of the dust house is at variance with his plan and suggests that he knew that his unlabelled building was indeed the dust house (Patterson 1995, 40).

The dust and packing house no longer survives but the massive rectangular platform on which it sat is still a prominent feature. According to Mike Thwaites (*pers comm*) such a sizeable excavation is unlikely to have been carved out for the caravan park so what survives may be largely an original gunpowder feature. The platform stands about 1.6m above the caravan park access road which borders the former on the east; in this area the road follows the route of the works tramway and the side of the platform is now bounded by a very recently built dry-stone wall. The western limit consists of a high rock scarp that rises to a maximum of 4.5m above the surface of the platform and is where the side of the low natural hill has been cut into. Overall the platform measures about 27m (almost north to south) by up to 22m and is currently occupied by a caravan (2 Cherry Avenue); access to the platform is now via a ramped approach to the south.

6.1.4 The manufacture of blasting cartridges (Fig 34)

(see also Postscript, page 153)

The Explosives Act of 1875 made the filling of blasting cartridges illegal except on licensed premises. Prior to the act this had been carried out away from the gunpowder works, often by the quarrymen and miners using candlelight to see by - a dangerous practice (Marshall and Davies-Shiel 1969, 84). Cartridge production at Blackbeck must have started soon after the act was passed because four purpose-built processing houses erected for their

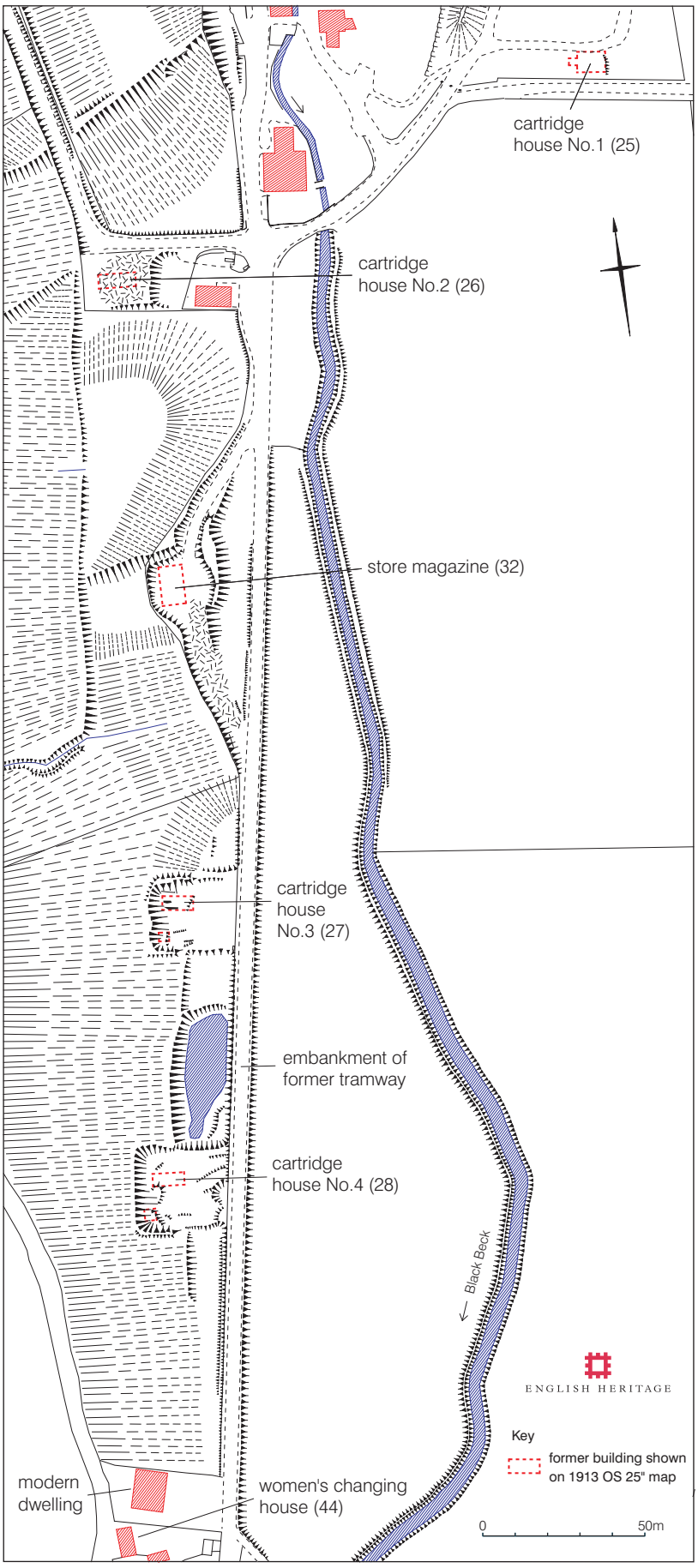


Figure 34. *Reduced extract from the English Heritage 1:1000 scale earthwork plan showing the location of the cartridge houses and store magazine.*

manufacture appear on the 1881 site plan. They were situated in the southern part of the works where, apart presumably from the store magazine (see section 6.1.5, below), there had been no buildings previously and on this plan they are annotated cartridge houses and numbered 1-4. They are similarly labelled and numbered on the 1898 site plan but unfortunately this part of the works was excluded from the 1928 site plan. The numbers allocated to these buildings by the above sources have been adopted below by EH. On Tyler's site plan a fifth cartridge house is shown situated about 34m to the north-north-east of cartridge house No. 1 (Tyler 2002, 227). No cartographic or documentary evidence for this building has been found by EH and Tyler shows a tramway spur terminating against its south-west corner. The spur is marked on the OS 25" map of 1890 (surveyed 1888) but it had been removed by 1911 (Ordnance Survey 1913b) and is included below in the account of cartridge house No. 1. Perhaps there has been confusion with the site of a possible late building situated some 64m north-north-east of cartridge house No. 1; the former is described below in section 6.1.7 (the possible building at the south-east boundary of the works).

The exact function of each of these buildings in the cartridge production process cannot be ascertained from the rather generalised annotations on the site plans, but it seems that cartridge houses Nos 1 and 2, which were closest to the central part of the works and the power source, may have been cartridge compressing houses, where the cartridges were formed under great pressure, while cartridge houses 3 and 4 were almost certainly cartridge packing houses. The evidence for this last identification comes from the report by the Explosives Inspectorate into the explosion at the first stove house in January 1898 which mentions a hitherto unreported incident at 'No. 3 Cartridge Packing House' (Explosives Inspectorate 1898, 9). This must be a reference to cartridge house No. 3 which is positioned immediately south of the store magazine on both the 1881 and 1898 site plans. On this last plan (and on the OS 25" map of 1913 (revised 1911)) a small structure is also shown just south-west of this building. The portrayal of cartridge house No. 4, situated to the south of No. 3, is identical on both these sources to that of No. 3, even down to having a small structure to the south west; these similarities suggest that No. 4 was also a cartridge packing house - it would appear, therefore, that Patterson (1995, 40) was incorrect in identifying them as the cartridge compressing houses. However, his account is useful because it contains quite detailed information about the cartridge presses themselves which was based on the late Alfred Cattle's notes (Patterson 1995, 40 and handwritten notes by Patterson (Patterson Collection)). Apparently there were two cartridge compressing houses containing a total of four hydraulic machines. Two of the latter had 171 moulds, another 105 moulds and the fourth machine 85 moulds; Patterson had no information about how they were allocated between the two buildings. The hydraulic power would have been provided by pumps - via hydraulic accumulators - located in the main part of the works with the water under pressure being transported along iron pipes to the cartridge compressing houses (see section 6.1.1, above for details about the pump houses and accumulators at Blackbeck). According to a note in the caravan park files each cartridge packing house was staffed by eight women and one man. Six of the women wrapped the cartridges in grease-proof paper while the other two packed them into boxes, etc; the lids were fixed to the boxes and barrels by the man.

The cartridge houses seem to have suffered few recorded incidents. A potentially dangerous one occurred, however, on January 5th 1898 when a match found lying on the floor of packing house No. 3 partially ignited but was put out by keeping a foot on it before it could cause any damage. It seems to have come into the building accidentally with a parcel of cartridge wrappers that had been delivered (it was assumed that the match had been lying on the bed of the railway truck in which the parcel had been transported) (Explosives Inspectorate 1898, 9 (fn). Tyler (2002, 256) describes another incident which occurred in one of the cartridge compressing houses in January 1928 while carrying out maintenance to the machinery. The work dislodged powder from the rafters and was ignited by a spark from a hammer. Fortunately no one was hurt. The original source of this information is not given but George Shackley, who worked on the cartridge press machines and is mentioned twice in Tyler's account of the event, seems a possibility. Tyler gives the impression in his book that there was only one cartridge compressing house at Blackbeck and on his plan this function is credited to cartridge house No. 2 (Tyler 2002 227). But there were in fact two cartridge compressing houses so it is not clear if this was the building where the incident occurred.

Cartridge house No. 1 (25)

Cartridge house No. 1 was situated in the south-east corner of the works and was probably where cartridges were compressed. On the OS 25" maps published in 1890 (surveyed 1888) and 1913 (revised 1911) the building is depicted as rectangular in plan, orientated east to west, and measuring 9m by almost 7m. A small central porch is shown at its west end where a spur from the main tramway terminated; entry to the spur was from the south west. The cartridge house no longer survives and the whole area has been levelled and grassed over to accommodate touring caravans but a low, east-facing scarp, 0.2m maximum height, is visible which may relate to the east end of this former structure. A large blast mound, almost triangular in shape, is also depicted on both OS maps a short distance north of this cartridge house, but it too no longer survives. A short tramway spur to the north of this mound is also shown on the 1890 OS map but it had gone by 1911 (Ordnance Survey 1913b). This spur was entered from the south west and apparently did not lead to a building - unless one had been erected and demolished here during the short period between the 1881 site plan and 1888 (survey date of OS 1890 map). Part of the spur's trackbed may still survive because, in the grassy area used for the touring caravans, there is a short length of broad bank, at best 0.2m high (Fig 33).

Cartridge house No. 2 (26)

Cartridge house No. 2 may also have been a cartridge compressing house and was located on the western side of the main valley, 86m to the north of the store magazine. It is shown lying at the west end of a narrow rectangular enclosure on the OS 25" maps surveyed in 1888 (Ordnance Survey 1890b) and revised in 1911 (Ordnance Survey 1913b). These maps indicate that the foot of the natural slope was cutback to create a sunken platform which formed a base for the building while the high sides of the cutting provided blast protection. On the map revised in 1911 the foot of the cut slopes forming the sides of the platform, at least on the north and south, appear to have been revetted with walls that also just extended

around the two eastern corners of the building, presumably to give added blast protection. These walls survived long after the works closed and appear on the 1976 OS 1:2500 map (revised 1974) which also shows a tiny building just beyond the east end of the northern wall (see section 6.1.7, below). The narrow rectangular cartridge house depicted on the two earlier OS maps is orientated east to west and measures about 11m by 4m. The principal entrance must have been at its east end where the maps show a spur from the tramway terminating; the spur was entered from the south. It is interesting that its plan and dimensions differ from those of cartridge house No. 1, suggesting that, if they were indeed both cartridge compressing houses, they may not have been built at exactly the same time. No. 2 is in fact very similar in shape and size to the packing houses but lacks the small square structure which each of the latter had to their south west (see this section, below).

Cartridge house No. 2 no longer survives but the enclosure which surrounded it is still extant and its perimeter is largely defined by a fence. The enclosure is set in the bottom of a natural gulley, open to the east, which helped to isolate the cartridge house (and thus contain the blast in the event of an explosion) from the central area of the works and also from the store magazine to the south which was similarly placed at the base of an open-ended natural depression. The western part of the enclosure (the site of the cartridge house) has been filled in and dumped on, but an outward-facing scarp, 1.3m high, near its southern edge and supporting at least one old-looking tree, may be - in part at least - an original gunpowder feature. To the east of the infilling, the central area of the enclosure has recently been cut-down to a depth of 1.5m to form a broad shelf. When EH surveyed this part of the works in December 2003 a number of narrow-gauge tramway waggons - some in a very dilapidated condition - had been placed in a line along its eastern edge (Fig 57), but these had removed by October 2004 when EH revisited the works. The eastern part of the enclosure currently houses the timber reception building for the caravan park and behind it to the west is a modern revetment wall (surmounted by a wooden fence) separating it from the recently cut-down central area.

Figure 35.
Sites of cartridge house No. 4 (left) and cartridge house No. 3 (right), from the north-north-east. (NMR: DP003382)

Cartridge house No. 3 (27) (Fig 35)

This cartridge packing house, the scene of the January 1898 incident (see this section, above), was located on the western side of the main valley, about 90m to the south of the store magazine. On the first edition of the OS 25" map (surveyed in 1888) it is shown as a narrow rectangular building measuring 10m by 4m and orientated almost east to west (Ordnance Survey 1890b). The map also depicts it in the bottom of a cutting, open at its east end, which had been excavated for it into the foot of the natural slope. On the 1913 edition of the map (revised 1911) the cutting is shown flanked by a pair of banks, one to the north and the other to the south. Just beyond the south-west corner of this last bank a small square structure is also depicted which must have been erected between 1888 and 1898; it is marked on the 1898 site plan but not on the first edition OS map. By 1911 all these features had been enclosed, probably by a fence, and thus now lay within an almost square enclosure. Although the packing house had long since gone, the enclosure with the embanked hollow within and the small square structure were still shown on the 1976 OS 1:2500 map (revised 1974).

The function of the small square structure is uncertain. At 3m across it seems too large for a dedicated privy for the female packers and Ron Mein (*pers comm*) has suggested that it housed a stove which provided the latter with heat during the winter months. It may indeed have contained a stove and it is possible that in addition to providing warmth, it was also used for heating wax in which the wrapped cartridges were dipped to make them air tight and thus keep out any moisture. According to Tyler (2002, 180) this additional process in blasting cartridge manufacture was adopted at the Elterwater gunpowder works at around 1890; one of the cartridge houses which still survives at this last site was labelled dipping and packing house on a site plan of 1926 (Jecock *et al* 2003, 78). If this extra process was also introduced at Blackbeck at about the same time then it could explain why the probable stove house was erected between 1888 and 1898; the bank which separated it on the north from the packing house presumably helped to protect the latter from sparks.

The packing house and probable stove house have gone but the large platform on which they stood, the perimeter of which largely mirrors that of the enclosed area on the 1913 edition of the 25" OS map, survives as a prominent earthwork in pasture. In order to create a level area its western end was cut into the natural slope and the back scarp thus created still rises 1.9m above the base of the platform. The material excavated was probably used to build up the eastern part of the platform in order to raise it above the poorly drained valley floor and also to provide easy access to the east end of the packing house for a spur from the tramway; in this area the platform is about 0.5m high. At the time of survey a 0.8m high outward-facing scarp, just beyond the north-west corner and along part of the northern side, combined with the one defining the inner edge of the platform to form a bank - the remains of that shown on the 1913 OS map flanking the north side of the packing house. A short length of retaining wall was also visible in the southern face of this bank. Traces of the foundations of the packing house are probably represented by fragmentary walls which were just visible on top of the platform near its north-west corner. However, by October 2004, the bank flanking the northern side had been levelled and its material spread over the

northern end of the platform - thus obscuring the fragmentary walls near the corner. The site of the probable stove house is marked by a step within the south-west corner of the platform.

Cartridge house No. 4 (28) (Fig 35)

Cartridge house No. 4 was almost certainly a packing house and was situated on the western side of the main valley, 80m to the south of cartridge house No. 3 and similarly on the west side of the principal access road to the caravan park. The depiction of this cartridge house on the OS maps and site plans (including size, shape, orientation, location on a purpose-built platform, flanking banks on the 1913 and 1976 OS maps, and with a probable stove house to the south west, beyond the southern bank) is identical to that of cartridge house No. 3. The area occupied by this packing house and probable stove house was similarly enclosed, probably with a fence, by 1911.

The packing house and probable stove house have been demolished but, as with cartridge house No. 3, the platform on which they sat forms a prominent earthwork whose outer limits coincide with those of the enclosed area which is shown on the 1913 OS map (revised 1911). On the west where the natural slope was excavated for the platform the cut scarp rises up to 3m above the top of the platform and an area of exposed bedrock is visible in its face. A low mound protrudes east from the base of this cut scarp and appears to separate the area occupied by the packing house from that of the probable stove house (surviving as a step in the south-west corner); it may be the last remnants of the bank which is shown on later OS maps between these buildings. The eastern part of the platform stands 0.8m above the valley floor. A shallow linear hollow near the north-east corner of the platform may relate to the tramway spur on the OS maps which serviced the packing house and terminated against its east end which must have been where the entrance was. The ground to the

Figure 36. *Standing water between the sites of cartridge houses Nos 4 and 3; the latter is visible in the middle distance and the site of the store magazine is marked by the clump of tall trees on right. Taken from the south. (Abby Hunt, December 2003)*

south of this hollow has been disturbed and stone blocks, possibly from dumping, are visible.

In December 2003, when EH surveyed this part of the site (after a rainy period), the section of valley floor between cartridge houses Nos 3 and 4 was under standing water whose edges were fairly regular in places and suggestive of a reservoir, 0.6m in depth (Fig 36). This water is now thought to be no more than the result of impeded drainage because when Blackbeck was revisited during spring 2004 most of the water had already seeped away. During wet periods surface water collects here and is unable to escape due to the raised platforms (for the cartridge houses) at either end together with the steep valley side to the west. The access road to the caravan park forms the east side of this area and is on the course of a former lane and tramway that serviced this part of the works and provided access from the south. A massive embankment, 0.8m high opposite cartridge house No.4, was created for the tramway by the gunpowder Company which tends to act as a dam preventing the drainage of surface water into the Black Beck.

6.1.5 The storage of gunpowder at the works (for building locations see Figs 27-28 and 34)

The 1772 Gunpowder Act stipulated that gunpowder magazines or storehouses were to be constructed of brick or stone and must be situated at least 50yards (45.7m) from any mill building (Cocroft 2000, 28). Blackbeck appears to have had a single store or main magazine, where the finished product was probably kept until dispatch, situated to the south of the central area of the works. The magazine is situated near the cartridge houses which may mean that as at New Sedgwick (Dunn *et al* 2003, 24) powder destined for blasting cartridge production was also temporarily stored in the store magazine until the cartridge compressing houses were ready to receive it. Patterson also believed that there was a relationship between the store magazine and the cartridge houses at Blackbeck - indeed he appears to have viewed it as a raw material store for the latter (Patterson 1995, 40). In addition to this magazine, there were a total of three expense magazines at Blackbeck. These buildings housed part-manufactured gunpowder between processes but there was only ever a single expense magazine in use at Blackbeck at any one time. In later years the third expense magazine was used to store the ripe charge from the incorporating mills until the powder press house was ready to receive it (Imperial Chemical Industries 1928, 2). This working practice at Blackbeck may have had much earlier origins and have also involved the first and second expense magazines. In addition to these buildings, a charge house at Blackbeck was used to store the green charge on its way from the mixing house to the incorporating mills; the charge houses have been described above in section 6.1.3.

The expense magazines

The expense magazines were situated at or towards the north-eastern end of the works. The first expense magazine was demolished after the explosion which destroyed the first stove house in 1898 and replaced by the second expense magazine which was erected at a new location. In 1912 this expense magazine was also taken down so that its site could be used for a new corning house. Its replacement, the third expense magazine, was thus again built at a new location.

The first expense magazine (29)

The first expense magazine was erected at the north-eastern end of the low natural rocky hill which dominates the central area of the former works. It was sited at the foot of the hill, a location which provided it with good natural blast protection from most of the other processing buildings - the closest was the first stove house situated 64m to the south west. It is depicted on the 1881 site plan and annotated 'Expense Magazine'. It is also drawn on the 1890 OS 25" map (surveyed 1888) on which it is rectangular in plan, orientated north to south, and measures 9m by nearly 6m. The expense magazine was served by the main tramway whose course through this part of the works lay just beyond the east side of the building (Ordnance Survey 1890a). The magazine is mentioned by the Explosives Inspectorate (1898, 14) in their report of the catastrophic explosion at the first stove house in January 1898. During this incident the windows and door were broken, the roof stripped of its slates and 'several stones [from the stove house] fell through into this building'; the walls were apparently 'uninjured', perhaps an indication that, because this was a magazine, they had been stoutly built of stone. It was decided to rebuild the stove house on a new site at the foot of the low rocky hill, about 17m to the south of the expense magazine. This was much too close to the latter whose demolition was thus an essential prerequisite of the scheme. The replacement (second) expense magazine was erected about 190m away from it in a north-easterly direction.

The site of the first expense magazine, together with the area immediately to the north west, has been landscaped to accommodate caravan pitches and nothing now survives above ground. It is uncertain if the bedrock - which forms the lower slope of the low natural hill - to the south west was exposed when the ground works for the expense magazine were executed, or is merely the result of much later landscaping for the caravans.

The second expense magazine (30)

The second expense magazine was situated at the north-eastern edge of the works and must have been erected in 1898 when the new stove house was built very close to the first expense magazine which had therefore to be demolished and resited. The site chosen for the new magazine was so far from the rest of the works that the gunpowder company may have had to acquire additional land on which to erect it. The sole source of information found by EH for the location and plan of this magazine is the 1898 site plan which shows the expense magazine as a rather schematically drawn rectangular structure, orientated approximately south-south-east by north-north-west, and measuring about 18m by 8.5m (this seems rather large for a Cumbrian expense magazine but given the rather sketchy nature of the plan these measurements are probably not reliable). The plan accompanied Amending License No. 789 which presumably authorised the changes in this part of the works resulting from the 1898 stove house explosion. There is also a very brief reference to the expense magazine in the report of the explosion at the second powder press house in May 1900 (Explosives Inspectorate 1900a, 6). According to this source the first corning house site (to the west) and 'the expense magazine, 335ft (77.5m) E., being screened by tree-covered hills, were entirely untouched'. The magazine appears to have had a relatively short life because all the evidence suggests that it was demolished when its site was

chosen for the second corning house location where the tenth corning house to be erected at Blackbeck was built in 1912 (see section 6.1.3, above). A spur from the main tramway served this corning house but logic dictates that the expense magazine would also have needed a tramway connection, so the spur shown on the 1913 edition OS 25" map (revised 1912) may thus have been installed as early as 1898.

Field inspection indicates that the expense magazine, like the corning house which succeeded it, probably occupied a platform cut into rising ground that in this area formed a steep-sided horseshoe-like feature which partly surrounded the building and thus gave excellent natural blast protection. The location has already been described in detail elsewhere in this report (see section 6.1.3, above (the second corning house)).

The third expense magazine (31)

This magazine replaced the second expense magazine and it must have been erected in 1912 when the latter was demolished to make way for a new corning house (the second corning house site). The exact site of this third magazine is not known for certain because it was built long after the 1881 and 1898 site plans which label the functions of individual buildings; unfortunately the 1928 site plan which also annotates buildings does not extend to this part of the former works. The most likely candidate, however, is the small isolated rectangular building shown for first time on the 1913 edition of the OS 25" map (revised 1912) situated some 110m south-south-west of the second corning house site. On this map it is orientated south west to north east and measures almost 6m by just over 4m (this is very similar to the size of the upper expense magazine at New Sedgwick (Dunn *et al* 2003, 87)) and lay on the west side of the tramway spur to the corning house. Just beyond the southern end of the magazine the map depicts the spur bifurcating, with one line heading towards the south-east area of the works (dust and packing house) and the other to the central and northern parts of the works (powder press and glaze houses plus incorporating mills). The structure is thus ideally sited to serve many of the processing buildings at Blackbeck. Patterson (1995), who seems to have been particularly knowledgeable about this area of the works, also labels it 'Expense Magazine' on his site plan where it is numbered 24. Tyler (2002, 227) does not show the third expense magazine on his plan but has a building just beyond where the tramway spur divides into two and calls it a pony shelter; EH has found no evidence for a structure with this function here and it may be that there has been confusion with the expense magazine.

The expense magazine no longer survives and much of the area has been disturbed by access roads to caravan pitches together with a waste disposal point (which may occupy the actual site of the expense magazine). The natural topography here would have provided limited blast protection because to the west there is a natural rocky spine, aligned north to south and about 2m high. This also appears to have been incorporated into a field boundary, possibly a wall, shown on the early OS 25" maps (Ordnance Survey 1888a; 1913a); it too has gone. This building lay beyond the eastern limit of the area surveyed at large scale by EH, so its site does not appear on figure 66.

Figure 37.
Site of store magazine from the north east. (Christopher Dunn, November 2003)

The store magazine (32) (Fig 37)

The 1881 and 1898 site plans show a rectangular building annotated 'Magazine' situated on the western side of the main valley midway between cartridge houses Nos 2 and 3. It is similarly depicted on the OS 25" maps published in 1890 (surveyed 1888) and 1913 (revised 1911) - on the former it is also called a magazine. On these two maps it is orientated north to south and measures almost 12m by 7m and is shown situated on the west side of a loop from the tramway; the loop allowed entry to and exit from the magazine in two directions (north and south). The loop is depicted lying within a cutting, about 100m in length, which follows a curved course; an expansion about half-way along on its west side was excavated to accommodate the magazine. The OS maps also show boundary lines crossing the cutting at both ends which probably means that gates prevented unauthorised access to the magazine via the cutting. Twentieth-century OS maps also show a wall, 46m long, revetting the west side of the cutting immediately to the south of the magazine (Ordnance Survey 1913b; 1976).

The store magazine has gone but the wooded cutting which contained it and the tramway loop still form a prominent feature on the side of the approach road to the caravan park from the south. The magazine was constructed in the bottom and near the back of a short natural gulley, orientated almost east to west, which penetrates the lower part of the steep valley side; the rising ground to the south, west and north would have provided the magazine with natural blast protection. The north side of the gulley is marked by a particularly prominent south-facing scarp which is partly the result of this also being the site of a former field boundary which pre-dated the gunpowder works (Ordnance Survey 1851); the western section of this boundary also appears on the 1881 site plan. The gulley was cut into to provide a rectangular platform for the building and the sides of this excavation still rise to a height of 1.6m above the base of the platform. On the OS 1:2500 map published in 1976 (revised

1974) angled walling is shown near the edges of the platform which is almost certainly the remains of the magazine (unless it is revetting to the sides of the excavation) but these are no longer visible and the platform is currently used to store building materials on. However, according to Mike Thwaites (*pers comm*) the foundations of the magazine still survive below the present surface. The east side of the platform opens out into the cutting of the former tramway loop.

Much of the southern part of this cutting has been obscured because it is now used for storing leaf mould for spreading on flower beds within the caravan park. Elsewhere the cutting still survives to a depth of 2.5m and the northern part is currently the access route to the stored materials. Part of the revetment wall shown on the 1913 OS 25" map (revised 1911) still survives at the southern end of the cutting on its west side; it consists of a 4m length of coursed, dry-stone walling surviving to a height of 0.5m. Immediately to the east of the magazine the mouth of the natural gulley is blocked by a large blast mound whose west face forms the east side of the tramway cutting. The mound itself is not depicted on any of the cartographic sources used by EH but must be an early feature because on the 1898 site plan its location is annotated 'Low Mound covered by Trees'. Although it has been dumped on at its southern end, and its west side, opposite the site of the magazine, has been cut into recently (which shows the bank to be of earthen construction), it is still a sizable earthwork standing up to 2.5m high. Old tree stumps protruding through its surface must be those of at least some of the trees referred to on the 1898 site plan.

6.1.6 Testing the gunpowder

The finished gunpowder was tested for both quality and reliability at gunpowder manufactories. This was initially done by firing a mortar over a measured distance on the proofing range; at New Sedgwick the proofing range with its long avenue of trees still survives within the licensed area of the former works (Dunn *et al* 2003, 90-2). At Lowwood cartographic evidence indicates that the proofing range was similarly located within the powder manufacturing area of the works (Jecock *et al* 2004) but at Elterwater the testing was carried out near the river in a field outside and to the south-east of the works (Jecock *et al* 2003, 96). EH has found no evidence for the location of a proofing range at Blackbeck, but given the restrictions imposed by the topography suitable sites are rather limited. The flattest and most open area lies to the south-east of the works on either side of the Black Beck - the fact that much of this area is boggy may not have mattered. Later gunpowder tests were supplemented by less visual demonstrations in a proofing house or laboratory. The laboratory building at Blackbeck still survives and forms the northern component of a building range (7) situated on the east side of the beck opposite the former incorporating mills (Figs 38 and 48); it is fully described below in section 6.1.7 with the other elements which make up this range.

6.1.7 Ancillary buildings (for individual locations see Fig 38)

Ancillary buildings include the search and watch houses, storage buildings, offices, possible privies, an oil store, a carpenters shop and two building ranges - one to the south and the other to the east of the incorporating mills. In addition to the structures described below, the danger buildings at Blackbeck were also supplied with little wooden hutches or receptacles

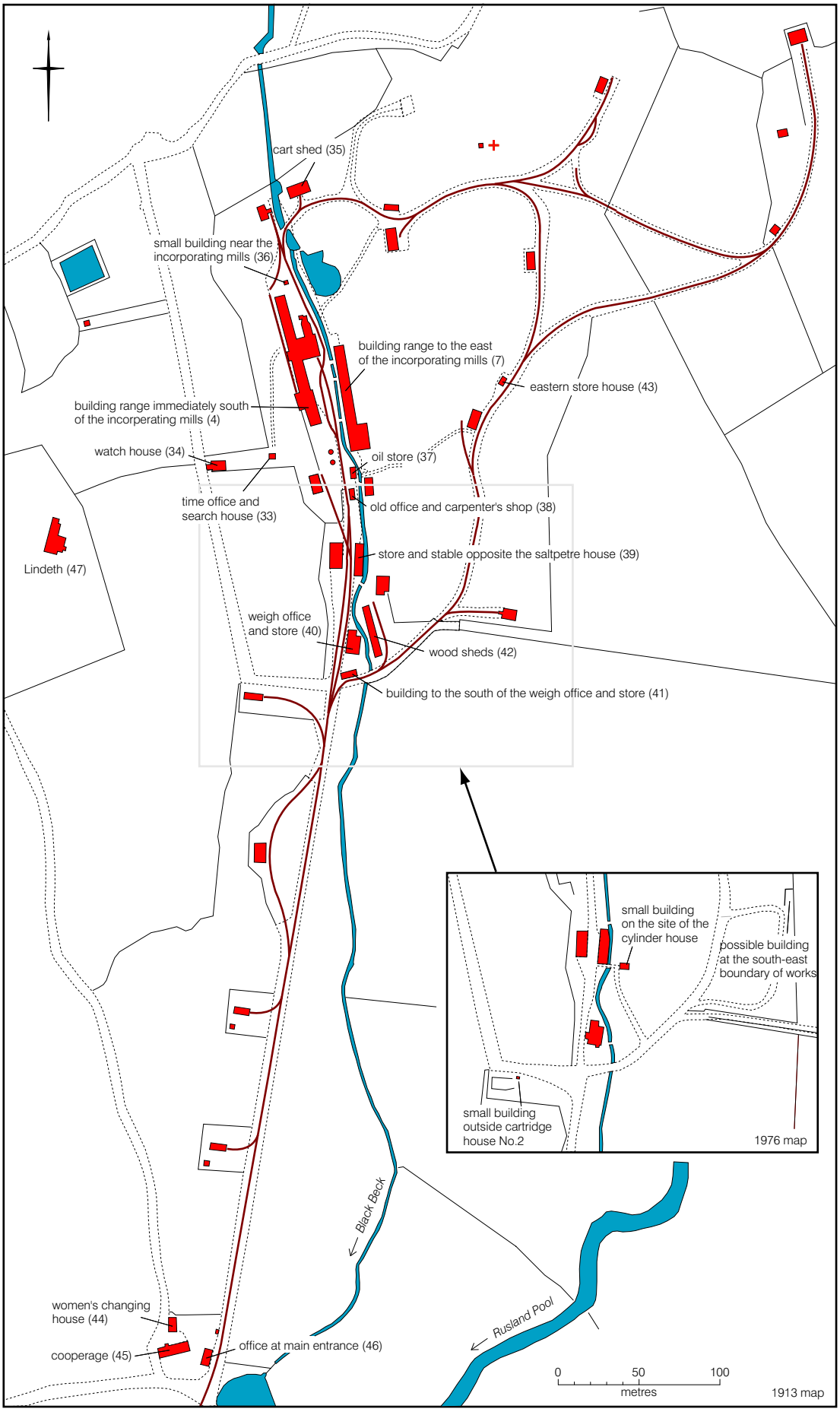


Figure 38. *Reduced extracts of the Ordnance Survey 1913 and 1976 1:2500 scale maps showing the ancillary buildings.*

for the disposal of cotton waste (this was to satisfy one of the regulations of the Explosives Act); amazingly the hutch outside the first powder press house site survived the March 1881 explosion which started at the press house (Explosives Inspectorate 1881, 7). Two buildings, one probably the replacement for the other, are shown in a small paddock immediately south of Black Beck Farm (on the opposite side of the road to the farmhouse) on the 19th century site plans used by EH together with the first edition of the OS 25" map (Ordnance Survey 1890a). However, they were clearly unrelated to the gunpowder works because they lay outside the latter's northern boundary and were probably farm buildings - as a result they has not been numbered or included on any of the drawings produced for this report. Their site is currently occupied by a large cowshed (shown by EH on their 1:1000 survey plan) and attendant yard.

The time office and search house (33)

This small rectangular building is situated on the valley side above the main area of the works and to the south-south-west of the incorporating mills. It appears to have started off as a watch house because it is described as such on the 1881 site plan; at this time it had a fire and was also where the men often breakfasted (Explosives Inspectorate 1881,7). But by 1898 a new and much larger watch house had been erected a short distance to the west (see this section, below). On the 1928 site plan the earlier watch house is numbered 32 and annotated 'Time office' and 'Search office' indicting that by this time it was where the workers clocked in and were searched to ensure that they brought nothing into the works which could cause an explosion. However, during the latter part of the nineteenth century the men appear to have changed and been searched in a wash house which was probably situated within the processing area (see this section, below - the building range east of the incorporating mills). The windows of the time office and search house were broken during the explosion at the incorporating mills in 1928 (Imperial Chemical Industries 1928, attached list of buildings damaged).

EH visited Blackbeck in May 2002 when the time office and search house still survived, despite having been converted into a garage for Meadow Bank Cottage (the former new watch house to the west). The single-storey rectangular building, gabled east to west, was built of coursed rubble with quoins of crude blocks and had a slate roof. A broad opening for the garage door inserted into the west gable wall must have destroyed the original entrance to the building (Fig 39a). The north wall contained a pair of windows. By November 2003 the time office and search house had been largely demolished, only parts of the east and south walls surviving. These remains indicated that the building had originally measured about 4.8m by 4.35m with walls some 0.5m thick, and a plastered interior. In the outer face of the east wall a blocked central window, photographed by EH in May 2002 (Fig 39b), was still visible (inside the building it had been plastered over) while traces of another blocked window just survived in the centre of the south side. Two cast-iron pipes, each almost 6cms in diameter and arranged one above the other with centres 1.05m apart, pierced the east wall some 1.1m back from the north-east corner; the lower pipe was at ground-level.

The site plans and OS 25" maps show a track leading in a northerly direction from this building down to the incorporating mills. This track, hollowed in places, still survived as a

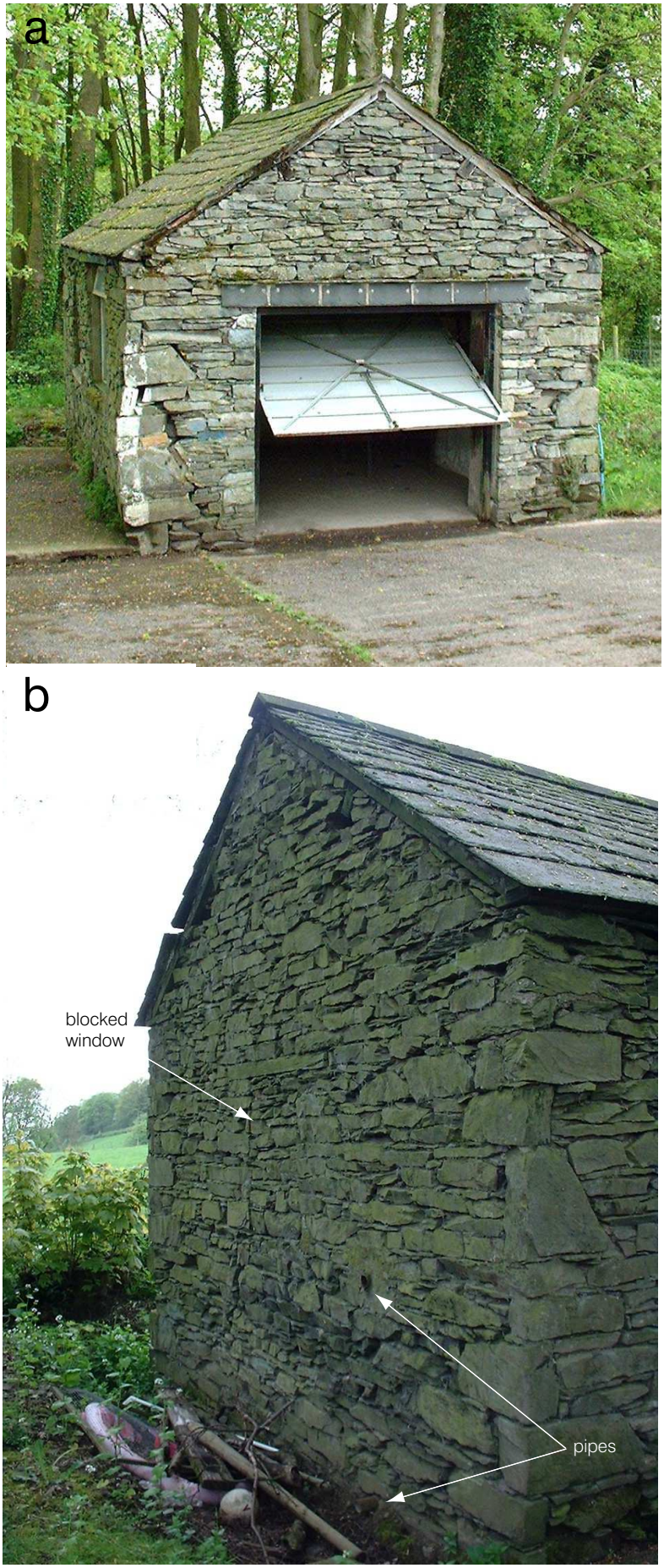


Figure 39.
Time office and search house from the west (a) and north east (b). (Abby Hunt, May 2002)

Figure 40.
The watch house in 1958, from the south. (Ron Mein Collection, copyright reserved)

prominent feature at the end of 2003 when EH recorded it. Since then its course has been cleared and redefined to provide a usable route in this part of the caravan park.

The watch house (34)

This surviving building, situated on the hillside above and west of the main part of the works, and close to the track to Black Beck Farm, was constructed some time between 1888 (Ordnance Survey 1890b) and 1898, the date of the site plan on which it first appears. It replaced an earlier watch house to the east which in 1928 was being used as a time office and search house (see this section, above). The new watch house probably belongs to the same construction phase that involved major alterations to the track layout and the erection of a new mixing house at this end of the site. On the 1898 site plan the watch house is shown as a rectangular structure, orientated east to west, with a narrow central projection at its east end. It appears that alterations had taken place by the time of the 1913 edition

Figure 41.
Watch house (now Meadow Bank Cottage) from the south. (NMR: DP003387)

of the OS 25" map (revised 1911) since this map shows a narrow projection at its west end while that at the east end had gone, its site occupied by a possible yard or hard standing. The depiction of the watch house on the OS 1:2500 map (revised 1974) is very similar to that of 1913. The building contained at least one fireplace because a fire and chimney in it are mentioned by the Explosives Inspectorate (1898, 8; 1900a, 9). The watch house was also used for holding inquests, as was the case in 1900 when the *post-mortem* enquiry into the two deaths caused by the explosion at the powder press house was held here (*North Lonsdale Herald and Dalton Advertiser*, 2 June 1900). Its windows were broken during the explosion at the incorporating mills in September 1928 (Imperial Chemical Industries 1928, attached list of buildings damaged).

The watch house, as shown in a photograph (Fig 40) taken in 1958 before recent major alterations, was a tall single-storey building gabled to east and west, with a low gabled addition against its west, uphill gable. Both parts of the structure are built of coursed stone rubble with red sandstone quoins, and have slate roofs. The main part was entered from a doorway at the downhill end of its north elevation, which opened directly off the road down into the works. The interior was lit by opposed central windows set high in the north and south walls, triangular vents in the roof slopes above them affording ventilation. A chimneystack in the west end wall indicates where the only fireplace to heat the building was. Curtains and a flower vase in the window in the 1958 photograph indicate that it was already being reused as a dwelling, and more recently it was heightened (Figs 41 and 56) to create a two-storey cottage with an upper floor partly in the roof, and is a holiday let known as Meadow Bank Cottage. The original central window positions were retained, but in altered form, and new windows were inserted. The roof vents were also retained in the new, raised roof.

The cart shed (35)

The cart shed was situated at the northern edge of the works on the east side of the beck between the first corning house site and the second charge house; it was quite close to the latter which lay to the south west on the opposite bank of the beck. It has been suggested above in section 6.1.3 that the cart shed may have occupied the site of the first charge house, and if this is correct then the former could not have been erected until after the explosion in October 1879 which destroyed the charge house. The cart shed was certainly in existence by the latter part of 1881 because it is depicted and labelled 'Cart Shed' on the 1881 site plan (and again on the 1898 site plan). It is presumably the 'Waggon House' where some of the roof sheets were loosened in the stove house explosion of January 1898 (Explosives Inspectorate 1898, 14). On Patterson's plan it is numbered 18 and annotated 'Breaker House' but no evidence for where this name came from (or what it means) is given (Patterson 1995). Its depiction on the OS 25" maps (Ordnance Survey 1890a; 1913a) indicates that it was orientated south west to north east and measured about 14m by 7m; on the south east it appears to have been entered by a short spur from the tramway while on the 1913 map (revised 1912) a free-standing small circular structure is shown just beyond its south-west corner. The depiction of the cart shed on the 1898 site plan indicates that internally it was sub-divided into two unequal parts by a partition wall with the smaller part at

the north-east end. The building no longer survives and the earthworks associated with its site have been described above in section 6.1.3 (first charge house).

The small building near the incorporating mills (36)

This small building, which no longer survives, is depicted about 6m to the north of the incorporating mills on the OS 25" map revised in 1912 (Ordnance Survey 1913a). On the latter it is square in plan and measures about 3m across. It is also shown on the 1928 site plan on which is neither annotated nor numbered with the result that its function is not known for certain. However, given its restricted size and proximity to the processing buildings in this part of the works it could either have been a privy or a small store. Another possibility is that it may the dynamo house referred to in 1928 but whose exact location is also not known (see section 6.1.1, above).

The building range immediately south of the incorporating mills (saw mill, lathe house and pump house)(4)

(see also Postscript, page 153)

The L-shaped building range shown abutting the south end of the incorporating mills on the 1881 and later site plans (and on the OS 25" maps) still survives (Fig 42) - it was probably erected when the works was established in the early 1860s. It is divided into two compartments on the 1898 site plan, the larger one at the north end annotated 'Engine Saw Mill', the narrower one to the south annotated 'Lathe House'. It is suggested above (section 6.1.1) that the northern compartment, in addition to housing a possible dedicated steam engine for the saw mill, may also have contained the hydraulic pumps for the powder press and cartridge compressing houses during at least the late 19th century. Three compartments are shown on the 1928 site plan and in the accompanying report these compartments are called (from north to south) pump house 29, saw shed 30 and engineers shop 31 (Imperial Chemical Industries 1928, attached list of buildings damaged). Shortened descriptions, together with these numbers, also appear on the site plan - on the latter the engineers shop

Figure 42.
Building range immediately south of the incorporating mills, from the south east. (NMR: DP004101)

Figure 43.
Wall box in outer face of north wall of building range immediately south of former incorporating mills. Broken pipe from later reuse is visible in upper hole. (NMR: DP003397)

is labelled 'Lathe House'. At the time of the 1898 explosion at the stove house the skylights in the front roof of the 'Saw Mills' were blown in and a few slates shifted while the front windows of the 'Fitting Shop' (?engineers shop) were blown in (Explosives Inspectorate 1898, 14). All sustained damage to their roofs, windows and doors during the 1928 explosion at the incorporating mills. Part of the north wall of this building is clearly visible on one of the photographs taken after this explosion (Fig 23). A short angled pipe with a vented top is particularly clear protruding through the wall; surprisingly, although the pipe has since been broken off its lower end still survives and leaves the building through a reused wall box (Fig 43). The 1928 photograph also shows that that part of the north wall immediately adjacent to mill 1 continued above the roof line to form a blast wall, and that the western part of the pump house ran back under two slated pitched roofs, that to the south the taller of the two. Air photographs show that by 1945 these two roofs had been replaced by the single wide roof which still exists today (NMR: RAF 106G/UK.653/13-AUG-1945/4140-1) (Fig 26). Also visible on these last photographs is what looks like a narrow drive shaft alley separating the end wall of the pump house from the southern end of mill 1; originally this may have been roofed - hence its omission on the OS 25" maps. On the 1881 site plan a short projection is depicted at the southern end of the incorporating mills on their west side which may be an attempt to show this roof.

This building, which is one storey high and has a slate roof, is built of coursed slate rubble with substantial quoins at its corners. The deeper part at the north end, the former engine

house of the saw mill of the 1898 site plan, has a pair of wide doorways in its front wall, the wider taller one with double-leaf doors, the lower one having a single-leaf door set under a timber lintel with outer slate sheathing. Inside, the front half of this part, which is separated from the former lathe house to the south by a stone cross wall, has a roof supported on a single king-post truss with struts, its tie beam supported at the rear on a rolled steel joist which presumably replaces a timber beam. The single-span roof over the rear part of the structure, which is presently obscured, post-dates 1928 (see paragraph above) and replaces

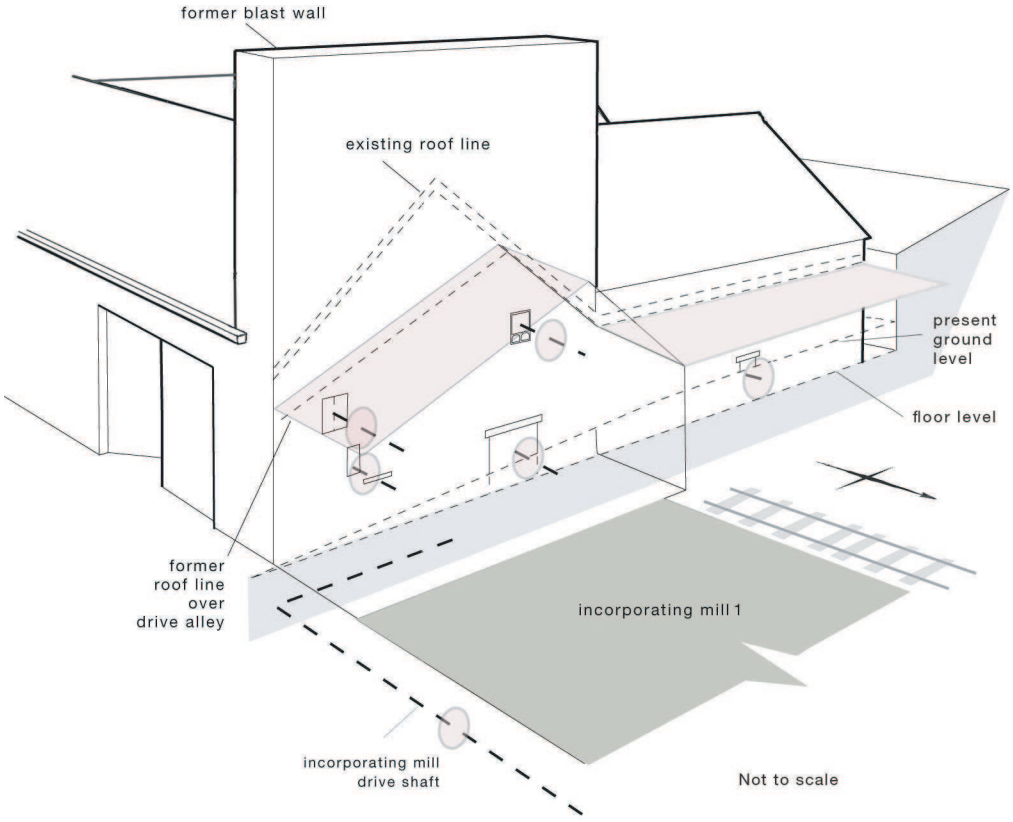


Figure 44. *Photograph (NMR: DP004100), elevation and partial reconstruction by English Heritage of the outer face of the north wall of the building range immediately south of the incorporating mills. To aid reconstruction the surviving wall boxes have been shown with shafts and pulleys (for drive belts).*

two roofs of unequal height which must have been supported down the centre on cast-iron columns. The west wall of this rear area was originally lit by a blocked window, and its south wall has a near-central doorway which has been partially blocked and converted into a window. The building retains incidental evidence of its former use. A stone slab set high at the west end of the south wall supported a drive shaft which ran south, along a tunnel, to the second mixing house. This drive shaft was probably powered by the steam engine which drove the incorporating mills - the north wall of the L-shaped building, which formed one side of a drive alley immediately south of the range of incorporating mills, contains a series of wall boxes and openings related to power transmission (Fig 44). The wall face below the uppermost wall boxes is heavily stained with oil from lubricating the drive shaft bearings. Close to the front wall, fixing holes in the tie beam supported a line shaft which entered the saw mill from the north and continued on into the lathe house to the south. This latter part of the building, which has a gabled south wall with a central doorway with a stone lintel, has a tall and wide front doorway between two windows, and three rear windows. Its roof is supported on two king-post trusses with struts. Apart from brackets on the tie beams of the trusses to support the line shaft already noted, there are not internal features of note. Outside the rear (west) wall contains a blocked opening for a drive belt near the junction between this wall and the south wall of the deeper northern part of the building; the belt may have been conected to the drive shaft which powered the second mixing house.

The foot of the natural slope to the west was partly cut away to accommodate this building range, the cut scarp thus created being revetted with stone walling. The OS maps indicate that towards the south this walling turned away from the natural slope to front the southern end of the building range, presumably as a free-standing wall (Ordnance Survey 1913b; 1976). The latter may have been designed to provide blast protection in the event of a possible incident at the nearby second mixing house. The blast wall has gone but the wall revetting the natural slope is still in good condition. It is of coursed rubble and varies in height from 1.4m to 3.5m. Its course mirrors the shape of the west side of the L-shaped building with the result that it has two angular bends where it follows the south-west corner of the projecting west end (pump house on 1928 site plan) of the range. Just east of this corner a drive shaft left the range (or was attatched to the building) and crossed the narrow space between it and the revetment wall. Two opposing stone slabs, one just below the roof line of the building range and the other near the top of the revetment wall, still survive (Fig 45). They held the bearing blocks which supported the drive shaft which led to the second mixing house (the slots below the slabs enabled the fixing bolts holding the bearing blocks in place to be adjusted), the heavy oiling on their faces, and on the masonry below them, coming from years of lubricating the brackets. The stone slab in the wall of the building is 1.77m above ground level and is 0.56m wide by 0.12m high, while that to the south is 2m above the base of the revetment wall and is 0.75 wide by 0.14m high with a dressed stone lintel above it. Two straight joints, 1.4m apart, in the face of the revetment wall are associated with this slab. They indicate that the installation of the drive shaft tunnel was later than the construction of the wall: the wall evidently dates from the establishment of the works in the early 1860s whereas the drive shaft tunnel is contemporary with the second mixing house which was not erected until after the fire of 1891 which destroyed the first mixing house.

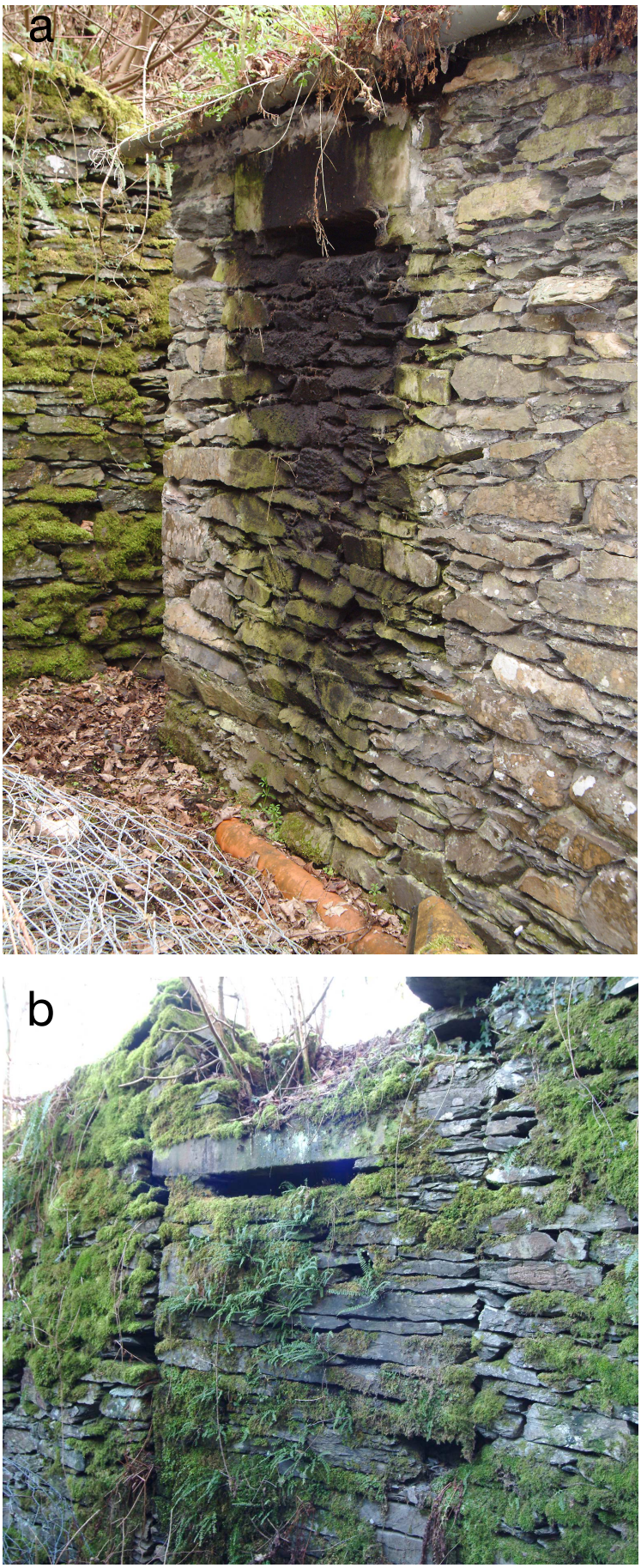


Figure 45.
Stone slabs supporting bearing blocks for former drive shaft leading to second mixing house; (a) in south-west corner of building, (b) in revetment wall opposite. (NMR: DP003532; DP003396)

Figure 46.
Drive shaft tunnel to second mixing house, looking south. (NMR:DP003534)

The Patterson Collection contains a colour photograph (dated July 1993) of the slab in the revetment wall but the caption on the back erroneously links it to the boiler house flue.

Between the revetment wall and the second mixing house the drive shaft was set within a brick-lined tunnel which ran north-south. The northern section still survives and is generally in good condition except that immediately beyond the revetment wall a short section of the tunnel roof has collapsed and a linear hollow therefore marks its course. The tunnel is, however, visible at the southern end of this collapse, from where it survives intact for about

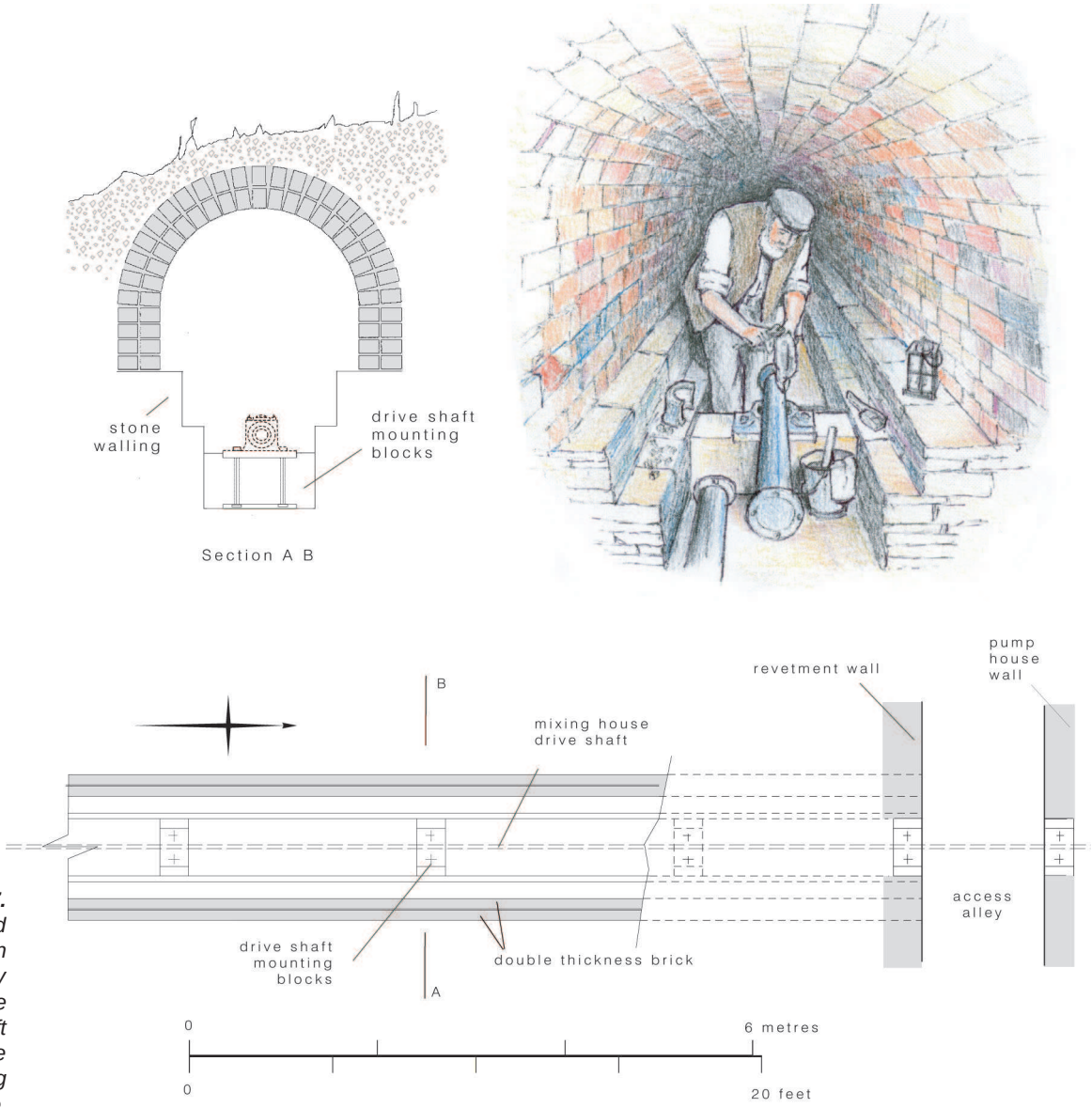


Figure 47. *Section, plan and reconstruction drawing by English Heritage of the drive shaft tunnel to the second mixing house.*

10m (Fig 46). It can be seen to be built with a double skin of orange red common brick and in cross section takes the form of a stilted arch supported on a double-stepped base. The floor of the tunnel is flat and houses the cross bearers or mounting blocks which supported the fixing brackets of the drive shaft (Fig 47). The bearers are 0.61m wide, and some of the bolts which held the brackets in place still survive. Internally the tunnel is about 1.1m wide and 1.6m high from the underside of the arch to the floor. The southern end of the tunnel, near the site of the mixing house, has gone but its base is visible in places as a narrow brick-edged ledge in the eroding cut face of the valley side above the caravans.

The building range to the east of the incorporating mills (wood sheds, laboratory, wash house, case making shed and pump house) (7)

A long range of buildings, aligned almost north-south, is depicted (but not identified) on the 1881 site plan east of the incorporating mills but on the opposite side of the beck. It is shown divided into three compartments of unequal length; the middle one is particularly long. On the first edition OS 25" map (surveyed 1888) the range measures about 50m long by 6m wide. It is suggested above (section 6.1.3) that the first mixing house may have

occupied one of the subdivisions of this building. In 1891 the mixing house burnt down and its replacement was erected at a new location on the other side of the beck. The rebuilding of the fire-damaged part of the range may account for the modifications visible on the 1898 site plan on which the range is depicted as L-shaped with a wide southern end, divided into two and projecting well beyond the building line on the east side (this extra width may be an indication that this end of the range was also built higher than the rest). The remaining part of the range to the north is split into five compartments of equal size and 'Wood Sheds' is written across all of them (including those at the south end); but this labelling may need to be treated with caution - see next paragraph. Just beyond the north end of the range a small isolated structure annotated 'Lab' (Laboratory) has been sketched on the plan; it is uncertain if this annotation is contemporary with the plan or a later addition. The 1913 edition of the OS 25" map (revised 1912 (north sheet) and 1911 (south sheet)) confirms the overall shape of the range as shown in 1898, and a comparison with the first edition map indicates that by the time of the revision the structure had been extended at both ends; the short extra compartment added at the north must have been for the laboratory (this compartment is labelled 'Laboratory' on the 1928 site plan). The laboratory was involved with testing the gunpowder (see section 6.1.6, above). Overall the range now measured about 66m in length with the wide southern end (12m across) accounting for 21m of this length. In addition to the laboratory, the OS also depict a 15m long compartment abutting the laboratory to the south. Beyond it the outline of the rest of the range (including the southern end) is depicted with a broken line indicating that its sides were open - presumably because it was still being used to store timber - and that its roof was probably supported on pillars. On the 1928 plan the long compartment to the south of the laboratory (the latter is numbered 34) is split into two with the northern one (35) annotated 'Wash house' and the southern one (36) 'Case Making Shed' (probably producing cartridge boxes). Four compartments labelled 'Wood Sheds' are also shown extending south from the latter and terminating against the wide southern part of the range. The wood sheds which had previously occupied this end of the southern range had gone by 1928 because their site was now the location for a wide building (still an integral part of the range) labelled 'Pump House' (see also section 6.1.1, above). A small rectangular feature is also shown on the 1928 plan butting up against the west wall of the northernmost wood shed; its function has not been ascertained.

During the 1928 explosion at the incorporating mills the roof of the laboratory was lifted and its windows and door badly broken while the slated roof, windows and doors were damaged at the wash house and case making shed (Imperial Chemical Industries 1928, attached list of buildings damaged). In the special report dealing with the fatal explosion of March 1881 (which started at the powder press house) it was noted that on the morning in question the deceased had eaten their breakfasts not in the watch house but in the wash house (Explosives Inspectorate 1881, 7). If this wash house was one element of the building range under discussion then it would suggest that the annotation 'Wood Sheds' for the whole of this range on the 1898 site plan is either an over simplification or based on out-of-date information. A wash house at Blackbeck is referred to again in a newspaper account of the inquest into the deaths caused by yet another powder press house explosion, this time in 1900; it was

Figure 48.
Building range east of the incorporating mills, from the north west. (NMR: DP004099)

stated that 'all the employees change in the wash house, where the pockets are searched' (*North Lonsdale Herald and Dalton Advertiser*, 2 June 1900). A box house at the works was damaged in the 1898 stove house explosion when its ridging was stripped off and the windows looking east were blown in (Explosives Inspectorate 1898, 14). This may be just another name for the case making shed and if this is correct then its presence by this date again supports the view that the range's annotation on the 1898 site plan may be misleading. The pump house had been demolished by 1945 (NMR; RAF 106G/UK.653/13-AUG-1945/ 4140 and 4141) and the wood sheds by 1974 (Ordnance Survey 1976).

The northern end of the range, equivalent to compartments 34-36 of the 1928 site plan, still survives (Fig 48) and consists of a single-storey stone rubble structure under a slate roof, gabled north to south; overall this surviving part measures 17m by 6m. The northern end seems to have been built as a single long room with a central doorway between two windows, its roof supported on two identical trusses with king post trusses. The king posts are bolted to the tie beams, and both they and the principal rafters have decorative run-out chamfers. When this room was subdivided, its original doorway was blocked and new doorways were inserted into the two rooms north and south of the subdividing wall, one the laboratory in 1928, the other the wash house - it still contains sinks. The lintel of the original doorway is a reused length of cast-iron tram rail whereas all the other lintels are of timber with external slate sheathing. The two inserted doorways, and the adjacent edges of the two windows, are built with distinctive stones which incorporate quartzite, confirming both their association and contemporaneity. The cross wall which runs back from the blocked original doorway is built of breeze blocks, with glazed lights contrived either side of it above the blocked base. The southern end of the surviving range, a case making shed in 1928, appears to abut the north end just described, on the evidence of a straight joint, and originally to have had two tall wide openings in its front wall. The southern one still functions, but the northern one has been blocked in two stages - the base is full width stone with a narrower window set between red brick blocking. The doorway and window both have timber lintels. Two windows

Figure 49.
Oil store from the north west. The store and stable (right) is visible in the background. (Christopher Dunn, November 2003)

in the rear wall are likely to be insertions. Inside a single king-post truss supports the roof but only the king post is chamfered. The south end wall is relatively modern and must have been erected when the range was shortened with the demolition of the wood sheds.

A flat area just beyond the north end of the range is edged to the north and east by a revetment wall which appears to be relatively modern. Built into it, on end, are two flat-faced circular stones much like small millstones (Fig 64); they are each about 0.75m in diameter and 0.14m thick with a pair of holes in their faces, their centres 0.32m apart. Towards the rims the edges of their faces have been smoothed. It is unclear whether they have been reused from the gunpowder works or have been brought in as ornamental features for the caravan park, although the former seems more likely. The slope behind the northernmost stone and revetment wall has much clinker on its surface which may have come from the boiler house which formerly stood nearby.

The oil store (37)

This small building (Fig 49), situated on the western side of the beck a short distance north west of the charcoal house, is shown but not annotated on both the 1881 site plan and the first edition of the OS 25" map (Ordnance Survey 1890b). It is annotated 'Store' on the site plan of 1898 and 'Oil Store' on the 1928 plan, on which it is numbered 37. It is a single-storey rectangular building, gabled north to south, and measures 8.7m by 3.4m. It has walls of coursed rubble and a slated roof. Its west front wall has two doorways, one wider than the other, and both with modern concrete lintels. There is a small window with a slate lintel in the north gable wall. The building, at the time of survey, was used by the caravan park for storage.

The old office and carpenter's shop (38)

This building was situated on the west side of the beck some 6m to the south of the oil store described above. Documentary evidence indicates that during the early years of the works it was an office but then became a carpenters shop. This change occurred sometime between 1881 and 1898 with the office function perhaps being transferred to the store building (which appears to have been extended at this time) situated 80m to the south (see this section, below (weigh office and store)). The old office is shown but not annotated on the 1881 site plan, although there are several references to it as an office in the accompanying indenture. It is stated, for example, that the lessees will 'repair, maintain and keep in good and substantial repair the said office and the wall in front of the said office and keep the open space between the said office and high road [the track which ran from this part of the works to Black Beck Farm] tidy and in good order' (CRO(B) BDX 294). The wall is presumably the one shown extending westwards from the north-west corner of the office on the first edition OS 25" map, surveyed in 1888; the wall would have prevented unauthorised access from the south into the central manufacturing part of the works. The open space is also shown on the map lying in front of the office and extending from the north end of the saltpetre house

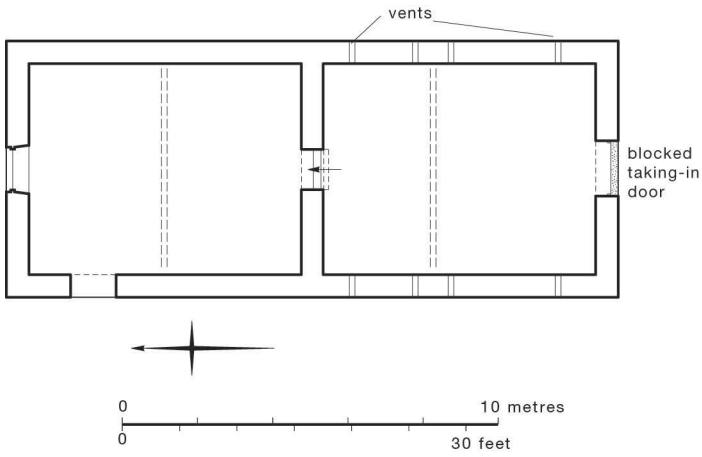


Figure 50.
Store and stable looking north east (NMR: DP003425) and plan of first floor by English Heritage.

to the wall just described. The building is referred to as the 'Old Office and Carpenter's Shop' on the 1898 site plan and merely as 'Carpenter's Shop' on the 1928 site plan where it is numbered 39. On the OS 25" map it measures about 7m (north to south) by 4m. The building no longer survives above ground and its site is currently occupied by a caravan.

The store and stable opposite the saltpetre house (39)

This building (Fig 50), aligned north-south, is situated against the west side of the beck and is now separated from the saltpetre house by the main caravan park road - the latter follows the line of the principal factory road and tramway which served the gunpowder works. It had been erected by the time the 1898 site plan was prepared and replaced a much smaller rectangular building shown here on both the 1881 site plan and the first edition of the OS 25" map (surveyed 1888). It is suggested above (section 6.1.2) that this earlier structure may have been the sulphur store. On the 1898 site plan the later building is subdivided internally into two unequal parts with the much longer northern compartment labelled 'Store' while the one to the south is annotated 'Stable'. On the 1913 edition of the OS 25" map (revised 1911) it measures 20m by 5m overall and is linked by a probable wall extending north to the old office and carpenters store, and east to the cylinder house; the wall was probably installed to restrict access to the principal processing area of the works. On the 1928 site plan the building is labelled 'Store' (although the writing suggests that this may have been added later); it still survives and at the time of survey contained toilets and a shop for the caravan park.

The two-storey building, which has a slate roof, is built of slate rubble and has rock-faced sandstone quoins with dressed-back corners. The ground-floor openings in the front (west) wall have slate water tabling above them, but all the lintels, except one which is of red sandstone over the doorway at the north end of the ground floor, are modern rolled steel joists which probably replace timber originals. The building is divided more or less equally by a full-height stone cross wall, to the south of which was the stable and harness room with a hayloft over. Circular-section ceramic pipes in the front and rear walls of the stable and the hayloft, and in the gable apex, provided ventilation. The stable and harness room, which have been thoroughly modernised, each had its own door in the front wall, the stable at the south end being the larger, its door set against the ground-floor wall which separated it from the harness room. A Jacob's Ladder in the latter led up to the hayloft which was served by a taking-in door in the gable wall and is open to the roof which is supported on a king-post truss with struts, all with decorative run-out chamfers, and the king-post bolted to the tie beam. The north end of the building was a store: it had a ground-floor door and first-floor taking-in door in its west, front wall, and a window in its first-floor gable wall. The roof truss is identical to that over the hayloft. The single-storey block with a single-pitch roof set against the north gable wall is primary and may have been a privy: it is well sited for such use.

The small building on the site of the cylinder house

(Not numbered but see extract from 1976 map, figure 38.)

On the 1:2500 OS map revised in 1974, a small rectangular building, orientated east to west and measuring about 6m by 4m, is depicted on the site of the former cylinder house (Ordnance Survey 1976); it is annotated 'P C' (Public Convenience) by the OS. Tyler (2002, 243) includes a photograph of this structure in his book and in the caption claims that it was a small store. It was still extant when EH first visited Blackbeck in November 2000 but has since been demolished. It was built of roughly coursed rubble, with crude quoins at the corners, under a pitched roof clad in slates. The north wall had a pair of closely-set windows, the west end wall a doorway. The door recess was clearly once much wider and the build quality and general state of the building suggest that it was unlikely to have been originally built as a toilet for the caravan park. If it was a former gunpowder building then it was probably erected late in the life of the works. The cylinder house was still being shown here by the OS in 1911 (Ordnance Survey 1913b) but unfortunately it lies just outside the southern limit of the 1928 site plan. However, the EH survey has also produced evidence that some building work took place at Blackbeck between the closure of the works and 1945, possibly during World War II. It is possible, therefore, that this building has nothing to do with gunpowder manufacture and belongs to this later phase of activity. A new building for the caravan park was being erected on its site when EH carried out their survey during the latter part of 2003; this recent addition has been included on EH's 1:1000 survey plan.

The weigh office and store (40)

This building stands, albeit altered, in the space between the western edge of the beck and the main access route through the works, some 38m south of the saltpetre house. The 1881 and 1898 site plans depict a long, narrow rectangular building here which is labelled 'Store' on the 1881 plan. The building appears to have been extended (probably at the southern end) by the time the 1898 site plan was prepared, on which it is shown divided into two compartments of unequal length. Of these the longer occupies the northern end of the structure and is labelled 'Weigh Office' while the shorter southern compartment is annotated 'Store'. It appears, therefore, that some time between these two plans the building was modified due to the inclusion of weighing facilities; it may also have taken over the functions of an earlier office, situated 80m to the north (see this section, above). In contrast to its depiction on the site plans, the first edition (surveyed 1888) and 1913 edition (revised 1911) of the OS 25" map show the building as a wider rectangular structure with a narrow projection at its north end. Overall the building measures 14m by 8m on the map and the projection at the north end is 5m wide. A loop from the main tramway lay immediately outside the west wall of the weigh house and store. The fact that the depiction of the building is identical on both maps strongly suggests that it had already been extended by 1888. It survived the closure of the works and is still shown by the OS in 1974 (Ordnance Survey 1976). By this time it had probably been converted into a dwelling for the site manager of the caravan park. The plan of the building on the 1974 map is identical to that on the earlier OS maps, apart from the addition of two small projections - one on the west side near the south-west corner and the other on the south side close to the south-east corner. Patterson (1995) labels this structure an office on his site plan and numbers it 5 while on Tyler's (2002, 227) plan it is

Figure 51. *Weigh office and store converted into a bungalow for the site manager of the caravan park. Looking south east. (Amy Lax, November 2000)*

Figure 52. *Caravan park manager's new house from the north west. Single storey part to left incorporates north end of weigh office and store. (NMR: DP003426)*

simply called a weighbridge; on the plan in the caravan park files produced by Ron Mein, it is labelled 'Clothing, Bag store, and the Pay office'.

When EH made a preliminary visit to Blackbeck at the end of 2000 the building was still a dwelling for the caravan park's site manager and consisted of a single-storeyed bungalow, rendered on the outside, under a slated roof (Fig 51). However when the EH investigators returned in late 2003 they found that the southern part of this building had been demolished and replaced with a much taller house for the site manager, built on a different alignment but still with a projection on its north side (Fig 52). Apparently this projection, although re-roofed and newly rendered, still contains the northern end of the gunpowder building in its fabric and during construction of the new house the remains of a weighbridge were also observed (Mike Thwaites, *pers comm*).

The building to the south of the weigh office and store (41)

This rectangular building is first shown on the 1913 edition of the OS 25" map (revised 1911). No documentary evidence for its function has been found but Ron Mein (plan in

caravan park files) has suggested that it may have been a store for empty barrels and kegs. On the map it is orientated west-south-west to east-north-east and it measures 10m by 4m. This building stood in the angle formed by the junction to the south of the western and eastern lines of the tramway system; it was probably served by the eastern line which lay just beyond its southern long side. The building no longer survives and its site now forms the southern part of the garden belonging to the house of the caravan park's site manager.

Wood sheds (42)
A long rectangular structure, apparently sub-divided internally into five compartments, is shown towards the southern end of the main part of the works on the 1898 site plan where it is labelled 'Wood Sheds'. It is also depicted on the OS 25" map revised in 1911 (Ordnance Survey 1913b); each of the long sides is depicted by a broken line suggesting that these sides were open to allow the wood to season and that the roof was supported on pillars. On the map the building measures approximately 32m (north-north-west to south-south-east) by 5m. It does not appear on the first edition of the OS 25" map which indicates that it was erected after 1888. A spur from the tramway served it on the east. The building no longer survives

The eastern store house (43)
A small rectangular building is marked on the OS 25" maps (Ordnance Survey 1890a: 1913a) situated 19m north-east of the dust and packing house on the eastern side of the low rocky hill which dominates the central part of the works. On these maps it measures 6m (north east to south west) by a little over 3m in width. The works tramway passed close to its south-east side and on the 1890 map (surveyed 1888) a short spur is depicted leaving the tramway and extending to the south-west end of the building; the spur had gone by the 1913 map which was revised in 1912. The building is marked on the site plans of 1881 and 1898 on which it is labelled 'Store'; Patterson (1995, 40) wondered if it was a sieve store. It had a slated roof which received minor damage during the explosion at the first stove house in January 1898 when all its windows were also blown in (Explosives Inspectorate 1898, 14).

The eastern store house no longer survives, but extending north east from its site is a platform, triangular in plan, which is entered via a ramp at its south-west end. The eastern side of the platform stands above a caravan park road (on the site of the works tramway) and is edged by a 0.9m high dry-stone wall of coursed rubble which may have been rebuilt quite recently. The north-west side of the platform is cut into a natural slope and is revetted by a combination of roughly coursed dry-stone walling (much of it looks as if it could belong to the gunpowder phase), about 1.1m high, and a 1.7m high area of exposed bedrock. The platform measures about 18m long by a maximum of 9m wide which is much larger than the approximate outline of the store house's platform that appears on the 1913 OS map. This latter platform is also closer to the dust and packing house. On the 1976 OS 1:2500 map (revised 1974) three sides of what may be a ruined building (10m north east to south west by 5m) are depicted which suggests that some time between 1912 (revision date of 1913 map) and 1974 the platform was enlarged and extended to the north east and that the

original small store house was replaced by a much more substantial building (see also Fig 33). What it was used for is uncertain although three possibilities come to mind (but see also the reel house, section 6.1.3 above). The first is that it could have housed an engine to provide power for machinery associated with the dusting process in the nearby dust and packing house. Against this is its distance from this last building given that the natural topography in this part of the works may not provide an easy route for a drive shaft; it is also uncertain if mechanical separators were ever installed in this dust and packing house. The second possibility is that in later years the dust and packing processes were separated and that this building was the new dust house. EH has found no documentary evidence to support this suggestion but Mike Thwaites (*pers comm*) recalls seeing a small brick building (similar to the electric motor house which provided the reel house with power (see section 6.1.1, above) and also containing a machine bed) above this platform and 8m to its north. It is possible that this was similarly an electric motor house which provided the power for mechanical separators inside the new dust house. At New Sedgwick an electric motor house had been erected beside the dust house by the end of 1900 to power one of the separators within (Dunn *et al* 2003, 76). By 1926 at Elterwater, a turbine which provided power to the dust house had been replaced by an electric motor (Jecock *et al* 2003, 73). The third possibility is that it was erected after the works closed (possibly during World War II - see also the possible building at the south-east boundary of the works (this section, below) or during the early years of the caravan park) - and is therefore nothing to do with the gunpowder works. The platform is currently occupied by a caravan (3 Cherry Avenue).

A possible building at the south-east boundary of the works

(Not numbered but see extract from 1976 map, figure 38.)

Mike Davies-Shiel shows a building in this position on his plan of Blackbeck (copy in caravan park files), which he identifies as a cartridge stove house. This might suggest that during the later years at Blackbeck the drying of loose powders and blasting cartridges was no longer being carried out in a single stove house (as was certainly the case earlier) and that now each had its own dedicated building. EH has found no other evidence to support such a possibility. The sole cartographic source which EH has located for the existence of some form of structure here shows two lines meeting at right angles, possibly representing the remnants of a ruined building or even the edge of a platform - see the 1976 OS 1: 2500 map (revised 1974). The longer line is orientated north to south and is about 10m long while its companion is 5m long. A light coloured rectilinear area, approached by a curving track from the west, is visible at this location on air photographs taken by the Royal Air Force in August 1945 (NMR: RAF 106G/UK.653/13-AUG-1945/3113, 4114 and 4140); the former works was not a caravan park at this date. The rectilinear area may have been a hard standing, possibly for a recently demolished building, but its fresh appearance on the photographs suggests that it may post-date the gunpowder works - perhaps it belongs to World War II. Ron Mein (plan in caravan park files) has also suggested that in 1928 there may have been a cartridge drying stove in the adjoining field. But this site, about 35m to the south east of the feature under discussion, is totally unsuitable for building purposes because the land here is permanently boggy. There is also no surface evidence for a structure here and it seems likely that there has simply been some confusion.

There is now no above ground trace of this feature at the south-east boundary, but Mike Thwaites (*pers comm*) remembers seeing building foundations here which were exposed during recent ground works for caravan pitches. Apparently the foundations were covered over again and therefore still survive under the surface; a hedge may have been planted over part of them.

The small building outside cartridge house No. 2

(Not numbered but see extract from 1976 map, figure 38)

A tiny rectangular structure, probably a building, is shown on the 1976 OS 1:2500 map (revised 1974) just beyond the east end of the north wall which revetted the platform on which cartridge house No. 2 sat. The structure no longer survives but on the map it measures about 2m (east to west) by just over 1m. Although the works had long since closed the revetment wall is still shown which could mean that this little building is much earlier than the map and perhaps belongs to the last years of the gunpowder works. It is not shown on the 1890 or 1913 (revised 1911) editions of the OS 25" maps so it is unlikely to have early origins unless of course it was too small to be shown under the OS rules of depiction in force during those years. At Elterwater and New Sedgwick small buildings near some of cartridge packing houses have been interpreted as privies (Jecock *et al* 2003, 88; Dunn *et al* 2003, 96)) which may also have been the function of this building at Blackbeck. However, there is no firm evidence to place it with the gunpowder works and it could well have been erected long after the latter had closed.

The women's changing house (44)

This structure, which is situated just over 100m south of cartridge house No. 4, forms one element of a small concentration of buildings grouped at the extreme southern end of the works, near the main entrance at Pool Bridge. Some time after the closure of the works this building was converted into a dwelling which is now called the Watch House, but originally it is almost certainly where the women who worked in the nearby cartridge packing houses

Figure 53. *Women's changing house from the south west. (NMR: DP004104)*

changed into their factory clothes and were searched. The female cartridge packers at the Elterwater Gunpowder Works in Cumbria were probably also provided with their own changing house after 1878 (Jecock *et al* 2003, 79). In the New Sedgwick Gunpowder Works report a drawing of 1859, by the architect Richard C Shaw, for a new saw mill which also incorporated a watch house and clock tower is discussed (Dunn *et al* 2003, 109). Shaw's watch house appears to have been replaced by a new watch house erected much closer to the centre of the works during the late 1860s or beginning of the 1870s (Dunn *et al* 2003, 93), and on further reflection it now seems likely that after 1880 the earlier watch house was reused as a changing house for the female cartridge packers there.

The changing house at Blackbeck is first shown on the 1913 edition (revised 1911) of the OS 25" map but it probably dates from the late 19th century when much new building work was being undertaken at the gunpowder works (unfortunately the 1898 site plan does not extend this far south). On the OS map it is depicted as a small rectangular building, aligned almost north-south and measuring about 9m by 5m - it is similarly portrayed on later maps (Ordnance Survey 1913b; 1976). It stands on the east side of the road, which would have provided access for the women, and which extends from a junction at Pool Bridge up the side of the valley to the east end of Bouth village. The original building, terraced into the natural slope (Fig 53), is one storey high and constructed of slate rubble with a slate roof. It had two rooms, and its front (east) elevation originally had a central door set between windows, with a chimneystack in the south gable wall. It was later extended to the east and north.

The cooperage (45)

This building (Fig 54), located at the north end of a prominent rock outcrop, is situated a short distance south of the women's changing house, from which it was originally separated by a small yard or turning area off from the public road on its west side (Ordnance Survey 1913b). It is now a dwelling called The Cooperage, but it clearly has much earlier origins as

Figure 54.
Cooperage at the southern extremity of the works (near Pool Bridge), from the south. (NMR: DP003379)

an industrial building. It pre-dates the gunpowder works because it is shown as an existing building on the 1860/1861 site plan of the proposed gunpowder manufactory (CRO(B) BDKF Plan 7). Its depiction on both the 1890 (surveyed 1888) and 1913 (revised 1911) OS 25" maps is identical and comprises a rectangular building, orientated almost west-south-west by east-north-east, measuring about 19m by 6m with a small off-centre projection (possibly a porch or canopy) on its northern side. By 1974 the projection had been replaced by a much longer structure extending for most of the length of the building (Ordnance Survey 1976). No building at the works is specifically called a cooperage, although there must have been one, but the 1881 and later site plans do not extend far enough south to include this building. It is, therefore, a very likely candidate for the missing cooperage, particularly given its road-side location which would have eased both the delivery of raw materials and the dispatch of the finished products.

The original part of the building, at its west end, is a single-storey five-bay long structure built of stone rubble which has been rendered and painted white. It has a slate roof. The building was entered through a doorway at the east end of its rear, north, elevation, and its five windows face south and are set under continuous slate water tabling. There may also be a blocked window in the west gable wall.

The office at the main entrance (46)

This small building, orientated almost north to south, is shown on the OS 25" maps surveyed in 1888 and revised in 1911 (Ordnance Survey 1890b; 1913b). It still survives (Fig 55) and is now a dwelling, called The Lodge, situated at Pool Bridge just inside the main entrance to the caravan park and on the west side of the access road. It originally flanked the principal road and rail link to the gunpowder works - a location which indicates that it must have been the office from which the movement of materials and products in and out of the works was controlled - apparently the office was staffed by a single clerk (note in caravan park files). The OS 1888 map shows a small projection at the south-west corner of the building but this

Figure 55.
Small office at the southern entrance of the works (near Pool Bridge), from the south. (NMR: DP003377)

appears to have gone by 1911. Another projection is depicted by the OS in 1974, but it is a porch at the north-west corner (Ordnance Survey 1976). A small isolated structure is also shown on the OS 25" maps situated on the west side of the road about 10m north-north-east of the office - in 1974 another small structure was depicted abutting it on the west (Ordnance Survey 1976). Given the close proximity of the office to the former tramway, it is tempting to see both being installed at the same time during the mid 1880s.

The office is a single-storey building of slate rubble with a slate roof. All openings have slate lintels. The building has a two-room plan, the rooms heated from back-to-back fireplaces in a central two-flue chimneystack. Each room has two windows in the east front wall, all but

Figure 56. *Houses associated with the gunpowder works: (a) Lindeth on hillside with watch house (now Meadow Bank Cottage) in left foreground, looking south west; (b) Abbots Reading, looking north east. ((a) NMR: DP003535, (b) Christopher Dunn, October 2004)*

that at the south end having distinctive red-brick jambs. The south room has a window set high up in its south gable wall, while the north room has a window and the original doorway, now sheltered by a modern porch, in its north gable wall.

6.1.8 The houses associated with the works

This section is concerned with the manager's house, Lindeth, and also Abbots Reading where Arthur Benson Dickson who established the works lived.

The manager's house (47) (Fig 38)

Lindeth, now a private residence, is situated on the hillside to the west of the works (Fig 56a). It was erected for the works manager between 1888 and 1911 on the edge of what had previously been a small wood and agricultural land (Ordnance Survey 1890b; 1913b). Direct access between the house and the works was provided by a footpath, shown on both the 1913 edition of the OS 25" map and 1928 site plan, which went past the watch house. The house lay just outside the survey area and has not been investigated by EH.

Abbots Reading (Fig 2)

This house is situated on the east side of the Rusland Pool valley, 1km from the gunpowder works on the side of a minor road linking the villages of Bouth and Rusland (Fig 56b). It has not been investigated by EH because it lay well beyond the limits of the survey area.

6.1.9 Transport (Figs 2, 5 and 6)

This section is arranged under two sub-sections: one dealing with the tracks and tramways within the gunpowder works; the other with transport to and from Blackbeck.

The roads and tramway system

The main purpose of this sub-section is to provide an overview of the communication system which operated within the works and to identity any unresolved issues. Most of the individual surviving elements will not be described in detail - the latter often occur near buildings and any information has already been included in the building descriptions (see previous sections).

The road system

The tramway system at the works was probably established in 1885, before this the various buildings at the works being serviced by a network of interlinked factory roads and tracks. It is clear from the 1881 indenture that access through part of the works was required by the tenant of Black Beck Farm, to enable him to gain access to his fields on the valley floor. The principal track for this purpose is the one that extended southwards from the farmstead to Pool Bridge. The location of the time office and search house at Blackbeck next to this track suggests that it was also used by male gunpowder employees coming to work from the north and from the village of Bouth. Cartographic and documentary sources indicate that between 1888 and 1891 part of its route, from near the incorporating mills to cartridge house No 2, was realigned and moved further away from the works. The 1881 site plan and first edition of the OS 25" map (surveyed 1888) both show the track following the side of the valley for about 180m from the farm before turning through ninety degrees and heading east down the hillside to the foot of the natural slope. At this point the track swung south again

and passed the saltpetre house on its west side as it headed towards Pool Bridge. Provision for moving the track, should the need arise, was provided for in the indenture, and this seems to have happened by or during 1891. In April 1891 the first mixing house burnt down and its replacement was built at a new location north of the saltpetre house. The tramway spur for this new building and a blast wall were erected on the actual course of the track which must, therefore, have been moved. The revised layout, shown on the 1898 site plan, meant that the track from the farm now followed the hillside for an additional 135m before turning east to descend to the foot of the natural slope and passing the north side of cartridge house No. 2 in the process. The southern part of this track was the main access route into the works from the south and later provided the route for the rail link. This section of track also served three of the cartridge houses and, via a loop, the store magazine. This revised track layout still survives with the northern part continuing to be used by the farm for field access; much of the track on the hillside lies in a shallow cutting up to 1.5m deep. The southern part is now a private road providing entry to the caravan park. South of cartridge house No. 1 a short track is still extant which is specifically mentioned in the 1881 indenture; it provided access from the main track described above to the fields east of the gunpowder works.

The works itself was served by a main factory road which left the one described in the previous paragraph just before the latter ascended the hillside on its way from the valley floor to the farm. The factory road formed a large loop which enclosed the low rocky hill that separated the Black Beck valley from that of the Rusland Pool and around which the works was built. Beyond the incorporating mills the 1881 site plan shows that the road had a meandering course, the result of it being laid out to give direct access to as many buildings as possible. Where buildings were too far away to be accommodated, short spurs between them and the main track were provided - examples include those which went to the first corning house site and the first stove house. The caravan park's internal road system fossilises much of this earlier network. In 1881 horses pulling carts provided the only source of power at Blackbeck for the conveyance of powder (Explosives Inspectorate 1881, 7). This was not without its problems because when the powder press house exploded in March 1881 a horse took fright, bolted and collided with a tree. This upset barrels on the cart which spilled powder; the latter ignited and also caused an explosion at the corning house (Explosives Inspectorate 1881, 12). It appears that in the last years of the works there were two big horse-drawn carts at Blackbeck which delivered gunpowder to Stainton and Plumpton quarries (note in caravan park files). According to Tyler (2002, 230) small handcarts and wheelbarrows were also used within the works.

The tramway system

(see also Postscript, page 153)

A standard gauge tramway entered the works from the south (see this section, below) which was installed in 1885 to link the gunpowder works to the Furness Railway at Dickson's Siding (LRO DDMC30/81). According to Andrew Lowe (*pers comm*), who recorded its remains in the 1960s, it extended into the works at least as far as the site of the weigh office and store (now occupied by the caravan park manager's house); in this area he found

standard gauge sleepers. Its former route through the southern part of the works is now represented by the embankment which carries the main access road into the caravan park. The scale of the embankment certainly suggests that it was built for a standard gauge line rather than for just the narrow gauge system which operated within the works. However, it must have been dual gauge in places in order to permit direct access by narrow gauge bogies to cartridge houses 2-4 and the store magazine; this would have facilitated both the delivery of powder etc from other processing or store buildings at the works and also the collection of blasting cartridges for drying in the stove house.

The narrow gauge tramway system within the works was probably installed when the standard gauge link - described in the previous paragraph - was established. The system was surveyed by the OS in 1888 and depicted on the first edition of their 25" map. A comparison between this map and the 1881 site plan shows that the route and principal layout chosen for the narrow gauge tramway was virtually identical to that of the earlier internal road system, much of which presumably remained in use despite the presence of the rails. It most cases it would seem that the tramway was merely laid along the principal road surrounding the low rocky hill (referred to in this report as the main tramway) and on the spurs which served the outlying buildings. The tramway system did not remain static and as buildings were rebuilt at new locations following explosions so redundant spurs were lifted and additional spurs put in. The spur to the second mixing house, for example, must have been installed after the fire at the first mixing house in April 1891, while the spur to the first stove house was presumably lifted soon after the building was destroyed in 1898 - it had certainly gone by 1912 (Ordnance Survey 1913a). The first expense magazine was demolished and rebuilt after the 1898 explosion on a new site in the north-eastern extremity of the works. This location was a long way from the tramway network and a rail link between the latter and the new expense magazine must have been installed at the same time. During 1912 a new corning house was erected on the site of this expense magazine and a replacement for the latter was constructed further to the south. The triangular arrangement of tracks which linked these new buildings with the rest of the system is depicted on the 1913 edition of the OS 25" map (revised 1912) and in essence it consists of a spur to the magazine and corning house which splits into two tracks immediately south west of the former, thus giving direct access to both the northern and south-eastern part of the main tramway. Map evidence also indicates that between 1888 and 1912 changes were also made to the track layout serving the second powder press house location (Ordnance Survey 1890a: 1913b). Patterson (1995, 38) says that the tramway gauge was 3ft 6in (1.067m), but according to Lowe (1968, 36) it was 3ft (0.914m). A note in the caravan park files refers to several metal bogies, four powder vans and a locomotive; this reference to a locomotive is most surprising in view of the possibility of sparks causing explosions and seems unlikely to be correct. Other authorities state categorically that horses provided the sole source of power because locomotives were not allowed within the works (Quayle and Jenkins 1977, 69-70). According to Tyler (2002, 230) the bogies were made of wood and were sufficiently light so that they could be easily moved by either ponies or men - all horseshoes were of copper or brass. Until recently the remains of some of the bogies, which were indeed largely of timber construction, survived behind the caravan park's reception

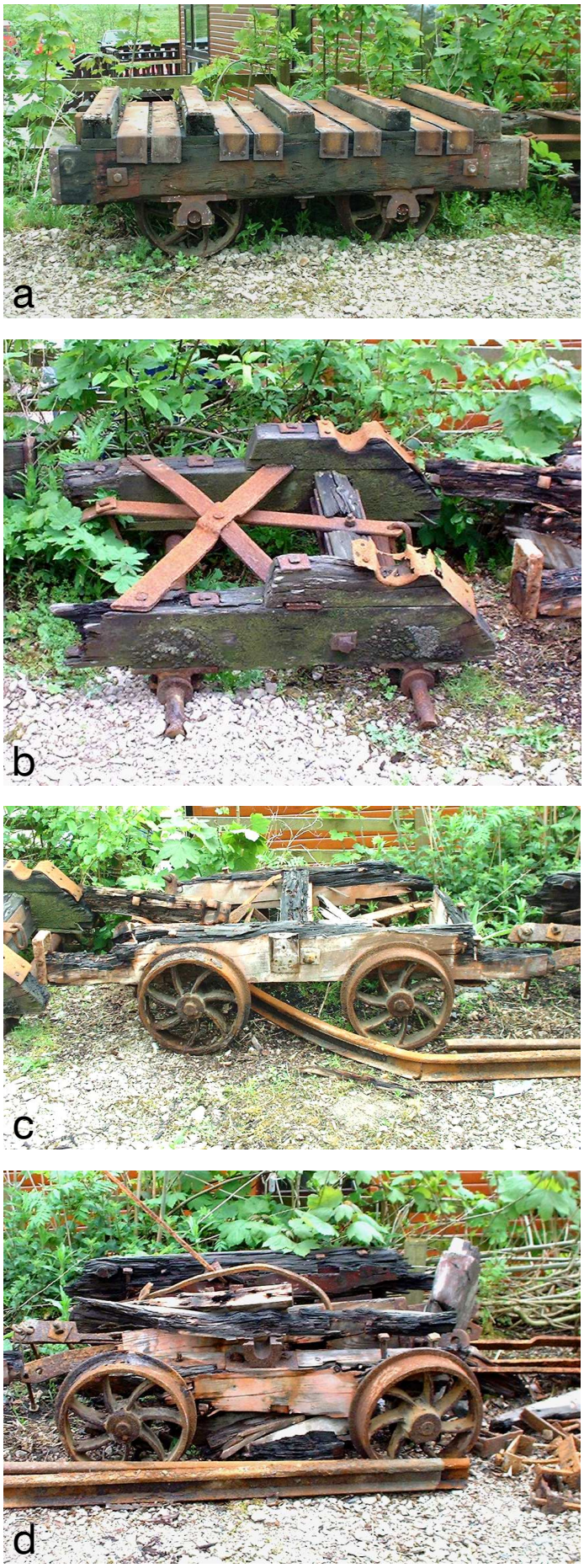


Figure 57.
The bogies which formerly stood behind the caravan park's reception office. (Abby Hunt, May 2002)

office (see section 6.1.4, above (cartridge house No. 2)) (Fig 57). Tyler also claims that the tramway track adjacent to the incorporating mills and magazines was plated with either copper or zinc in order to reduce the risks of sparks (Tyler 2002, 230).

To and from the site

(see also Postscript, page 153)

The movement of goods to and from the site has not been researched in detail for this report, and this section relies heavily on published accounts and cartographic sources. In April 1869 a branch from the Furness Railway main line at Plumpton (near Ulverston) to Lakeside at the southern end of Lake Windermere was officially opened (Quayle and Jenkins 1977, 10), and in 1885 Blackbeck Gunpowder Works was linked directly to this branch by a standard gauge tramway which branched off from the new line near Lady Syke Bridge to the east of Greenodd (LRO DDMC30/81). The tramway, annotated 'Blackbeck Tramway' by the OS (1890c; 1893; 1913c), left the railway in a northerly direction to cross the Rusland Pool by means of a timber trestle viaduct. It then extended up the west side of the Rusland Pool valley, close to the river, for 2km to Pool Bridge where it entered the works. Apparently there were two exchange sidings at the railway junction, which is labelled 'Dickson's Siding' by the OS, and horses provided the sole form of haulage along the tramway (Joy 1968, 48). The sidings are shown forming a loop on the OS first edition 25" map and at this time the western ends of both were connected to the branch line (Ordnance Survey 1990c). However, by 1911 this arrangement had been revised and now only the westernmost siding had a direct connection with the branch (Ordnance Survey 1913c); at this time the OS also depict a small rectangular structure (about 5m by 4m) just beyond the eastern end of the sidings close to the southern side of the tramway. The loop appears not to have been used as a run-round facility and according to Quayle waggons *en route* to Blackbeck had to be shunted at Greenodd station before being taken to the start of the tramway by the daily freight train bound for Haverthwaite and Lakeside. The junction with the tramway was controlled by a ground frame whose key could be procured from either Greenodd or Haverthwaite signal boxes (Quayle 1974, 476). The tramway was lifted following closure of the works but elements of it were still very apparent, including sleepers towards its southern end, when Lowe (1968) undertook his fieldwork in the 1960s. Apart from its extreme northern end, where it is still traceable as a field track, its former route has not been inspected by EH. At this north end, on the south side of the road to Bouth and immediately opposite the entrance to the works, the OS (1890b; 1913b) show a triangular area on the west side of the tramway containing a short siding. According to Tyler (2002, 226) the gunpowder company initially had three standard gauge vans, each of which could hold up to five tons of gunpowder, which when not in use were stored in this siding. The siding has gone but the triangular area is still extant and is used for storing farm items and building materials. The eastern side of this area is edged by a high revetment wall of coursed rubble which strengthened the river bank and thus protected the bed of the tramway from water erosion. A similar siding is shown by the OS on the west side of the tramway about 750m to the south west near New Pool Bridge (Ordnance Survey 1890b; 1913b). The rail network not only facilitated the transportation of materials and products to and from the works but could also be of value during emergencies; when the corning house at Blackbeck exploded in August 1900, for

example, six ambulance men and an ambulance waggon came by train from Ulverston (*Westmorland Gazette*, 1 September 1900).

Before the rail and tramway connections were installed it appears that sulphur and saltpetre were brought to the works via the docks at Greenodd by barges using the Rusland Pool (Quayle and Jenkins 1977, 69). EH has found no evidence for the location of a quay at Blackbeck where the barges were unloaded, but it may be significant that the course of the river swells out immediately beyond Pool Bridge at its confluence with the Black Beck to form a basin-like feature the extra width of which would certainly have been useful if barges had had to be turned there. The finished gunpowder may also have gone out by this route but Tyler (2002, 226) states that it was taken by cart to the docks at Greenodd or Ulverston. He also refers to a fire in February 1867 on the ship 'Arrow' which was loaded with gunpowder from Blackbeck (Tyler 2002, 224).

6.2 Miscellaneous features

6.2.1 Former field boundaries

The EH survey recorded a number of stony banks and scarps on the hillside to the west of the gunpowder works. These are the remnants of former field boundaries whose full extent was not surveyed by EH as this is not directly relevant to the production of gunpowder. In addition, they are shown in their entirety on the various editions of the OS maps, and all that has been recorded for this new survey are their eastern sections just beyond the boundary of the former gunpowder works; these elements were surveyed because they contribute to the landscape setting of the latter. Some with an approximate west to east alignment originally terminated against the Black Beck but were truncated when the gunpowder works was erected in the valley. On figure 58 they have been labelled FB1 to FB7 and their chronology, derived from the OS 6" map (surveyed in 1848) and the OS 25" maps (surveyed in 1888 and revised in 1911) (Ordnance Survey 1851; 1890b; 1913b), is as follows: FB1 is shown on all three maps and survives largely as a 0.8m high scarp; FB2 and FB3 were mapped in 1848 but had gone by 1888; FB4 was depicted in 1848 and again in1888 but not in 1911; FB5 was first surveyed in 1888 but had gone by 1911 - its demise may have been due to the erection of the managers house, Lindeth, which impinged on to the western part of the fields here; FB6 appears on all three maps; FB7 is only shown on the 1888 map and now consists of a very low bank, at best 0.3m high. This boundary is not shown on the 1881 site plan but a footpath close or at its location is depicted which gave access into the works from the north west.

6.2.2 The concrete platform

A rectangular concrete base was surveyed by EH on the lower slope of the valley to the south west of the building range immediately south of the former incorporating mills. Initially EH wondered whether it was the base of a temporary hut, perhaps of World War II origin, however, Mike Thwaites (*pers comm*) remembers seeing a modern water tank at this location; the concrete platform has been labelled on figure 58.

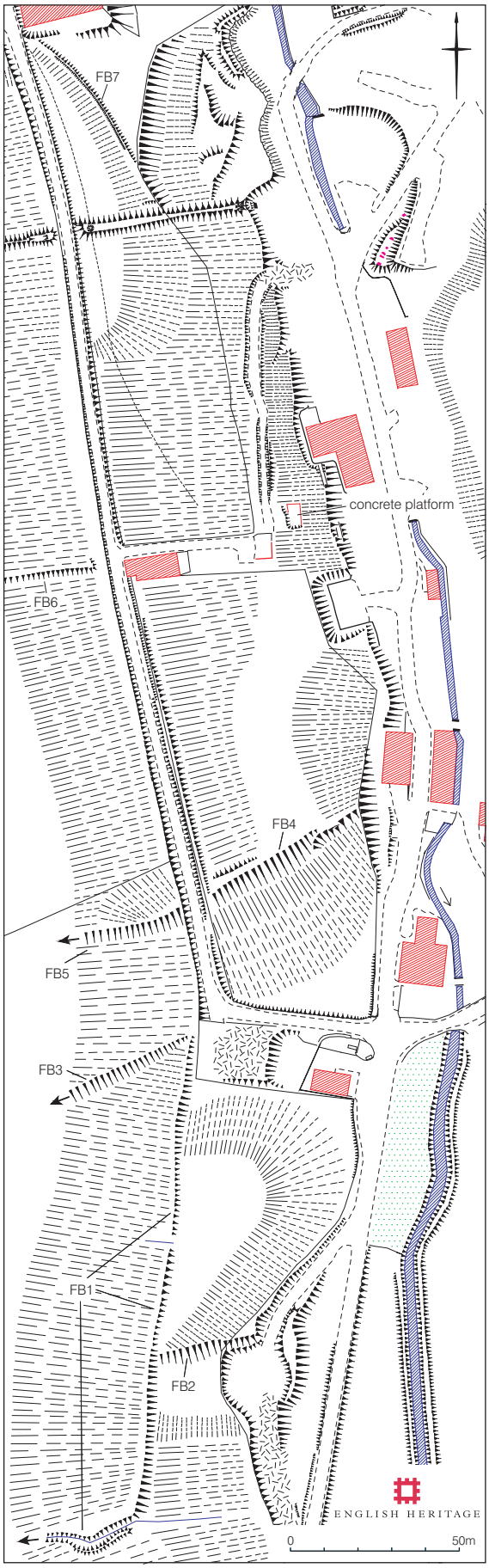


Figure 58.
Reduced extract from the English Heritage 1:1000 scale earthwork plan showing the field boundaries recorded on the hillside to the west of the works.

7. DISCUSSION

The individual archaeological features and standing buildings have been discussed and described in detail in section 6, above. What follows here is a general commentary that is intended to provide a historical perspective and summary of the site's overall development. Phase diagrams (Figs 59, 61 and 62) have been produced for each of the main phases of activity at the works. The OS 25" maps published in 1890 and 1913 have been used to construct these diagrams, supplemented with information derived from contemporary site plans, documentary sources and extant archaeological evidence. In order to assist the reader the gunpowder buildings on these diagrams have been numbered and annotated. The numbers have also been included (in brackets) in section 6, above.

7.1 The pre-gunpowder landscape

Prior to the construction of the gunpowder works this part of the Rusland Pool and Black Beck valleys comprised woodland (Rough Moss) and fields. Field names indicate that of the latter, those to the south occupied poorly drained low quality land. The area chosen for the works was centred on the wooded area but also spilled over on to the fields to the south and the eastern ends of those on the hillside to the west; some of the of boundaries which defined the fields in this last area remained current throughout the life of the works. The former field boundaries on the hillside still survive as earthwork features in the modern pasture fields and EH has recorded those elements which fall within the area surveyed at large scale (see section 6.2.1, above and Fig 58).

7.2 The early years of the gunpowder works (Fig 59)

Arthur Benson Dickson's application for a licence to build the Blackbeck Gunpowder Works was presented to the Justices of the Peace for their consideration and approval at the very end of 1860, which implies that construction is likely to have started in 1861. One of the problems with Blackbeck in trying to arrive at a plan of the works as originally built is that there appears to be no surviving site plan showing its layout and the functions of individual buildings between 1862, when production started, and November 1881, the date of the first site plan of the established works. This creates uncertainties about the exact layout of the site during the early years because at least two of the gunpowder buildings were rebuilt at new locations prior to the preparation of the 1881 plan. The 1860/1861 site plan (Fig 60) has the proposed layout of the new works but it is clear from the 1881 site plan and the first edition of the OS 25" map (surveyed 1888) that major changes had been made to this layout by the time that actual construction took place. The incorporating mills, for example, are shown on the 1881 site plan and on all subsequent contemporary site plans and maps forming a single, long range which also contained a steam engine house. There is no evidence to suggest that this was not the arrangement from the beginning yet on the 1860/1861 plan three separate mills are depicted - spaced at regular intervals across the area occupied by the incorporating mill range of the later plans and maps. The corning house, annotated 'Granulating house' on the 1860/1861 plan, was originally intended to be sited well away from the rest of the danger buildings at the extreme north-east end of the low

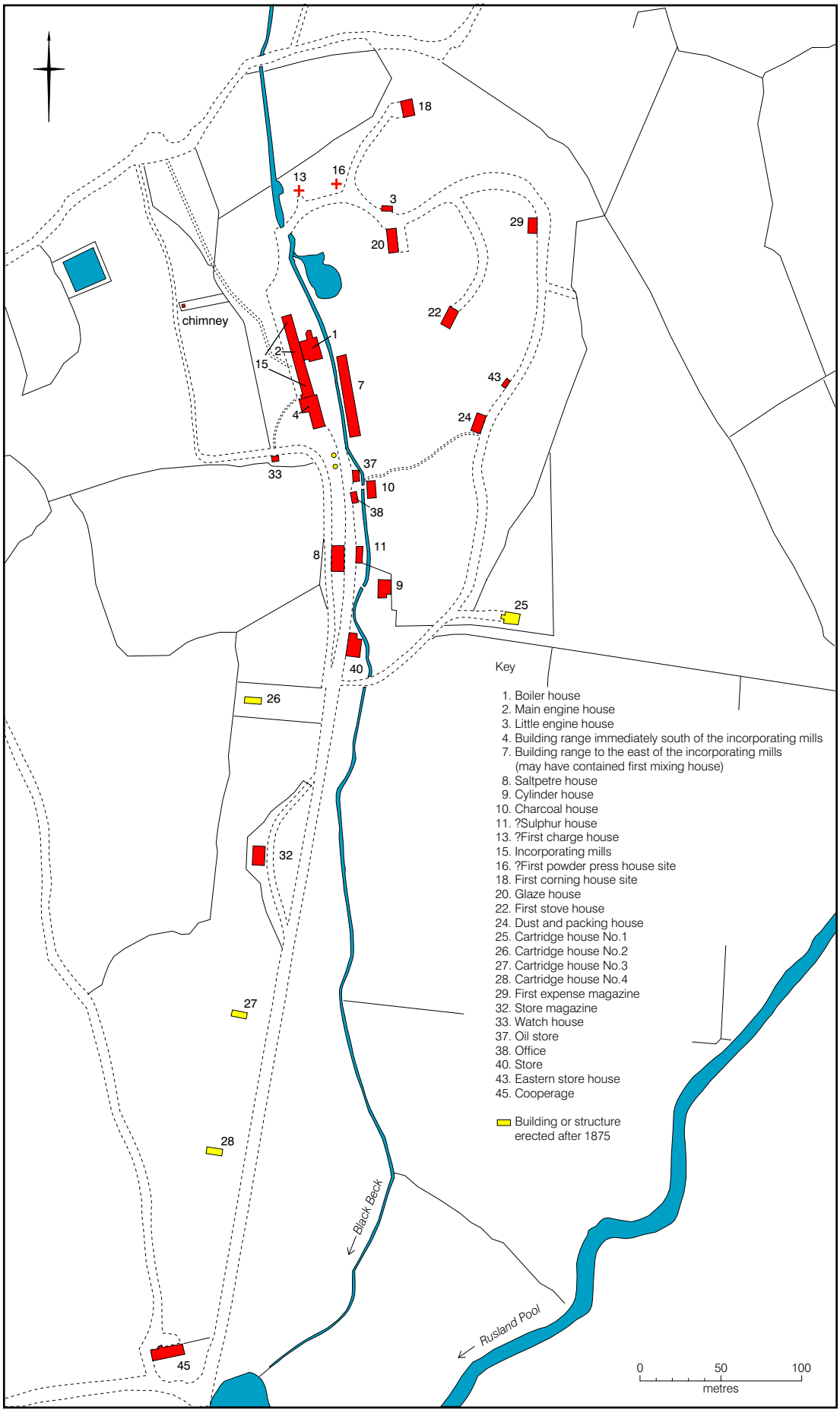


Figure 59. *Plan of the gunpowder works as it may have looked during the early part of 1879.*

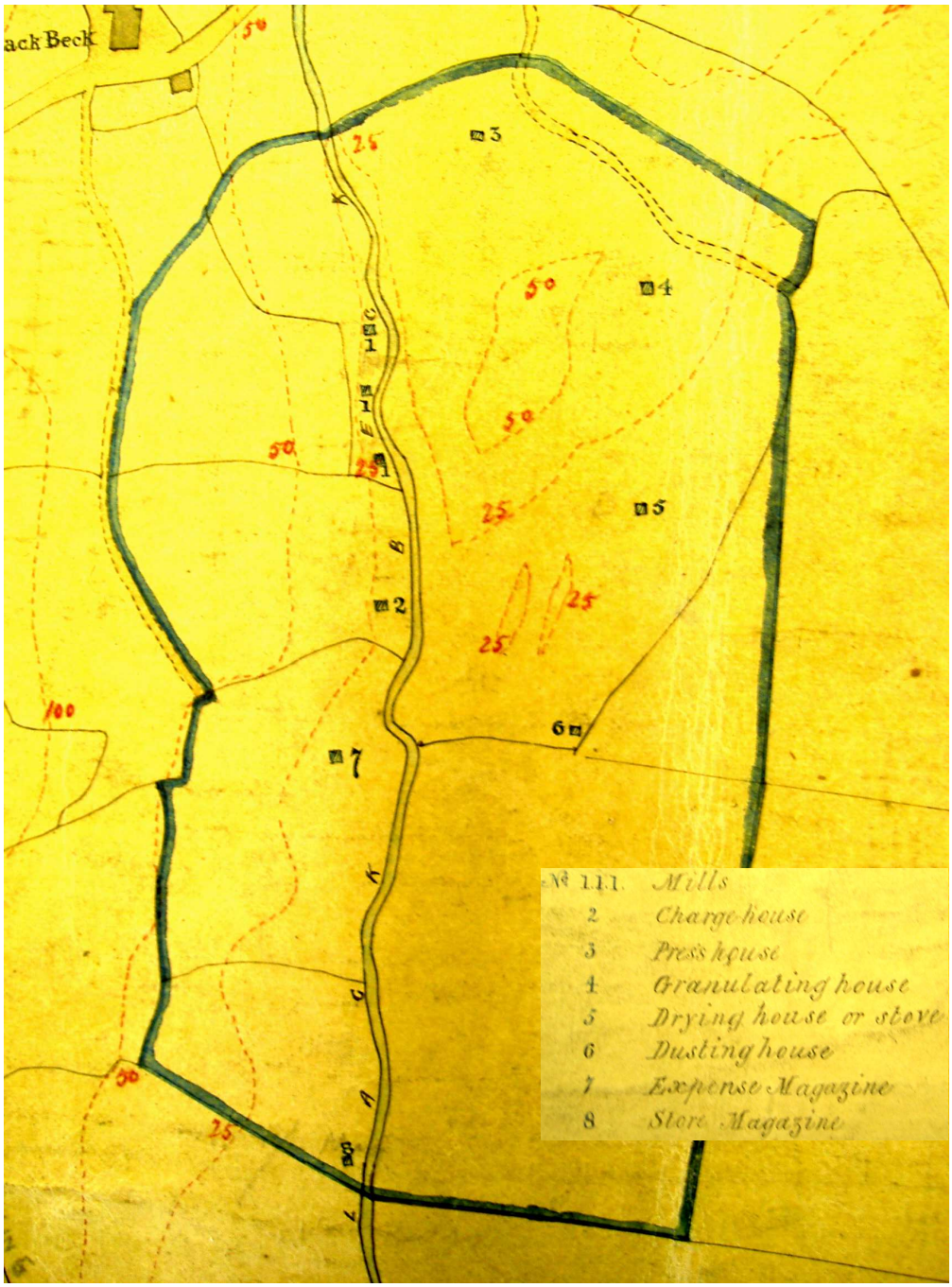


Figure 60.
Extract from plan of the proposed gunpowder works ('the 1860/1861 site plan'). Taken from CRO(B) BDKF Plan 7, reproduced with acknowledgments to Cumbria Record Office & Local Studies Library, Barrow. (Christopher Dunn, October 2004)

rocky hill which dominates the central area of the works, but documentary and later cartographic evidence indicates that this was not followed because it was erected below the hill to the north. These changes may have been made so that the most efficient use could be made of the power system employed at the works and any technological limitations overcome. It has been explained in section 6.1.1 (above) that unlike the other Cumbrian gunpowder works which relied heavily on water-powered wheels and turbines to drive the machinery, Blackbeck was always steam powered, the steam produced in a boiler house in the main part of the works adjacent to the incorporating mills. The steam supplied at least two stationary steam engines comprising a principal or main steam engine situated between incorporating mills 3 and 4, a more isolated one towards the northern end of the site (housed in the little engine house) and possibly a third in the building range immediately

south of the incorporating mills. Had the latter been built as proposed on the 1860/1861 site plan then each incorporating mill would have required a separate power source whereas the revised arrangement which was adopted meant that the main steam engine was able to power the edge runners in all the incorporating mills via a drive shaft, pulleys and belts. This also made it possible to add extra mills as required, the drive shaft being extended as necessary. The erection of the corning house to the north of the low hill brought it much closer to the glaze house with the result that a steam engine in the little engine house was able to power the machinery in both buildings via drive shafts. The disadvantage of this was that it brought the corning house not only much nearer to the glaze house than originally proposed, but also far too close to the first powder press house which itself was not sufficiently distant from the first charge house. The consequence of this was that when an explosion accidentally occurred in one building it often spread to others in the vicinity, hence the high number of fatalities at Blackbeck. In July 1868, for example, nine men lost their lives when an explosion reduced the first charge house, powder press house and corning house to their foundations and badly damaged the glaze house. The glaze house had only just been rebuilt following its destruction in December 1867 by an explosion which started at the corning house. The insufficient distances between a number of the processing buildings was highlighted by the Explosives Inspectorate, who visited the gunpowder manufactory in 1876, and wrote a letter on July 26th 1876 to F.C. Dickson & Company enumerating the buildings involved (Explosives Inspectorate, 1881, 1). Their findings did not result in any immediate remedial work and the reaction of the Company was to wait for one of the affected buildings to be destroyed during an incident and then to site its replacement at a new and more suitable location. This resulted in the first charge house being replaced further to the west by the second charge house after its destruction by the explosion in 1879 which started at the first powder press house. The powder press house itself was rebuilt at a new location in 1881 following its destruction by an explosion in March of that year. Although several buildings were much too close to one another the site itself was a good one for a gunpowder manufactory; the irregular natural topography and trees helped to provide good blast protection and limit the spread of air-borne debris in the event of an explosion, while some of the danger buildings had been placed so that their angles - rather than their ends or sides - faced one another, which also helped to give protection (Explosives Inspectorate 1898, 13). The original locations of the charge and powder press houses had been abandoned before the 1881 site plan which means that their exact sites are not known for certain. However EH believes that it may have discovered them through its detailed recording of the surviving archaeological remains supported by a study of the contemporary documentary sources. Their probable sites certainly help to illustrate the clustered nature of the danger buildings which occupied the northern part of the works during the early years. The abandoned site of the first powder press house was not used again for buildings although by the end of 1881 a cart shed had been erected on the first charge house site. Apart from the store magazine and the cooperage, which were situated well to the south, the buildings which made up the works at this time were mainly arranged around the foot of the low hill which is such a prominent local feature of the site. The ingredient stores, workshops, office and incorporating mills were concentrated on the narrow floor of the Black Beck valley to the

west of the low hill while the charge house, powder press house, corning house and glaze house occupied the northern end of the works with the first stove house set in a natural depression on top of the low hill. The first expense magazine occupied a site near the north-east corner of the low hill while beyond it to the south along the eastern foot of the hill was the eastern store house and the dust and packing house. This clockwise arrangement of factory buildings around or on the low hill meant that the movement of powder from one process building to another was carried out in a logical manner reflecting the various manufacturing stages. At this time the track between Black Beck Farm and Pool Bridge passed through the southern part of the main works area although none of the danger buildings fronted or backed on to it. The incorporating mills were served by a small watch house which was erected to the south of them above the valley floor on the side of this track. Initially there were probably six mills but by 1878 a seventh had been added. Two ponds or reservoirs, one beside the beck and the other on the hillside near Black Beck Farm, supplied the works with water. Although both water features were in existence by 1881 it is possible that the lower pond is the earlier of the two. During this period there were a number of explosions which initially started at one of the following: the incorporating mills; the powder press house; and the corning house. However these incidents often spread to other buildings in the vicinity causing further damage. By the end of 1879 a total of fifteen men had been killed and a number injured during these incidents. The cartridge houses at Blackbeck were erected in the short period between the passing of the Explosives Act of 1875, which made the filling of blasting cartridges illegal except at licensed establishments, and spring 1881 when the Explosives Inspectorate (1881, 1-2) refer to the production at the works of blasting cartridges in both compressed and uncompressed form. The area chosen for the compressing and packing of the cartridges was to the south of the main part of the works towards Pool Bridge. The only gunpowder building which occupied part of this area before the Act was the main store magazine and at the far southern end the cooperage, so their provision represents a significant expansion of the works into another part of the site. Cartridge houses Nos 1 and 2 were probably the compressing houses and were built to the north east and north respectively of the magazine. The pair of hydraulic accumulators, which are shown to the north of the saltpetre house on the 1898 site plan and OS 25" maps, must also belong to this period because water under pressure would have been needed to operate the presses. The hydraulic pumps which supplied the accumulators and the powder press house were probably located within the building range situated immediately to the south of the incorporating mills. Cartridge houses Nos 3 and 4, where the cartridges were packed, were erected to the south of the store magazine.

7.3 The late nineteenth century (Fig 61)

The last two decades of the nineteenth century saw a great deal of investment in the infrastructure at the works. In some instances this was caused by the need to replace buildings destroyed by explosions such as those in 1884 when the corning house was wrecked and in 1898 when the first stove house blew up, damaging a large number of other buildings at the works. In the mid 1880s the gunpowder manufactory was provided with an internal narrow gauge tramway system which largely followed the routes of the earlier factory roads. In the southern part of the works this tramway was linked to a standard gauge

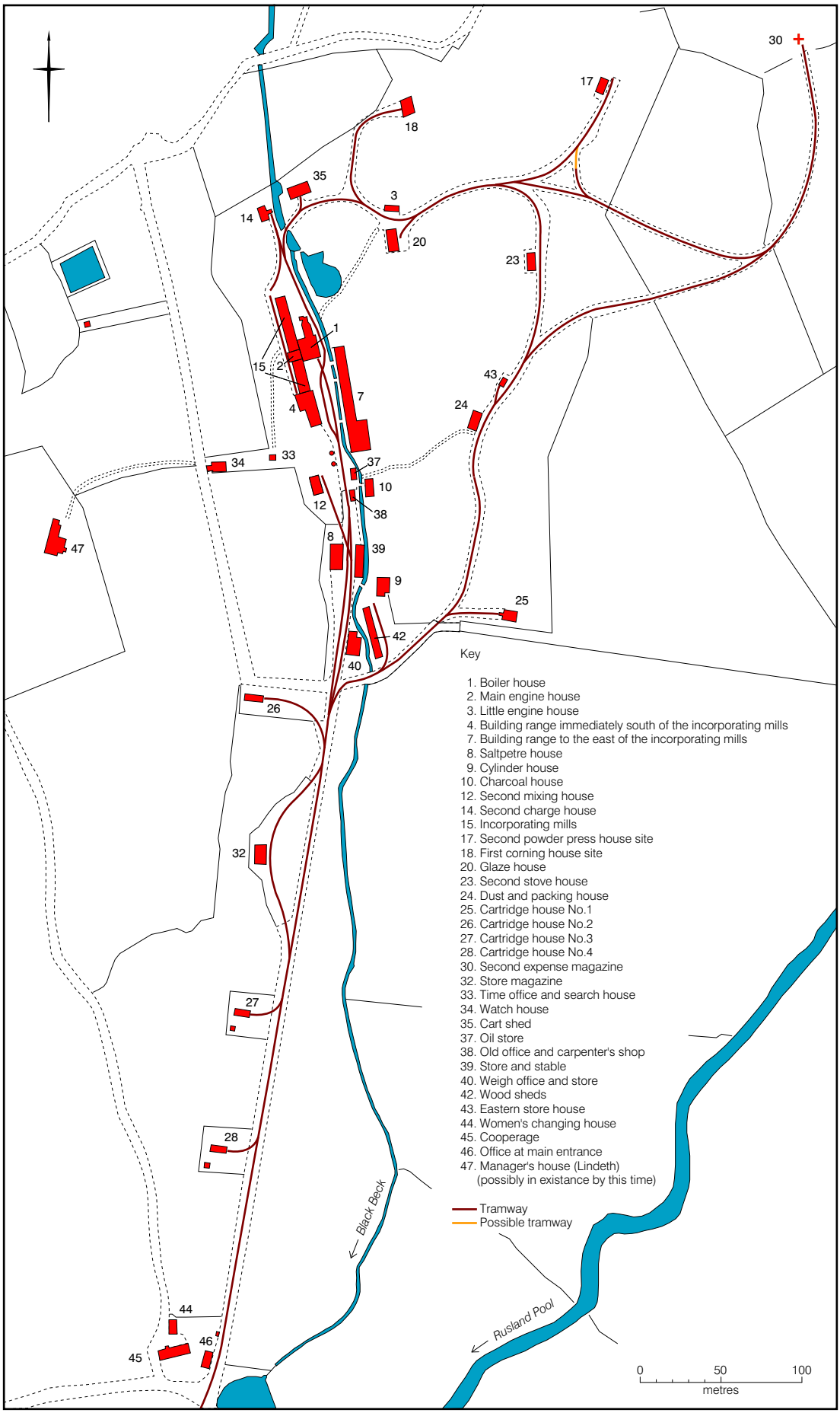


Figure 61. *Plan of the gunpowder works as it may have looked during 1899.*

tramway which was constructed by the Company to join the gunpowder works with the railway branch line (opened in 1869) that extended from Plumpton near Ulverston to Lakeside at the southern end of Lake Windermere. At Plumpton the branch joined the main Furness Railway system thus providing the Blackbeck Gunpowder Works with access to good transport networks. Previous to this it had had to rely solely on road and water transport for bringing raw materials to the site and taking the finished products away. There is a small office, now a dwelling, on the west side of the standard gauge tramway just inside the works entrance at Pool Bridge. It was first recorded in 1888 by the OS but unfortunately the 1881 site plan does not extend far enough to the south to include its site. It is thus unclear if the office pre-dates the tramway or - as seems more likely given its close relationship to the latter - was constructed at the same time. In 1891 sparks from the boiler house chimney caused an explosion at the incorporating mills and the resulting fire spread to the mixing house which the Explosives Inspectorate in 1876 highlighted as being too close to other buildings. The mixing house was rebuilt at a new location north of the saltpetre house and immediately west of the track which linked Black Beck Farm to Pool Bridge. The tramway spur which served the new building occupied the actual bed of the track with the result that this section of the latter also had to be repositioned (unless this had happened a year or two before) further up the hillside to the west of the works. Around this time and certainly by 1898 a new and much larger watch house (now converted into a holiday let called Meadow Bank Cottage) was built in the angle between the old and realigned sections of track and its predecessor to the east became a time office and search house. To the west, above the watch house, a substantial residence, Lindeth, was also erected either during the latter part of the nineteenth century or early in the next century for the manager of the gunpowder works. The lofty situation chosen for this house and its fenestration, especially to the east, provided the manager with a good view over the works for its overall supervision. Within the works itself the production capacity of the incorporating mills had been increased by 1898 (and possibly even as early as 1888) by the addition of an eighth mill erected at the north end of the incorporating mill range. The probable early sulphur store, situated immediately to the east of the saltpetre house, was demolished some time between 1888 and 1898; it was replaced by a larger building which was used as a store and stable. An office to the south of the oil store had become a carpenters shop by 1898 while a store at the southern end of the main part of the works had also been extended by this date to incorporate a weigh office (OS maps indicate that this increase in size had probably happened by 1888) - perhaps some of the functions of the earlier office were transferred to this building too. On the opposite side of the beck to the weigh house and store a long wood store had also been erected by 1898. The first mixing house probably occupied part of the building range east of the incorporating mills but after it was moved following the 1891 incident, the range appears to have been used largely for wood storage and extended to the south. It is possible too that by the late nineteenth century this range also contained a wash house and a case-making shed. Either at the very end of this century or during the early years of the next the north end of the range was altered to accommodate a laboratory. A changing house for the female cartridge packers at the far southern end of the works near Pool Bridge is also likely to have been constructed during the latter part of the nineteenth century.

During this period work was also carried out at the boiler house to make the firing of the coal more efficient and thus reduce the production of sparks and smoke; an automatic stoker had been installed by 1900, if not before, while it is likely that the boiler was renewed too. The main steam engine between incorporating mills 3 and 4 may also have been replaced in the 1890s by a triple expansion engine. The 1891 incident, which involved the incorporating mills and the first mixing house, was caused by sparks from the boiler chimney - the latter was situated at the end of a long flue on the hillside to the west. To help prevent this happening again the chimney was demolished and replaced by a new and much taller stack situated further up the hillside. The flue was also extended to take the exhaust gases to it. Towards the end of the century the works reached its maximum extent to the north east with the erection of the second expense magazine in this area. Its predecessor was situated much closer to the main part of the works but was demolished when the new (second) stove house was erected nearby. The original stove house had been erected in the natural hollow on top of the low hill which dominates the central part of the works but it was destroyed by an explosion in 1898 and the decision was taken to locate its successor at the foot of the hill near the latter's north-east corner. The tramway must also have been extended at this time into the north-eastern part of the works to provide a link between the second expense magazine and the processing buildings. The end of the century was marred by two further explosions, both of which caused fatalities. The first building to explode was the powder press in May 1900 followed by the corning house in August. The powder press house was the one which had been rebuilt further away from the other danger buildings after the explosion which destroyed its predecessor in March 1881 and killed three men. The last time that the corning house had blown up was in July 1884 when four workers were killed due to the building having been fitted with a faulty lightning conductor. It is just possible that at the very end of the century hydraulic pumps were installed in the little engine house in order to remedy a problem with the hydraulic supply to the powder press house that was identified by the Explosives Inspector who investigated the May 1900 incident (see section 6.1.1, above (little engine house)). Actual charcoal production at Blackbeck, in the cylinder house, probably ceased either towards the end of this period or during the first years of the twentieth century.

7.4 The early twentieth century (Figs 62 and 63)

(see also Postscript, page 153)

There is not the same evidence for major investment at the works during the early twentieth century and much of the money that was spent seems to have been largely directed at replacing buildings destroyed or damaged during explosions. The corning house blew up on three occasions between the beginning of April 1906 and the end of December 1911; sadly each incident caused two fatalities but damage to other buildings was slight. These incidents were not due to lax safety practises at the works and at the inquest into the first of these explosions Mr Wraighte, the manager, stated that the shoes worn in the corning house lacked nails and were not allowed to be worn outside. In addition, the men were 'searched [for matches] every morning before they go to work. After entering the factory they have to change the whole of their clothing to the skin and put on suits provided by the company' (*North Lonsdale Herald and Dalton Advertiser*, 5 May 1906). After the explosion

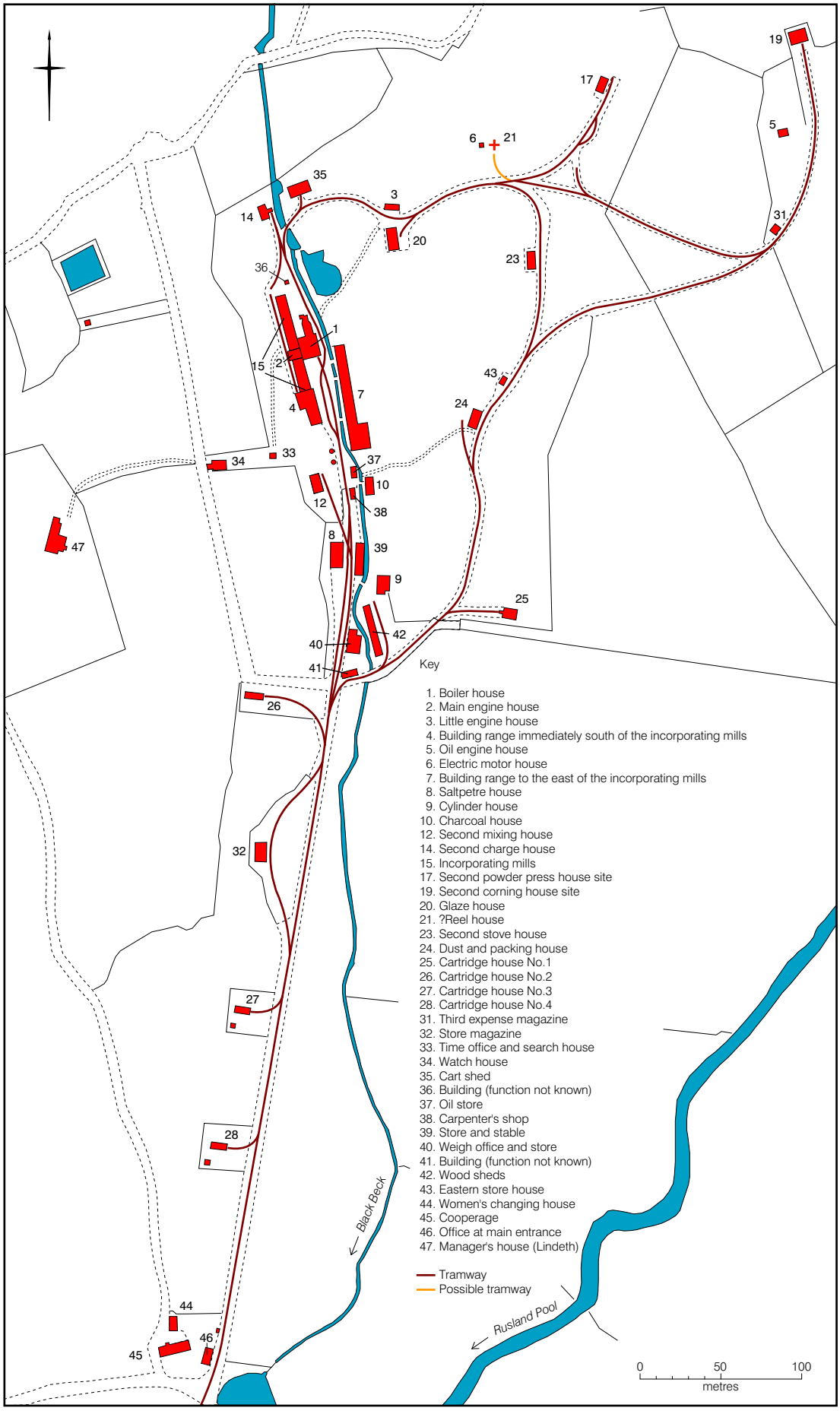


Figure 62. *Plan of the gunpowder works as it may have looked in the 1920s.*

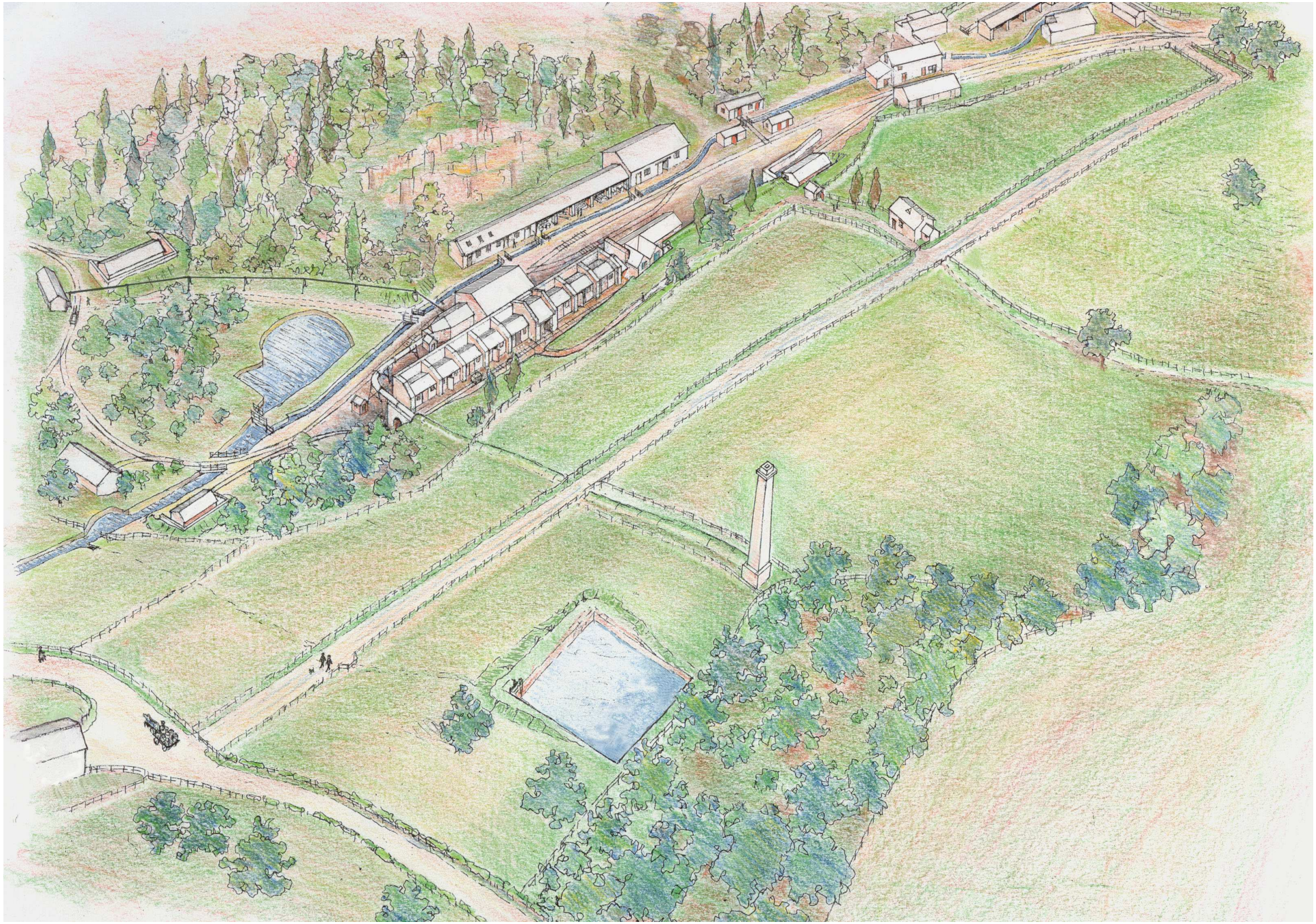


Figure 63. *Bird's eye view from the north west showing what the main part of the works may have looked like prior to the explosion at the incorporating mills (centre) in 1928. (Reconstruction drawing by English Heritage)*

in 1911 the decision was taken to rebuild the replacement corning house (the tenth to be built at Blackbeck) at a fresh site well away from the other processing buildings. The archaeological, photographic and cartographic evidence suggest that the site chosen was the one previously occupied by the second expense magazine in the north-eastern part of the works. This latter building must therefore have been demolished and a small rectangular structure shown on the OS 25" map of 1913 (revised 1912) situated on the west side of the tramway and well to the south of the new corning house is probably the replacement (third) expense magazine. The OS also depict a small building between and equidistant from them which housed the oil engine which provided the power for the corning machinery. The oil engine is interesting because, like the electric motor house (see next paragraph), it shows that as danger buildings requiring mechanical power were erected at the extremities of the manufactory and thus away from the steam engines which provided the power, so the new buildings had to be provided with their own independent power sources.

By 1928 there was a reel house at Blackbeck which may be significant because reeling was used for the removal of dust from very fine powders. Sporting guns required fine powders so the provision of a reel house may mean that in later years as the demand for blasting powder was diminishing, that diversification took place into other types of powder. Unfortunately the location of this building is not known from the cartographic and documentary sources used by EH but there are archaeological remains which probably mark its site. These are located on the north side of the gap which separates the low hill which dominates the works from the steep rising ground to the north. A small brick building adjacent to these remains is, at the time of writing, used as a store for the caravan park, but originally it probably housed an electric motor which powered the reels. Electricity was certainly being produced at Blackbeck during the 20th century, hence ICI's reference to the dynamo house which was damaged in the 1928 explosion at the incorporating mills. Mr Cowtan, the last manager of Blackbeck, apparently had his house, Lindeth, lit by electricity produced at the works (Tyler 2002, 256). By 1928 the wood sheds at the southern end of the building range to the east of the incorporating mills had been replaced by a large pump house. Some of the other archaeological remains may also reflect alterations at this time such as the enlargement of the platform which had been the site of the eastern store house. One of a number of suggestions put forward in section 6.1.7 (above) is that in later years the dusting and packing processes may no longer have been carried out in the same building and that a new dust house was erected on this platform.

An incident at one of the cartridge compressing houses in January 1928 gave an inauspicious start to the New Year at Blackbeck - fortunately there were no casualties. However a much more serious tragedy, with terminal consequences, occurred during September when an explosion which started at incorporating mill 1 spread to the other mills and caused damage (mostly to doors, roofs and windows) at a number of other buildings in the vicinity; two men were also killed. There is no evidence that the damaged buildings were ever repaired after this event and some authorities believe that the works closed after this incident. It had certainly been officially shut by the autumn of 1929 when Blackbeck is mentioned in an article in the October edition of ICI's house magazine as having 'recently closed down'

(Imperial Chemical Industries 1929, 339). True to form even its demise was not incident free because in early June 1929 the corning house burnt down due to a fire, which was probably the result of a lightning strike. Gunpowder production at Blackbeck certainly appears to have ceased well before this event because the report of this incident in a local newspaper claimed that gunpowder had not been stored in the corning house for sometime. Presumably the other danger buildings at Blackbeck were also demolished during 1929 in order to make the site safe and the tramways lifted.

7.5 Blackbeck from 1929 to the present day

EH has only found limited information about how the former manufactory site was used after closure and has identified this as an area which would benefit from further research. Some of the buildings which were not directly involved with powder production survived closure and are still used by the caravan park. The latter was certainly in existence by the late 1950s but some of the changes at the site clearly pre-date this event. Indeed it is doubtful that the surviving buildings would still have been usable in the late 1950s if they had not been maintained after the works closed. Support for this assertion is provided by the ground and air photographs which indicate that sometime between September 1928 and 1945 alterations were made to the building range immediately to the south of the incorporating mills. The pump house here had formerly had two pitched roofs but by 1945 a new, single wide roof had been installed. According to local information the site was used during World War II but apparently not by the military and food storage has been put forward as one of its functions. There are also elements amongst the archaeological remains - such as the small former building on the site of the earlier cylinder house (see section 6.1.7, above) - that could belong to the war years rather than to the gunpowder era. The former works has been heavily landscaped for the caravan park and these developments are still taking place, but in spite of all this significant features relating to the gunpowder works still survive which have added importance because the former Blackbeck Gunpowder Works is the sole example in Cumbria of a gunpowder manufactory powered by steam from the start. In this context extant archaeological items such as the boiler house flue, the drive shaft tunnel to the second mixing house and the supports for the steam pipes which supplied the little engine house are of particular interest; the status of the two circular stones (Fig 64) north of the former laboratory (section 6.1.7 - building range east of the incorporating mills) is uncertain.

Figure 64.
The northernmost circular stone embedded in the modern wall north of the laboratory. (Christopher Dunn, October 2004)

8. SURVEY METHODOLOGY

The archaeological measured survey was carried out using a Trimble 5600 series electronic theodolite with Electromagnetic Distance Measurement to establish a ring traverse around the site. Points of archaeological and topographical detail were then observed by radiation from each of the station set-ups and coded with line and point information before being processed using Trimble Geosite software (Fig 65). The data were then imported into AutoCAD and plotted at 1:1000 scale. The resulting plan was then taken out into the field and additional archaeological detail (such as that obscured by trees or buildings) plotted using hand tapes and traditional graphical methods. The top of the low hill which dominates the central part of the works was not surveyed because it was considered unlikely that any above ground features survive given the quantity and size of the caravan pitches and service roads which have been created in this part of the site. An overall electronic plan (Fig 66 (inside back cover)) was then produced and in order to show the wider setting of the works, the roads to the west and north (together with Lindeth, Black Beck Farm and Rusland Pool), which were not surveyed in the field, were added from OS maps. Inevitably some adjustment of the detail derived from the latter was required in order to make it fit the archaeological survey. The buildings were measured with hand tapes and drawn digitally using Microstation software.

Site photography for archival purpose was undertaken using a professional digital camera (image size 12 million pixels). High powered electronic flash was used for some of the interior photographs.

Figure 65. *English Heritage surveying the archaeology north of the former store magazine. (Christopher Dunn and Abby Hunt, November 2003)*

9. ACKNOWLEDGEMENTS

Christopher Dunn and Abby Hunt carried out the archaeological investigation while Ian Goodall and Tony Berry were responsible for the architectural investigation and recording. Bob Skingle took the ground photographs of the standing buildings and archaeological remains for the NMR archive. The report was written and researched by Christopher Dunn with Ian Goodall providing the analytical accounts of the standing buildings; Ian Goodall also edited the text. Philip Sinton produced the archaeological drawings and plans, and desk-top published the final report. Tony Berry prepared the architectural illustrations and reconstruction drawings. Amy Lax participated in the initial reconnaissance visit to Blackbeck and also undertook some of the initial research. Colum Giles provided advice on how the water supply may have functioned while Paul Everson helped with assessing the survey requirements of the site during a field visit in May 2002. Marcus Jecock and Wayne Cocroft also assisted with the locating of a number of the documentary sources and commented on them while Danny Parker provided copies of photographs and notes on Blackbeck from the Patterson Collection held by the NMR. Yvonne Boutwood examined and commented on air photographs which show the site of the possible building at the south-east boundary of the works while Kate Bould prepared the list of NMR photographs in appendix 2. Some of the figures incorporate Ordnance Survey data and are reproduced with their permission under license number GD03085G.

EH is most grateful for all the help and information which it has received from a number of local people and organisations. In particular thanks are due to Mike Thwaites (who was the caravan park manager when EH undertook the main part of the survey) and to his successor Paul Kay for giving permission to survey and record the remains within the caravan park (Mike Thwaites also very generously passed on his considerable knowledge of the site while Paul Kay kindly allowed EH access to the caravan park files), Nick Watson for moving vehicles and caravans at short notice in order to facilitate access by EH to some of the standing buildings, and to Jean Tyson and Gerald Buchanan (Black Beck Farm) for allowing EH to survey the earthworks which survive in the fields situated south and west of the caravan park. Thanks are also due to Ron Mein who kindly discussed aspects of the site with EH (he also made available a photograph of the watch house and supplied a copy of his reconstruction drawing of the boiler house flue and second chimney), Peter Cartwright (ICI) for information on archive material held at Ardeer, to John Phillp (Hon Secretary, Northern Mill Engine Society) for information about Belliss and Morcom triple expansion engines, and also to Mike Davies-Shiel and Andrew Lowe for information. Last, but by no means least, EH is extremely grateful to the assistance so willingly given by the staff at the Cumbria Record Office & Local Studies Library (Barrow), the Lancashire Record Office (Preston) and the Local Studies Library (Kendal).

Ron Mein, ICI plc (Peter Cartwright), and the Cumbria Record Office & Local Studies Library, Barrow (Aidan Jones) have also kindly allowed EH to reproduce archive material from their collections in this report.

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Manuscript sources and newspapers

1. Caravan park files, Blackbeck (private archive, Blackbeck Caravan Park):
Photocopies of special reports by the Explosives Inspectorate and accounts of explosions from local newspapers, notes (including a list of employees at the works) and interpretative site plan/diagrams by Ron Mein, correspondence including letters from Ted Patterson and a Mr R. Allen from North Wales (concerning a barrel lid found at Bettws Garmon), a copy of an interpretative plan of the works by Mike Davies-Shiel, and copies of official photographs taken in 1928 and 1929. Many of the above sources have been typed up to form a narrative account which has been ring bound. There is also a small group of objects relating to the works

2. Cumbria Record Office & Local Studies Library, Barrow (CRO(B)):
BDKF Plan 7. *Map of Bouth and position of proposed Gunpowder Works at Blackbeck*, no date

BDX 294 Lease re. Blackbeck Gunpowder Mills, Near Ulverston 1881

North Lonsdale Herald and Dalton Advertiser, 2 June 1900

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3. Davies-Shiel Archive, Windermere (in private possession - Mike Davies-Shiel):
For summary of contents see Postscript, page 153

4. Heritage First! (HF):
LW/959/365 letter in Lowwood files

5. Imperial Chemical Industries (ICI), Ardeer:
Copy of plan labelled 'Factory No. 40. Lanc. Plan to Amending License No, 789', drawn by Settle and Farmer and signed by J H Thomson, Captain, HM Inspector of Explosives, 12 April 1898

6. Kendal Reference Library:
Westmorland Gazette & Kendal Advertiser, 14 December 1867

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7. Lancashire Record Office (LRO):
QSP 3619/3 Lancaster: Epiphany 1861 12 Dec 1860. Notice of intention of Arthur Benson Dickson to apply for license to erect mills, magazines and offices at Abbots Reading Estate, with plan (Plan: scale 5chains to 1 in , size 10x10cms; paper , ink and wash)

RG10/4239 Census of 1871

DDMC30/81 Correspondence re tramway from Furness Railway at Dickson's Siding, Haverthwaite, to Black Beck Gunpowder Works at Bouth, par. Colton, 2 Apr. 1885 - 3 Aug. 1890

8. National Monuments Record, Swindon:
Patterson Collection, boxes 1 and 3: HMIE reports and lists, photographs, copies of newspaper articles and handwritten notes

Nobel Times, May 1986 (photocopy of Cattle's obituary in Patterson Collection)

Air photographs cited in this report

9. Ron Mein Collection, Bouth (in private possession, Ron Mein):
No details but extracts supplied for this report to EH include reconstruction drawing of factory chimney and flue together with photograph of watch house taken in 1958.

Appendix 1: List of recorded explosions at Blackbeck

As a consequence of the 1875 Explosives Act, the reporting of fires and accidents involving explosives at gunpowder works became a statutory requirement (Cocroft 2000, 99). As a result, major accidents after 1875 were described and analysed at length, to try to identify their causes in a series of special reports by HM Inspectors of Explosives. Before 1875 local newspapers are the chief source of information for such events, but their reporters tended to concentrate on the more spectacular explosions and on coroners' inquests. A number of local newspapers have been consulted by EH, and Table I has been compiled from both these newspapers and the special reports from the HM Inspectors together with information contained in Tyler (2002). Omitted from the table is a so called incident on 19 October 1869 at Blackbeck which allegedly killed three men - this is briefly referred to in some of the newspapers (*Ulverston Mirror and Furness Reflector*, 26 March 1881; *North Lonsdale Herald and Dalton Advertiser*, 17 July 1909); EH has found no real evidence to support this claim and believes that it is simply a confusion with the explosion which occurred in October 1879. It might be possible to produce a fuller list of accidents for Blackbeck by systematic scrutiny of all contemporary local newspapers, but this task is beyond the remit of the present report.

From 1876, minor explosions not resulting in fatalities were noted briefly in the Explosives Inspectorate's annual reports. It has not been possible to consult all this series at first hand, but Patterson (1986, 29) has compiled a list of explosions from them which occurred in incorporating mills whilst in motion. Details for Blackbeck have been extracted from this list and largely form Table II.

The tables show that the incorporating mills at Blackbeck, as at other gunpowder manufactories, were the focus of a large number of incidents. The last explosion at the mills in September 1928 had far reaching consequences for Blackbeck because it seems to have caused the premature cessation of gunpowder manufacture and thus hastened the closure of the works. In at least two instances the mill explosions were caused by the green charge having been incorrectly laid while another was started by sparks from the first factory chimney. The corning house was also another danger building at gunpowder works where explosions were not uncommon. The first corning house site at Blackbeck was subject to an amazingly high number of very damaging explosions which destroyed in total nine corning houses (there was only ever one corning house at the works at any one time). Even after gunpowder production had ceased the tenth corning house, erected at a different location from its predecessors, was destroyed in June 1929 following a lightning strike; this last natural cause also appears to have been behind incidents which wrecked two of the earlier corning houses. One of the main problems with some of the corning houses at the first corning house site was their very close proximity to a number of the other danger buildings in the northern part of the works, such as the first powder press house. This meant that if an explosion started at one building then it invariably spread to the others in the vicinity leading to even greater damage and more fatalities. In a particularly nasty

incident in July 1868 which destroyed the powder press house, charge house and corning house, nine men lost their lives and one was seriously injured. This explosion not only affected the works but the house at Black Beck Farm and some of the dwellings over the hill in Bouth village also sustained damage. In total thirty-six lives were lost at Blackbeck during explosions - this was more than at any other gunpowder manufactory in Cumbria. A number of the explosions were probably the result of mechanical failures or problems, such as the one at the second powder press house location in May 1900, while grit or foreign matter may have got into the powder which destroyed corning house 6 in August 1900. However, the explosion which destroyed the first stove house in January 1898 seems have been caused by the condition of its rather elderly roof, part of which may have fallen in during a storm. Fortunately this explosion together with the incident at one of the two cartridge compressing house in January 1928 did not cause fatalities; the latter incident was caused by a spark from a hammer during repair work.

Table I: Major explosions and incidents (see also Postscript, page 153)

Date	Location of initial explosion	Cause	Damage	Casualties	References
1867, 7 December	Corning house	Not known	Started in the corning house and then spread to the nearby glaze and engine houses - all three buildings were ruined. Some of the windows at Black Beck farmhouse, situated above the works, were also damaged	3 killed and at least 1 man injured; a horse was also killed	*Westmorland Gazette and Kendal Advertiser*, 14 December 1867 and 1 August 1868; *Soulby's Ulverston Advertiser*, 12 December 1867
1868, 25 July	Powder press house, charge house and corning house	Not known	The three buildings were destroyed and the glazing house left in a dilapidated state. Windows and ceilings damaged at Black Beck farmhouse. Slight damage to a few dwellings in Bouth village. Estimated cost varied from between £700 and £800 to £1,200 and £1,500	9 killed and one man seriously injured (the latter was also injured in the 1867 explosion)	*Westmorland Gazette and Kendal Advertiser*, 1 August 1868; *Ulverston Mirror and Furness Reflector*, 1 August 1868
1871, 20 May	Incorporating Mills	Not known	Mill 6 blew up followed by other five mills	None	Tyler 2002, 228
1873, 22 July	Corning house	Lightning	Building destroyed	None	Explosives Inspectorate 1881, 2; 1884, 5
1878, 26 Septemb-er	Incorporating mills	Not known	Incident at mills 4 and 5	1 man slightly injured	Explosives Inspectorate 1879, 67
1878, 15 October	Incorporating mills	Incorrectly laid green charge	Five mills (Nos 3-7) affected	1 man injured	Explosives Inspectorate 1879, 67
1879, 19 October	Powder press house	Not known	Powder under pressure at time so explosion violent and destructive. Started in the powder press house and then extended to a charge house and also to the incorporating mills	3 killed	Explosives Inspectorate 1881, 2

Date	Location of initial explosion	Cause	Damage	Casualties	References
1881, 19 March	Powder press house	Probably caused by a blow struck with a wooden mallet either on the cotters at the front of the press-box or (and more likely) on the mill cake (grit may have been present)	Started in the powder press house and extended to the corning house, probably via gunpowder that had spilled from barrels on a cart (these are likely to have been dislodged when the horse attached to the cart (which had been outside the corning house) took fright on hearing the powder press house explode and collided with a tree). Both buildings destroyed (damage to the powder press house was particularly destructive). A window was also broken in a nearby engine house while the upper windows in a building at Black Beck Farm were similarly damaged	3 killed and 3 men injured. The horse received burns but these were not serious	Explosives Inspectorate 1881; *Westmorland Gazette*, 26 March 1881; *Ulverston Mirror and Furness Reflector*, 26 March 1881
1884, 26 July	Corning house	Lightning aided by a defective lightning conductor attached to the building	Corning house wrecked but no other buildings damaged. Cost of damage estimated at £300 to £400	4 killed	Explosives Inspectorate 1884; *Westmorland Gazette*, 2 August 1884; *Ulverston Mirror and Furness Reflector*, 2 August 1884
1891, 16 April	Incorporating mills	Sparks from boiler house chimney	Mill 2 exploded followed by mills I and 3 together with the mixing house	None	Explosives Inspectorate 1898, 4; 1904, 15
1898, 19 January	Stove House	Stove house roof was old and part of it may have fallen in	Stove house destroyed, some damage (chiefly to windows and roofs) to mixing house, fitting shop, saw mills, incorporating mills (fronts slightly blown out with mill 6 the most badly affected), boiler house, box house, charge house, waggon house, corning house, little engine house, glazing house, expense magazine, powder press house, store, and dust and packing house. Outside the works at Black Beck Farm windows in the house were damaged, a room was apparently set on fire, and slates on a barn lifted	None	Explosives Inspectorate 1898; 1899, 171; *North Lonsdale Herald and Dalton Advertiser*, 5 May 1906

Date	Location of initial explosion	Cause	Damage	Casualties	References
1900, 26 May	Powder press house	Possibly due to the failure of one of the columns of the press	Building completely destroyed. A window in the stove house was also broken. Cost of damage (machinery, materials and compensation) £2000 to £2500	2 men killed	Explosives Inspectorate 1900a; *Westmorland Gazette*, 2 June 1900 and 1 September 1900; *North Lonsdale Herald and Dalton Advertiser*, 2 June 1900
1900, 27 August	Corning house	Possibly caused by grit or foreign matter in the powder	Framework of the walls and roof left standing, metalwork of machinery undamaged. No damage to any other building at the works	4 men killed	Explosives Inspectorate 1900b; *Westmorland Gazette*, 1 September 1900; *North Lonsdale Herald and Dalton Advertiser*, 1 September 1900
1906, 30 April	Corning house	Friction caused by a badly fitting key in the main line of shafting	Corning house and its machinery wrecked. Damage to other buildings slight apart from broken glass. At the glaze house a recently fitted matchboard panel was blown off	2 men killed	Explosives Inspectorate 1906; *Westmorland Gazette*, 5 May 1906; *North Lonsdale Herald and Dalton Advertiser*, 5 May 1906
1909, 15 July	Corning house	Probably friction caused by a copper strip being dragged into the crackers	Corning house demolished and its machinery almost completely destroyed. Damage to other buildings slight comprising a broken window and skylight at the glaze house, a few broken panes of glass at the boiler house. The window frames in the side of the little engine house which faced the corning house were also blown out	2 men killed	Explosives Inspectorate 1909; *Westmorland Gazette*, 17 July 1909; *North Lonsdale Herald and Dalton Advertiser*, 17 July 1909
1911, 14 December	Corning house	Probably a heated bearing	Damage largely confined to corning house although its machinery was largely untouched. A single window was broken in the glaze house and another was also broken in the little engine house	2 men killed	*Westmorland Gazette*, 16 December 1911; Explosives Inspectorate 1912
1928, 6 January	Cartridge compressing house	Spark from hammer during repair work	Extent of damage to building not given	None	Tyler 2002, 156

Date	Location of initial explosion	Cause	Damage	Casualties	References
1928, 21 Septemb-er	Incorporating mills	Faulty or improperly laid charge	Started in mill 1 and then spread to the wrought charges on a bogie left outside mill 2. Mills 2 and 3 ignited and mills 4-8, together with the engine house (between mills 3 and 4), also sustained damage (chiefly to roofs and fronts). The following buildings were also damaged (mostly roofs, windows and doors): boiler house (No 27), economiser, dynamo house, pump house (No 29) and saw shed (No 30), engineers' shop (No 31), laboratory (No 34), wash house (No 35) and case-making shed (No 36), wood sheds, mixing house (No 40), building [saltpetre house] (No 41), time office (No 32), watch house (No 33), stove house (No 12) and reel house (14) (numbers in brackets are quoted in ICI report and some are on the plan attached to report)	2 men killed	Imperial Chemical Industries 1928; Explosives Inspectorate 1929, 17-18
1929, 8 June	Corning house	Probably lightning	Corning house and machinery destroyed. Estimated cost over £4000. Noted in newspaper account that corning house had not been used for some time and that no gunpowder was stored there	None	*Westmorland Gazette*, 15 June 1929

Table II: Incorporating mill explosions from 1876 (some of the below are described in more detail above in Table 1)

Year	Number of explosions	Year	Number of explosions	Year	Number of explosions
1876	3	1885	2	1918	1
1877	2	1887	1	1919	3
1878	2	1890	1	1920	1
1880	1	1891	1	1924	2
1882	2	1911	1	1928	1
1883	1	1914	1		
1884	3	1915	1		

Appendix 2: The archive and photographic record

A survey archive consisting of the field plans and supportive background information such as the project design, has been deposited in the NMR (NMRC, Swindon), under Collections reference AF 00158 where it is available for public consultation upon request. The digital plan is currently retained at the EH York office and is also publicly available on request.

Official site photographs for archive purposes were taken by Bob Skingle during 2004 and are held at the NMRC Swindon and a number have been included in this report. They are listed below with their NMR numbers and are publicly available on request. Some of the other recent images in this report are working photographs taken by the archaeological investigators using digital compact cameras and are retained at the EH York office. To distinguish these from Bob Skingle's official photographs, their captions give the name of the investigator and date when the photograph was taken. With the exception of figure 40, the historic photographs reproduced in this report are from the Patterson Collection which is also housed in the NMR.

NMR number Subject

DP003373 Electric motor house for (?) reel house looking east

DP003374 Electric motor house for (?) reel house, from the south

DP003375 Machine beds on site of (?) reel house, from the east

DP003376 Electric motor house for (?) reel house, from the east

DP003377 Small office at the southern entrance (near Pool Bridge) of the works. Taken from the south

DP003378 Small office at the southern entrance (near Pool Bridge) of the works, looking south-south-west

DP003379 Cooperage at the southern extremity of the works (near Pool Bridge), from the south

DP003380 Small office at the southern entrance of the works, from the south

DP003381 Expanded area which contained the tramway siding south of Pool Bridge. Taken from the north

DP003382 Sites of cartridge house No.1 (left) and cartridge house No.2 (right), from the north-north-east

DP003383 Site of the store magazine from the south east

DP003384 Northern approach into the cutting which contained the store magazine. Taken from the north east

DP003385 Site of the cartridge house No.2 from the south-south-east

DP003386 Remains of bogies behind the caravan park's reception office. Taken from the east

DP003387 Watch house (now Meadow Bank Cottage) from the south

DP003388 Watch house from the north west

DP003389 Upper part (west of the farm track) of the flue from the boiler house. Looking west

DP003390 Lower part (east of the farm track) of the flue from the boiler house. Looking east

DP003391 West wall of the caravan park manager's new house, from the south

DP003392 Saltpetre house from the south east

DP003393 New building being erected on the site of the cylinder house and later small building. Taken from the south west

DP003394 Site of the second mixing house looking west

DP003395 Oil store from the west

DP003396 Slot for holding drive shaft (to mixing house) fixings in revetment wall near south-west corner of building range south of the former incorporating mills

DP003397 Wall box in face of north wall of the building range immediately south of former incorporating mills

DP003398 Building range immediately south of the former incorporating mills looking north west

DP003399 Boiler house flue in wooded area of caravan park immediately west of north-west end of former incorporating mills. Looking north west

DP003400 Inspection hatch in roof of boiler house flue (east end)

DP003401 Internal view of east end of boiler house flue, looking west

DP003402 Internal view of east end of boiler house flue, looking west

DP003403 Remains of the time office and search house from the south west

DP003404 View over former works looking towards the north east from just north of the time office and search house

DP003405 Building range east of the incorporating mills with the former laboratory on the left. Taken from the north west

DP003406 Northernmost surviving pillar which supported the steam pipes to the little engine house

DP003407 Supports for the steam pipes to the little engine house and stove house. Taken from the south west

DP003408 Supports for the steam pipes to the little engine house and stove house, looking south west

DP003409 Area occupied by former glaze house, from the north west

DP003410 Black Beck Farm (house and outbuildings) from near the first corning house site, looking west-north-west

DP003411 First corning house site, looking north east

DP003412 Drive shaft channel leading from the first corning house site, looking south

DP003413 View of caravan park (looking east) from the 'dry gap' north of the low hill which dominates centre of works

DP003414 View of caravan park showing topography of area to the east of the second powder press house location

DP003415 View of caravan park showing topography of area to the east of the second powder press house location

DP003416 View of caravan park showing topography of area to the east of the second powder press house location

DP003417 Site of lower pond from the south

DP003418 Widened beck channel and sluice to the north west of the former lower pond

DP003419 Second charge house site from the south

DP003420 Bank and cutting for second charge house, looking south west

DP003421 Probable site of first charge house and later cart shed, from the south west

DP003422 Revetted bank on south side of probable first charge house site, looking north west

DP003423 Second corning house site, looking north east

DP003424 Second corning house site from the south east

DP003425 Store and stable looking north east

DP003426 Caravan park manager's new house from the north west

DP003427 Side of cutting at the second stove house site. Taken from the east

DP003428 The eastern store house site looking north east

DP003429 Site of the dust and packing house from the south west

DP003430 View of former works site looking north east from the hillside south of the manager's house (Lindeth)

DP003431 Upper pond from the west-north-west

DP003532 Slot for drive shaft (to mixing house) fixings in wall of building range immediately south of former incorporating mills

DP003533 Drive shaft tunnel to mixing house, looking south

DP003534 Drive shaft tunnel to mixing house, looking south

DP003535 Watch house with the manager's house (Lindeth) in the background. Looking west-south-west

DP003536 Manager's house (Lindeth) from east-north-east

DP003537 Site of (?) first powder press house from the south east

DP003538 Site of the glaze house from the north west

DP003539 Site of (?) reel house looking north

DP003540 Looking east towards site of second powder press house (to the right - by the caravan)

DP003541 Site of the dust and packing house from the south

DP003542 North end wall of the saltpetre house looking south

DP004105 Saltpetre house taken from the north west

DP004098 Manager's house (Lindeth) from the east

DP004099 Building range east of the incorporating mills, from the north west

DP004100 Building range immediately south of the incorporating mills, from the north east

DP004101 Building range immediately south of the incorporating mills, from the south east

DP004102 North end and west wall of the saltpetre house from the north west

DP004103 Women's changing house from the south east

DP004104 Women's changing house from the south west

Appendix 3: List of NMR numbers linked to the survey

SITE NAME	COUNTY	DISTRICT	PARISH
Blackbeck Gunpowder Works	Cumbria	South Lakeland	Colton

SITE NAME	NGR	NMR No.
Blackbeck Gunpowder Works	SD 3344 8560	SD 38 NW 16

Appendix 4: Addendum to English Heritage's report on the New Sedgwick Gunpowder Works, Cumbria

Since the production of the New Sedgwick report (Dunn *et al* 2003) new information has come to light on some of the aspects mentioned in the report concerning Thomas Faulkner (the penultimate foreman at the works) and his family. EH is extremely grateful to his relative, Mrs Holden from Skipton, for coming forward with this information. The family-type photographs referred to on page 15 of the report were taken by Thomas Faulkner's daughter, Mona Faulkner. Thomas did not have a grand daughter so the lady who leant Mike Davies-Shiel his notebook (page 18) was almost certainly Mona Faulkner. In Appendix 2 reference is made to a photograph (AA035269) showing Thomas Faulkner and three ladies having tea outside the gate house at the entrance to the works. According to Mrs Holden the lady sitting next to him is his wife, Julie Faulkner, while the other two are probably her sisters who lived in Switzerland. Mrs Holden's foster father, James Faulkner, also worked at New Sedgwick and took the finished gunpowder by horse and cart from the works to the railhead at Hincaster Junction.

POSTSCRIPT

This report was at an advanced state of publication when a package of material relating to Blackbeck from the Mike Davies-Shiel Archive was received by EH. EH is extremely grateful to Mike Davies-Shiel for the sight of this material. In summary it consists of copies of his annotated site plan, a transcription of an interview he had with George Shackley in 1988, hand written notes and letters (including one from Ted Patterson), a number of colour slides of the site (mostly taken in 1991) and copies of newspaper articles. Of the latter one is of very great interest because it was written by George Shackley and published in the *Ulverston News*, 26 October 1984. This article throws additional light on the **power systems and water supply** at Blackbeck. It confirms that, certainly in later days, the drive shaft from the **main steam engine** which powered the incorporating mills also 'worked a sawmill, sets of hydraulic pumps, the mixing department and a huge dynamo. From this electricity was used to drive the **reel house** a quarter of a mile away'. Further on in the article George Shackley also says that the **manager's house** was supplied with electricity from the works (Ian Tyler mentions this in his book but does not give his source). George Shackley also states that water for the **boiler house** economiser was taken 'from a pond fed by a beck' (presumably the lower pond) while a small donkey engine was used to pump water uphill to the **upper reservoir**.

Additional information is also given in the newspaper article about the **manufacture of blasting cartridges**. The operation of the two metal hydraulic accumulators is briefly described while an account of the incident at one of the cartridge compressing houses in January 1928 is also given. George Shackley was one of the men in the building at the time and writes that one wall was blown out and the building set ablaze. It appears that while the machinery had been washed down prior to the maintenance work on the ram, the rest of the building had not been so treated. In this newspaper article he also confirms that the incident at the incorporating mills in September 1928 did indeed mark **the end of powder production** at the Blackbeck Gunpowder Works which was already scheduled for closure. In his book Ian Tyler mentions a fire on the **ship** 'Arrow', which was loaded with gunpowder from Blackbeck; the ship was moored at Greenodd and the incident took place in February 1867. Tyler does not give his source but it is clear from another newspaper cutting that the fire was originally reported in the *Westmorland Gazette and Kendal Advertiser*, 2 March 1867.

Amongst the hand written notes and transcription of the interview with George Shackley there are a number of extra details which are of particular interest. The original **steam engines** installed when the works were erected, were apparently of 50 horse power and came from the firm of Benjamin Hicks and Sons, Bolton. There is also a note that a mill first began to work in July 1861 and that the **works was in full operation** at the end of June 1862. The standard gauge **tramway**, which entered the works from the south, appears to have extended as far as the boiler house and was indeed dual gauge in places so that the store magazine and cartridge houses could be reached by narrow gauge waggons. A reference to the *Kendal Mercury*, 20 May 1871 may be the source for the incident at the

incorporating mills in May 1871 which is mentioned by Ian Tyler in his book. Other hand written notes claim that a 'new **reel and cracking house** [was] put in by JHP in 1915' and that in '1928 there were only four incorporating mills at work'.

The site of the former **little engine house** was apparently still visible when Mike Davies-Shiel undertook his fieldwork because near its west end he marks a machine bed on his site plan together with two fireplaces at its opposite (east) end. Between this building and the oil engine house (for the second corning house location) he also shows two areas of former **allotments** and what he calls a 'Jardin des Pommes'.

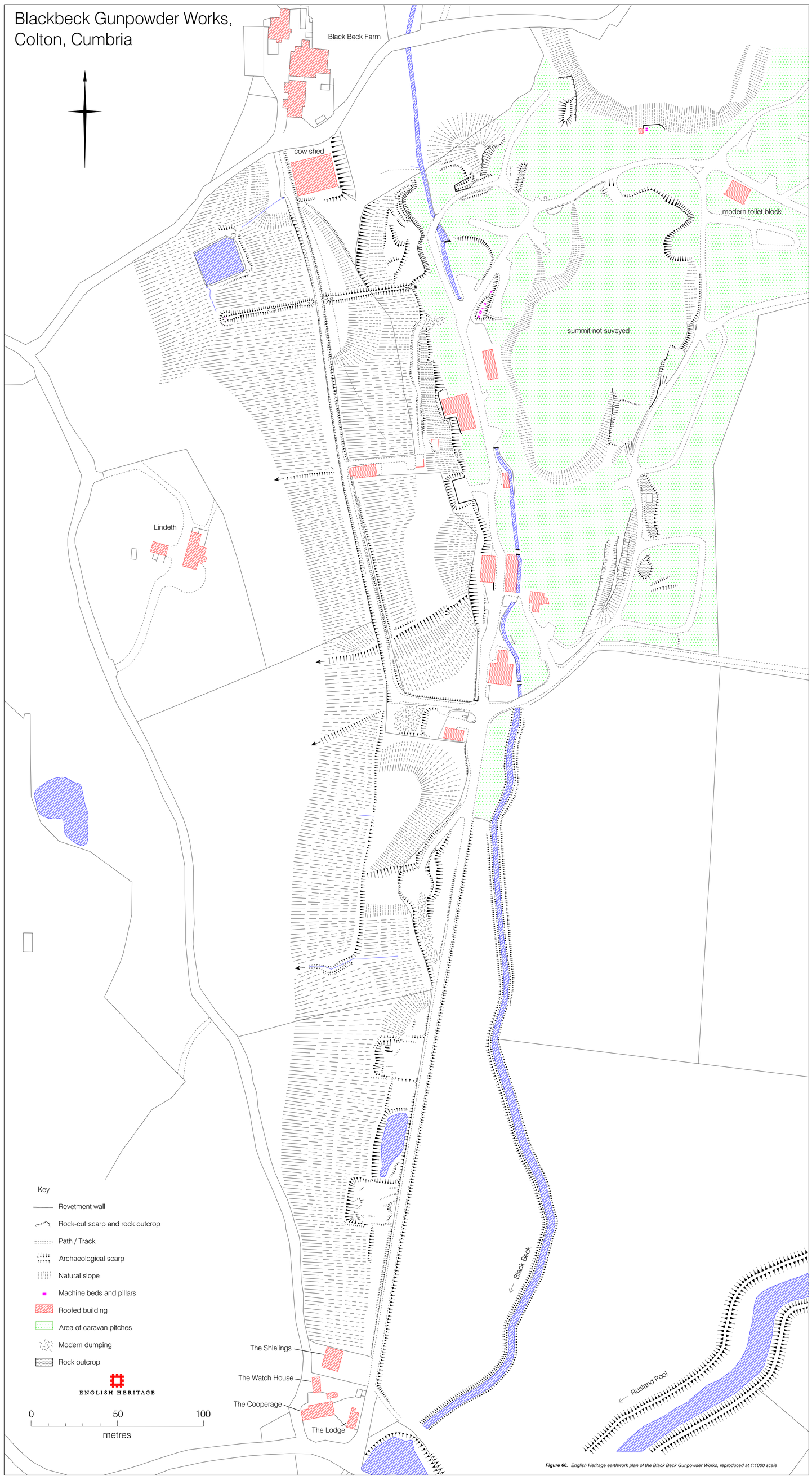

Figure 66. *English Heritage earthwork plan of the Black Beck Gunpowder Works, reproduced at 1:1000 scale*